INSTRUCTION MANUAL

FOR

MODEL S-3400N

SCANNING ELECTRON MICROSCOPE

(User's Operation/Maintenance Edition)

Please read through this manual carefully before using the instrument.

- Before using the instrument, read the safety instructions and precautions carefully.
- Keep this manual in a safe place nearby so it can be referred to whenever needed.

Hitachi High-Technologies Corporation

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NOTICE:

1. Information contained in this document is subject to change without notice for improvement.
2.
3. Hitachi High-Technologies Corporation assumes no liability for any direct, indirect, or consequential damages arising from use not described in this manual.
Utmost care must be exercised when using the instrument.
4. This document does not provide any warranty or permission for industrial properties or any rights to grant license lawfully and without infringement.

FOREWORD

APPLICATION	• The S-3400N SEM utilizes an electron beam accelerated at 300 V to 30 kV. The instrument is designed mainly for observation and evaluation of specimens prepared for the SEM. • Note that Hitachi High-Technologies Corporation will not be responsible for injury or damage caused by usage of the instrument in a manner not described in this manual.
CAUTION	Regarding the use of the electron microscope, it is not required to make registry notification to the authorities concerned in accordance with the "Radiation Hazard Preventive Laws" or "Ionizing Radiation Hazard Preventive Regulations" currently in effect since X-rays are not taken out of the electron microscope in common application. In the Model S-3400N SEM, the effective dose equivalent of leakage X-ray radiation is 0.5 μSv/hour under its actual operating conditions, which satisfies the requirement specified in the JAIMAS 1010-2001 (Japan Analytical Instrument Manufacturers Association Standards). The Radiation Hazard Preventive Laws and the Ionizing Radiation Hazard Preventive Regulations (protection against radioisotopes; revised in April 1, 2001) stipulate that a radiation controlled area must be established if the effective dose equivalent of leakage X-ray radiation exceeds 1.3 mSv per three months. On the presumption that the S-3400N SEM is operated for 48 hours a week, the effective dose equivalent of leakage X-ray radiation per three months (13 weeks) is 0.3 mSv. It is therefore not required for the user to set up a radiation controlled area around the S-3400N SEM. However, in cases where the instrument operating time per week/month is to be longer than that presumed above or the effective dose equivalent standards stipulated by law is revised, use the S-3400N SEM so that its effective dose equivalent will not exceed the allowable standard level. In the ICRP recommendations, it is stated that electron microscopes, along with home television sets, fall into a category of potential radiation sources that could produce undesired byproduct X-rays. It is therefore required to ensure safety with sufficient care in operation of the S-3400N SEM. To be on the safe side, please observe the following cautionary instructions: (1) Use the instrument properly according to the application purposes and procedures specified in this manual and other accompanying technical documents.

	(2) Do not remove the protective external parts from the instrument or mount any unspecified parts on it. (3) Do not modify the instrument for unlocking its safety mechanisms. (4) The laws and regulations concerning radiation hazard prevention may be revised or amended as required. When using this instrument, be sure to check the latest issues of the relevant laws and regulations, and take proper safety measures if necessary.

Before using the equipment, read this instruction manual and pertinent instruction manuals of relevant accessories to assure proper operation of the equipment.

Scope of Instruction Manual

This instruction manual comprises the following:

1. Specifications and Installation Requirements
2. Functions (Description of Controls)
3. Operation (Viewing Images, Saving Data, and Taking Photographs)
4. Maintenance (Procedures, Troubleshooting, and Action on Power Failure)
5. Replacement Parts
6. Accessory Operation

This instruction manual describes the operation, maintenance, and specific precautions pertinent to daily operation on the model S-3400N scanning electron microscope.

First, read and get familiar with the safety precautions described in the opening pages and General Safety Guidelines.

Acronyms

Listed below are acronyms frequently used in this manual.

- SEM : Scanning Electron Microscope
- WD : Working Distance
- SE : Secondary Electron
- BSE : Backscattered Electron
- PC : Personal Computer
- GUI : Graphical User Interface

GUARANTEE

Period of Guarantee

The charge-free guarantee period is one year from the date of installation.

Details of Guarantee

(a) The instrument will be repaired free of charge if it malfunctions due to a defect in manufacture within the charge-free guarantee period.

(b) Note that a substitute part may be used for repair, or replacement with an equivalent product may be made instead of repair.

(c) Such system components as a personal computer and printer which are frequently modified for improvement may not be available in original versions at the time of replacement.

(d) Maintenance procedures are provided to allow system operation for 10 years after its delivery. During this period, the maintenance of units or parts having a rather short product cycle such as personal computer and printer may entail the purchase of substitute parts because of limits on the repair period of the former, for which we request your understanding. Even when more than 10 years have elapsed after delivery, maintenance will basically be provided as long as the relevant units and parts are available.

Exclusions from Guarantee

The guarantee will not be valid for the following failures and/or cases even during the charge-free guarantee period.

(a) Failure due to use in improperly installed condition.

(b) Failure due to power supply voltage/frequency other than specified by Hitachi High-Technologies Corporation or due to power failure.

(c) Corrosion or deterioration of the tubing due to impurities contained in gas, or air supplied by the customer.

(d) Corrosion of electric circuits or deterioration of optical elements due to corrosive gases or much dust contained in the atmosphere.

(e) Failure due to disassembly, modification, parts replacement, or relocation not approved by Hitachi High-Technologies Corporation.

(f) Consumables and parts having a limited period of guarantee.

(g) Failure attributable to use of non-guaranteed parts (parts not described in the instruction manual).

(h) Failure due to acts of God, including fire, earthquake, storm, flood, lightning, social disturbance, riot, crime, insurrection, war (declared or undeclared), radioactive pollution, contamination with harmful substance, etc.

GUARANTEE

(i) Failure due to replacement parts that pass their expiration time.

(j) Failure of instrument or damage of basic software, application software or other data due to a computer virus.

(k) Failure of the PC used with the instrument or damage to basic software, application software and/or data because of momentary voltage drop caused by lightning or power interruption.

(l) Failure of the PC used with the instrument or damage to basic software, application software and/or data caused by turning off the PC main power without taking the normal termination procedure.

(m) Using the system in ways that are not covered in this operating manual, or employing operating procedures not covered in the same; or failure of the system due to repairs performed not under control of Hitachi or under service personnel authorized by Hitachi.

(n) Failure of the system due to relocation or transport of the system after installation, not under Hitachi's control or under the control of service personnel authorized by Hitachi.

(o) Failure of components outside the scope of the warranty, covered by operating manuals.

Limitations on Guarantee

HITACHI HIGH-TECHNOLOGIES CORPORATION MAKE NO GUARANTEES, EITHER EXPRESS OR IMPLIED, EXCEPT AS PROVIDED HEREIN, INCLUDING WITHOUT LIMITATION THEREOF, GUARANTEES AS TO MARKETABILITY, MERCHANTABILITY, FOR A PARTICULAR PURPOSE OR USE, OR AGAINST INFRINGEMENT OF ANY PATENT.

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INSTALLATION AND AFTER-SALES SERVICE

Installation

- Only the persons who have been trained by a certified engineer of the manufacturer are allowed to carry out the installation work
- Before installation, refer to section 1 and prepare the necessary utilities.
- Installation at another place after delivery will be provided at charge. Consult your nearest Hitachi service representative for details.
- Service office location is listed on end of this manual. However, depending on the area, other service company might take charge. Please contact sales person for detail.

After-sales Service

- For after-sales service of the instrument, contact the Hitachi sales or service representative in charge.
- For service after the guarantee period, consult Hitachi service with regard to a maintenance and inspection service contract.
- For a period of ten (10) years after delivery of the instrument, maintenance service will be available to support its normal operation.
  Note, however, that such a system component as a personal computer (PC) to be updated frequently for improvement has a limited time for repairability in maintenance servicing. For such a component, the user may be requested to purchase a substitute or equivalent product.
  Even when more than ten years have elapsed from the date of delivery of the instrument, maintenance service will be provided if necessary items are obtainable. It should however be noted that maintenance service after a lapse of ten years from the date of delivery does not mean an extension of the estimated service lifetime of the instrument.

CAUTION ON DISPOSAL OF INSTRUMENT

Although at present the instrument does not use materials that will directly harm the environment, changes are apt to be made in relevant laws and/or regulations, so be sure to consult a qualified specialist when planning to dispose of the instrument.

Perchlorate Material _Special handling may apply,
See www.dtsc.ca.gov/hazardouswatste/Perchlorate.

ESTIMATED SERVICE LIFE OF THE INSTRUMENT

The instrument has a useful service life of ten (10) years after the date of initial use (installation), which is estimated under the condition that periodic maintenance, checkup, replacement of life-limited parts, and repair of worn parts are carried out as specified in the instruction manual.

Available Training Programs

Hitachi service offers various kinds of training programs at its own facilities or at the user's site and facilities to ensure proper and safe operations of the equipment to its full performance. Please contact your sales representative about the details of the training programs and application to them. Applicants will be charged.

Handling of Chemicals

(1) The user is responsible for proper handling and disposal of chemicals used for cleaning of the equipment in accordance with applicable regulations.

(2) Follow the supplier's instructions on handling, storage, and disposal of chemicals.

Instruction Manual

(1) This instruction manual and those instruction manuals for relevant accessories may be revised for improvement without prior notice.

(2) Hitachi High-Technologies Corporation has the copyright of this instruction manual.

(3) Reproducing or copying of part or all of this instruction manual is not allowed without our written permission.

⚠ SAFETY SUMMARY

⚠ General Safety Guidelines

Before operating the machine, read the following instructions carefully.

Safety precautions are indicated with the following headings combining the alert symbol ⚠, words "DANGER", "WARNING", and "CAUTION", and heading words:

⚠	: This safety alert symbol calls the user's attention to a danger that can potentially be injurious to people. To avoid the hazard, or even death, that can occur, all safety messages following the symbol must be heeded.
⚠ **DANGER**:	Indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury.
⚠ **WARNING**:	Indicates a potentially hazardous situation which, if not avoided, can result in death or serious injury.
⚠ **CAUTION**:	Indicates a hazardous situation that, if not avoided, will or can result in minor or moderate injury, or serious damage of product.
IMPORTANT:	Indicates a hazardous situation that, if not avoided, can cause property damage.

In addition to the above hazard tips, precautions for safe operation are indicated with the following headings:

NOTICE: Indicates information and descriptions for ensuring correct usage.

⚠ SAFETY SUMMARY

⚠ General Precautions on Safety

Before Using the System

- Before using this product, read the operating manual careful and be sure to understand its contents.
- The operating manual should be kept in a safe place near you for ready access and reference.
- The system should be handled according to the procedures given in this manual.
- Be sure to understand the safety-related instructions provided in this manual and heed them.
- Be sure to observe the precautions indicated on the system or in the manual. Failure to heed such precautions can result in equipment damage or bodily injury.
- Be sure to observe the operating instructions on the product itself and those provided in its operating manual.
- Do not carry out modification of the instrument, parts replacement, use non-specified parts, nor detach safety mechanisms since this could be hazardous.
- Do not perform any operation or action in any way other than as provided in this manual. When in doubt, call the designated field engineer.
- The customer is responsible for proper ventilation of the room when using chemicals. Inadequate ventilation could cause a health hazard.
- Most system operations are performed by viewing the monitor. Looking at the monitor continuously for long hours can cause fatigue-related eye problems. For the safe system operation involving the use of display devices, adequate labor management standards should be established and implemented.
- Keep in mind that the hazard warnings in this manual or on the machine cannot cover every possible case, as it is impossible to predict and evaluate all circumstances beforehand. Be alert and use your common sense.

The above instructions should be observed strictly. Failure to do so can result not only in improper specimen observation and evaluation, but also in bodily injury.

⚠ SAFETY SUMMARY

⚠ General Precautions on Safety (cont'd)

Precautions on Using the System

- When leaving the system unattended, turn off the acceleration voltage.
- If abnormal conditions arise when the system is being used, such as abnormal noise, noxious odor, fumes, or gas leakage, immediately shut off the power, shut the master gas valve, and take any other safety measures that the situation may dictate, and call the Hitachi Service Department.

Precautions in Installation, Maintenance, and Relocations

- To ensure the safe and accurate use of the system, installation will be performed by either personnel from Hitachi Service Department or qualified engineers trained and certified by Hitachi.
- Upon completion of the installation work, when receiving the transfer of the product, please make sure that nothing is missing in the standard accessories that are supposed to come with the system.
  Operating the system with some standard accessories missing can lead to system malfunction and safety problems.
  If you notice anything missing, damaged, or out of the ordinary, please discuss the matter with installation personnel, the sales office servicing your installation, or the nearest Hitachi Service Department.
- Servicing operations to be performed by the customer are limited to the items covered in this operating manual. Maintenance services should be performed with a good understanding of the information contained in the manual.
  To avoid system malfunction, or even bodily injury, maintenance operations not covered in the manual should not be performed.
- Replace the replacement parts listed in this manual at their expiration time. The parts passing their expiration time might cause the failure of the instrument or serious injury.
- To avoid below-standard performance due to vibrations, the system should not be moved after installation.
- If the warning labels deteriorate due to aging or are damaged, please contact the nearest Hitachi Service Department.

⚠ SAFETY SUMMARY

⚠ Warnings in the Operating Manual

Warnings provided in this manual and where they occur are summarized below.

This system does not have components that require ⚠ DANGER signs.

⚠ WARNING Indicators

Burns from the Rotary Pump

- If it stops abnormally, the rotary pump remains hot. Touching it can cause burns. Do not touch the rotary pump in the event of an abnormal stoppage.

(Chapter 4 Maintenance)

Burns from Touching the Filament Assembly

- When the filament assembly is replaced, it can be as hot at 90°C. Touching it can cause burns. When replacing a filament assembly, turn off the acceleration voltage, and let the assembly stand for 30 minutes or longer after the air is let in before working on it.
  Or, execute the filament exchange by using heatproof gloves of the clean room specification.

(Chapter 4 Maintenance)

Beware of Electric Shock

- Voltages up to 100 V AC and 30 kV DC are used inside this instrument. Do not touch inside or you may receive an electric shock.
  Do not remove the covers of main unit and display unit and do not touch internal parts or circuits while the instrument power is turned on. There is a hazard of fatal or serious injury due to electric shock.

(Chapter 4 Maintenance)

- Do not open the cover of the detector or the scanning electron microscope main unit. Death or serious injury may occur due to electric shock.

(Chapter 6 Accessory operation)

⚠ SAFETY SUMMARY

⚠ WARNING Indicators (cont'd)

Injury from Splashing Compressor Drain

- The inside of the compressor tank is pressurized. When draining off the compressor, jerky motion can cause the liquid to splash, causing eye injuries.
  When draining off the compressor, do not stand directly in front of the drain. Turn the drain cock slowly.

  (Chapter 4 Maintenance)

⚠ CAUTION Indicators

Fatigue due to Long Hours of Operation

- In operating the system while viewing the display, looking at the display for long hours at the same posture can build up fatigue in the eyes or body. For your health, when operating the system for long hours, take a break 10 to 15 minutes every hour or so to rest your eyes and body.

  (Chapter 3 Operation)

Injury from Lifting Heavy Objects

- The goniometer (stage) is a heavy object. Removing the stage involves the risk of dropping it accidentally, injury hands or feet.
  To avoid the danger, do not remove the stage from the system unit.

  (Chapter 2 Functions)

- The rotary pump is a heavy object weighing approximately 30 kg. When moving the rotary pump, it should be lifted by at least two persons to prevent your hands or feet from getting caught.

  (Chapter 4 Maintenance)

⚠ CAUTION Indicators (cont'd)

- The weight is a heavy object, weighing as much as 40 kg. Any installation or relocation of the weight must be performed by Hitachi or a service department authorized by Hitachi. The weight should not be lifted by customer personnel.
  (Chapter 1 Specifications and Installation Requirement)

Injury from Getting Caught in a Heavy Object

- The goniometer (stage) is a heavy object. When replacing specimens, be sure to operate the stage by grasping the handle.
  (Chapter 3 Operation)

- To avoid injury to hands or fingers, do not touch the operating parts while the Z stage is moving.
  (Chapter 3 Operation)

- When lifting the entire electron gun unit, be sure to hold it in two hands and move it until it stops. Releasing the hand in the middle carries the risk of injury such as a finger getting caught.
  (Chapter 4 Maintenance)

- When lowering the electron gun unit, be sure to hold it in two hands and lower it quietly until it stops. Releasing the hand in the middle carries the risk of injury such as a finger getting caught.
  (Chapter 4 Maintenance)

⚠ SAFETY SUMMARY

⚠ CAUTION Indicators (cont'd)

Burns from Touching the Heated Aperture Plates

- Heated aperture plates after baking are hot. Touching it can cause burns. Do not touch the heated aperture plates with bare hands.

(Chapter 4 Maintenance)

Handling Volatile Solvents

- When handling organic solvent (volatile solvent), take the following points into consideration to avoid the danger of injury or explosion caused by ignition.
  (a) Volatile solvent should be handled at a place which is well ventilated and is well away from flame.
  (b) If volatile solvent is excessively inhaled, dyspnea (difficulty in breathing) may be caused. If volatile solvent is swallowed or gets onto the skin or into the eyes, the symptoms of polyneuritis including anesthesia and ataxia (difficulty in walking) may develop. So use a gas mask for organic gas, plus an inhaler, safety goggles, protective gloves, protective boots, etc. as the occasion demands or in consideration of conditions.

(Chapter 4 Maintenance)

When the compressor is running continuously and abnormally

- When the compressor is running continuously and abnormally, the discharge pipe becomes high temperature. Do not touch the discharge pipe.

(Chapter 4 Maintenance)

Connection of the ground cable

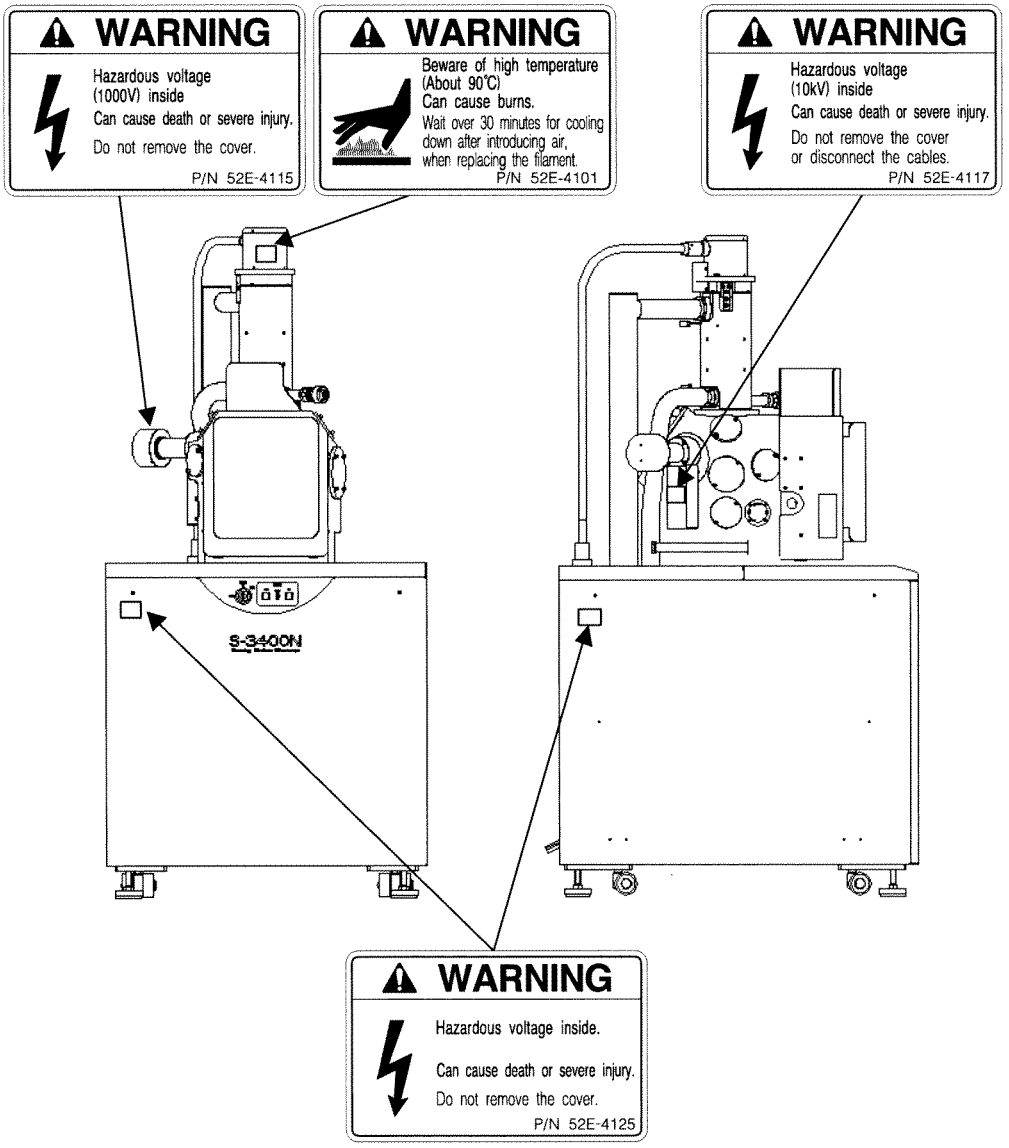
- Connect the ground cable correctly. If the ground cable is not connected correctly, not only will the system operate abnormally, but also there is a danger of electric shock.

(Chapter 6 Accessory operation)

⚠ SAFETY SUMMARY

⚠ System Warning Labels

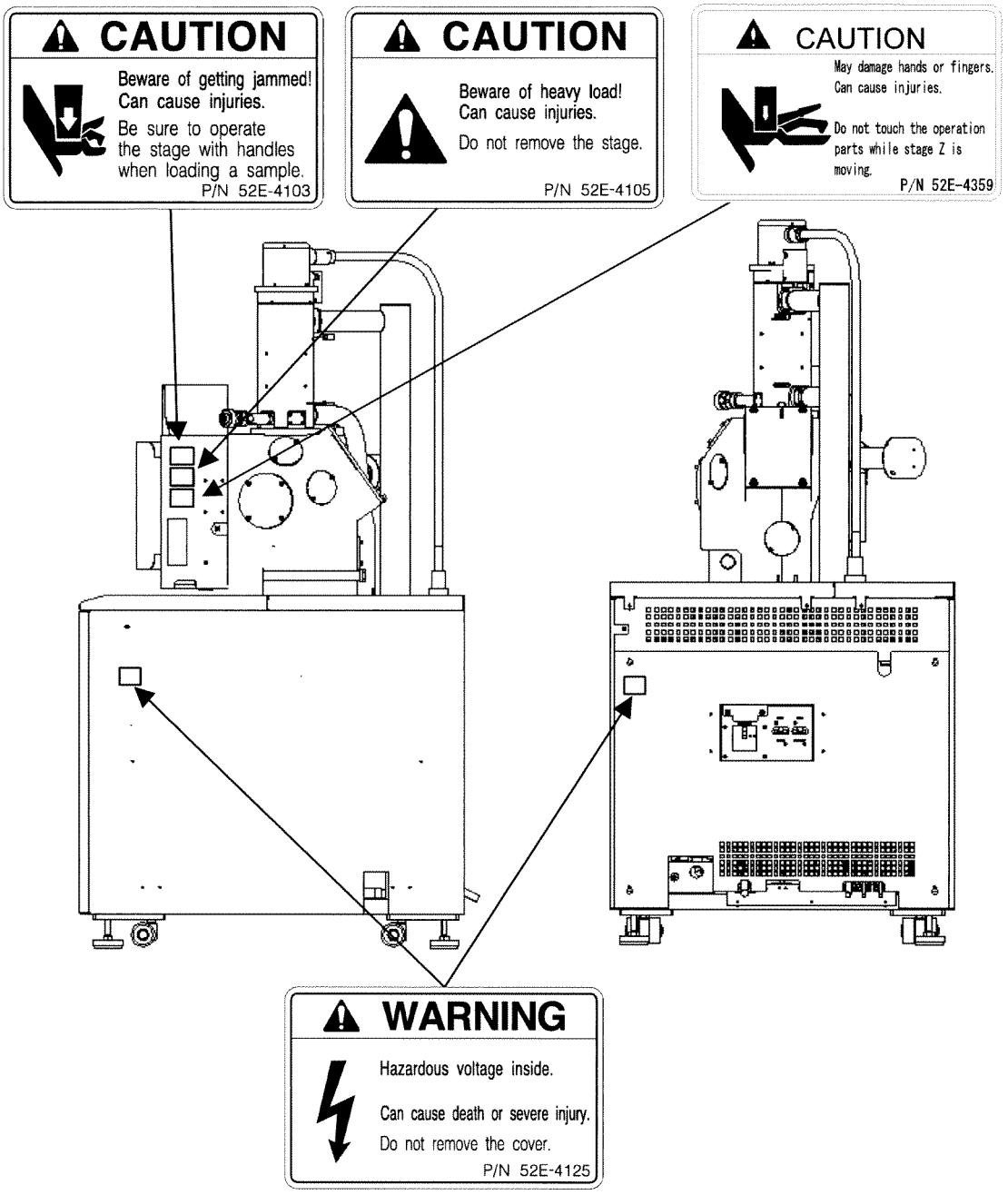
Safety pages 8 to 13 show Warning labels that are affixed to the S-3400N SEM. The contents of the warning labels should be checked against the actual equipment.
Warning labels should be checked, cleaned, and maintained from time to time so that they are clearly visible from a safe distance.
If warning labels fade and become difficult to read due to aging, call the nearest Service Department for replacement.



(Front view) (Left side view)

Warning Label Pasting Locations on System Unit

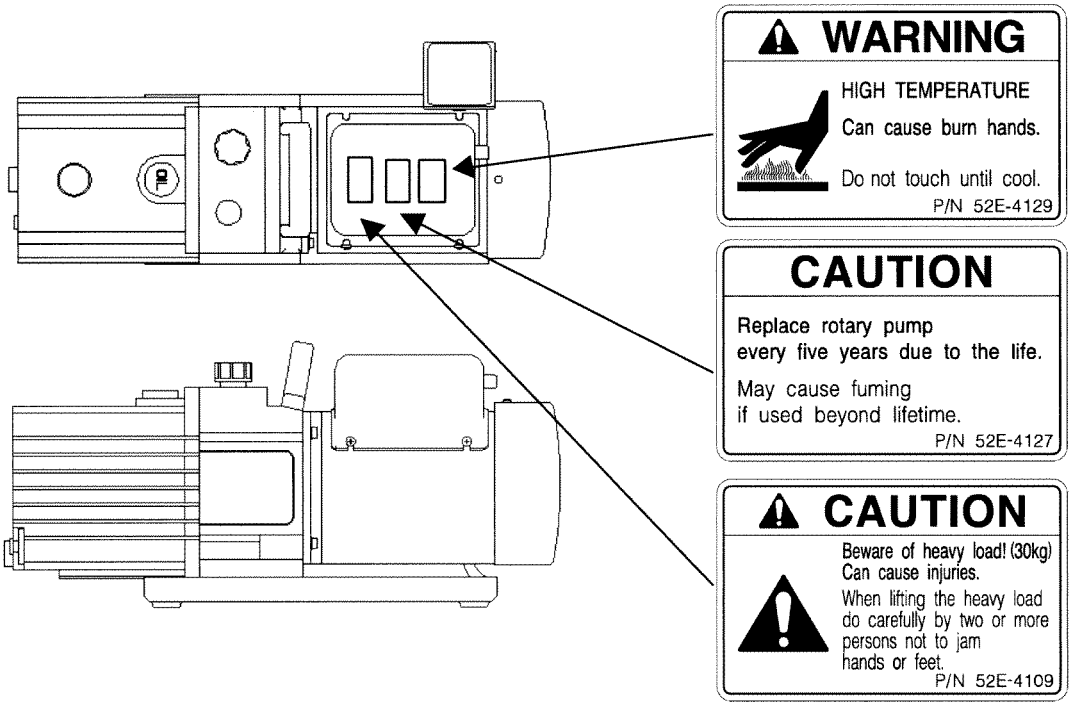
SAFETY SUMMARY



(Right side view) (Rear view)

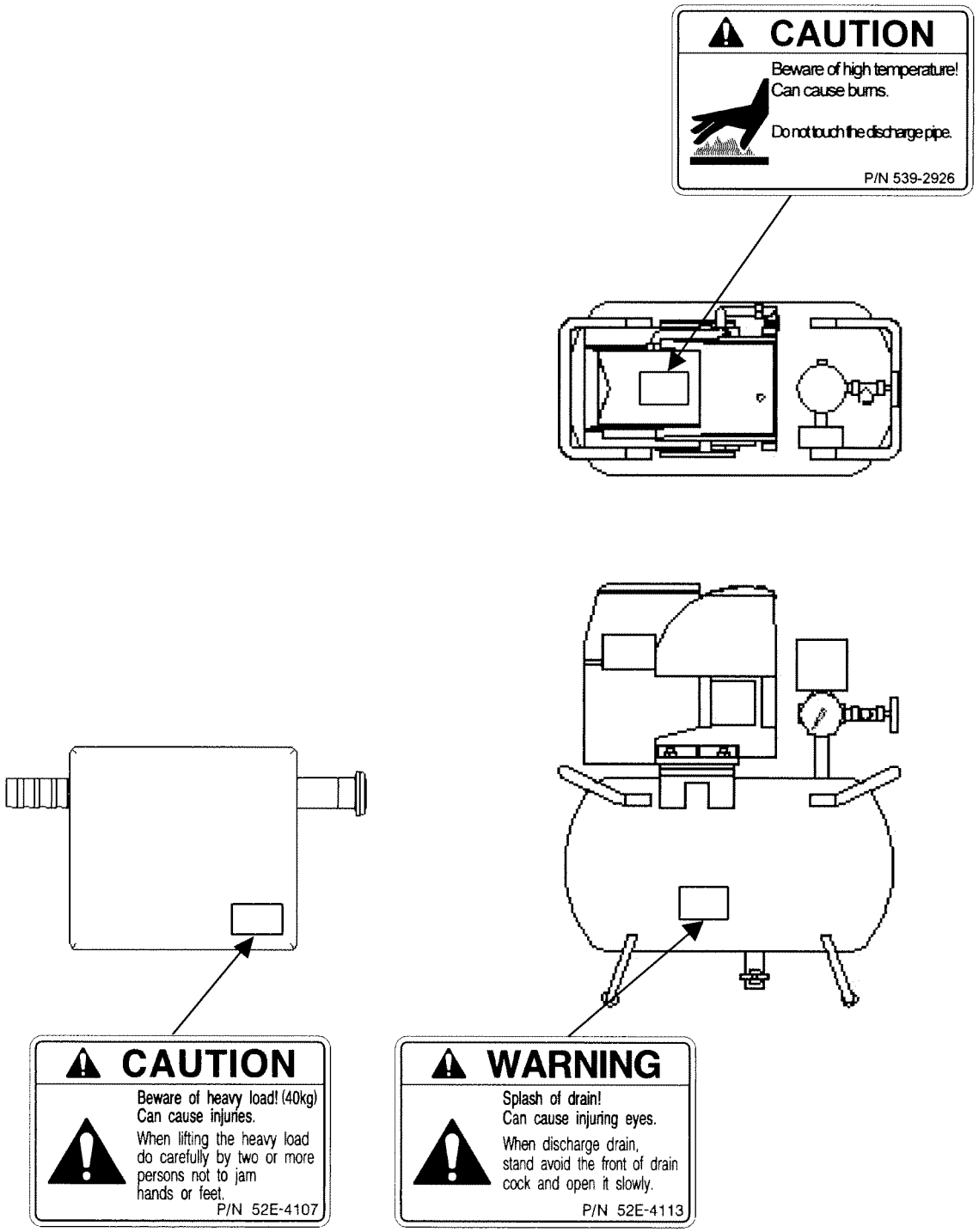
Warning Label Pasting Locations on System Unit

SAFETY SUMMARY



Warning Labels Pasting Locations on Rotary Pump

SAFETY SUMMARY

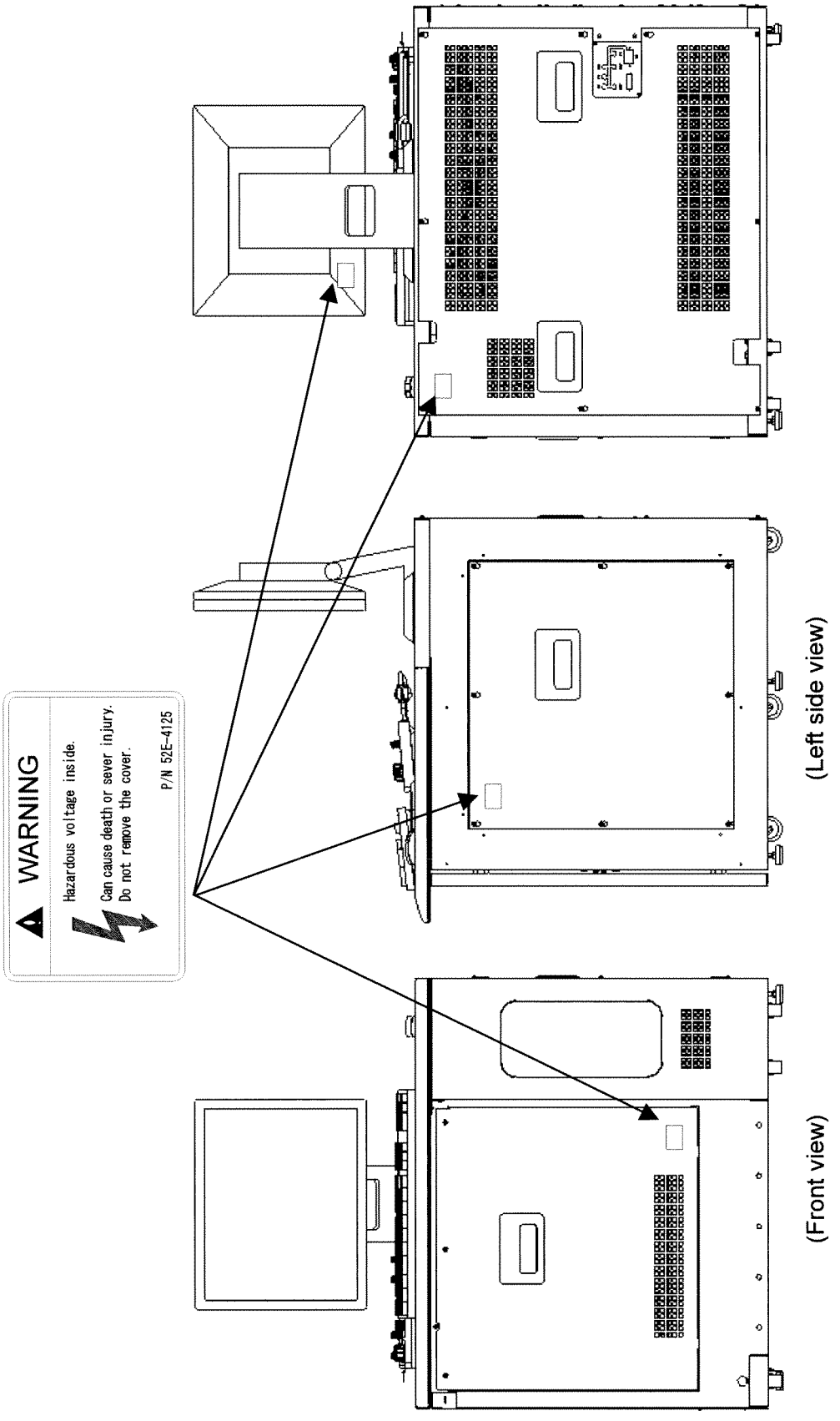


Motion shielding weight (Top view)

Compressor (Back view)

Warning Label Pasting Locations on Weight/Compressor

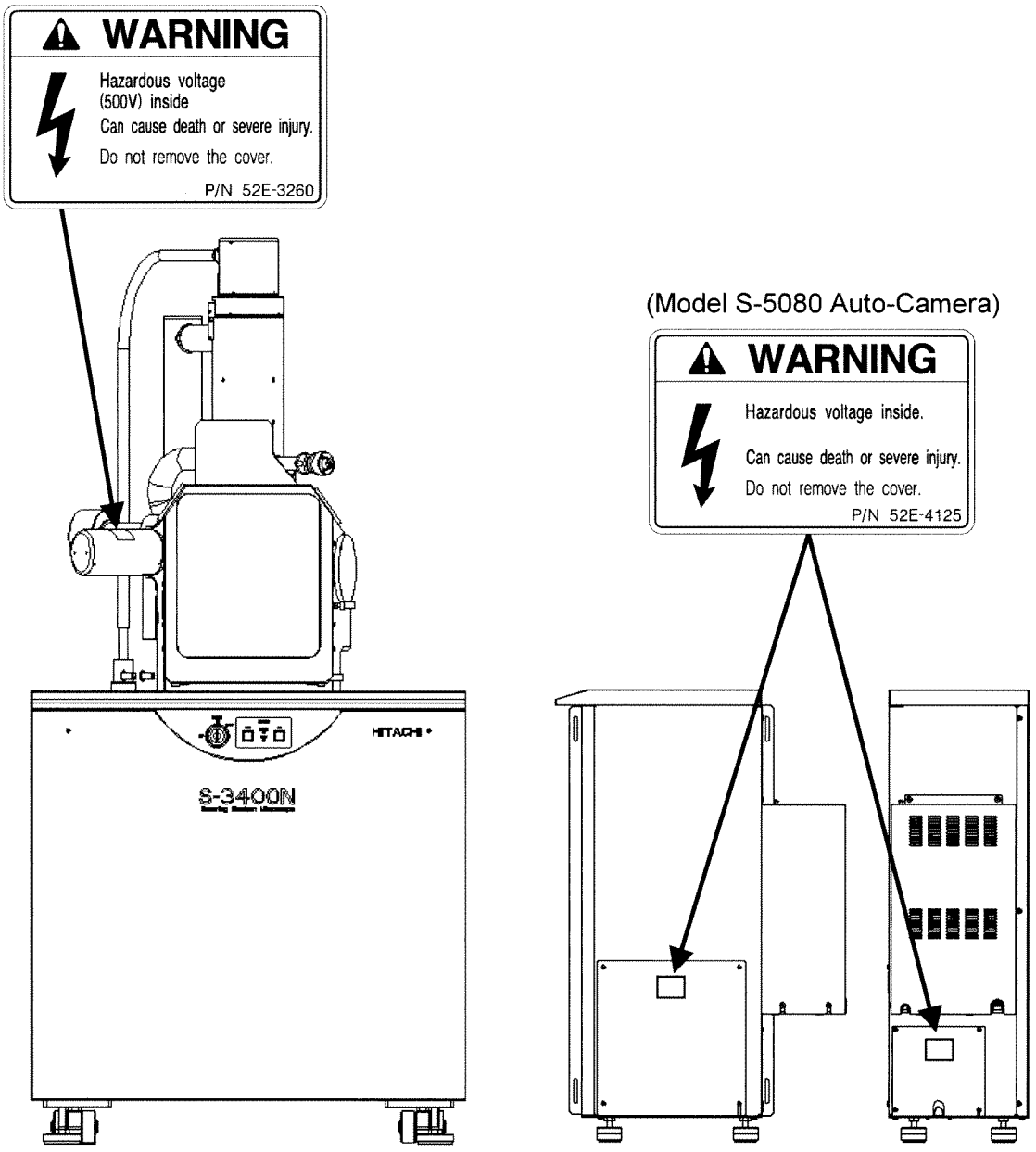
SAFETY SUMMARY



Warning Label Pasting Locations Display Unit

SAFETY SUMMARY

(ESED)



Warning Labels Pasting Locations on Option Units

SAFETY SUMMARY

Precautions for Proper Operation

— Precautions for the Proper Operation of the S-3400N —

About Electricity

(1) Single-phase AC 100 V(±10%), 50/60 Hz, 2 kVA (for main unit).When the supplied power line voltage is 100 V, the instrument works by direct connection.
When the supplied power line voltage is other than 100 V (200 V or others), use a step down transformer to step the power line voltage down to 100 V. Refer to Chapter 1 (Specifications and Installation Requirement) for the step down transformer requirement.

(2) Connect the instrument to ground based on the standard of your country to prevent electric shock hazards due to the high voltage. Otherwise, you could suffer an electric shock or a malfunction could occur in the instrument.
Avoid sharing the ground terminal with other power equipments. Be sure to ground the instrument independently. The image trouble and the malfunction of the equipment might be caused when sharing.

Third Party's Industrial or Proprietary Rights

Hitachi High-Technologies Corporation shall not be responsible for a third party's claim regarding infringement of any patent rights or industrial properties with respect either to products manufactured through the use of equipment supplied by Hitachi or its related companies or to applications of the Hitachi equipment.

⚠ SAFETY SUMMARY

Precautions for Proper Operation (cont'd)

Laser Light Hazard

The CD-ROM or CD-R/W drive in the personal computer is equipped with a laser device. The personal computer with laser device complies with safety standards including International Electrotechnical Commission (IEC) 825. With specific regard to the laser, the equipment complies with laser product performance standards set by U.S. governmental agencies for a Class 1 laser product. The product does not emit hazardous light; the beam is totally enclosed during all modes of customer operation and maintenance. Therefore be sure to observe the following warnings when operating a product equipped with a laser device.

- Do not try to open the unit enclosure.
  There are no user-serviceable components inside.
- Do not operate controls, make adjustments, or perform procedures with the laser device other than those specified herein.
- Allow only service personnel to repair the unit.

Laser Information:

Laser type:	Semiconductor GaAlAs
Wavelength:	780 ± 35 nm
Divergence angle:	53.5° ± 0.5°
Output power:	Less than 0.2 mW or 10,869 W m-2 sr-1
Polarization:	Circular 0.25
Numerical aperture:	0.45 ± 0.04 inches

Harmful Chemicals

This product contains chemicals, including lead, known to the State of California to cause cancer, and birth defects or other reproductive harm.
Wash hands after handling.

⚠ SAFETY SUMMARY

Precautions for Proper Operation (cont'd)

Backup of Important Data

Trouble-free operation cannot be guaranteed for the computer system. You are recommended to copy important data on the hard disk into CD-R or external hard disk at a regular interval.

About Computer Applications Software

Other applications software except for Hitachi-confirmed working should not be installed on the PC that is a part of this system. Such software can cause unexpected animation screens to pop-up, exert adverse impact on the system, and interfere with the operation of the system. The warranty does not cover situations where the system fails to run properly due to the installation of other application software.

⚠ SAFETY SUMMARY

Precautions for Proper Operation (cont'd)

Protection against Computer Viruses

Computer viruses are malicious programs that sneak into the PC to cause misbehavior or damage to data. And, a program designed to offer protection against and eradicate computer viruses is called an anti-virus software.

Computer and storage mediums are shipped after confirming with anti-virus software.

Using a CD-R, USB flash drive or other storage medium infected by a virus can cause virus infection. Note also that once a virus infects the PC, it may spread to other computers through storage media. Therefore, never use a program or storage medium that is suspected of containing a virus. External storage mediums and network connection have to be checked with an anti-virus software before inserting to the PC that is a part of this system. To connect with network, it is recommended to set firewall between the PC of this system and network. Setting firewall is to be operated by the user on his or her own responsibility. Also we do not guarantee to be able to protect all viruses with setting firewall.

The user is requested to prepare proper anti-virus software and carry out virus removal on his or her own responsibility. Our company does not guarantee anti-virus software itself.

Note, however, carrying out computer virus check during operation of this system may cause incorrect operation of this system control program. Below items are requested to the user.

(1) Set the switch of virus monitoring function to OFF during operation of this system.

(2) If an anti-virus software has regular scanning function, it is requested to avoid virus scanning during operating time of this system and to operate virus scanning while the control program of this system is not working.

⚠ SAFETY SUMMARY

Precautions for Proper Operation (cont'd)

About Changes in Computer Settings

Do not change the following system settings of your PC. These are set up at the optimum conditions for operation of the S-3400N SEM before shipping.

(1) Connection to the USB ports
This instrument uses a USB port for communication between the PC and the internal microprocessor. The USB port number 1 is assigned to the instrument. Therefore, if external storage devices or printers are to be connected to USB ports, ports that are available to users are subject to restrictions.

(2) Monitor screen setting
Monitor properties need to be set at 1280 × 1024 pixels for the desktop area, true color (24 bit) mode and 60 Hz to 70 Hz for the refresh rate. Using other resolution, faster refresh rate or 256 color mode may cause an abnormal screen display.

(3) Sub programs
This instrument operates using many DLL programs along with the control program. Deletion of files in the Windows directory or change of the registry will cause troubles. Also do not delete tasks and processes using the task manager.

(4) Screen saver settings
The screen saver can cause to exert adverse impact on the system, and to interfere with the operation of the system. For using the screen saver, read the following carefully.
(a) Use only the screen saver of the windows standard.
The operation of the screen savers other than the Windows standard are not guaranteed.
(b) Password Protection should not be set on a screen saver.
Password Protection can prevent SEM images to display properly when the system wakes up from the screen saver mode. If you need to lock Windows when leaving your work site, the option to activate Password Locking from the S-3400N control program should be used.
See 3.9.19 Password Locking of Windows.

Precautions for Proper Operation (cont'd)

(5) Power Saving mode
Do not use the Power Saving mode. It will cause trouble in communication between the PC and internal microprocessor.

(6) Virtual memory setting
Do not change the virtual memory setting.

(7) Any saved image data is subject to control by SEM data Manager. Image files should not be renamed or deleted by using Windows File Manager or Windows Explorer. The use of Windows File Manager or Windows Explorer can cause a conflict between the data controlled by SEM Data Manager and the actual data. Such files generate a "Reference disabled" message on SEM Data Manager. If such a conflict arises, the offending file should be deleted by using the Remove List Function of the Batch Process of SEM Data Manager. Valuable images contained in such a file can be re-registered using the Add From File function.

⚠ SAFETY SUMMARY

Precautions for Proper Operation (cont'd)

OS Operation during S-3400N SEM Operation

Although the Windows Task Manager can be launched from the Taskbar or by Ctrl+Alt+Del key operation, if Standby or Halt mode is set or logged-off while the S-3400N control program is running, it will not work normally when recovered from such a status. Close S-3400N control program if setting of such mode is necessary.

USB Devices

When connecting USB devices such as external storage unit, printer etc., take notice of the following.

(1) USB Port 1 is used by the display control unit, ports available to users are subject to restrictions.

(2) Terminate S-3400N control program when carrying out disk formatting or copying a large volume of image files to MO disk, hard disk or other storage devices using USB port.

(3) By the above operation, sometimes the message "USB not connected" will be shown. In such case, S-3400N control program will not continue normal operation. If this message appears, close Windows, shut down the PC, turn off the key switch for the system unit, wait 30 seconds, and then restart the system by turning on the power again.

Network Connection

The PC is equipped with Ethernet ports for network connectivity. Performing a network connection using the Ethernet requires extensive knowledge of the network environment. Such a connection should be undertaken in consultation with the Network Administrator.

(1) Connecting a cable to the Ethernet port must be performed by a system installer or by a service engineer. If such work is needed, please contact your servicing Sales or Service department.

(2) The system is not supplied with an Ethernet cable; an appropriate cable should be procured by the customer.

Precautions for Proper Operation (cont'd)

(3) Modifying PC settings for the purpose of a network connection should be undertaken with care. Changing the settings necessary for the operation of the system can disable the system from running properly. For further information, see the section on Changing Computer Settings in this chapter.

(4) For network connection, no special software should be installed, since such software can adversely affect the system and prevent the system from running properly. If the system must be connected to a special network that is not supported in the standard configuration, please contact your servicing Sales or Service department.

(5) Connecting to an external device, such as an EDX through the use of an optional external communications interface requires the use of an Ethernet port. Therefore, if the system must be connected to a unit other than an external device, a branching hub must be procured. Some external devices come with a hub as part of a standard configuration. Please check with your servicing sales department about this.

(6) Establishing a network connection using the Microsoft-TCP/IP protocol requires an IP address. Secure such an address by consulting the Network Manager. Connecting to an external device, such as an EDX, requires another IP address for that device.

NOTICE: The user is requested to prepare a proper Computer viruses protection on his or her own responsibility with consulting to the network administrator. It is not guaranteed Failure of instrument or damage of basic software, application software or other data due to a computer virus. (For detail, refer to Protection against Computer Viruses in this chapter.)

Precautions for Proper Operation (cont'd)

Using Other Windows Applications

Running non-SEM Windows applications (especially the Printer or Internet Explorer) during a SEM operation, especially image capture, transfer of saved.

Personal Computer (PC)

When the system is running, do not turn off the key switch on the main unit, since doing so can turn off the PC. If power is unilaterally cut off during access to a hard disk or floppy disk (FD), the PC can be damaged and the data and software stored on the disk can potentially be destroyed.
If the PC lock up for some reason, take steps to shut down the PC safely by referring to [4.4.9 When PC has Hung Up].

Precautions for Proper Operation (cont'd)

Transportation and Relocation of Instrument

(1) The transport of the system, which carries considerable risk, should never be attempted by a customer. Any system transport should be performed with the assistance and supervision of Hitachi-approved engineers.

(2) Do not lift the instrument by holding the table. The strength of table fitting is not sufficient for bearing the weight of display unit, approximately 120 kg. Should the table be lifted, the display unit might slip off and crash. Hence, it is recommended to remove the table and transport the display unit independently when moving the instrument.

Ambient Temperature and Humidity

Even when the system is not running, the room in which the system is installed should be maintained under the following environmental conditions:
Room temperature: 15°C to 30°C
Humidity: 70% or lower (no condensation)
If the system is not used for a long time, the specimen chamber should be evacuated instead of being exposed to the atmosphere.

Additional Information of PC Setting

Setting of Windows® XP Professional Service Pack2 and Service Pack3

1. Outline

As of August 2010, OS of the personal computer for the PC-SEM control is Windows XP Professional Service Pack3 (SP3). In SP3, a security function is strengthening in addition to accumulation of the correction program published in the past. It is confirmed that the software for PC-SEM control works within an existing SP2 and SP3 standard environment. The setting of SP2 and SP3 when PC-SEM is shipped from factory is described as follows. The factory does not provide guarantee when PC-SEM is used in the settings not described in this manual.

2. Setting of Security Center

(1) Click the **Start** button, and select the Control panel.
(2) Click the Security Center icon.

2.1 Firewall

The Firewall is set to ON. When you confirm this setting, refer to the following procedures.

(1) Click Windows Firewall in the **Windows Security Center** window.

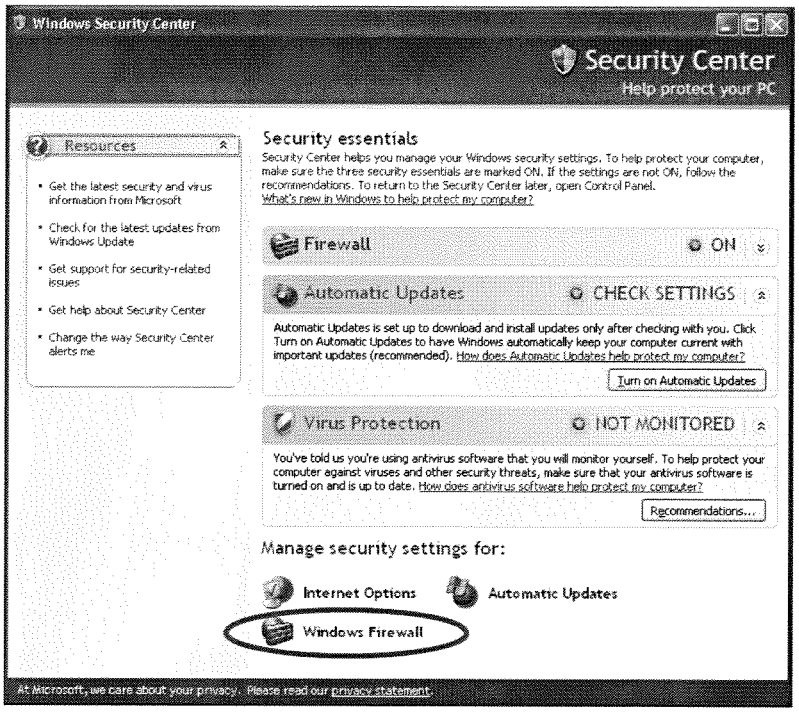


Fig. 1 The Windows Security Center Window

The Windows Firewall is set as shown in the figure below.
To restore all Windows Firewall settings to a default state, select the **Advanced** tab and click the **Restore Defaults** button.

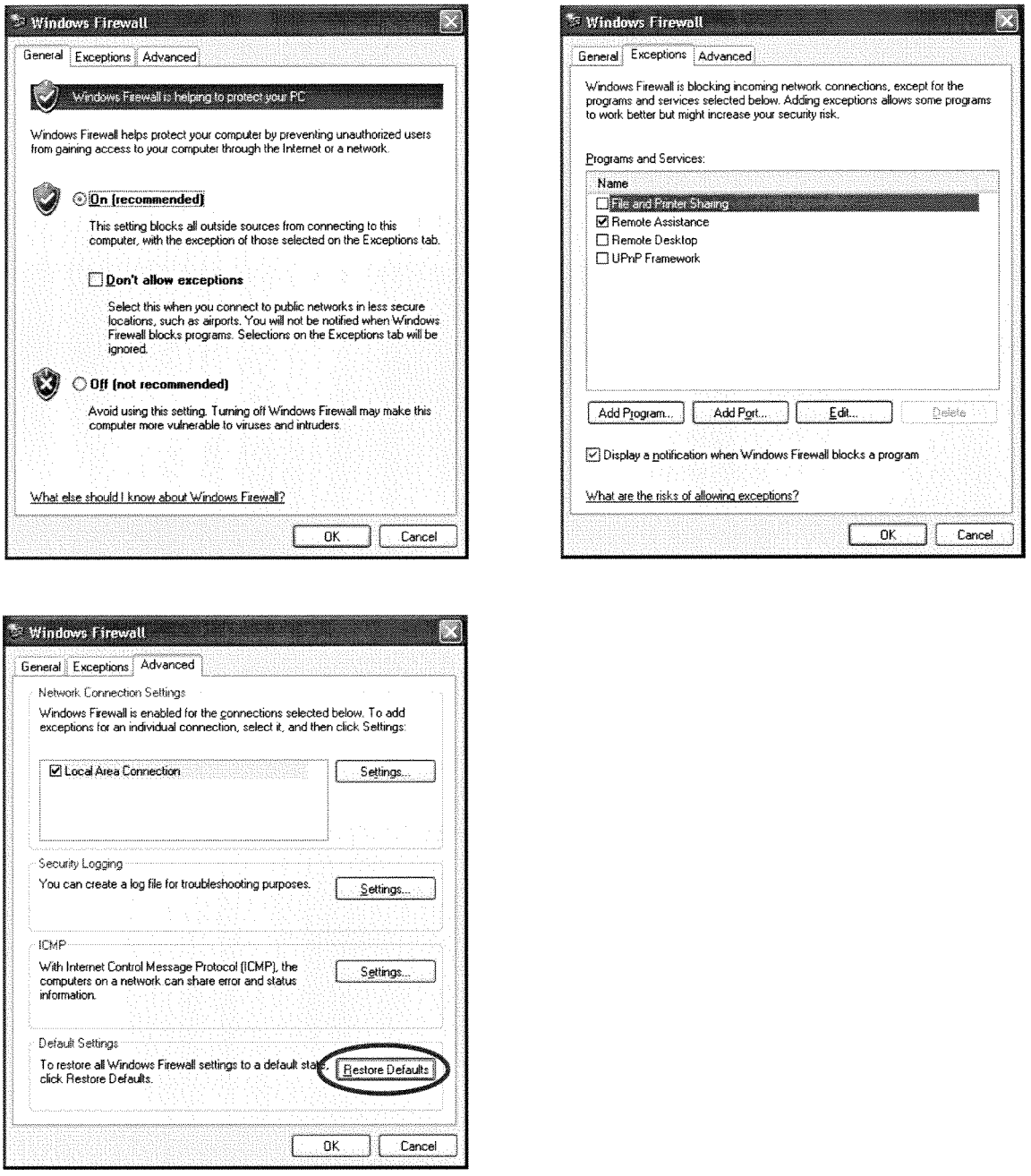


Fig. 2 The Windows Firewall Windows

2.2 Automatic Updates

(1) Click Automatic Updates in the **Windows Security Center** window or click the **Automatic Updates** tab in the System window.

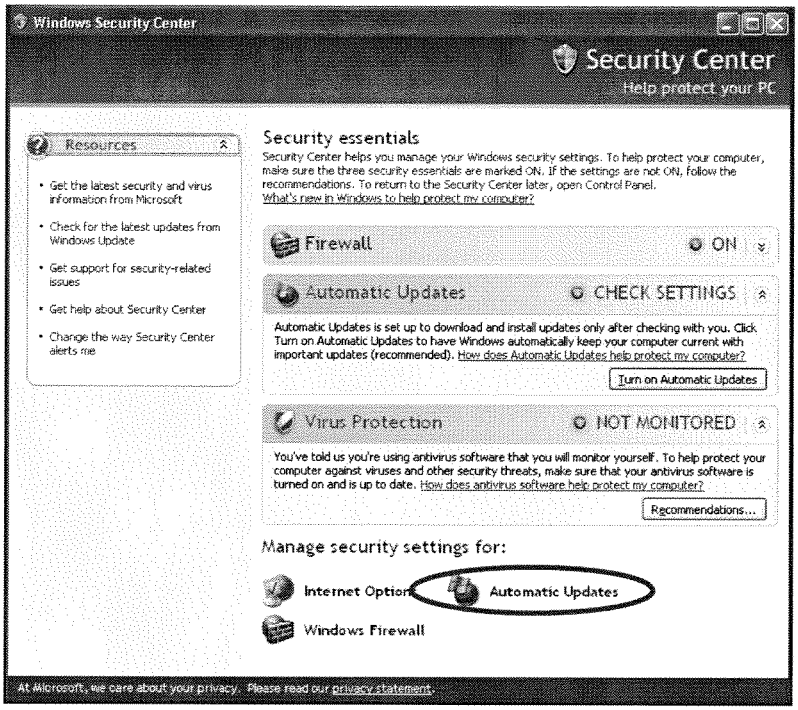


Fig. 3 The Windows Security Center Window

(2) Select "Notify me but don't automatically download or install them."

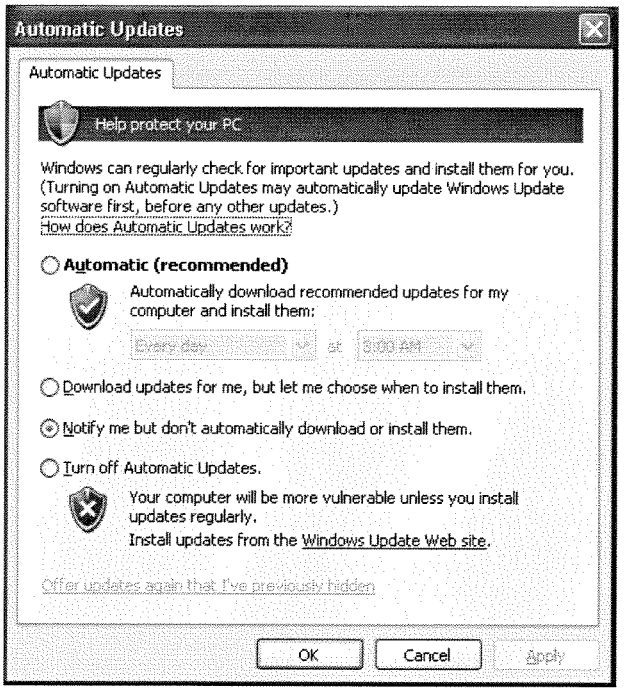


Fig. 4 The Automatic Updates Window

2.3 Virus Protection

The anti-virus software is not installed. In SP2 and SP3, if the anti-virus software is not installed or the date of the virus definitions file is old, message is displayed when OS starts.
When the instrument is shipped from factory, the Virus Protection setting is set as follows so that the message is not displayed.

(1) Click the **Recommendations** button in the **Windows Security Center** window.

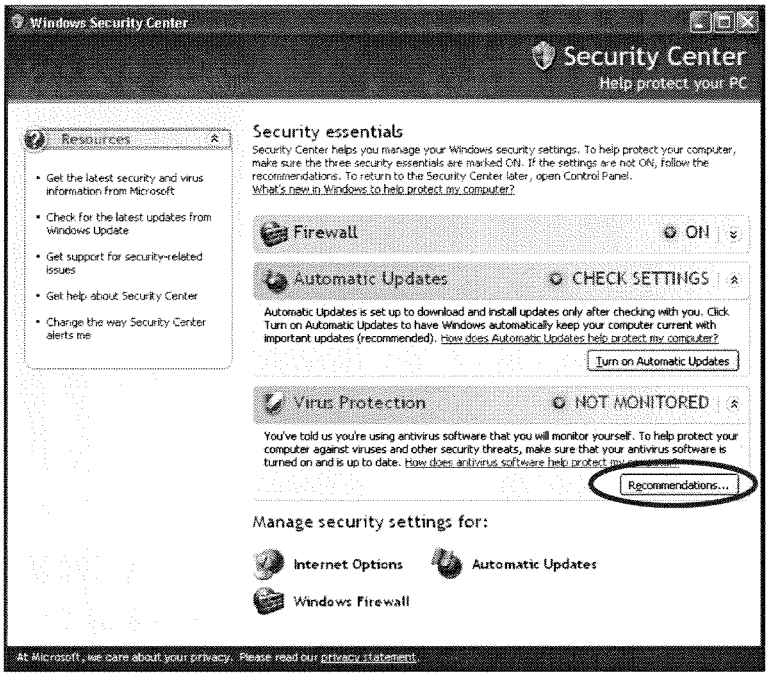


Fig. 5 The Windows Security Center Window

(2) Check "I have an antivirus program that I'll monitor myself." and click the **OK** button.

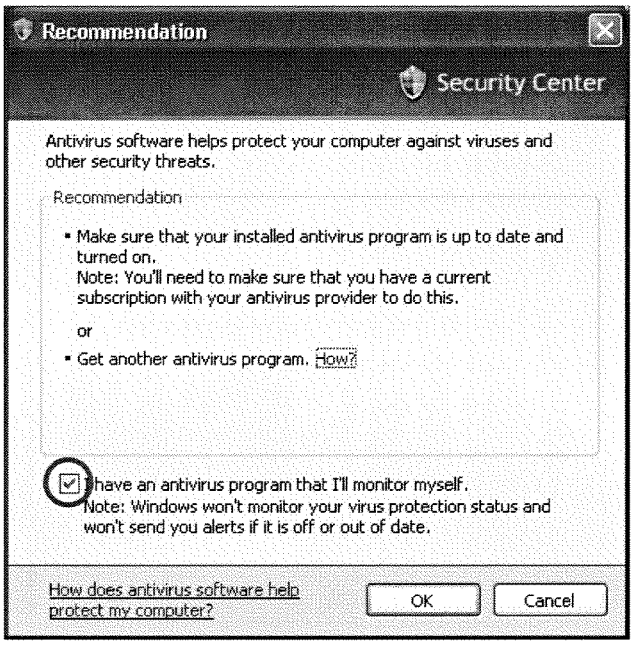


Fig. 6 The Recommendation Window

We have tested the following anti-virus software that install in the personal computer of PC-SEM, and confirmed that the SEM control software operates correctly (as of August 2010).

Symantec Norton Anti Virus 2010

Symantec Norton Anti Virus Corporate Edition

Our company does not support above-mentioned anti-virus software. The user is requested to prepare a proper Computer viruses protection on his or her own responsibility with consulting to the network administrator. It is not guaranteed failure of instrument or damage of basic software, application software or other data due to a computer virus.

3. Other setting

3.1 Login User Name

When the instrument is shipped from factory, the Login User Name is set as follows.

User Name	Password	Group Memberships	Application
PC-SEM	Not registered	Power Users	Used for operation of SEM. System environment cannot be set.
Administrator	hitachi	Administrators	Used for system management. System environment can be set.
SEM	****	Administrators	Used for maintenance of SEM. Do not change setting.

- It is possible to set a password for users "Administrator" and "PC-SEM". For setting way of the password, refer to the instruction manual for Windows.
- Set the Group Memberships to "Administrators" or "Power Users" when you create a new account. The control software does not execute normally, when setting it to "Users".

3.2 Setting of Display Properties

Right-click on Desktop, and select Properties in the displayed menu.

(1) Desktop tab
Background: [None]

(2) Screen Saver tab
Screen saver: [None]
Monitor Power (Click the **Power** button):
Power schemes: Always On
Turn off monitor, Turn off hard disk, System standby, System hibernates: Set everything to Never.

(3) Appearance tab
Windows and buttons: Windows XP style
Color scheme: Default (blue)
Effects: (Click the **Effects** button): do not check "Use the following method to smooth edges of screen fonts."
(If it is checked, when the SEM image with a high brightness is displayed, the character of the data display becomes hard to see.)

(4) Settings tab
Screen resolution: 1280 × 1024 pixels
Color quality: Highest (32bit)
Monitor refresh rate (Click the **Advanced** button, and select the Monitor tab): 60Hz (LCD)

3.3 Setting of Hard disk drive

The hard disk drive of the Windows XP model PC-SEM is separated for two partitions of drive letter C and drive letter D. Save the data of the SEM image etc. to drive D.
To share the data of Drive D when two or more user names to be able to log in Windows are registered, the access permits of group Everyone is set to Full control.
To share data in Drive D, The access permit of the group "Everyone" is set to "Full control" so that two or more user names to be able to log in Windows are registered. If you change this setting, image data might not be able to be written in the hard disk with the SEM data manager and so forth according to the user name. Refer to the following for the setting. (Do not change this setting except the person who is well informed about the setting of Windows.)

(1) Select Drive D by the Explorer, and select Folder Options in the Tool menu.

(2) Select the View tab in the Folder Options dialog, and remove the check mark of "Use simple file sharing (Recommended)" in the Advanced Settings list, and then click the **OK** button.

(3) Select and right-click Drive D by the Explorer, and then select Properties in the displayed menu.

(4) Select the Security tab in the Properties dialog, and select Everyone* in the Group or User Names list. Then check Full Control the Allow side in the Permissions for Everyone list.
Then check the Allow side of the Full control check box in the Permissions for Everyone list.
*: If there is not Everyone in the Group or User Names list, add it according to the following procedures.
(i) Click the **Add** button.
(ii) Click the **Advanced** button in the displayed Select Users or Groups window.
(iii) Click the **Find Now** button, then the list appear.
Select Everyone from the list, and then click the **OK** button.

3.4 Setting of Taskbar

When the instrument is shipped from factory, the setting of the taskbar is set for the following. There is no influence in the operation of the SEM software even if this setting changes.

(1) Taskbar (Right-click on the taskbar and select Properties): Check "Auto-hide the taskbar"

(2) Start Menu (Select the Start tab in the Taskbar and [Start] Properties) : Select "Start menu"

3.5 Setting of BIOS

Note that the setting of BIOS might be different in each model of PC. The following procedure is the setting of HP Z200 Workstation (as of August 2010).

(1) Restart the PC.

(2) Press the F10 key while the logo of "HP" is displayed on the screen.

(3) The language select menu is displayed in the first. Select "English" and press the Enter key.

(4) The main-menu is displayed. Select "Advanced", and then select "Power-on options" and press the Enter key.

(5) The sub-menu is displayed. Select "After power loss", and change the settings to "on" pressing the "→" key.
Then select "Post Delay (in seconds)", and change the settings to "15" pressing the "→" key.

(6) Select "File" in the main-menu, and then select "Save Changes and Exit", and then press the Enter key.
The Exit Message is displayed, and then press the F10 key.

Table of Contents

1. SPECIFICATIONS AND INSTALLATION REQUIREMENTS

1.1 Specifications

1.1.1 Resolution

Secondary electron image resolution:	3.0 nm (30 kV acceleration voltage, in high vacuum mode) 10 nm (3 kV acceleration voltage, in high vacuum mode)
Backscattered electron image resolution:	4.0 nm (30 kV acceleration voltage, in low vacuum mode)

1.1.2 Magnification

5× to 300,000×
(Highest and lowest magnifications are dependent upon accelerating voltage, WD and scan speed.)

1.1.3 Electron Optical System

Electron source:	Pre-centered cartridge type tungsten hairpin filament
Acceleration voltage:	0.3 kV to 30 kV
Gun bias:	Quad-/self-bias switching and continuously variable fixed bias
Beam alignment:	Electromagnetic two-stage deflection (doubles as blanking when the image is frozen)
Lens system:	Three-stage electromagnetic lens reduction optical system
Stigma correcting unit:	Electromagnetic 8-pole XY method
Scanning coil:	Two-stage electromagnetic deflection method
Movable objective aperture:	Four-hole movable aperture (30, 50, 80, and 150 µm)
Image shift:	±50 µm or greater (WD = 10 mm)
X-ray analysis position:	WD =10 mm, X-ray take-out angle (TOA) = 35°
Detector and image types:	Secondary electron detector; secondary electron image (high vacuum mode) Quad-type semiconductor backscattered electron detector; backscattered electron image (High/low vacuum mode)

1.1.4 Specimen Goniometer Stage

(1) Type Ⅰ (80 × 40 stage)

Range of motion:	X-axis: 0 to 80 mm
	Y-axis: 0 to 40 mm
	Z-axis (WD): 5 to 35 mm
	R-axis (rotation): 360°, continuous
	T-axis (tilt): -20° to 90°
Drive method:	Manual drive
Specimen size observable over entire region:	106 mm diameter (also R)
Maximum specimen size:	200 mm diameter

(2) Type Ⅱ (100 × 50 stage)

Range of motion:	X-axis: 0 to 100 mm
	Y-axis: 0 to 50 mm
	Z-axis (WD): 5 to 65 mm
	R-axis (rotation): 360°, continuous
	T-axis (tilt): -20°to 90°
Drive method:	5-axis motor drive
	With eucentric rotation feature
	With image navigation feature
Specimen size observable over entire region:	130 mm diameter (also R)
Maximum specimen size:	200 mm diameter

1.1.5 Evacuation System

Evacuation control:	Fully automatic pneumatic valve method
Vacuum gauge:	Pirani gauge
Attainable vacuum level:	1.5 x 10^{-3} Pa
Range of vacuum level settings:	6 to 270 Pa (22 stops)
Vacuum pump:	Turbo molecular pump (TMP) 250 L/s for high vacuum 1 ea.
	Rotary pump 135 L/min (50 Hz), 162 L/min (60 Hz)
	TMP back evacuation/low-vacuum settings 1 ea.
Compressor:	0.2 kW output, 1 ea.

1.1.6 Imaging Function

Display monitor:	Still image display on the PC monitor (at full scanning speed)
Observation monitor:	18.1 or 19-inch LCD (number of desktop pixels: 1280 × 1024)
Image display mode:	Full-screen display (1280 × 960 pixels)
	Small-screen display (640 × 480 pixels)
	Dual-screen display (640 × 480 pixels, two panes), with signal-mixing feature

Scanning mode:	TV/FAST Slow Reduced area (320 × 240 pixels) Waveform display Split screen/dual mag mode High-definition capture (5120 × 3840 pixels maximum) Frame integration capture (2560 × 1920 pixels maximum)
Scanning speed:	TV scanning (640 × 480 pixel display: 25/30* frames/s) FAST scanning (full screen display: 6.3/7.5* frames/s) Slow scanning (Full screen display: 1, 4, 20/16, 40/32, 80/64, 160/128* s/frame) (640 × 480 pixel display : 0.5, 2, 10/8, 20/16, 40/32, 80/64* s/frame) Reduced area scanning (320 × 240 pixel display: 25/30, 3/4* frames/s) High-definition capture scanning (2560 × 1920 pixels: 40/32, 80/64, 160/128, 320/256* s/frame) (5120 × 3840 pixels: 80/64, 160/128, 320/256* s/frame) * Power supply synchronization: 50/60 Hz
Auto-tuning feature:	Auto brightness & contrast control (ABCC) Auto focus control (AFC) Auto stigma & focus (ASF) Auto filament saturation (AFS) Auto beam alignment (ABA) Auto beam setting (ABS) (Auto filament saturation + auto beam alignment + auto gun bias alignment) Auto axial alignment (AAA) (applicable to aperture/stigma alignment)
Signal/image processing function:	S/N improvement by averaging (TV/FAST scanning) S/N improvement by pixel integration Frame integration (maximum number of integrated frames: 1024) (TV, FAST, SLOW1 scanning) 2-color synthesized image display (realtime/saved image in 2-image simultaneous display) Pseudo-color image display (saved image) Realtime image processing (brightness reversal, gamma adjustment) Realtime histogram display Image processing on saved images (brightness reversal, gamma adjustment, various space filter processing)

Saving image data:	Saved image size: (640 × 480 pixels, 1280 × 960 pixels, 2560 × 1920 pixels, and 5120 × 3840 pixels) Applicable format: BMP, TIFF, and JPEG
Image data printout:	Free-layout printing feature provided
Management of saved image data:	SEM Data Manager (an image database) provided (image data management, thumb nail display, and various image processing features)
Other functions:	Beam blanking (during image freeze) Raster rotation Dynamic focusing/tilt compensation Data display (image number, acceleration voltage, magnification factor, micron marker, micron value, WD value, date, time, vacuum level, and detector) Data display unit image/reversal switchable Data entry (graphics (circles, rectangles, arrows, dimensional lines) character input) Simple measurement function (displaying size and arrow between 2 points) 3D animation maintenance guide Image transfer to the Quartz Imaging PCI
X-ray mode feature:	Signal input pins (pins provided on each system) • X-ray Rate Meter signals (0 to + 10 V) • Mapping signals (TTL) Scanning mode • Line analysis • Spot analysis • Selected area analysis DBC interface (Option)

1.1.7 Safety Equipment

Protection features provided on power failures, electrical leakage, and vacuum failure

1.1.8 Size and Weight

Main unit:	700 (W) × 800 (D)* × 1460 (H) mm, 360 kg
Display unit:	850 (W) × 800 (D) * × 1200 (H) mm, 120 kg
Rotary pump:	526 (W) × 225 (D) × 306 (H) mm, 28 kg
Air compressor:	415 (W) × 210 (D) × 515 (H) mm, 16 kg
Weight:	200 (W) × 180 (D) × 160 (H) mm, 40 kg

* Exclusive of cables and connectors

1.2 Installation Requirements

Only the persons who have been trained by a certified engineer of the manufacturer are allowed to carry out the installation work described below.

1.2.1 General

The following places or conditions should be avoided for installation of the instrument.:

(1) Room adjacent to a transformer room
(2) Room adjacent to an elevator
(3) Location near large power-consuming equipment (e.g. electric furnace) or its power source
(4) Location near spark discharge source or high-frequency apparatus
(5) Atmosphere containing gas that may corrode metals
(6) Location exposed to direct sunlight or strong draft
(7) A dusty location
(8) Place subjected to strong vibrations
(9) Sharing of ground line with other electrical equipment
(10) Location near radio or sound wave source
(11) Place near railway

1.2.2 Room Temperature, Humidity and Altitude

(1) Room temperature .....15 to 30°C (without condensation)
Temperature fluctuation should be less than 5 °C during operation of the instrument and avoid climate control vents directed at the column.

(2) Humidity .....70% or less (without condensation)
The instrument should be operated in an air-conditioned room.

(3) Altitude.....Up to 2,000 m

1.2.3 Line Power Requirement

(1) Single-phase AC 100 V (±10%), 50/60 Hz, 2 kVA (for main unit)
When the supplied power line voltage is 100 V, the instrument works by direct connection.
When the supplied power line voltage is other than 100 V (200 V or others), use a step down transformer to step the power line voltage down to 100 V.
(Installation of the step down transformer is to be carried out by Hitachi installation engineers only.)

NOTICE:
(a) Line power fluctuation should be slow, and no abrupt fluctuation is allowable.
(b) Allowable line voltage fluctuation is ±10% max.
(c) This instrument over-voltage category is "CAT.II".
(d) The instrument provides Main ELB of the following type.
Leakage current breaker (CE conforming)
Rated current : 20 A
Trip current : 30 mA
Short-circuit interrupting capacity : 5 kA (Not be connected to supplies capable of delivering more than 5 kA.)
Conforms to IEC/EN 60947-2

(2) Notes concerning local preparation step down transformer

- A step-down transformer that meets the relevant standards and regulations of the country/region of use is required. The Hitachi installation engineer will verify the suitability of the transformer upon its installation.
- The step-down transformer must be self-protected against secondary overload or short circuit. Alternatively the MAIN-ELB overcurrent device (specifications listed above) of the Main Unit may be suitable to protect certain transformers. If relevant the Hitachi installation engineer will verify the transformer/circuit breaker combination upon installation.
- The step-down transformer (primary & secondary windings and protective earth) is connected to a terminals of the Main Unit that are sized M5 and suitable only for prepared (ring lug terminals). Please prepare the relevant cables for the transformer to the Main Unit. The Hitachi installation engineer will install the transformer and verify all connections.
- In the area of CE marking, the step-down transformer must be an isolating and double insulated type in accordance with IEC/EN 61558-1 and IEC/EN 61558-2-4 standard.

(3) External mains disconnection
Prepare an external mains disconnection device with the required isolation and lock-off/out characteristics for use in the electrical supply to the Main Unit. This disconnection device shall be located in close proximity to the equipment and within easy reach of the operator. It shall be marked as the disconnecting device for the equipment.

(4) An M5 ring lug terminal is equipped at the end of the input AC cord (ring lug terminal size: 5.3 mm in inside diameter, 9.5 mm in outside diameter), and the length of the input cord is 10 m.

1.2.4 Grounding Terminal

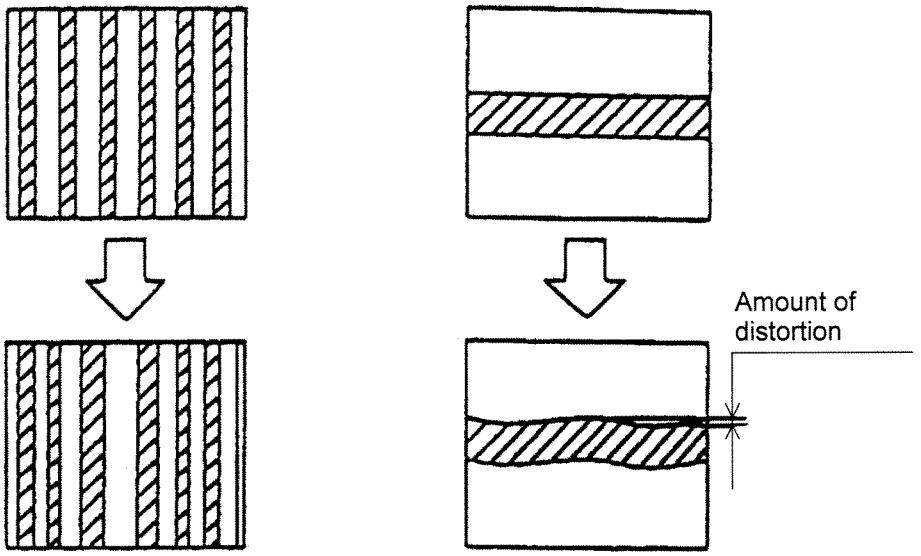
Connect the instrument to ground based on the standard of your country.
Avoid sharing the ground terminal with other power equipments. Be sure to ground the instrument independently. The image trouble and the malfunction of the equipment might be caused when sharing.

1.2.5 Stray Magnetic Field

Image disturbance will be negligible when the stray magnetic field conditions shown in Tables 1.2-1 are satisfied at the instrument installation place. Before proceeding to installation, check the stray magnetic field conditions as required. Make sure that the conditions shown in the tables are satisfied.
If there is a large-sized magnet clutch or power cable for other equipment in the vicinity of this instrument, abrupt variation in current or magnetic field may take place. Avoid installing the instrument in such a location.
If the instrument is installed in an environment having intense stray magnetic fields, the scanning electron beam is forced to tremble due to the magnetic field, causing abnormal expansion, shrinkage, distortion, unintentional shift, or whisker noise during imaging. These adverse effects occur differently depending upon whether the frequency component of stray magnetic field is synchronous with the power current frequency or not. Therefore, the allowable value of stray magnetic field component synchronous with power current frequency is different from that of stray magnetic field component asynchronous with power current frequency (DC magnetic field variation).

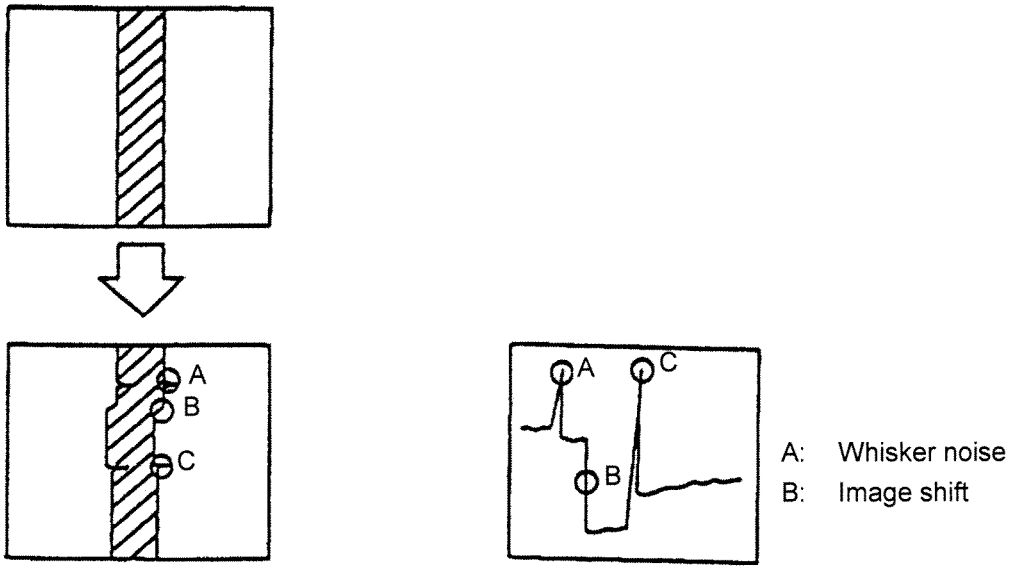
- The stray magnetic field component synchronous with power frequency appears as image distortion or deformation on the CRT display (Fig. 1.2-1). This is because the electron beam is scanned in synchronization with the power frequency.
  The maximum allowable value of stray magnetic field component synchronous with power frequency is specified so that no adverse effect will be given to CD measurement reproducibility.
- The stray magnetic field component asynchronous with power frequency affects imaging directly. That is, movement of the electron beam due to variation in external magnetic field appears as unintentional shift or whisker noise in imaging (Fig. 1.2-2).
  Even a slight variation in external magnetic field may result in conspicuous irregularity of the image. The maximum allowable value of stray magnetic field component asynchronous with power frequency is specified so that CD measurement reproducibility will not be affected by image shift or whisker noise.

The effect on the scanning electron beam varies also according to whether the stray magnetic field component is in the horizontal or vertical direction, and the allowable value differs for each of these components. Given below are the allowable values stipulated under the resolution guaranteeing conditions (high resolution observation conditions), and under conditions different from these. Image disturbance may occur even if the stray magnetic field at the site satisfies the allowable values given in Tables 1.2-1.
In general, the effect of a stray magnetic field (wavering of scanning electron beam) is inversely proportional to the square root of the accelerating voltage, provided the other parameters are kept constant. The effect increases nearly proportionally to the working distance.



(a) Image expansion/contraction (b) Image distortion

Fig. 1.2-1 Effect of Stray Magnetic Field Component Synchronous with Power Frequency (AC magnetic field)



(a) Appearance of image disturbance (b) DC magnetic field variation

Fig. 1.2-2 Effect of Stray Magnetic Field Component Asynchronous with Power Frequency (DC magnetic field variation)

Table 1.2-1 Allowable Stray Magnetic Field

Resolution Guaranteeing Conditions	AC magnetic Field (rms value)		DC magnetic Field Variation (peak to peak)	
	Horizontal Direction	Vertical Direction	Horizontal Direction	Vertical Direction
Accelerating voltage : 3 kV Magnification : ×30,000 WD : 5.0 mm Beam : 10	140 nT	730 nT	160 nT	820 nT
Accelerating voltage : 30 kV Magnification : ×100,000 WD : 5.0 mm Beam : 0	200 nT	640 nT	230 nT	720 nT

nT: nano-tesla

NOTICE:

1. The power frequency synchronous component (AC magnetic field) is in rms value. To evaluate in peak-to-peak value, the allowable value will be 2.8 times the rms value.
2. The DC magnetic field variation is an abrupt variation of stray magnetic field with respect to time. A slow, gently sloping variation with time is handled as a field drift.
3. The allowable AC magnetic field is the value at the prescribed image disturbance (expansion/contraction or bending of image) of 0.5 mm and at the specified magnification.
4. The allowable DC magnetic field variation is the value at the prescribed image disturbance (image shift or whisker noise) of 0.2 mm and at the specified magnification.
5. The DC component of stray magnetic field without fluctuation does not cause swaying of the electron beam, and will not affect the image if the amount is around several ten μT.
6. The allowable values in Table 1.2-1 are the ones under the resolution guaranteeing conditions in the table. In general, the longer the WD or the lower the accelerating voltage, the more the electron beam is susceptible to stray magnetic field effect.
7. If the allowable values in Table 1.2-1 are exceeded, the stray magnetic field must be reduced by one of the countermeasures below:
   (1) Try a different installation location.
   (2) Provide a magnetic shielding box.
   (3) Provide an active magnetic field canceller.

1.2.6 Vibrations

Before installing the instrument, measure floor vibration at the site. Image trouble will not occur if the allowable values in Table 1.2-2 are satisfied under the resolution/photographing conditions. If the instrument is installed on the first floor of a reinforced-concrete (steel-framed-concrete) building, the performance of the instrument will not be degraded by external vibration as long as vibration sources such as heavy-duty machine tools or transportation facilities (e.g. electric car) are not operated nearby.
Check the vibration conditions at the site before installation (or upon receiving an order) as required. Make sure that the values shown in the table are satisfied.
External vibration: Image trouble will not occur if the conditions in Table 1.2-2 are satisfied.

Table 1.2-2 Allowable Vibrations

Type I Stage Allowable Value (low-frequency region)

Frequency	X, Y-direction	Z-direction
2.0 Hz	0.8 μm p-p max.	-
3.0 Hz	0.8 μm p-p max.	-
5.0 Hz	0.8 μm p-p max.	4.0 μm p-p max.
8.0 Hz	2.0 μm p-p max.	1.5 μm p-p max.
10.0 Hz	3.0 μm p-p max.	2.5 μm p-p max.

Type I Stage Allowable Value (high-frequency region)

Frequency	X, Y, Z-direction
10.0 Hz	1.0 cm/s^2 max.
50.0 Hz	2.0 cm/s^2 max.
60.0 Hz	2.0 cm/s^2 max.

Type II Stage Allowable Value (low-frequency region)

Frequency	X, Y-direction	Z-direction
2.0 Hz	1.0 μm p-p max.	-
3.0 Hz	3.0 μm p-p max.	-
5.0 Hz	2.0 μm p-p max.	0.6 μm p-p max.
8.0 Hz	1.5 μm p-p max.	1.2 μm p-p max.
10.0 Hz	2.5 μm p-p max.	1.6 μm p-p max.

Type II Stage Allowable Value (high-frequency region)

Frequency	X, Y, Z-direction
10.0 Hz	1.0 cm/s^2 max.
50.0 Hz	2.0 cm/s^2 max.
60.0 Hz	2.0 cm/s^2 max.

Acceleration 4 cm/s^2 (gal) is the same as amplitude 10 μm p-p in the frequency 10 Hz.
The allowable values is the value at the prescribed image disturbance of 0.2 mm and at the X 100,000 in photograph.

NOTICE:
1. A sine wave should be used for vibration measurement. If other than a sine wave, measurement should be made with each frequency component concentrated at a dominant frequency level.
2. For vibration at an extremely low frequency of less than 1 Hz, complete prevention is impossible with the vibration-isolating technology available at present.
3. In a frequency region from 1 to 10 Hz, interpolation should be made through each allowable value point.
4. If floor vibration exceeds the allowable values, please consult Hitachi (floor vibration that may cause image trouble should be measured in advance).
5. The above-mentioned allowable amplitude is the value with a sample size of 5 mm diameter. The larger sample, the more susceptible to the effect of vibration and the lower the allowable amplitude.

1.2.7 Power Line Noise and Electric Field Noise

Image troubles may be observed when a device as given in Table 1.2-3 or its power line is installed nearby or, even if it is distant, it is a heavy-duty type. When selecting the installation site, therefore, whether a source of interference is located nearby or not must be checked.
In case an equipment energized by power of a frequency different from the commercial frequency employed on the Model S-3400N or the power line for it is located nearby, scan synchronization with power line frequency will become ineffective. Such a location should be avoided.

Table 1.2-3 External Noise Sources

Classification		Noise Source	Source Equipment
Small-sized electric equipments	Electric equipment with contacts	Electric discharge (spark, arc)	Flasher (neon sign, ornamental electric bulb), relay, electromagnetic contactor, thermostat (warmer, refrigerator, heating iron), cash register
	Equipment utilizing brush type motor	Electric discharge (spark, arc), sliding contact	Electric drill, laboratory engine, motor of sewing machine, cleaner, food mixer, shaver, massaging machine
	Electric discharge tube	Glow discharge	Neon discharge tube, high pressure mercury arc lamp
	Controller utilizing semiconductor	Phase control (transient noise)	Thyristor dimmer, inverter
Equipment using high frequency	Industrial high frequency equipment	* Electro-magnetic emission	Industrial high frequency heater, high frequency electric welder, microwave oven
	Medical high frequency equipment	* Electro-magnetic emission	VHF/UHF devices, electric scalpel
	Equipment utilizing ultrasonic wave	* Electro-magnetic emission	Flaw detector, depth sounder, fish finder, ultrasonic cleaner
Power equipment	Power cable (transmission line)	Electric or magnetic filed, Ground current	Induction of commercial frequency (electrostatic induction, electromagnetic induction, current leaking in ground)
		Electric discharge (corona, arc)	Corona, poor insulator, poor contact due to corroded metal (arc discharge)
	Electric railroad/train	Electric discharge (spark, arc)	Trolley wire, internal equipment, rectifier
		Magnetic field	Current flow deviation
Internal combustion engine	Automobile	Electric discharge	Ignition system
		Other	Dynamo, voltage regulator, wiper, horn, winker
Large power Radio frequency equipment		*Electro-magnetic emission	Broadcasting equipment, radar
		Electro-magnetic emission	Radio transceiver

* Emission that are signals in a given system but cause interference in other systems.

1.2.8 Disturbance by Sound Waves

Sound waves (vibrations of air) adversely affect the Model S-3400N regardless of their frequency and may cause image trouble. To prevent this, confirm before installation that equipment that may cause a sonic disturbance is not located in the vicinity of the S-3400N. If such equipment exists, then check for noise level.
In general, as the frequency of noise increases, the sound pressure level decreases, and the frequency of noise varies depending on the cause of noise. It is therefore necessary to carry out noise frequency analysis at the installation location of the S-3400N SEM to check the degree of noise (effective factor) in each case. If the frequency of noise matches the resonance frequency of the system, a frequency of less than 150 Hz can cause image faults if the noise level is greater than 58 dB.

Table 1.2-4 Allowable Sound Pressure Level (C characteristics)

Frequency: f (Hz)	Allowable Noise Level (Type Ⅰ)	Allowable Noise Level (Type Ⅱ)
$f \leq 150$	70 dB max.	75 dB max.
$150 \leq f \leq 800$	60 dB max.	65 dB max.
$800 \leq f \leq 2000$	70 dB max.	65 dB max.

NOTICE: The representative value at the noise level where this instrument is generated is recorded below.

Normal operation : 42 dB
Evacuation after specimen exchange : 50 dB
Compressor operation : 57 to 60 dB (use standard compressor)

* Operator's position in normal use. Exclude Buzzer sound. Condition with low noise other than instrument.

1.2.9 Electro-Magnetic Compatibility

This instrument has suited class A of EN standard EN61326-1: 2006. Do not set up this instrument near the equipment that is influenced data by the electromagnetic radiation noise in this standard allowance value. Moreover, this instrument might be influenced data by the electromagnetic radiation noise, and cause the malfunction of the instrument. Manage in the room where this instrument was set up so as not to bring the following electric equipment* in.

*: Equipment that generates electric wave like specific, small electric power equipment such as cellular phone, transceiver and cordless phone.

1.2.10 Site Requirements

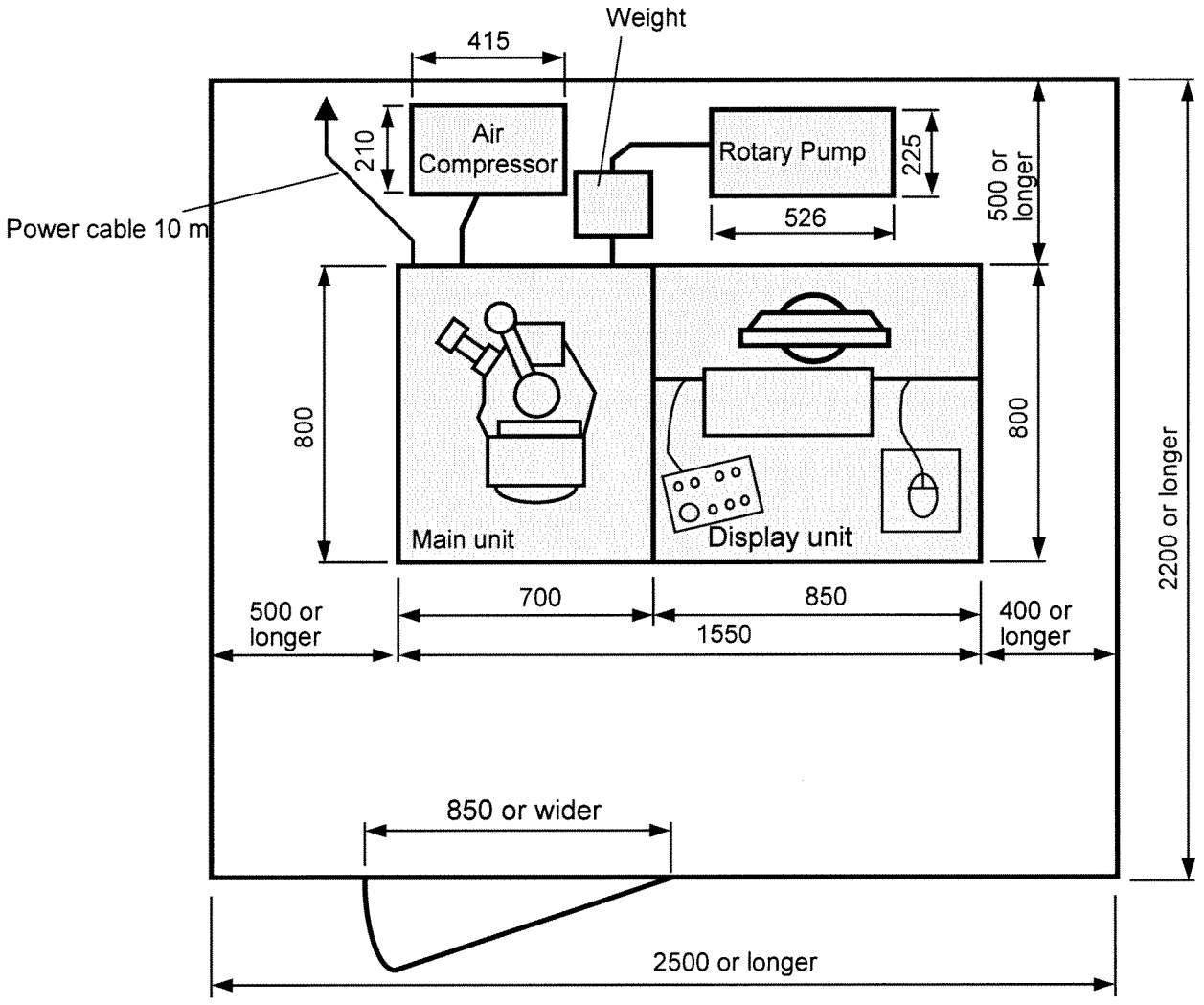
(1) Required floor space
A minimum area of 2.5 m × 2.2 m is required.

(2) Minimum required dimensions of the entrance
0.85 m (W) × 1.7 m (H)

(3) Required strength of the floor

$$\frac{\text{floor strength } (\text{N/m}^2)}{3} \geqq \frac{\text{total mass of equipment } (\text{kg}) \times 9.8}{\text{floor space } (\text{m}^2)}$$

(4) Other
For layout, see Fig. 1.2-3.



Dimensions in mm

*The chair is not contained to the instruments.

Fig. 1.2-3 Layout Diagram

NOTICE: Leave an approximately 500 mm clearance on the left side and rear side of the system for maintenance purposes.

1.3 Customer-supplied Items

The items listed in Table 1.3-1 should be procured prior to the installation work.

Table 1.3-1 Customer-supplied Items

Name	Quantity	Comments
Ethanol	500 mL	For cleaning/ultrasound cleaning of components
Acetone	500 mL	
Polyethylene gloves	1 box	For handling vacuum parts
Specimen vapor deposition system	1 set	For metal vapor deposition on specimen surfaces/aperture vacuum baking (cleaning)
Ion sputtering system	1 set	For specimen metal coating
Tungsten basket	1 ea.	For vapor deposition equipment filaments
Gold wire	1 ea.	Specimen vapor deposition targets
Ultrasonic cleaning system	1 set	For cleaning components
Aluminum foil	1 ea.	For storing cleaned components
Dessicator or a dry storage box	1 ea.	For the storage of specimens and filaments
Optical microscope	1 ea.	For verifying specimens
Conductive two-side tape	1 ea.	For fixing large specimens/for quick fixing (for low magnification applications)
Conductive paint	1 ea.	For fixing specimens (for high magnification applications). It is recommended to prepare appropriate conductive paint by customer. Conductive liquid silver paint (concentration of Ag≧ 60%) Colloidal graphite (example, TED PELLA cat No.16053) For solvent, we recommended isopropanol.
Bond	1 ea.	For wet specimens fixing
Tweezer	1 ea.	For handling specimens and parts
Blower	1 ea.	For cleaning
Metal polishing paste	1 ea.	For cleaning. Please prepare by each customer. We recommend [PIKAL (paste): Manufactured by NIHON MARYO-KOGYO CO., LTD].
RP oil	1 ea.	For oil rotary pump. Please prepare 1L SMR-100 (ULVAC) oil for rotary pump, if rotary pump comes with units.

2. FUNCTIONS

This chapter explains the mechanical configuration of the S-3400N SEM and describes its software.
Fig. 2-1 (a) and Fig. 2-1 (b) show the appearance of the Model S-3400N Type Ⅰ and Type Ⅱ.

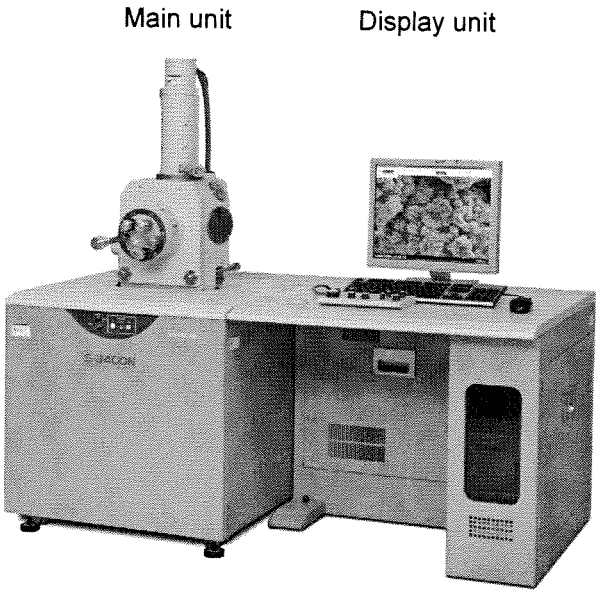


Fig. 2-1 (a) Model S-3400N Scanning Electron Microscope, Type Ⅰ

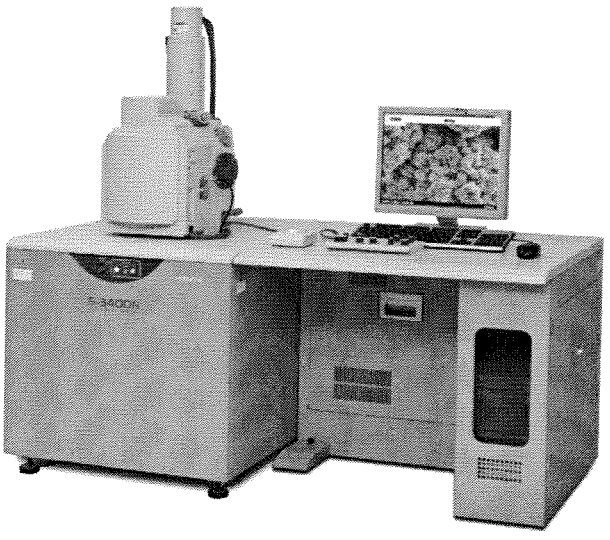


Fig. 2-1 (b) Model S-3400N Scanning Electron Microscope, Type Ⅱ

2.1 Control Knobs and Switches on Main Unit

2.1.1 Main Unit

Fig. 2.1-1 shows the appearance of the S-3400N main unit (Type Ⅱ).

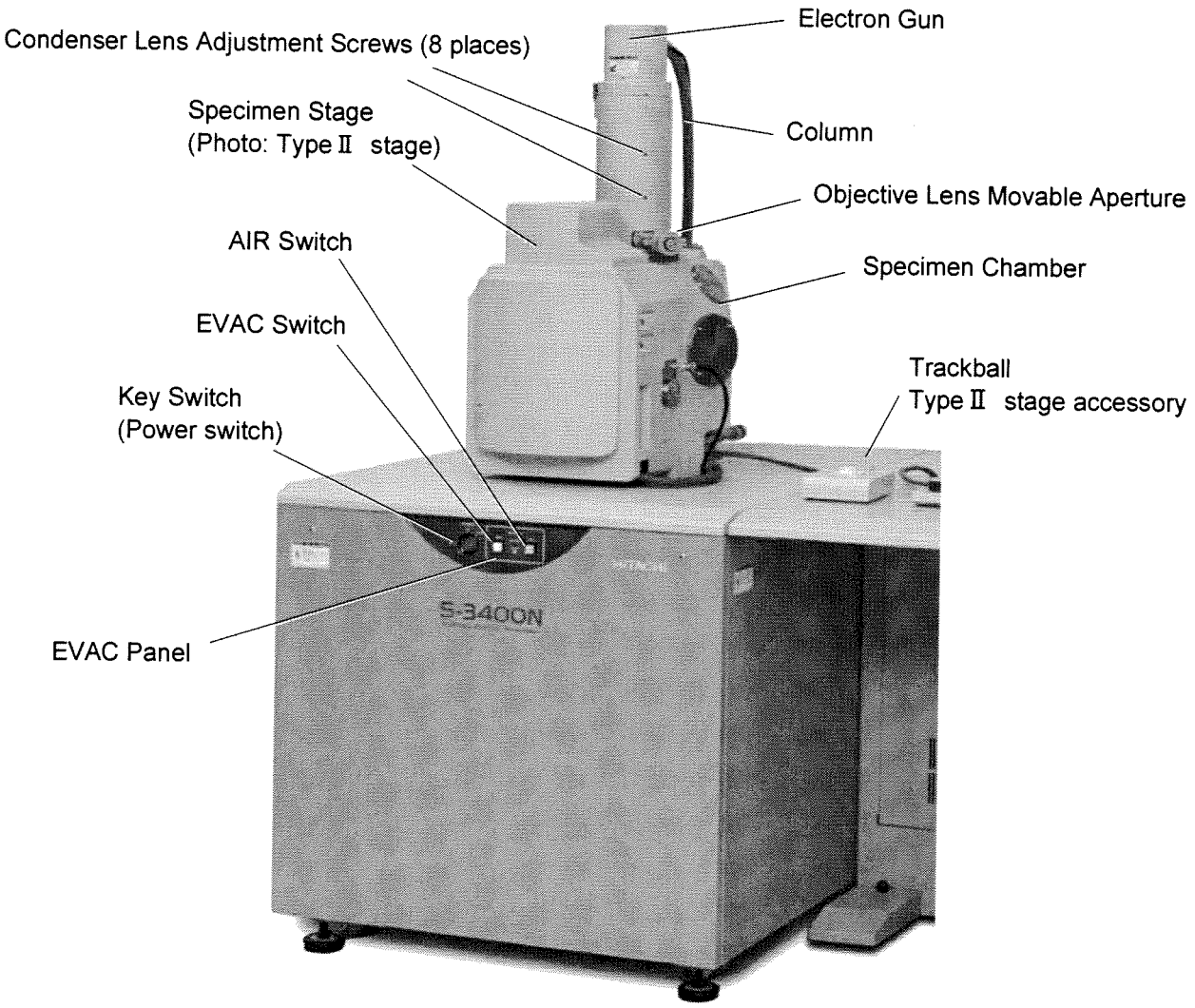


Fig. 2.1-1 External View of the Column (Type Ⅱ)

NOTICE:	Do not touch the Condenser Lens Adjustment Screws (8 places). The position of the condenser lenses adjusted shift, and the first performance might not be obtained.

2.1.2 Electron Optical Column

Fig. 2.1-2 sketches the sectional view of the S-3400N column.

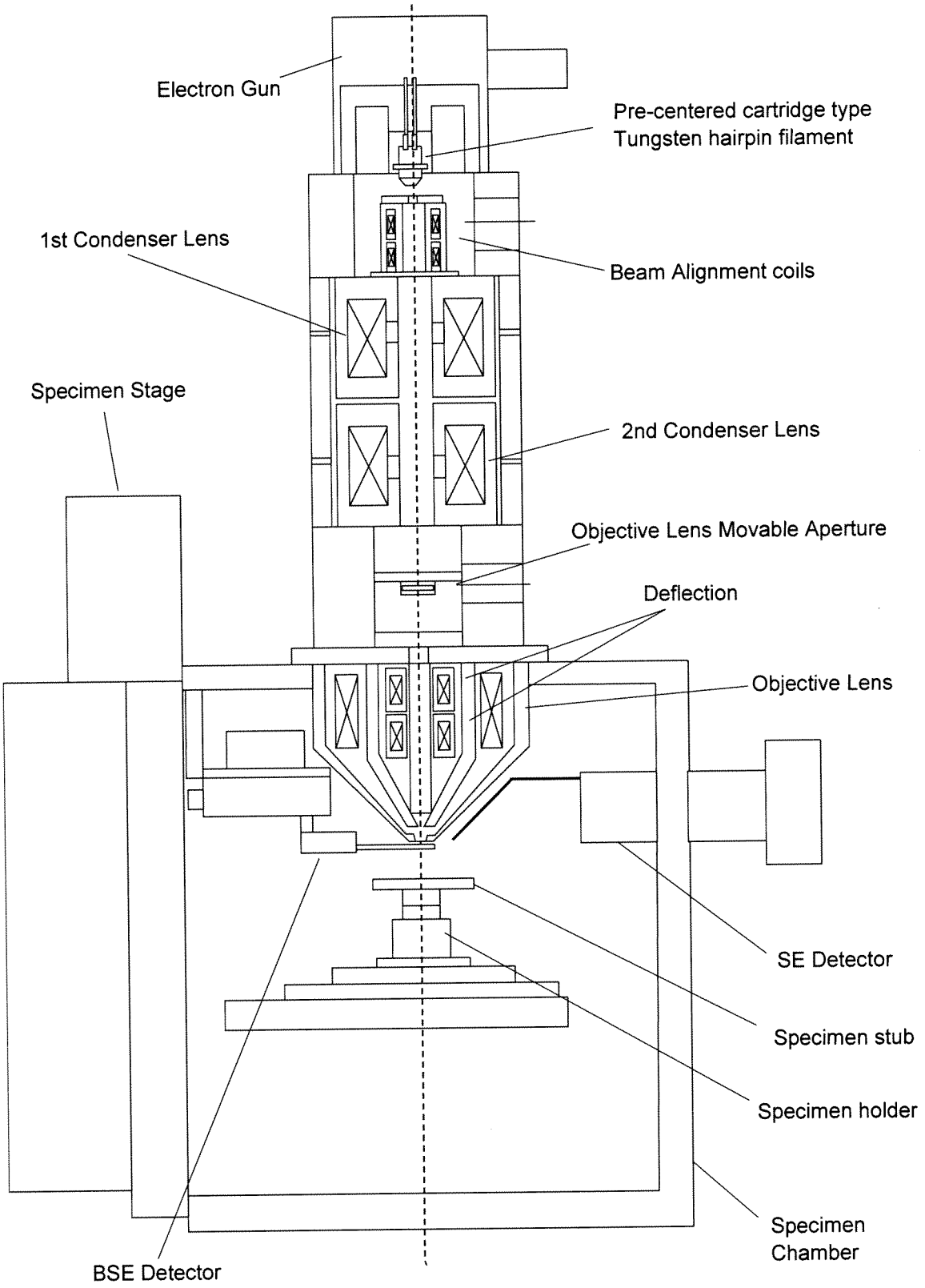


Fig. 2.1-2 Sectional View of S-3400N Column

2.1.3 Specimen Stage (Type I)

Fig. 2.1-3 shows the Type I specimen stage.

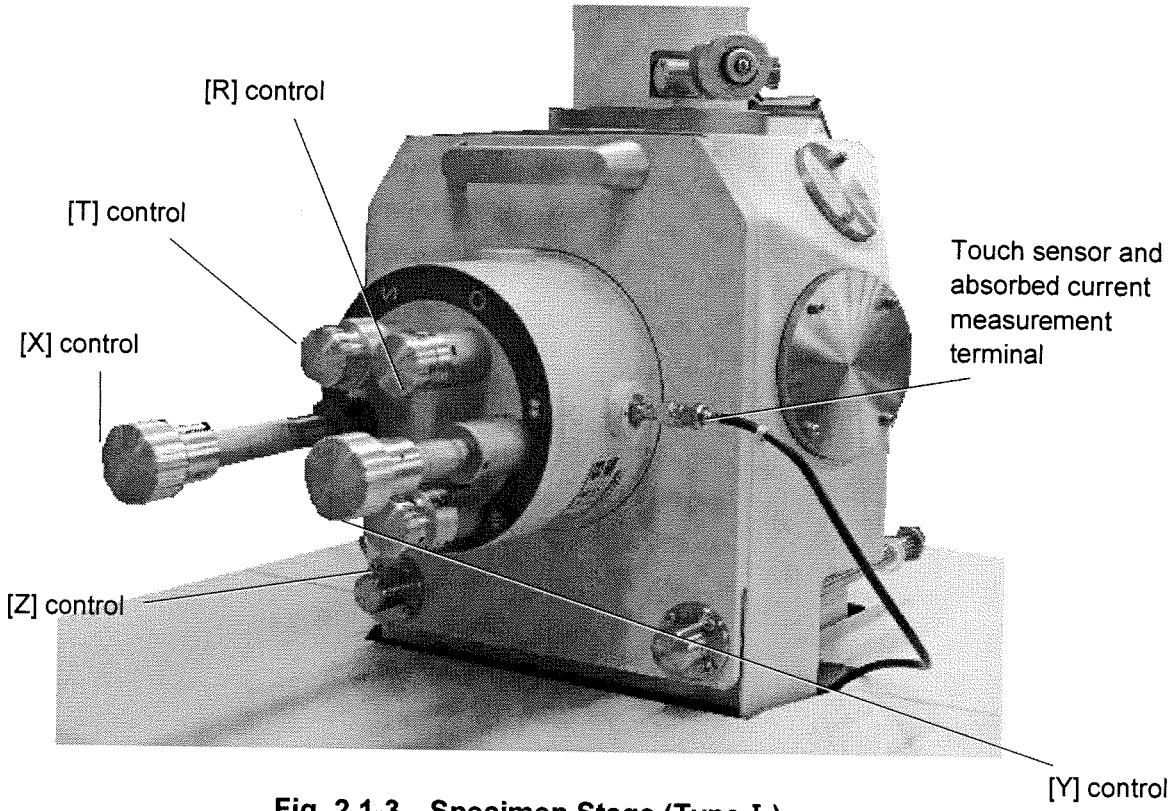


Fig. 2.1-3 Specimen Stage (Type I)

- [X] control: Moves specimen in X direction within a range from 0 to 80 mm.
- [Y] control: Moves specimen in Y direction within a range from 0 to 40 mm.
- [Z] control: Moves specimen in Z direction or shifts WD (Working Distance) within a range from 5 to 35 mm. (X-ray analysis position is at 15 mm working distance)
- [R] control: Rotates specimen through 360° (continuously variable)
- [T] control: Tilts specimen within a range from -20° to 90°.
- [Touch sensor and absorbed current measurement terminal]: This terminal is used for the measurement of the irradiation current of electrons on the specimen (normally it is used as a touch sensor).

Touch Sensor : This observes whether the specimen or the stage come in contact with components inside the specimen chamber
The sensor will inform with the buzzer and the message when coming in contact.

Absorbed Current Terminal : The absorbed current can be measured by removing the cable for the touch sensor, and connecting a minute ammeter instead.

2.1.4 Specimen Stage (Type Ⅱ)

Fig. 2.1-4 shows the appearance of specimen stage driven by motors (Type Ⅱ).

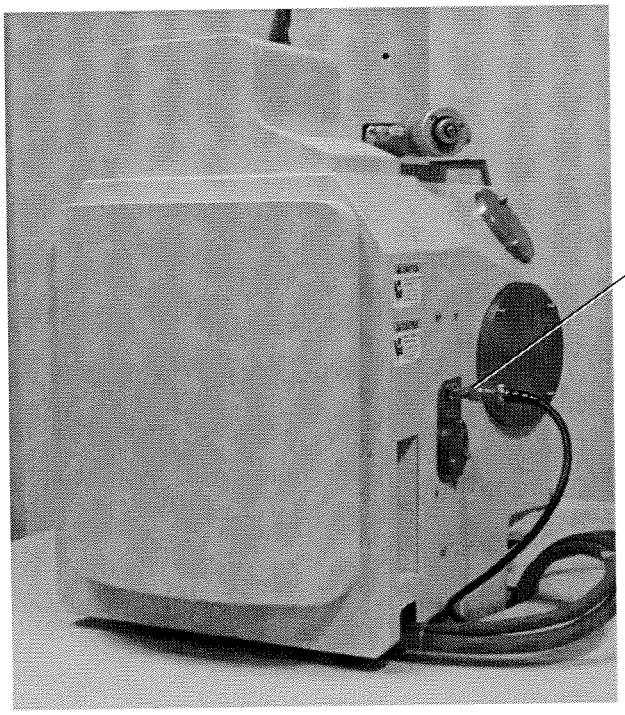


Fig. 2.1-4 Large Specimen Stage (Type Ⅱ)

- Range of movement in X direction: 0 to 100 mm
- Range of movement in Y direction: 0 to 50 mm
- Range of movement in Z direction: WD = 5 to 65 mm
  (X-ray analysis position is at 10 mm working distance)
- Range of movement in R direction: 360° continuously
- Range of movement in T direction: -20° to 90°
- Touch sensor and absorbed current measurement terminal: This terminal is for the measurement of the absorbed current of the electron image of a specimen (normally it is used as a touch sensor terminal).

2.1.5 EVAC Panel

Fig. 2.1-5 shows the EVAC panel.

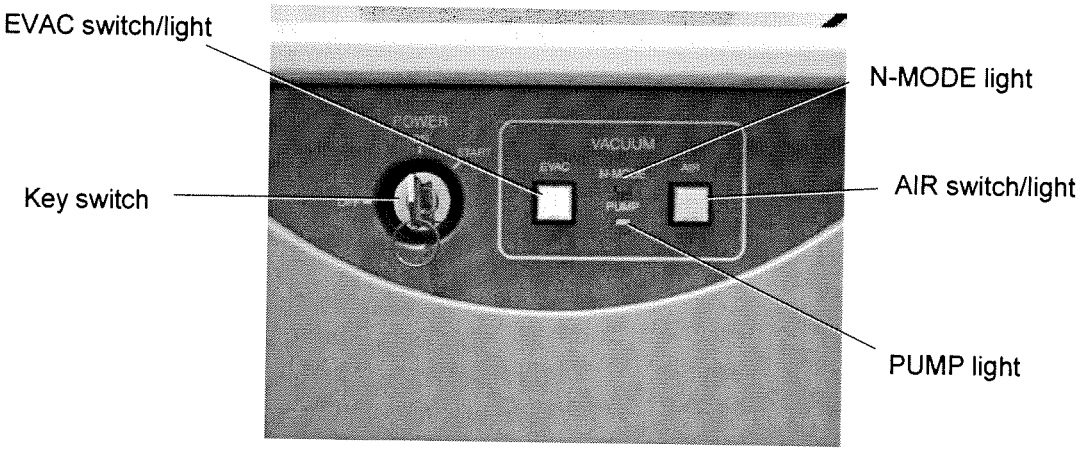


Fig. 2.1-5 EVAC Panel

- Key switch: The **POWER** for the system unit. Insert the key and turn it to the **START** position to start the system. Releasing the key stops the key at the ON position. Returning the key to the **OFF** position shuts down the system in a few seconds.

- EVAC switch/light: This switch introduces air into the specimen chamber. The built-in light comes on when the specimen chamber is at atmospheric pressure. When the air is being introduced, the light blinks. When held down for 0.5 second or longer, this switch acts as an AIR switch/light.

- N-MODE light: This light comes on when the **VP-SEM** mode is selected. See <2.3.7.4 VACUUM MODE Block>.

- PUMP light: This light, which indicates the operating status of the turbo molecular pump (TMP), blinks when the TMP is accelerating, and remains solidly lit when the pump is running at a steady state.

2.1.6 Evacuation System

Fig. 2.1-6 shows the block diagram of evacuating system.

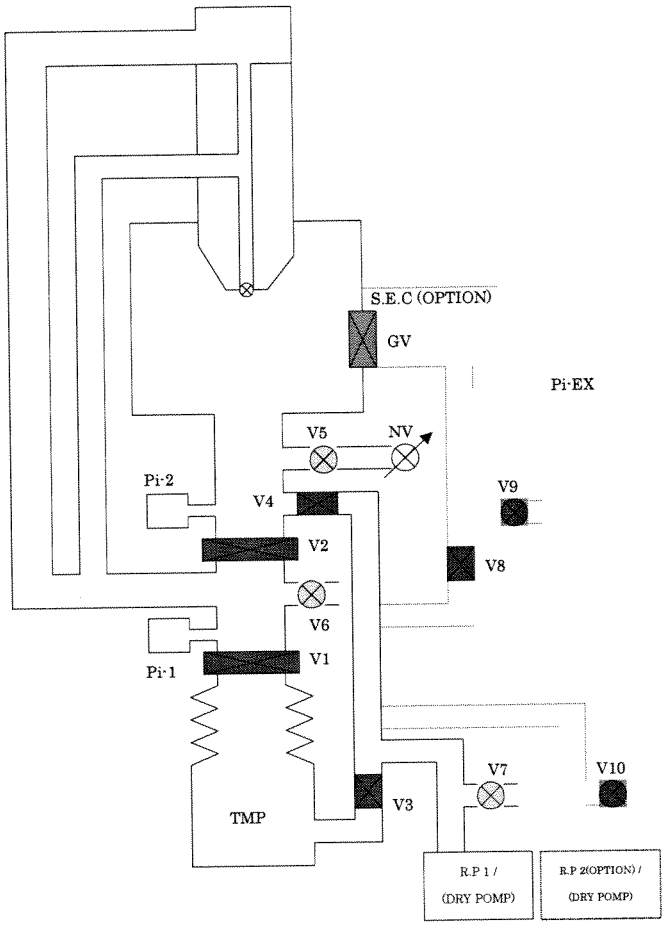


Fig. 2.1-6 Evacuation System

TMP: Turbo molecular pump for evacuating the specimen chamber
R.P: Rotary pump
V1-V9: Vacuum valves
NV: Needle valve
Pi-1: Pirani vacuum gauge
Pi-2: Pirani vacuum gauge

2.1.7 System Power Distribution Board

Fig. 2.1-7 shows an external view of the system distribution board located in the back of the main unit.

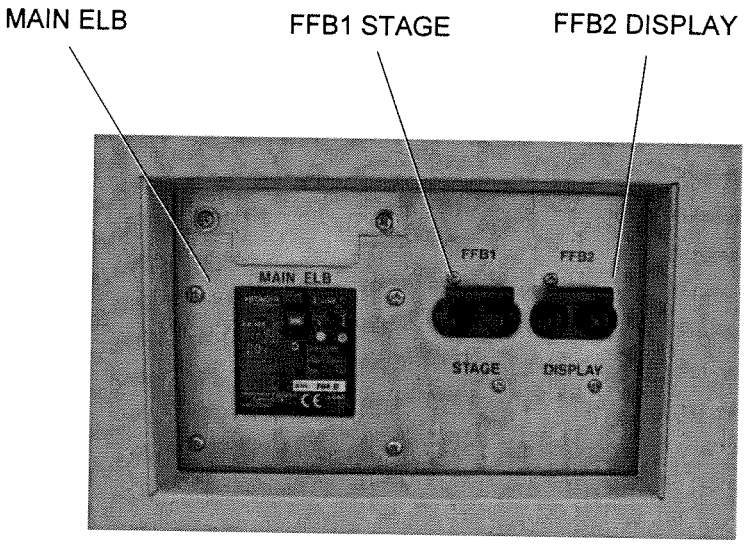


Fig. 2.1-7 System Power Distribution Board

- MAIN ELB: Main breaker. At starting turn it ON. Turn it OFF for a complete shutdown.
- FFB1 STAGE: Breaker for the power for the Type Ⅱ stage control unit. This breaker, which is not required for a Type Ⅰ stage, should normally be turned OFF.
- FFB2 DISPLAY: Breaker for the display power supply unit. Normally this remains ON. Turn it OFF for a complete shutdown.

2.2 Control Knobs and Switches on Display Unit

2.2.1 Display Console

Fig. 2.2-1 shows the display unit.

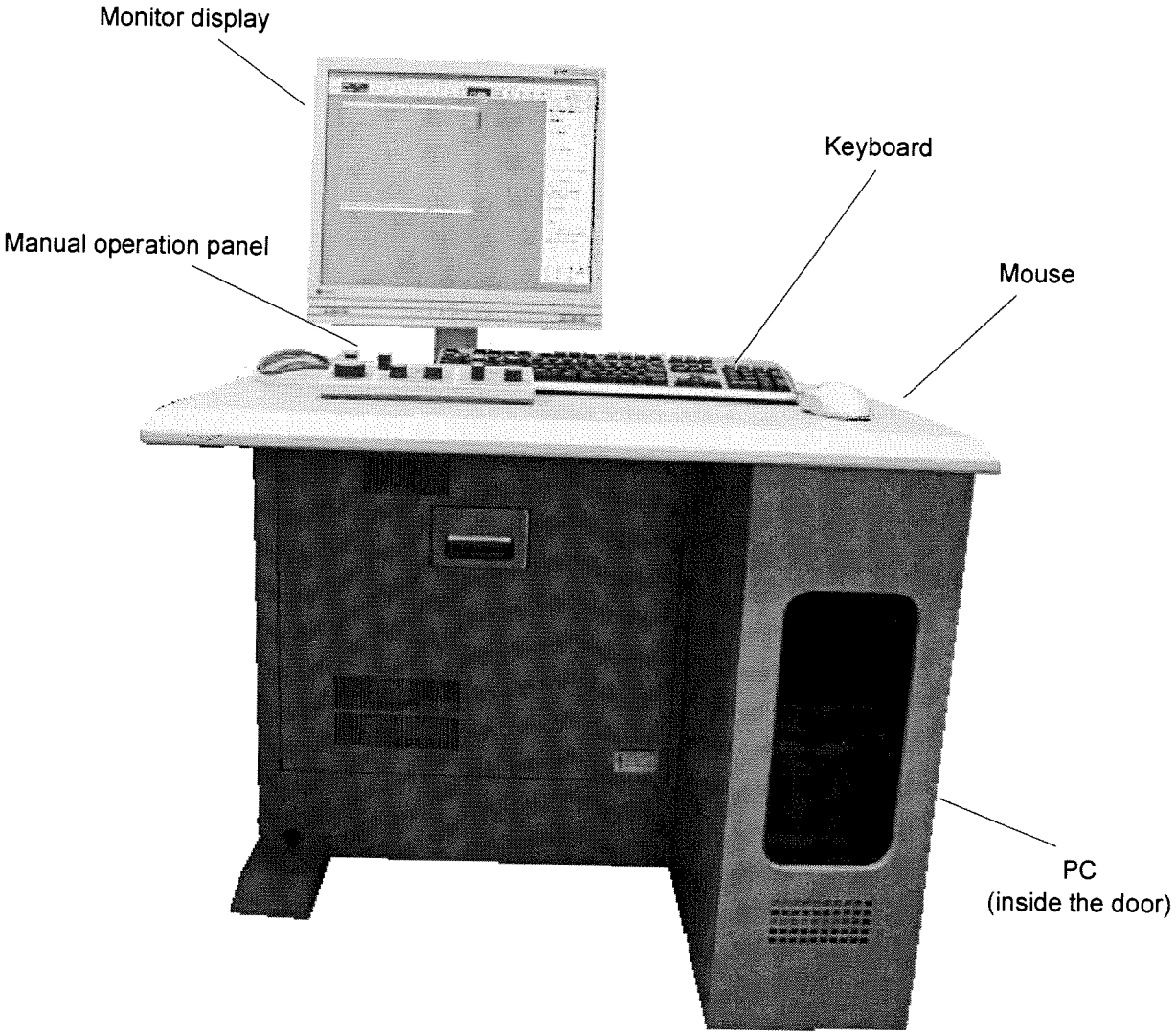


Fig. 2.2-1 Display Unit

- PC: SEM control personal computer. Placed inside of the door.
- Monitor display: Display monitor of PC. For adjustment of the monitor, refer to instruction manual of the monitor. Model of the monitor display is subject to change without notice.
- Manual operation panel: Frequently used controls are placed on the manual operation panel.
- Keyboard/Mouse: Use to operate the device.

2.2.2 PC (Personal Computer)

Fig. 2.2-2 shows the front part of the control PC. (Because PCs undergo frequent model changes, the photograph below may not be the same as the model that is actually delivered.)

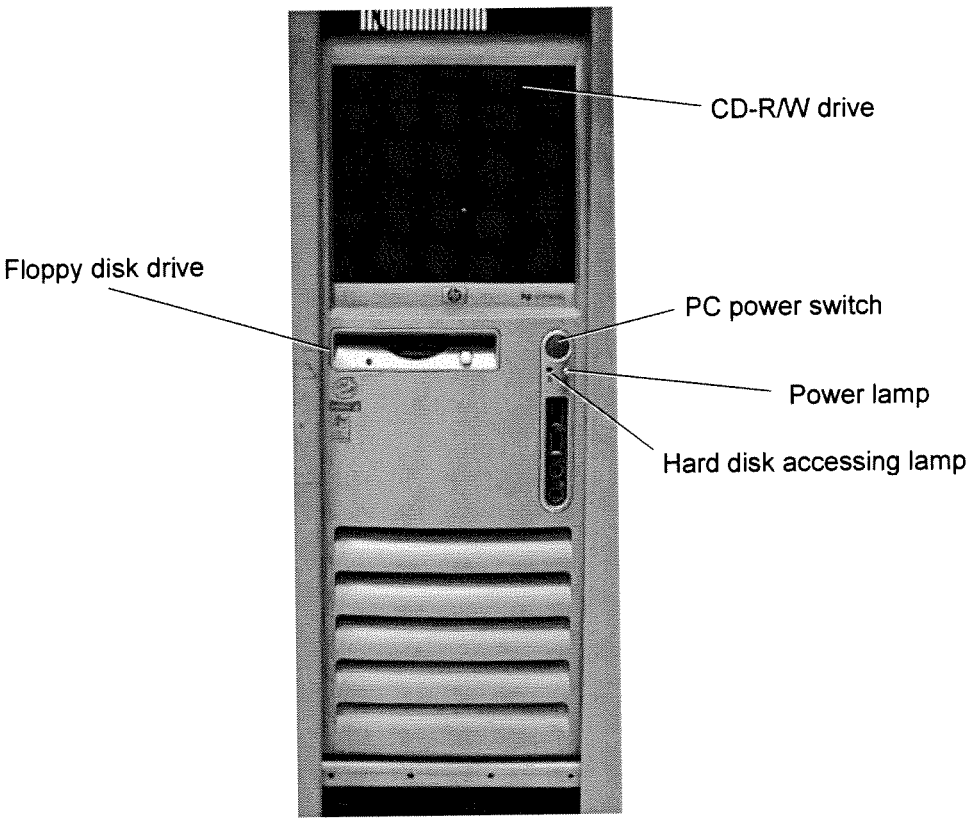


Fig. 2.2-2 PC Panel

- PC power switch: Power switch of PC. Usually the switch need not be used. The power for the PC is set so that it comes ON when the EVAC panel key switch is turned to the START position, and it turns OFF when Windows is shut down.
- Floppy disk drive: Floppy disk drive. Be careful not to insert or remove disk while the access lamp is lit.
- CD-R/W drive: CD-R/W drive.
- Hard disk accessing lamp: Shows that hard disk is being accessed.

2.2.3 Manual Operation Panel

Fig. 2.2-3 shows the manual operation panel.

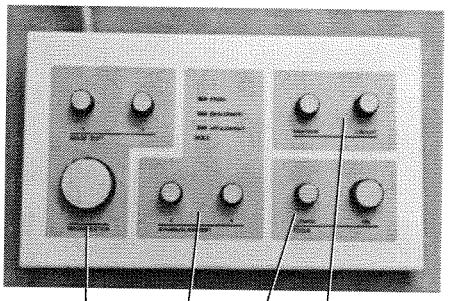


Fig. 2.2-3 Manual Operation Panel

- Stigma/Alignment adjusting section
  [Stigma/Alignment] [X], [Y] knobs: Use for astigmatism correction in a usual practice manual mode.
  In the electron optics alignment mode, these knobs serve for alignment adjustment.

- Focus adjusting section
  [Focus] [Coarse] [Fine] knobs: Use for coarse and fine focus adjustment.

- Magnification/Image shift control section
  [Magnification] knob: Use for magnification setting.
  [Image Shift] knobs: Move image by electrical image shift.

- Brightness/Contrast adjusting section
  [Brightness] knob: Use for brightness adjustment.
  [Contrast] knob: Use for contrast adjustment.

2.2.4 Mouse and Trackball

Fig. 2.2-4 shows the mouse used in this system.
The button name shown in the following photo is used in this manual.

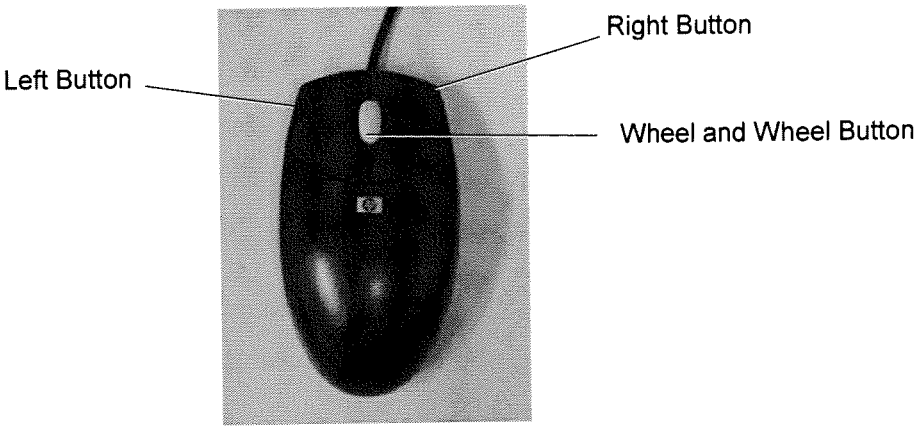


Fig. 2.2-4 Mouse

Fig. 2.2-5 shows the trackball unit.
It is used for stage X and Y axes manual operation of Type Ⅱ model.

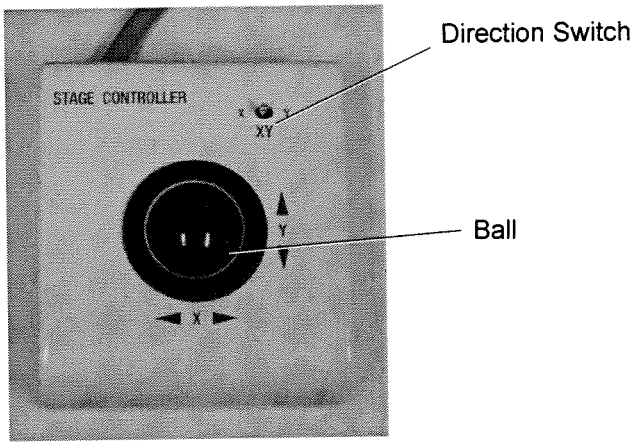


Fig. 2.2-5 Trackball Unit

- Ball: The field of view modes in the direction in which the ball is rotated. It is possible to set the direction of motion in a reverse direction. See 3.9.14 Optional Setting.
- Direction switch: If setting the switch to the X side and turning the ball, the stage moves in a horizontal direction only. Likewise, if setting the switch to the Y side and turning the ball, the stage moves in a vertical direction only. When the switch is in a neutral state, the stage moves in both directions.

2.2.5 Joystick Unit (Option)

Fig. 2.2-6 shows the joystick unit (option).

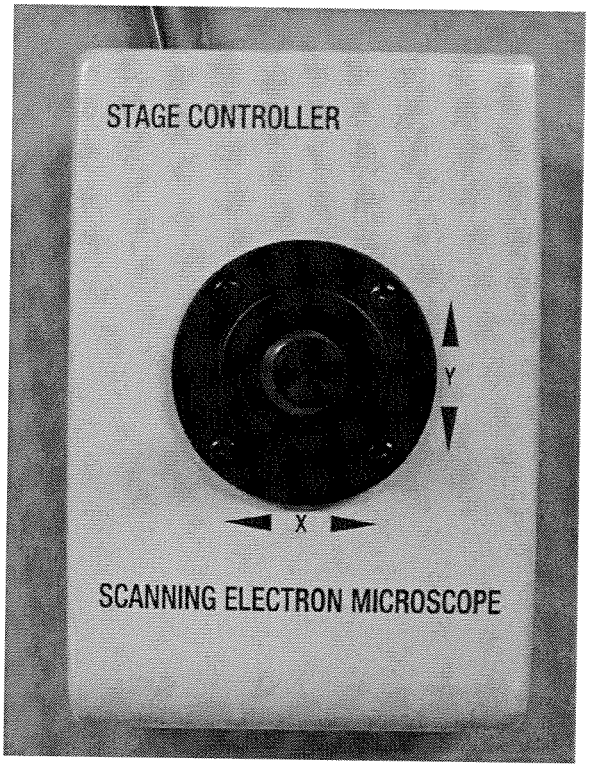


Fig. 2.2-6 Joystick Unit (Option)

Joystick : The field of view moves in the direction in which the Joystick is tilted.

NOTICE:	Select and use either a joystick (option) or a standard track ball. It is possible to set the direction of motion in a reverse direction. Do these settings in **Optional Setup** window. See <3.9.14 Optional Setting>.

2.3 Graphical User Interface (GUI)

2.3.1 Starting the PC and Logging in the S-3400N Program

Use the following steps to logon to Windows XP.

(1) Starting up the PC
Use the key switch to turn on the system and start it. The PC will also start up automatically.

(2) Logon
A message requesting key in will appear. Press **Ctrl**, **Alt** and **Delete** keys simultaneously. (This request message will be shown or not depending on network setting of SEM computer.) Then the Windows XP logon window will appear.

(3) Enter the logon name and password assigned to each user to log on.
When the system is delivered, the logon user name "PC-SEM" should be used.
No password for "PC-SEM" is set at delivery time.

NOTICE: When the system is delivered, the following two sets of Windows XP logon user names/privileges/passwords are in effect:

Logon user name	Privileges	Password
Administrator	Administrator	hitachi
PC-SEM	Power User	None

S-3400N control program will start up automatically. When starting S-3400N control program after once terminating it, select Start - PC_SEM on the taskbar S-3400N operating program. When closing this program and restarting it, select **All Programs - PC_SEM** from Start on the Taskbar. The program can also be started by double-clicking the shortcut  on the Desktop.

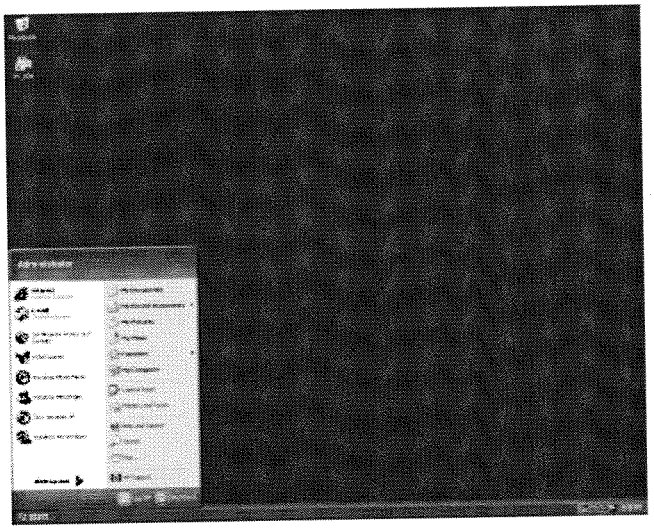


Fig. 2.3-1 Example of Windows Desktop

(Windows XP is a trademark of Microsoft Corp.)

The **S-3400N login** window will open.

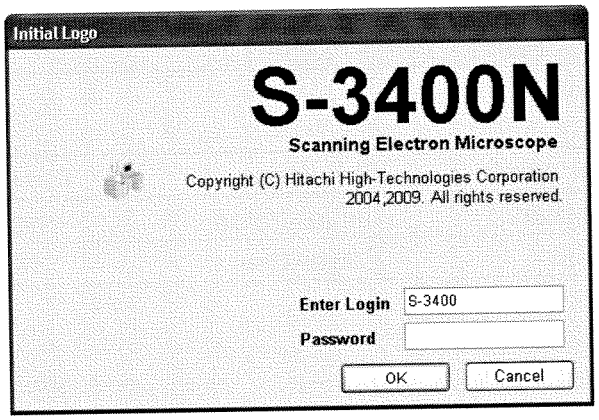


Fig. 2.3-2 S-3400N Login Window

At the first startup after installation of the program, use the login name "S-3400" and click the **OK** button. You need no Password. After login names and passwords have been set, input the name and the password and then click the **OK** button.

NOTICE:
- The system supervisor shall be responsible for setting and maintaining login names and passwords.
  Refer to <3.9.16 Setting Login Name>.
- Setting or change of password for a login name once registered with the above operation can be made using the Password Setting window.
  Refer to < 3.9.15 Password Setting>.
- For operation of Windows, refer to the instruction manual for Windows XP.

2.3.2 S-3400N SEM Main Window

Fig. 2.3-3 shows the main window for operation of the microscope.

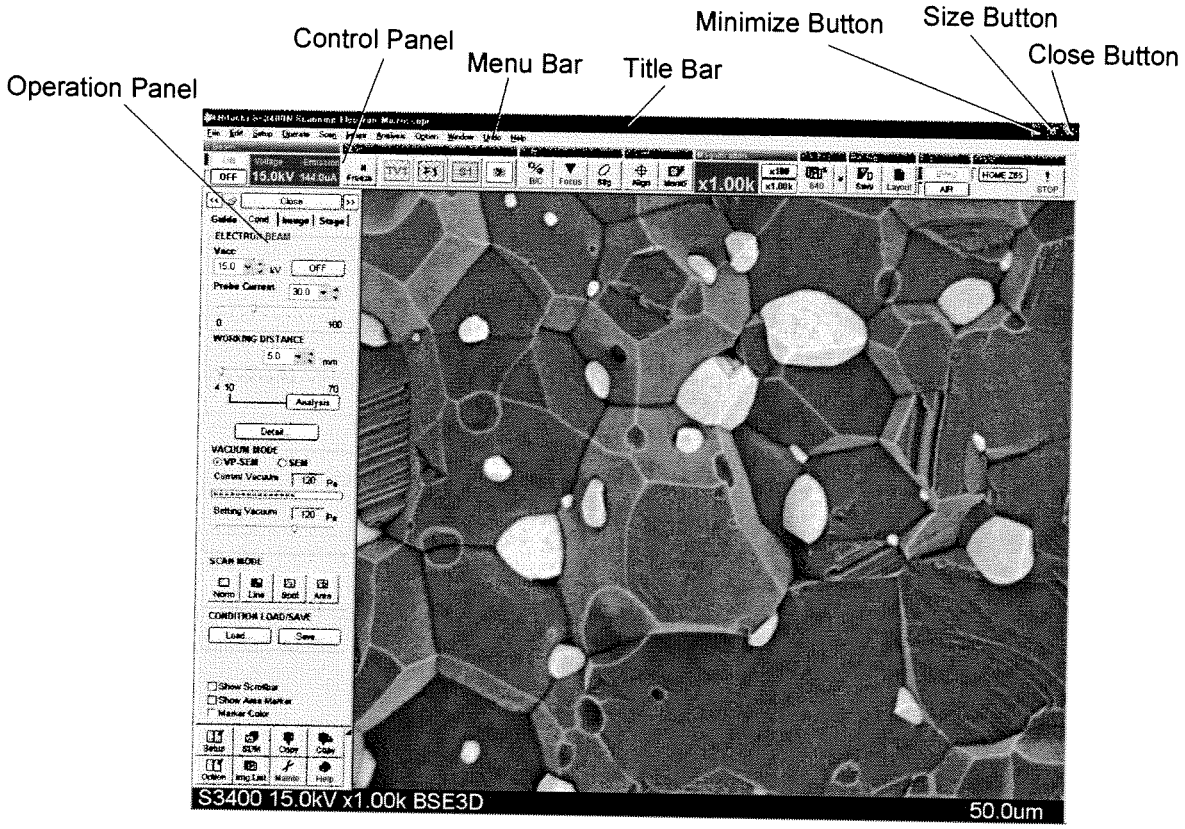


Fig. 2.3-3 S-3400N Main Window (Full screen display)

- **Title bar:** Shows the window title.
- **Minimize button:** Minimizes the window size. The window is iconized and placed on the Task bar.
- **Size button:** The window status becomes Normal type. You can change the window size. Clicking the button changes it to Maximize button.
- **Close button:** Terminates the S-3400N operation program and closes the window.
- **Menu bar:** Clicking a main menu on the menu bar shows a pull-down menu. Clicks one of the commands on the pull-down menu to execute the command.
- **Control panel:** Frequently used command buttons are placed on the control panel. Click a button to execute the command.

- **Operation panel:** The Close button hides the panel, and alternate << Show Panel >> shows it again. Position of the panel can be moved to left or right side with << and >> buttons.
  The display position can be moved to the right or left edge by using the << , >> buttons.
  The button can be used to specify whether the panel is to be on all the time.
  If the thumb tack ( ) is off, the **Operation Panel** automatically turns off when the mouse cursor moves away from the Operation Panel.
  When the thumb tack is sticking ( ) , the Operation Panel remains on all the time.

Three modes of scanning image display are available, **Full** screen (shown on previous page), **Small** screen (Fig. 2.3-4 left) and **Dual** screen (Fig. 2.3-4 right).

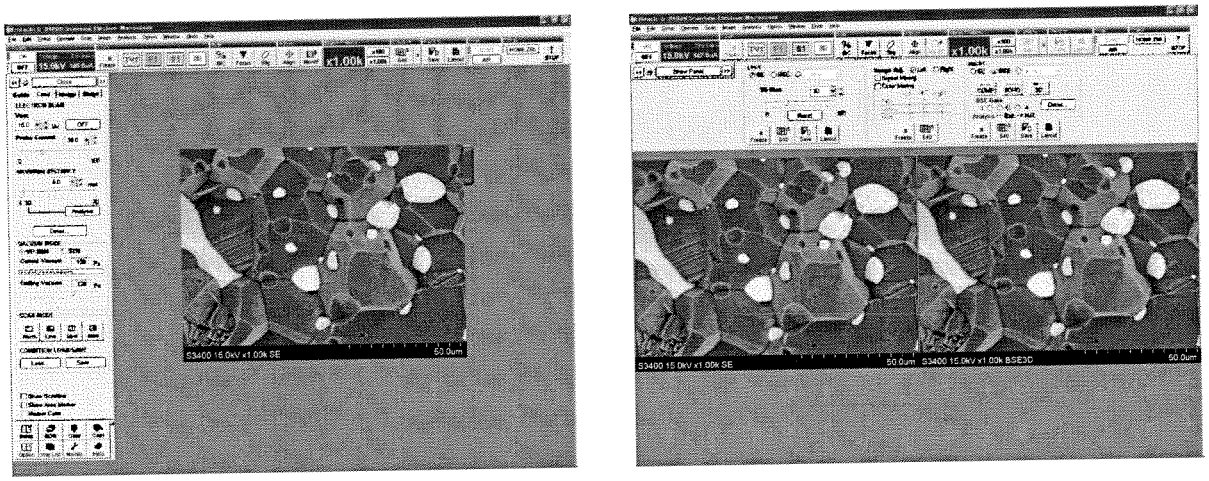


Fig. 2.3-4 S-3400N Main Window (Small and Dual screen modes)

2.3.3 Control Arrangement on the Window

Operation tools are placed as follows.

(1) Control panel
Most frequently used controls are placed on it.

(2) Operation panel
The Operation Panel is comprised of four tabs: **Guide**, **Cond.**, **Image**, and **Stage**.

- < **Guide** tab >
  Functions to set the basic observation condition and guide the operation from image adjustment to image capture.
- < **Cond.** tab >
  Scanning controls, and electron optical column controls are placed on it.
- < **Image** tab >
  Principally controls related to image size and detector settings are provided.
- < **Stage** tab >
  It has stage operation controls for Type Ⅱ model.

Functions to be placed on **Cond.** and **Image** tabs can be customized.
To change control arrangement, open **Operation Panel** window by **Optional setup** command in **Option** menu.

Also up to eight tool buttons can be placed on the tool button area (lower part of **Operation panel**).
Refer to <3.9.14 Optional Setting >.

(3) **Menu bar**
Most functions are executed on the menu bar.

(4) **Mouse operation** on the scanning image
The types of operations that can be performed on the image switch when appropriate modes are selected from the **Mouse Mode** on the **Option** menu or from the **Mouse Mode** of the pop-up menu that comes up when the mouse wheel button is clicked on the image.

- < Image adjustment >
  Focusing, astigmatism correction and brightness/contrast adjustment
- < Stage operation > (Only Type Ⅱ stage)
  X/Y operation as with joystick, R, Z, T (Coordinates specification and continuous movement), RISM
- < Image shift >

(5) **Pop-up menu**
Clicking the wheel button of mouse shows a pop-up menu.

(6) **Shortcut keys**
Some shortcut keys are specified.
Refer to <2.3.23 Using Short-cut Keys>.

2.3.4 Menus

The menu bar includes the following menus and commands.

(1) **File** menu: The **File** menu includes commands for opening SEM Data Manager, saving files, photo recording, and image printing.

- **Open SEM Data Manager**: Opens the **SEM Data Manager** window. Refer to <3.11 Managing Image Data (SEM Data Manager)>.
- **Direct Save**: Opens the **Image Save [Direct Save]** window for saving the currently displayed observation images. The **Direct Save**  button on the control panel works for the same operation as the Direct Save of the File menu. (To save captured images, use the **Save**  button in the **Captured Image** window.)
Refer to <3.6.5 Saving a Scanning Image (Direct Save)>.
- **Quick Save**: Displays the **Image Save [Quick Save]** window. Sets the file name etc. for the Quick Save function. After setting, the image can be saved without setting the file name etc. by the **Quick Save**  button on the control panel.
- **Direct Photo**: Executes direct photo recording.
Refer to < 3.6.7 Taking Photographs (Option)>.
- **Memory Photo**: Executes memory photo recording.
Refer to < 3.6.7 Taking Photographs (Option)>.
- **Direct Print**: Prints the currently displayed observation image.
- **Layout Print**: Displays the **Report Generation** window. Prints the currently displayed observation image, after a print layout is set and comments are added using the Layout Print function. (To print a captured image, use the **Layout**  button of the **Captured Image** window; to print an image saved in a file, use the Print function of the **SEM Data Manager** window.)

- **PCI Transfer**: Transfers image to Quartz PCI. This is enabled when the **PCI** option is set.
- **Assignment Record Buttons**: These buttons assign buttons in the **Record Area** on the **Control Panel**.
- **Password Lock**: This option can be used to lock Windows when you leave your work site unattended. To unlock Windows, you need to enter a password.
  See <3.9.19 Password Locking of Windows>.
- **Exit** Closes SEM operation.

(2) **Edit** menu: Copies the observation images and information associated with it to clipboard.

- **Copy Image**: Copies the currently displayed observation image to the clipboard.
  Refer to < 3.9.11 Copy Image>.
- **Copy Attribute**: Copies information on the currently displayed observation image to the clipboard.
  Refer to < 3.9.12 Copy Attribute>.

(3) **Setup** menu: Commands for setting system operating conditions.

- **Optics Setup**: Opens the **Optics** tab of the **Setup** window. Use it to select the optimal electron optical column.
  Refer to <3.4.1 Setting Parameters for the Electron Optical System>.
- **Condition Load**: Opens the **Op. Cond**. tab of the **Setup** window.
  Use it for loading and reproducing previously saved electron optical column condition.
  Refer to <3.9.6 Operating Condition Memory>.
- **Condition Save**: Opens the **Op. Cond**. tab of the **Setup** window.
  Use it for saving present electron optical column condition.
  Refer to <3.9.6 Operating Condition Memory>.
- **Image Display**: Opens the **Image** tab of the **Setup** window. Use it for setting the preset magnification, contrast and brightness of ABCC, and capture speed.
  Refer to <2.3.9.2 Image Tab>.

- **Photo Condition**: Opens the **Record** tab of the **Setup** window. Use it for selecting scanning speed and other photo recording conditions.
  Refer to <2.3.9.3 Record Tab>.
- **Data Display**: Opens the **Record** tab of the **Setup** window. Use it to turn data display On/Off and select specific information to be printed on image.
  Refer to <2.3.9.3 Record Tab>.
- **Mag. Preset Setup**: Displays a window for setting magnification preset values.

(4) **Operate** menu: The **Operate** menu includes commands for operation of column alignment, motorized stage (Type II instrument only), auto functions etc.

- **Alignment**: Opens the **Alignment** window.
  Use it for column alignment operation.
  Refer to <3.4.2 Axial Alignment>.
- **Filament Image**: Displays the **Filament Image** window.
  This button is used to perform appropriate image adjustments using a filament image. Normally this function is not used by customers.
- **Image Adjustment**: Displays the **Image Adjustment** window.
  This button permits the performance of basic adjustment operations, such as focusing and stigma compensation.
- **ABCC**: Executes automatic brightness and contrast control.
  Refer to <3.5.4 Image Brightness and Contrast Adjustment>.
- **Auto Focus**: Executes automatic focusing.
  Refer to <3.5.5 Focus and Astigmatism Correction>.
- **Auto Stigma and Focus**: Executes automatic astigmatism correction and focusing.
  Refer to <3.5.5 Focus and Astigmatism Correction>.
- **Assignment Auto Buttons**: Assigns buttons to the Auto function area of the Control Panel.
- **Assignment Adj. Buttons**: Assigns buttons to the Adjustment function area of the Control Panel.
- **Focus Monitor**: Starts **Focus Monitor** mode.
  Refer to <3.5.5 Focus and Astigmatism Correction>.
- **BC Monitor**: Starts **B/C Monitor** mode.
  Refer to <3.5.4 Image Brightness and Contrast Adjustment>.
- **Dynamic Stigma Monitor**: Starts up the **Dynamic Stigma Monitor**.
- **DeGauss**: Degausses the objective lens.

(5) **Scan** menu: The **Scan** menu includes commands for scanning control.

- **Run (Freeze)**: Runs or freezes scanning alternately.
- **Capture**: Starts image capture.
  Refer to <3.6.3 Image Capture>.
- **Capture Setup**: During the image capture operation, this button can be used to specify an image size (in pixels) and scanning.
- **Interval Capture** Captures images continuously at a fixed interval.
  Refer to <3.6.4 Interval Capture>
- **Split DM Mode**: Activates **Split/Dual Mag** mode.
  Refer to <3.9.2 Split Screen and Dual Mag Mode>.
- **Scan Speed**: Selects scanning speed.
  Refer to <3.5.3 Selecting Scanning Speed>.
- **Assignment Speed Buttons**: These buttons assign scanning speeds to the scan speed buttons. Twelve speeds can be assigned to four buttons.
  See <3.5.3 Selecting Scanning Speed>.
- **Scan Mode**: Selects the size of scanning image display (Screen mode) from **Full**, **Dual** and **Small**.
  Refer to <3.9.1 Screen Mode>.

(6) **Image** menu: The **Image** menu includes commands for signal processing of optional detectors.

- **Signal Processing**: Displays the **Signal Processing** window. Signal processing is applied to the display image in real time. It is digital processing.
- **Opt. Signal Processing**: Opens the **Opt Signal Processing** window.
  Refer to <3.9.5 Signal Processing>.
- **Show Histogram**: Displays a histogram of the image being observed.
  See <3.5.4 Image Brightness and Contrast Adjustment>.

(7) **Analysis** menu: The Analysis menu includes commands for analysis modes, measurement and others.

- **Normal**: Sets to **Normal** mode (image observation).
- **Line Analysis**: Selects **Line analysis** 1 and 2 mode alternately.
  Refer to <3.9.4 X-ray Analysis Mode>.
- **Spot Analysis**: Selects **Spot** 1 and 2 mode alternately.
  Refer to <3.9.4 X-ray Analysis Mode>.
- **Area Analysis**: Selects **Area analysis** 1 and 2 mode alternately.
  Refer to <3.9.4 X-ray Analysis Mode>.

- **Oblique**: Opens **Oblique Image** window and displays bird's-eye view of observation images.
  Refer to <3.9.13 Oblique Image>.
- **CD Measurement**: If the **CD-Measurement** option is installed, the **CD Measurement** window is brought up.

(8) **Option** menu: The **Option** menu includes commands for optional functions.

- **Optional Setup - Operation Panel Setting**: Opens **Operation Panel** tab of the **Optional Setup** window.
  Use for arrangement of functions on the **Operation Panel**.
  Refer to <3.9.14 Optional Setting>.
- **Optional Setup - Stage**: Opens **Stage** tab of the **Optional Setup** window.
  Use for setting parameters of stage control function.
  Enabled in Type Ⅱ.
  Refer to <3.9.14 Optional Setting>.
- **Optional Setup- Mouse Operation**: Opens **Mouse Op.** tab of the **Optional Setup** window.
  Use for setting sensitivity of mouse operation.
  Refer to <3.9.14 Optional Setting>.
- **Optional Setup- General**: Opens **General** tab of the **Optional Setup** window.
  Use for setting various operation parameters.
  Refer to <3.9.14 Optional Setting>.
- **Optional Setup- Evacuation**: Displays the **Evacuation** tab on the **Optional Setup** window. Sets the Evacuation mode for startup.
- **Optional Setup- AAA Adjust**: Displays the **AAA Adjust** tab on the **Optional Setup** window. Sets a scanning speed and the number of images to be integrated for auto adjustments.
- **Assignment Tool Buttons**: Assigns functions to the tool button located in the lower portion of the **Operation Panel**.
- **Mouse Mode**: Switches the types of operations that can be performed on the **Mouse Mode** image.
- **Login Setting**: Opens the **Login Setting** window. Use it for setting login names and passwords for users. The window can be opened only when logged in with the system manager's login name.
  Refer to <3.9.16 Setting Login Name>.

- **Password Setting**: Opens the **Password Setting** window. Use it for setting or changing the password for the login name of the current user.
  Refer to <3.9.15 Password Setting>.
- **Stage Calibration**: Starts calibration functions for stage controller.
- **Stage Program Download**: Use this function when the specimen stage control program needs to be updated due to a system version upgrade.
  Refer to <3.9.20 Downloading Stage Control Program>.

(9) **Window** menu: The **Window** menu includes commands for opening the **Captured Image** window, and others.

- **Captured Image**: Opens the **Captured Image** window.
  Refer to <2.3.10 Captured Image Window>.
- **Close All**: Closes all windows except for the **Scanning Image** window.

(10) **Undo** menu: Returns to the status prior to conducting the following operation.

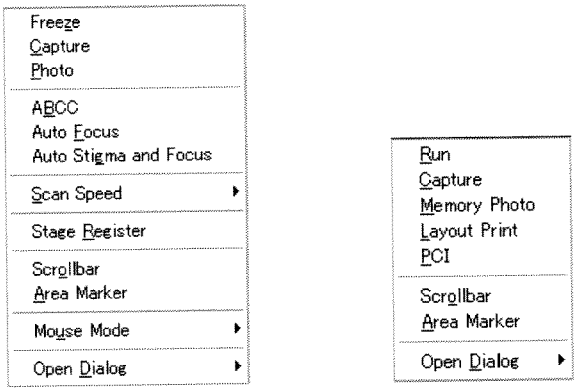
Auto Focus (AFC)
Auto Stigma and Focus (ASFC)
ABCC
Auto Filament (AFS)
Auto Beam Alignment (ABA)
Stage Drive

(11) **Help** menu: Opens Help for S-3400N SEM operation.

- **Maintenance**: Opens the **Maintenance** window Explains filament replacement procedures in 3D animation graphics.
- **Index**: Shows the index of **Help**.
- **Search**: Shows the key-word search of **Help**.
- **About S-3400N**: Indicates the version of S-3400N SEM.

2.3.5 Pop-up Menu

Click the center (wheel) button of the mouse on the image area to open the **Pop-up** menu. The **Pop-up** menu includes frequently used commands and changes depending on present status (scan is running or frozen).



(Scan) (Freeze)

Fig. 2.3-5 An Example of Pop-up Menu

(1) Click the image (the image being scanned)

- **Freeze:** Freezes scanning.
- **Capture:** Starts image capturing.
- **Photo:** Photographs images (optional).
- **ABCC:** Executes automatic brightness and contrast control.
- **Auto Focus:** Executes automatic focusing.
- **Auto Stigma and Focus:** Executes automatic astigmatism correction.
- **Scan Speed:** Selects scanning speed.
- **Stage Register:** Register the present stage position for the Stage History function.
- **Scrollbar:** Show or hide scrollbars for adjusting focus, stigma, brightness and contrast.
- **Area Marker:** Show or hide the area marker.
- **Mouse Mode:** Switches mouse operation functions on the image.
- **Open Dialog- Setup:** Opens the **Setup** window.
- **Open Dialog- Captured Image:** Opens the **Captured Image** window.
- **Open Dialog- Stage History:** Opens the **Stage History** window.

(2) Click the image (when the image is frozen) (Menu items that are not described above are shown)

- **Run:** Runs scanning.
- **Memory Photo:** Photographs a frozen image (optional).
- **Layout Print:** Opens the **Report Generation** window. Prints the currently displayed observation image.
- **PCI:** Transfers a frozen image to the PC.

2.3.6 Control Panel

Contains the most frequently used controls such as for image observation, and image recording. Usual operation can be performed using the **Control Panel** and the **Manual Operation Panel**.

2.3.6.1 Functional Windows on the Control Panel

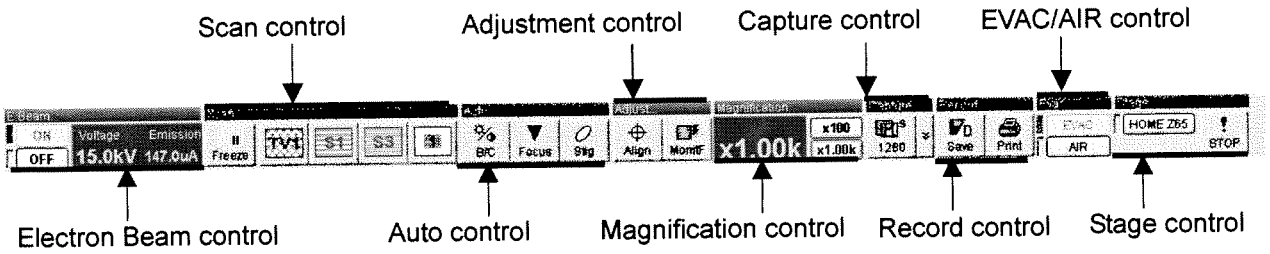


Fig. 2.3-6 Control Panel

2.3.6.2 Electron Beam Control

This unit has Accelerating voltage **ON/OFF** button and the Voltage/Emission display unit.

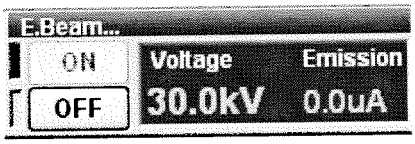


Fig. 2.3-7 Electron Beam Control Block

When becoming the condition that the accelerating voltage can be applied to the electron gun (proper vacuum levels in the electron gun and specimen chamber), the **ON** button is enabled, and the **Voltage** indicator blinks alternately in yellow and blue. Clicking the **ON** button applies the accelerating voltage, turns the **Voltage** indicator yellow, and causes the **Emission** section to display the emission current.
The **OFF** button shuts the gun accelerating voltage down. Clicking the mouse in this area brings up the **Optics** tab of the **Setup** menu.

2.3.6.3 Scan Control

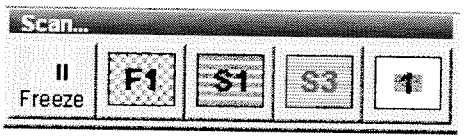


Fig. 2.3-8 Scan Control Block

(1) **Run/Freeze** button

To start scanning, click the **Run** Run button. To stop scanning, click the **Freeze** Freeze button.
When clicking the **Freeze** button during scanning, scanning continues until it reaches the end of the frame and then stops. "Going to Freeze" has been shown in the upper left section of the image until the scanning stops. And, it becomes "Freeze" when the scanning stops.
In the case of the slow scan mode, click the **Freeze** button again while displaying "Going to Freeze" so that the scanning stops before it comes to the end of frame.

(2) **Scan speed** buttons

The scanning speed buttons (in the Fig. 2.3-8, buttons Fast1 to Red1) allows you to change speed. Two kinds of speeds are assigned to each button (for example, Fast1 and Fast2). Scan speed assigned are switched by clicking the Scan speed button.
The scanning speeds to be assigned to each button can be customized. Clicking the Title area, clicking the right button on the mouse on the scanning speed button, or selecting **Scan - Assignment Speed Buttons** on the menu brings up an Assignment Speed Buttons window, as shown in the Fig. 2.3-9.

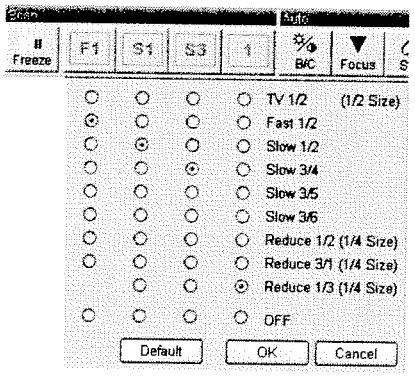


Fig. 2.3-9 Assignment Speed Buttons Window

Click the radio button under each button to select the speed assigned. Clicking the **OK** button sets the selected scan speed.
See <3.5.3 Selecting Scanning Speed>.

2.3.6.4 Auto Control

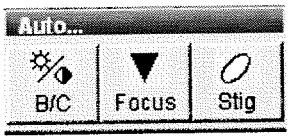


Fig. 2.3-10 Auto Control Block

(1) B/C
Automatically adjusts the contrast and brightness of the image being observed.
The extent of adjustment can be specified using the **Image** tab of the **Setup** window. This function can be used on SE (secondary electron) and BSE (back-scattered electron) images.

(2) Focus
Starts Auto Focus Control.
When magnification is lower than 5,000×, coarse focus (search using a wide focus range) is carried out. Fine focus (search using a narrow focus range) is carried out at magnifications higher than 5,000×.
Fine focus works correctly under conditions where the image is not clear but visible.
The result of Auto Focus depends on the surface structure of the specimen.
When there is little or no surface detail on the specimen, or when the specimen is charged, Auto Focus will not operate properly.

(3) Stig
Automatically corrects the stigma and focus.

(4) Customizing the buttons
The auto function to be assigned to each button can be customized. When clicking the Title area, clicking the right button on the mouse on the auto function button, or selecting **Operate - Assignment Auto Buttons** on the menu, the auto function assignment window is displayed as shown in the Fig. 2.3-11.

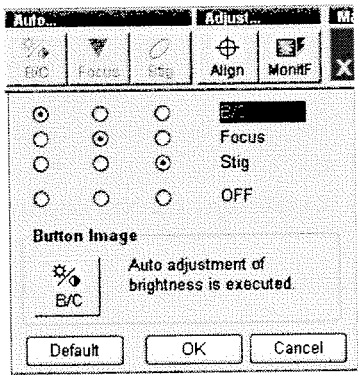


Fig. 2.3-11 Auto function Assignment Window

2.3.6.5 Adjustment Control

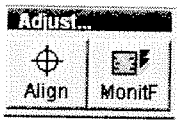


Fig. 2.3-12 Adjustment Control Block

(1) Align
Adjusts the electron optical axis.
Displays the **Alignment** window shown in the figure below, and launches the **Aperture Align** mode.

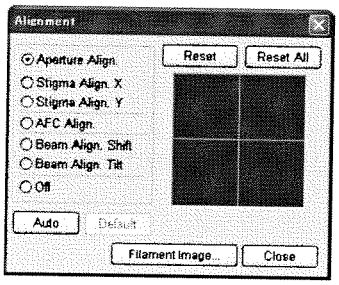


Fig. 2.3-13 Alignment Window

See <3.4.2 Axial Alignment>.

(2) MonitF
This function brings up the waveform monitor mode (where image signals are displayed in oscilloscope-like waveforms). The function is for adjusting the focusing; the electron beam horizontally scans the center in the vertical direction of the screen, and displays signal waveforms, fixing the magnification at 1,000×. When the focusing is changed, the waveform becomes sharp at the point where the image is in focus. Thus, when focusing must be performed from a completely unfocused condition, this function makes it easier to focus than finding a focus on the normal image. To return to the normal image, click the **Cancel** button of the message window displayed, or click the **Scan speed** button.
Refer to < 3.5.5 Focus and Astigmatism Correction>.

(3) MonitB
Displays the waveform monitor mode for the brightness adjustment of the image.
In this case, the electron beam performs two-dimensional scanning, and the signal waveform changes accordingly. To obtain a more or less appropriate image, adjust the brightness and contrast so that the bottom and the peak of the signal waveforms fit between the lowest and the highest lines of the four lines that are displayed.
To return to the normal image, click the **Cancel** button of the message window displayed, or click the **Scan speed** button.
Refer to < 3.5.4 Image Brightness and Contrast Adjustment>.

(4) Customizing the buttons
The adjustment function to be assigned to each button can be customized. When clicking the Title area, clicking the right button on the mouse on the adjustment function button, or selecting Operate - Assignment Adj. Buttons on the menu, the window for assignment is displayed as shown in the Fig. 2.3-14.

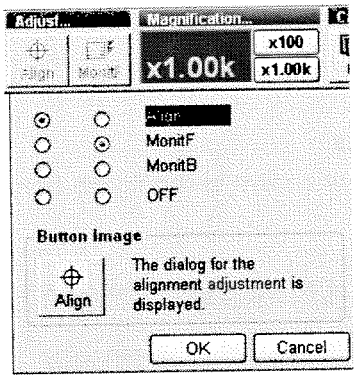


Fig. 2.3-14 Adjustment Function Assignment Window

2.3.6.6 Magnification Control

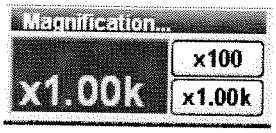


Fig. 2.3-15 Magnification Control Block

(1) **Magnification indicator Window**
Indicates magnification.
In this window, moving the mouse while holding down the left or right button changes magnification. To increase magnification, drag the mouse to the right. To decrease it, drag to the left.
For coarse changes, press the right button and for fine changes, the left button.
Alternately, click the area with the right button to increase or with the left button to decrease magnification stepwise.

(2) **Preset button**
Two magnifications can be preset.
For the magnification preset function, clicking **Setup** - **Mag.Preset Setup**, clicking the Title on the Magnification control, or right-clicking the Mag.Preset button brings up a setup window, as shown below.

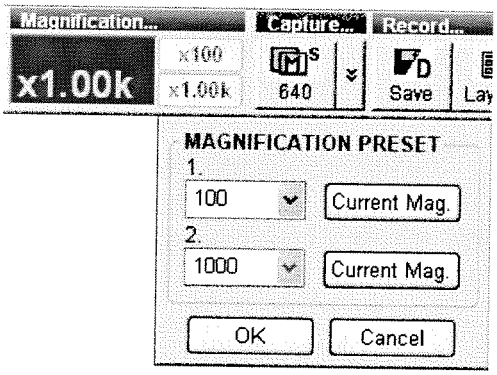


Fig. 2.3-16 Magnification Preset Setup Window

2.3.6.7 Capture Control

This block is used to capture images.

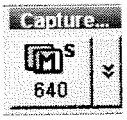


Fig. 2.3-17 Capture Control Block

Captures an image with pre-specified image resolution and scanning speed.
Displayed figures on the **capture** button (the number 640 in the above example) indicates the resolution of the captured image. Clicking **Scan - Capture Setup**, clicking the Title on the **Capture** button, or right-clicking the **Capture** button brings up a **Setup** window, as shown below, on which you can set a scanning speed and a resolution level for the capturing process.

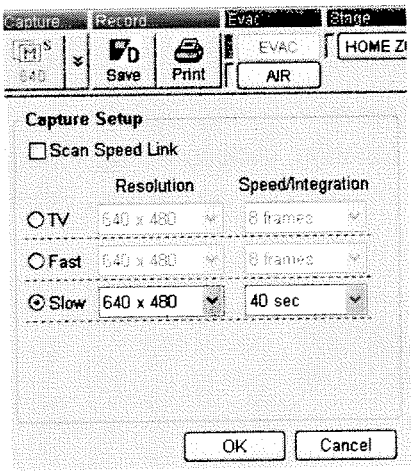


Fig. 2.3-18 Capture Setup Window

The capturing process runs in two modes: one in which capturing conditions can be set according to the capturing speed currently in effect (with the **Scan Speed Link** check ON) or one in which capturing is conducted at fixed conditions, irrespective of the scanning speed (with the **Scan Speed Link** check OFF).

- **Scan speed unlinked mode**

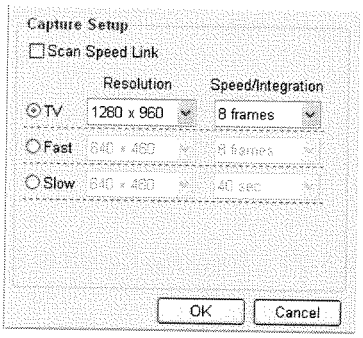


Fig. 2.3-19 Scan Speed Unlinked Mode Setting

Irrespective of the scanning speed currently in effect, the system captures images using a specified scanning speed, **Resolution**, and **Speed/Integration**.
Select one of **TV**, **Fast**, and **Slow**, and set the **Resolution** and **Speed/Integration**.
If an image cannot be captured using specified conditions, either the displayed image size changes or a message comes up.
For example, if the image size is **Full**, the capture scanning speed is **TV**, and a 1280 × 960 **Resolution** is specified for a capturing operation, the image size will change from **Full** to **Small**, the capturing process begins, and upon completion of that process, the image size will revert to **Full**.

- **Scan speed link mode**

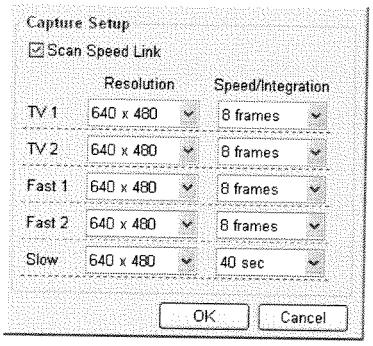


Fig. 2.3-20 Scan Speed Link Mode Setting

This option allows you to set capturing conditions independent of the scanning speed currently in effect.
For each scanning operation, setting a **Resolution** and a **Speed/Integration** causes the system to capture images under capturing conditions according to the scanning speed currently in effect.
If a capturing operation cannot be performed under specified conditions, either the image size changes or a message comes up.

2.3.6.8 Record Control

This block allows you to record captured images.

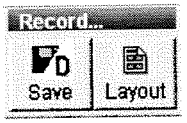


Fig. 2.3-21 Record Control Block

Recording function buttons
Select the two functions from seven recording functions and assigns them to two individual buttons.
The following seven recording functions are available:

Direct Save: Opens the **Save Image** window. Use it for saving viewing images to a disk.

Quick Save: Saves the currently displayed image under a pre-defined file name.

Layout Print: Opens the currently displayed image by adding it to the Preview page of the **Report Generation** window.

Direct Print: Directly outputs the current image to the printer.

Direct Photo: Executes **Direct Photo** recording. (The button is effective when the optional photo-recording unit is included.)

Memory Photo: Executes **Memory Photo** recording. (The button is effective when the optional photo recording unit is included.)

PCI Transfer: Transfers viewing image to Quartz PCI. (The button is effective when the optional **PCI** is installed.)

When clicking the Title area, clicking the right button on the mouse on the **Record Control** block, or selecting **File – Assignment Record Buttons** on the menu, the window for assignment is displayed as shown in the Fig. 2.3-22.

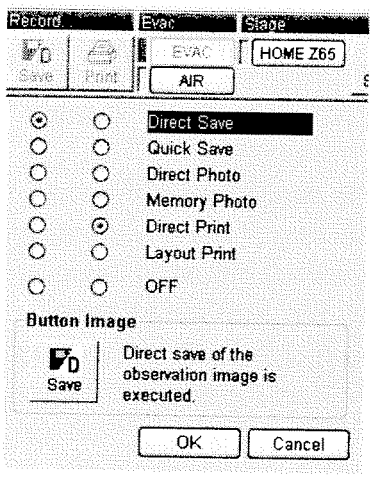


Fig. 2.3-22 Recording Function Selection Window

2.3.6.9 EVAC/AIR Control

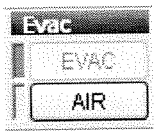


Fig. 2.3-23 EVAC/AIR Control Block

Clicking the **EVAC** button initiates the evacuation of the specimen chamber. Similarly, clicking the **AIR** button causes the AIR processing of the specimen chamber.
The display window to the left of the **EVAC** button lights up when the specimen chamber is in the EVAC state; it blinks when the EVAC process is in progress; and in other cases it remains off. Similarly, the display window to the left of the **AIR** button lights up when the specimen chamber is in the AIR state; it blinks when the AIR processing is in progress; and it remains off in all other cases.

Status	EVAC Button	EVAC Window	AIR Button	AIR Window
EVAC fall sequence	Disabled	※1	Disabled	※1
EVAC rise sequence	Disabled	※2	Disabled	※2
EVAC processing on specimen chamber	Disabled	Blinking	Enabled	Off
Specimen chamber in HVON/OFF operation in EVAC mode	Disabled	Lit	Disabled	Off
Specimen chamber undergoing an EVAC mode change in EVAC mode	Disabled	Blinking	Enabled	Off
Specimen chamber in EVAC mode, and in LOW-EVAC mode the vacuum level currently set does not agree with the current vacuum level.	Disabled	Blinking ※3	Enabled	Off
Specimen chamber in EVAC mode and in conditions other than the above 3 items	Disabled	Lit	Enabled	Off
Specimen chamber undergoing AIR processing	Enabled	Off	Disabled	Blinking
Specimen chamber in AIR	Enabled	Off	Disabled	Lit

※1: Both EVAC and AIR windows blink alternately.
※2: The applicable window blinks, depending on the EVAC/AIR condition.
※3: Only the **EVAC** window blinks in deep green.

NOTICE: The EVAC/AIR control is not displayed if an optional specimen exchange unit is installed. EVAC/AIR processing on the specimen chamber should be performed using the EVAC switch/AIR switch on the EVAC panel provided on the main unit.

2.3.6.10 Stage Control

(With Type Ⅱ 5-axis motor-drive stage)

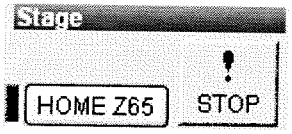


Fig. 2.3-24 Stage Control Block

(1) **HOME Z65** button
Moves the stage to the Exchange Position (X=60 mm, Y=25 mm, R=0°, T=0°, Z=65 mm). If the stage is in the Exchange position (the Z-axis at 65 mm), the display window on the left side of the button is in blue.

(2) **STOP** button
Use this button to stop stage movement when, for example, it has been started with incorrect stage coordinate value.

2.3.6.11 Extension for Dual Screen Mode

When the screen mode is **Dual**, the control panel is extended as follows.

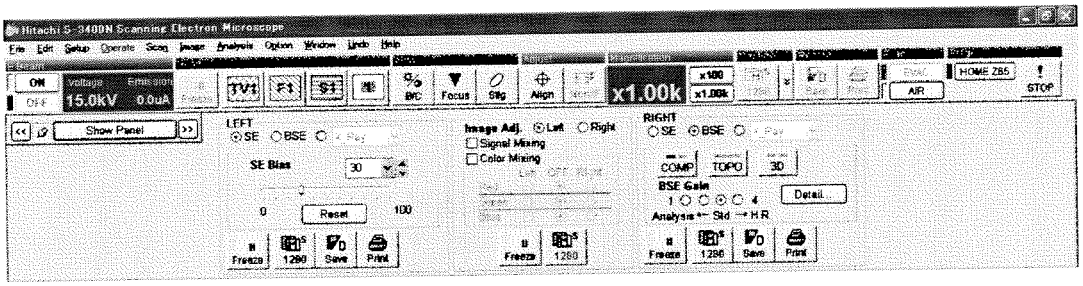


Fig. 2.3-25 Control Panel (Dual screen mode)

(1) Right-and-left dual control
The Run/Freeze, Capture, Recording, and detector selection control buttons are available in right-left configurations. By using these buttons, you can control right and left actions independently.

(2) Signal A/B selection
ABCC, brightness and contrast knobs on the manual operation panel are effective for the signal selected here.
(Brightness and contrast adjustment with mouse operation works on A and B images separately.)

(3) Signal Mixing
Different signals can be assigned to right and left, and the signals assigned to right and left can be mixed and displayed.
When the check box is checked, the system displays an image, produced by mixing the two selected signals, on the right screen.
- Brightness and contrast adjustments using the mouse on the screen operate not on the results of mixing, but on the image signal that is selected in the Signal Selection unit.
- Unchecking the box turns off the signal mixing option.

(4) Color Mixing
When different types of signals are assigned to the right and left screens, this function assigns different colors (R/G/B) to the two signals to produce a color-mixed image. The image on the right is displayed in color. First, set the dual mode, assign different signals to right and left, and then make observations. Check the **Color Mixing** check box. Click the colors to be assigned to A (left) and B (right) to assign colors to the signals. If a color is not to be assigned, click the **OFF** radio button. Unchecking the **Color Mixing** check box resets the display to the normal monochrome mode. Although mixed color images cannot be photographed, they can be saved. Selecting Screen B and saving it records the image as a color image.

2.3.7 Operation Panel

The Operation Panel is comprised of four tabs. The **Guide**, **Cond.**, and **Image** tabs relate to SEM operations. On each tab, control view/hide can be specified on a user-to-user basis.
The **Stage** tab is for operating the stage. This tab is displayed when the available stage is a Type Ⅱ stage (with a 5-axis motor drive).
The following explains the functions of the blocks that appear on the **Guide**, **Cond.**, and **Image** tabs. The **Stage** tab will be explained in the section on Stage Operation (3.5.7).

Guide tab　　Cond. tab　　Image tab

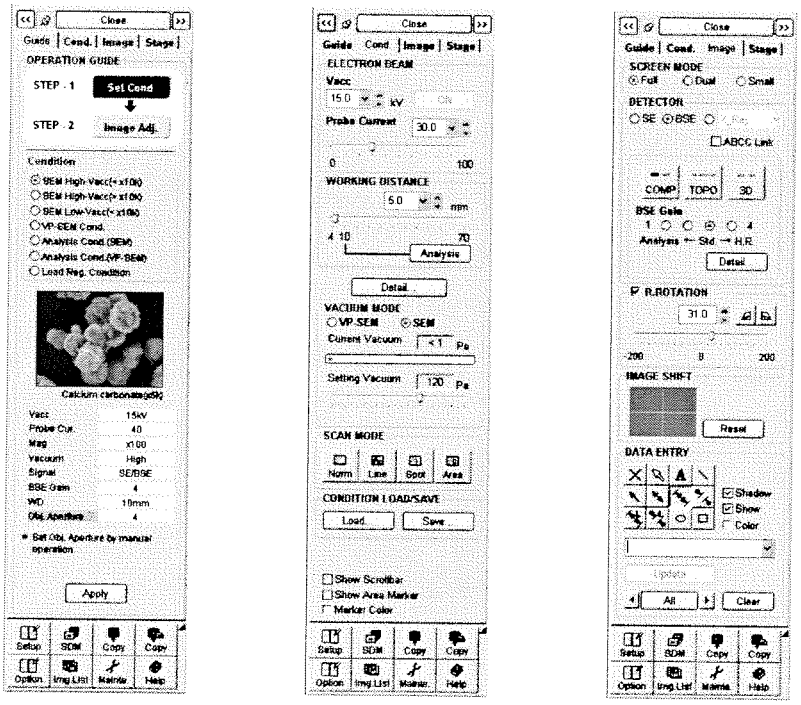


Fig. 2.3-26 Operation Panel

2.3.7.1 OPERATION GUIDE Block

Operation to obtain the image file is possible by selecting observation condition and following the image adjustment procedure.
It can explain the operation following operational procedure and display one-point advice.
Selecting suitable one condition for observation from six then clicking **Apply** button sets SEM condition.
SEM condition is set up by selecting suitable one from six conditions for observation and clicking the **Apply** button. Setting conditions of the electron optical column is saved and loaded by checking the **Load Reg. Condition** radio button and clicking the **Apply** button.

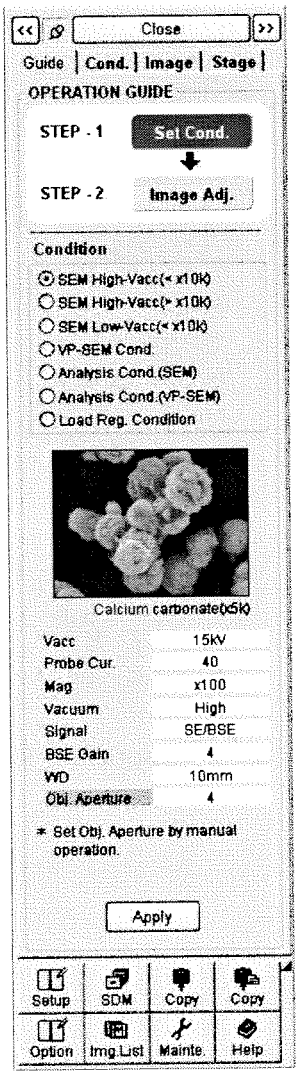


Fig. 2.3-27 OPERATION GUIDE Block (STEP-1)

Display in tab changes as follows after clicking the **Image Adj.** button.
It shows seven Adjustment procedure items. It is possible to operate observation until image capture by following procedure in number order.
When clicking item button, indicator that is on the left side button lights up in green in order to show progress adjustment.
One-point advice about image adjustment is shown as well.

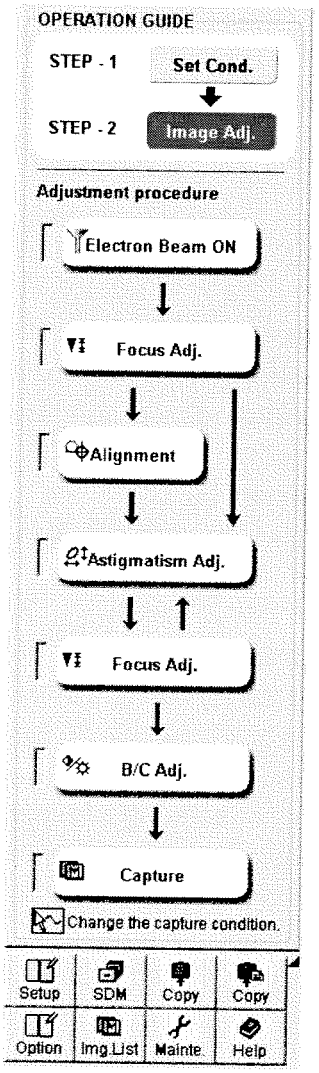


Fig. 2.3-28 OPERATION GUIDE Block (STEP-2)

2.3.7.2 ELECTRON BEAM Block

This block allows you to turn the accelerating voltage on and off, and to set the probe current.

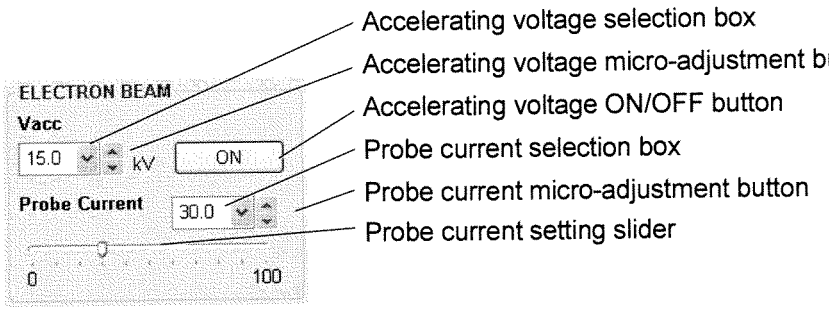


Fig. 2.3-29 ELECTRON BEAM Block

(1) Accelerating voltage selection box
To set an accelerating voltage, either enter a numerical value directly in this box or select a desired value from a list that is displayed by clicking a pull-down button.

(2) Accelerating voltage micro-adjustment button
By clicking the Up and Down arrows, you can adjust the accelerating voltage in 0.1 kV increments.

(3) Accelerating voltage **ON/OFF** button
This button turns the accelerating voltage on and off.

(4) Probe current selection box
You can set a probe current by either entering a numerical value directly in this box or selecting a desired value from a list that is displayed by clicking a pull-down button.

(5) Probe current micro-adjustment button
By clicking the Up and Down arrows, you can adjust the probe current in 0.1 increments.

(6) Probe current setting slider
By moving the slider to the right or left, you can vary the probe current. In addition, by clicking the side of the slider, you can adjust the probe current in 0.5 increments.

2.3.7.3 Focusing Position (WD) WORKING DISTANCE Block

This block allows you to set a focusing position.

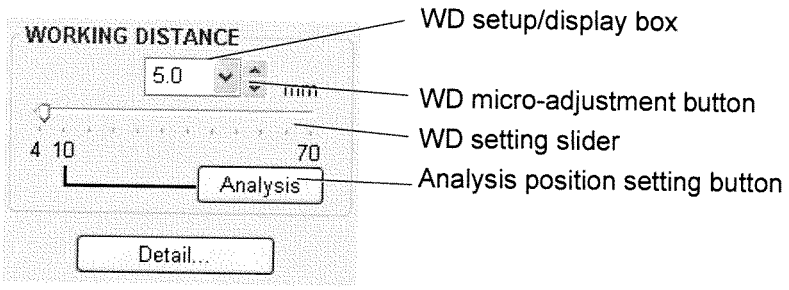


Fig. 2.3-30 Focusing Position (WD) Block

(1) WD setup/display box
This window displays the current working distance (the focusing position calculated from the lens current).
When a working distance value is selected from the pull-down list, focus point will be set to the specified working distance. The box also indicates present focal length if varied with manual focusing. This window can be used for focusing purposes when the Z-axis of the stage is moved or when it is necessary to set the WD accurately for EDX analysis purposes.

(2) WD micro-adjustment button
By clicking the Up and Down arrows, you can adjust the WD in 0.1mm increments.

(3) WD setting slider
The slider indicates the current WD. Also, by moving the slider with the mouse to the right and left, you can change the WD. By clicking the side of the slider, you can adjust the WD in 1 mm increments.

(4) Analysis position setting button
This button can be used to set the WD at 10 mm, such as during an EDX analysis.
This button sets a WD without the moving the stage itself.

(5) Detail button
Opens the Optics tab of the Setup menu.

2.3.7.4 VACUUM MODE Block

This block can be used to switch vacuum modes and set a vacuum level.

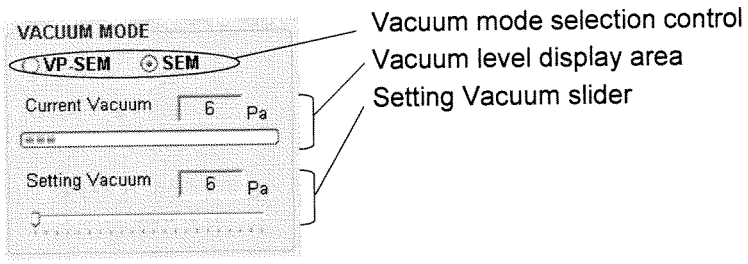


Fig. 2.3-31 VACUUM MODE Block

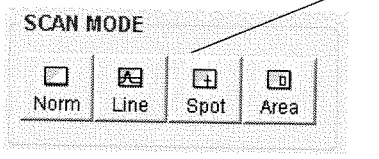
(1) Vacuum mode selection control
This control switches between the **VP-SEM** and **SEM** modes.
If the **VP-SEM** mode is selected, the vacuum level is set to the level specified in the **Setting Vacuum** option in the block.

(2) Vacuum level display area
This area shows the current vacuum level in the specimen chamber in terms of an indicator and a numerical value.

(3) Setting Vacuum slider
This control sets and displays the vacuum level that is specified in the **VP-SEM** mode.
The allowable range of vacuum level is from 6 to 270 Pa.

2.3.7.5 SCAN MODE Block

This block sets the Scan Mode.



Scan mode button
Norm
Line
Spot
Area

Fig. 2.3-32 SCAN MODE Block

(1) **Norm**
Sets the scan mode to Normal (normal observation mode).

(2) **Line**
Sets the Line analysis mode. This control switches between the 1 (position setting) and 2 (line analysis) modes.

(3) **Spot**
Sets the Spot analysis mode. This switches between the 1 (position setting) and 2 (spot analysis) modes.

(4) **Area**
Sets the Area-averaged spectrum analysis mode. This switches between the 1 (position setting) and 2 (area-averaged spectrum analysis) modes.

2.3.7.6 CONDITION LOAD/SAVE Block

This block calls and saves observation conditions.

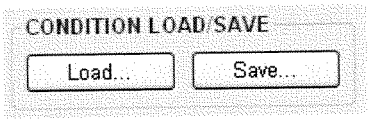


Fig. 2.3-33 CONDITION LOAD/SAVE Block

(1) **Load** button
Opens the **Op. Cond.** tab on the **Setup** window in the **Load** mode.

(2) **Save** button
Opens the **Op. Cond.** tab on the **Setup** window in the **Save** mode.

2.3.7.7 SCREEN MODE Block

Selects a screen mode.

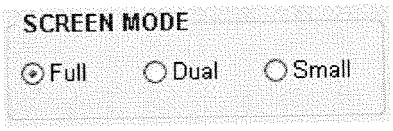


Fig. 2.3-34 SCREEN MODE Block

(1) **Full**: Full screen mode
Scanning image is displayed on full desktop.

(2) **Dual**: Dual screen mode
Two image screens are displayed. Use the mode to observe different signal images simultaneously or for color mixing image observation.

(3) **Small**: Small screen mode
Scanning image is displayed with a half size of desktop.
Faster frame speeds are available and in some cases results in better image quality.

2.3.7.8 DETECTOR Block

This block switches and controls detectors.

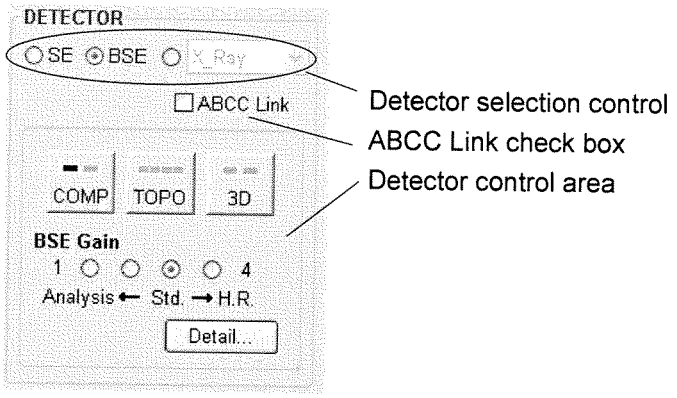


Fig. 2.3-35 DETECTOR Block

(1) Detector selection control
This control switches detectors.

(2) ABCC Link check box
If this box is checked, switching detectors automatically executes **ABCC**.
With the BSE selected, switching the BSE mode or modifying gains also automatically executes **ABCC**.

(3) Detector control area
If a detector-only control selected on the **DETECTOR** control is available, the control is displayed in this area. The figure above indicates the situation where a BSE detector is selected.

IMPORTANT: In high magnification observation, the image shifts by several micrometers due to the characteristics of the detectors when the detector is changed.

2.3.7.9 R.ROTATION Block

The raster rotation rotates the direction of the displayed image by rotating the scanning direction of the electron beam.

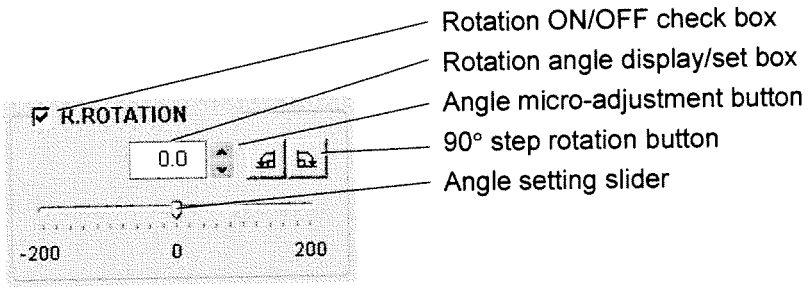


Fig. 2.3-36 R.ROTATION Block

(1) Rotation ON/OFF check box
Clicking this box and placing a check mark on it enables raster rotation.

(2) Rotation angle display/set box
This box displays the current angle of rotation. Entering an angle from the keyboard and pressing the Enter key causes the image to rotate by that angle.

(3) Angle setting slider
By moving the slider to the right and left with the mouse, you can vary the angle of rotation continuously. By clicking the side of the slider, you can adjust the angle in 0.5-degree increments.

(4) Angle micro-adjustment button
By clicking the ups and downs arrows, you can adjust the angle of rotation in 0.1-degree increments.

(5) 90° step rotation button
Rotates scanning direction in 90° increments.

2.3.7.10 IMAGE SHIFT Block

Indicates the present value of image shift with yellow cross mark.
Clicking the **Reset** button resets image shift at the mid-point of the movable range.

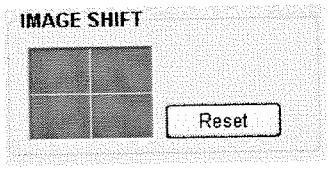


Fig. 2.3-37 IMAGE SHIFT Block

2.3.7.11 DATA ENTRY Block

Use for drawing texts and graphics on the scanning image.

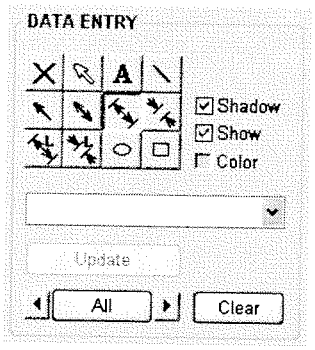


Fig. 2.3-38 DATA ENTRY Block

Refer to <3.9.8 Data Entry Function>.

2.3.7.12 Tool Buttons

Eight tool buttons are place on lower end of the Operation panel.
Buttons can be selected eight functions.

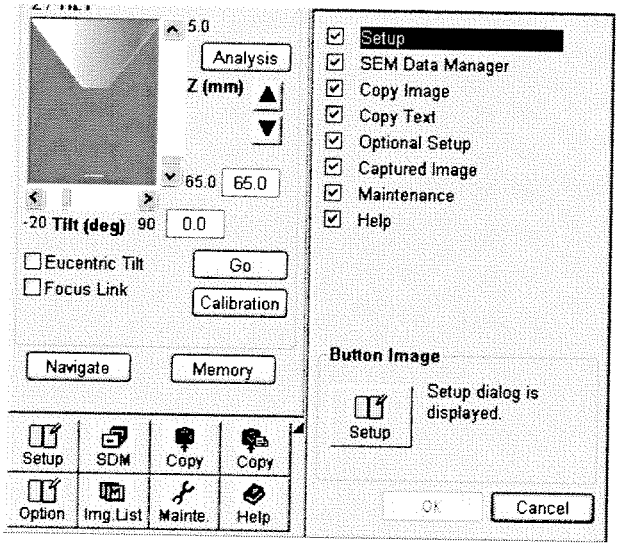


Fig. 2.3-39 Tool Buttons [Operation Panel]

Right –click the mouse on one of the tool buttons, click the customize button or select the Assignment Tool Buttons from the **Option** menu. The **tool button customize** window will open beside the tool button area. Check the check box of the function to be placed.
Function of each tool button is as follows.

Setup
Displays the **Setup** window.
Refer to <2.3.9 Setup Window>.

SDM
Displays the **SEM Data Manager** window. Use it to file images.
Refer to <2.3.11 SEM Data Manager Window>.
<3.11 Managing Image Data (SEM Data Manager)>.

Copy
Copies the current image to the clipboard as bitmaps.

Copy
Copies the information of the current image to the clipboard as text format.

Option
Displays the **Optional Setup** window.
Refer to <3.9.14 Optional Setting>.

Img. List
Displays the **Captured Image** window.
Refer to <2.3.10 Captured Image Window>.

Mainte.
Displays the **Maintenance** window.

Help
Displays the help for S-3400N.

2.3.7.13 Other

- **Scrollbar and Area Marker Block**

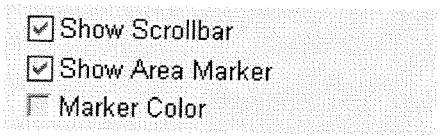


Fig. 2.3-40 Scrollbar/Area Marker/Marker Color Block

(1) **Show Scrollbar** check box
Scrollbars for stigma, brightness and contrast are shown around the scanning image when the **Show Scrollbar** is checked.

(2) **Show Area Marker** check box
The area marker, which is a crosshair cursor appearing at the center of scanning image, is shown when the **Show Area Marker** is checked.

(3) **Marker Color** box
The color of the area marker and Split/Dual Mag marker can be changed by the **Marker color** box. Moreover, the color of the mark displayed on the screen at Focus Monitor, BC Monitor, Dynamic Stigma Monitor and Scan Mode can be selected and changed. The color displayed is changed by clicking the **Marker Color** box.

2.3.8 Mouse Operation on the Scanning Image

Mouse operation tools for adjusting focus, stigma, contrast, brightness and specimen stage are provided.

2.3.8.1 Exchanging Mouse Control Functions

Image mouse operation can be switched to the following modes by using either the **Mouse Mode** on the **Option** menu or the **Mouse Mode** on the pop-up menu that comes up when the mouse wheel button is clicked on the image display unit:

(1) Focus/Stigma/Contrast/Brightness Adjustment

(2) Stage operation (X, Y, R, T, Z) and image shift operation

(3) Stage operation (X, Y, R) and image shift operation

(4) Stage operation (dragging with mouse) and image shift operation

(5) No operation (Off)

2.3.8.2 Focus/Stigma/Contrast/Brightness Adjustment

The design of mouse pointer is changed corresponding to its position as shown below.

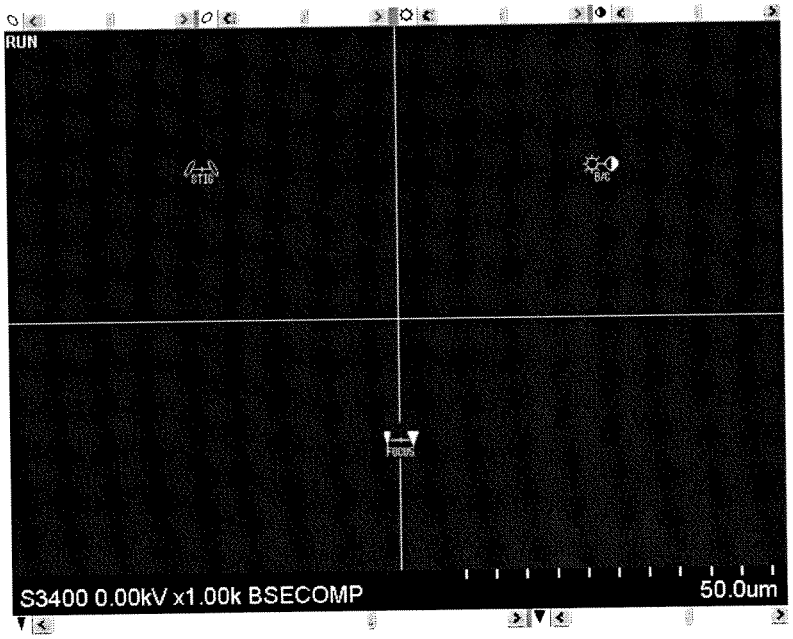


Fig. 2.3-41 Change in Mouse Icon Shape depending on the Area during the Image Adjustment Mode

Area:

Coarse focus adjustment: move mouse horizontally while pressing down right button.
Fine focus adjustment: move mouse horizontally while pressing down left button.

Area:

Stigma adjustment (X): move mouse horizontally while pressing down left button.
Stigma adjustment (Y): move mouse horizontally while pressing down right button.

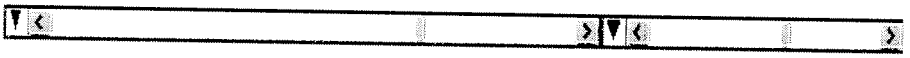
Area:

Brightness adjustment: move mouse horizontally while pressing down left button.
Contrast adjustment: move mouse horizontally while pressing down right button.

When the **Show Scrollbar** is checked on the **Cond.** tab, adjustment scrollbars are placed on the scanning image area.
It is possible to operate with these scrollbars.

Stigma Sliders: 

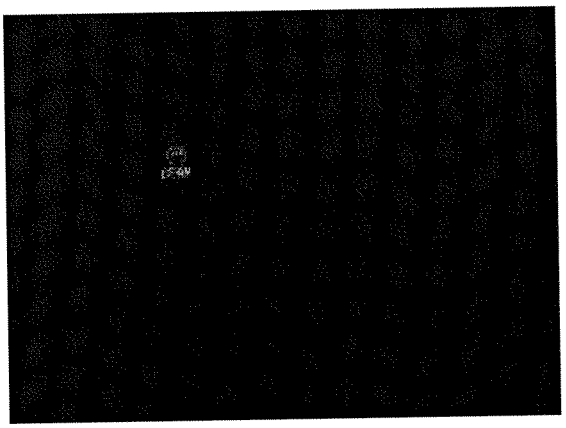
Brightness and Contrast Sliders: 

Focus: 

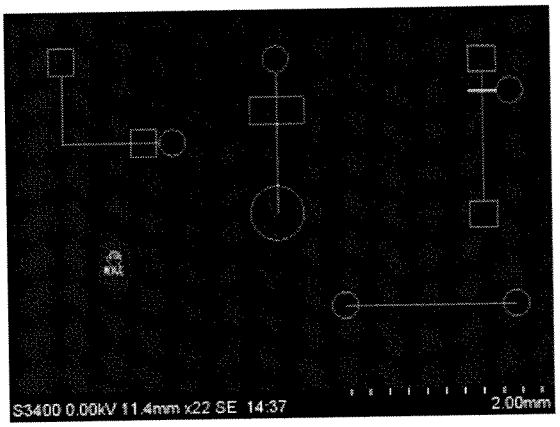
2.3.8.3 Stage and Image Shift Tools

Controls shown below will appear on the scanning image.

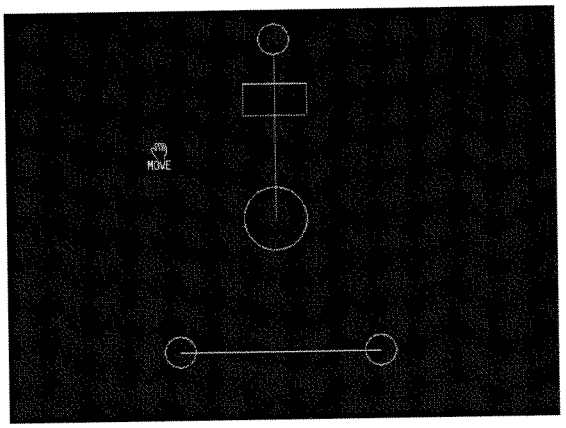
Type I manual stage



Type II motorized stage (X, Y, R, T, Z)



Type II motorized stage (X, Y, R)



Type II motorized stage (dragging with mouse)

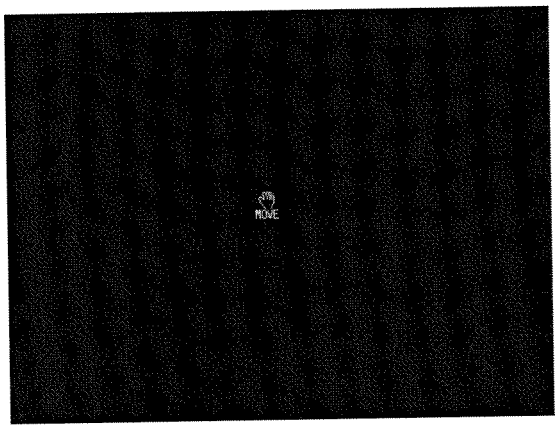


Fig. 2.3-42 Mouse Control (stage)

(1) Type I manual stage
It is for image shift operation. Move the mouse pointer  to a position and press down left or right button. The pointer will be changed to  mark. Move mouse to target position while holding down the button and then release the button.
If the above target position is near the center of the image area, the mouse trace line is changed and the target position is moved to the center of image.

(2) Type II motorized stage
All 5-axis are controlled with stage control tools.
Refer to <3.5.7.3 Operation Methods Used to Move the Specimen Stage> for operation procedure.

2.3.9 Setup Window

The **Setup** window has four tabs. To open the window, use the following operation.

(1) Click the **Setup**  button on the **Tool button** area of the **Operation panel**.

(2) Select following commands from the **Setup** menu.
Setup - Optics Setup: Opens Optics tab
Setup - Condition Load: Opens Op. Cond tab
Setup - Condition Save: Opens Op. Cond tab
Setup - Image Display: Opens Image tab
Setup - Photo Condition: Opens Record tab
Setup - Data Display: Opens Record tab

(3) Click the **Detail** button on the **Cond.** tab of the **Operation panel**.

(4) Click the **Load/Save** button on the **Cond.** tab of the **Operation panel**.

(5) Clicking **Accelerating voltage** on the **Control Panel** and the **Emission** display area:
Optics tab

2.3.9.1 Optics Tab

Sets conditions for the electron optical system. (The **Vacc**, **Probe Current**, and **WD** can be set directly by using the **ELECTRON BEAM** and the focus position (WD) **WORKING DISTANCE** block without opening the **Optics** tab).
This tab opens when the **Detail** button of the **Cond.** tab of the Operation Panel is clicked, the **Optics** command of the **Setup** menu, the **Setup** button of the Operation Panel Tool Button Area, or the **Voltage** and **Emission Display** area of the Control Panel is clicked.

(1) **ELECTRON BEAM** block
Sets electron optical system conditions.

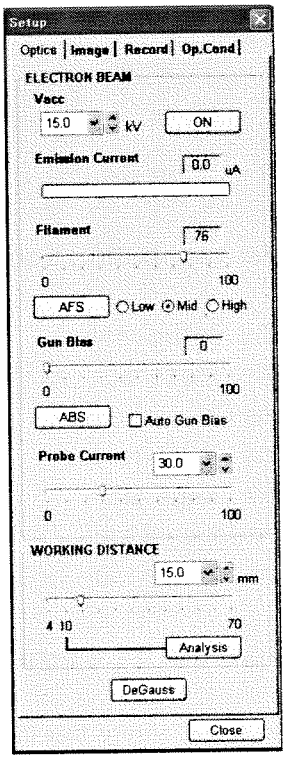


Fig. 2.3-43 Setup Window – Optics Tab

(a) **Vacc**
Sets and accelerating voltage. This function is equivalent to the **ELECTRON BEAM** block on the Operation Panel.

(b) **Emission Current**
Indicates the present emission current.

(c) **Filament**

Changes the filament current and adjusts the temperature to which the filament is to be heated. The filament current should be adjusted to a point slightly below the saturation point for the emission current.

The Auto Filament Saturation (**AFS**) function automatically sets an appropriate filament current. **AFS** can be run in three modes, low, medium, and high, and can be used for the following purposes:

Low: Long life mode (so that the filament can be used for a long time)

Med: Standard mode

High: High resolution mode (when the filament current is to be set near the saturation point for the emission current)

AFS can give an error if the filament is improperly installed or an emission current above a specified level fails to flow when a low accelerating voltage is applied.

(d) **Gun Bias**

This button, which sets a gun bias, can be used to adjust the emission current.

The **Auto Gun Bias** function automatically sets an appropriate gun bias when the accelerating voltage is changed. Normally this button should be check marked.

The correct operation of **Auto Gun Bias** requires the Auto Beam Setting (**ABS**) function, which is enabled when the **ABS** button is clicked. It is recommended that **ABS** be turned on whenever filaments are changed.

(e) **Probe Current**

This button, which sets a probe current, is functionally equivalent to the **ELECTRON BEAM** block on the **Operation Panel**.

(2) Focusing position (WD) **WORKING DISTANCE** block

This button, which sets a focusing position (WD), is functionally equivalent to the **WORKING DISTANCE** block on the **Operation Panel**.

(3) **DeGauss** button

The Degauss operation eliminates hysteresis of the magnetic field in the objective lens. When focus is changed greatly, accuracy of magnification or alignment of the electron optical axis may degrade due to hysteresis of the focusing magnetic field.

Click **DeGauss** button under the following conditions:

- After large change of focus without change of WD or Vacc in their respective windows.
- Before making the electron optical axis alignment.

Degaussing is automatically effected when WD is changed in the **WORKING DISTANCE** block, when the accelerating voltage is changed, or when a new Probe Current mode is selected.

NOTICE: The F2 hotkey also available for degauss operation.

2.3.9.2 Image Tab

The **Image** tab is for setting operating condition with respect to image observation.

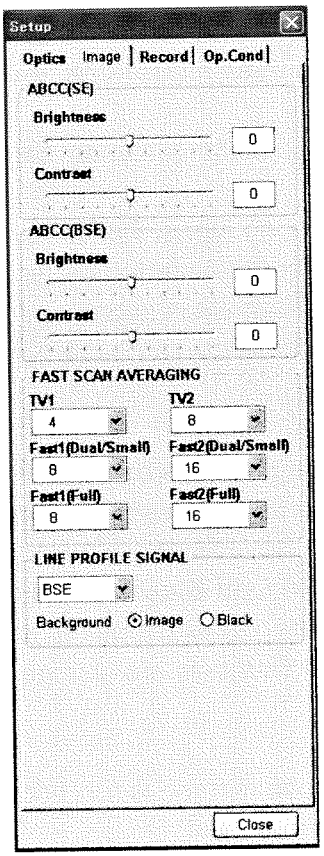


Fig. 2.3-44 Setup Window – Image Tab

(1) **ABCC** block **(SE/BSE)**
If the results of **ABCC** are not adequate, you can change the reference brightness and contrast. Adjustable range is -5 to +5. Adjustments can be set independently on the SE and BSE detectors.

(2) **FAST SCAN AVERAGING** block
Select number of frames to be averaged for TV1, 2 and Fast1, 2 speeds. Recommended numbers are 4 for TV1 and 8 or 16 for TV2, 2 for Fast1 and 4 for Fast2. The higher the number of frames, the better the attainable image quality. However, the higher number results in longer persistence time. Select an optimal value for the present observed image.

NOTICE: The number of frames to be averaged is set for each screen mode (**Full, Small** or **Dual**) independently.

(3) **LINE PROFILE SIGNAL** block
The signal for line profile can be selected independently from the signal for image. For example, you can observe or take a photograph of an X-ray intensity line profile on the secondary electron image. Select a signal for the line profile in the box. When the **Image** is selected in the **Background** select buttons, the line profile is overlaid on the image. When the **Black** is selected, only the line profile is shown on the screen.

2.3.9.3 Record Tab

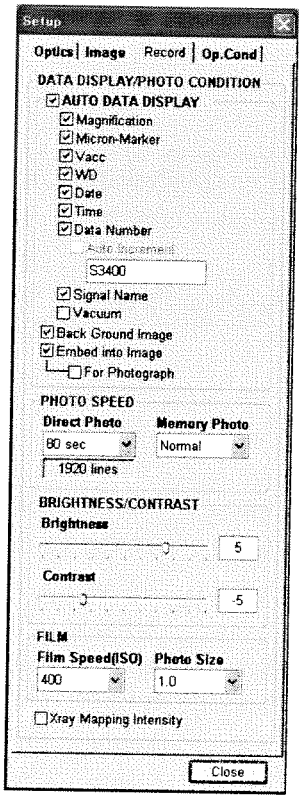


Fig. 2.3-45 Setup Window - Record Tab

(1) **DATA DISPLAY/PHOTO CONDITION** block

(a) **AUTO DATA DISPLAY** check box
Auto data display is engaged when this box is checked.

(b) **Magnification ~ Time** and **Signal Name** and **Vacuum** each check box
These items are included in data display if checked.

(c) **Data Number** check box
Input data number into this box. Up to ten characters may be keyed in. Do not use "," (comma) or " " (space).
If the Auto Increment check box is checked and the Data Number has "-nn" at its end (n : numerals, for example "Hitachi-00"), Data Number is incremented with each successive photographing.

(d) **Back Ground Image** check box
When this box is checked, the data display is overlaid on the scanning image. If it is not checked, the background of the data display area is black.

(e) **Embed into Image** check box
When this box is checked, the auto data display is embedded into the image data when the image is saved to disk. If it is not checked, only the image data is saved. This setting is also applied for **Print**, **Copy** and **PCI Transfer** commands.
If the **For Photograph** is checked, the position of the auto data display in the saved image is shifted slightly upward to ensure that it is properly framed in photographs.
It is recommended to not check the box if the saved image data will be used on the computer only.

NOTICE: If all of the above display items (**Magnification ~ Time** and **Signal Name**) are selected, data display on the photograph may be overlapped because of limited display space.
In such a case, remove insignificant items.

(2) **PHOTO SPEED** block

(a) **Direct Photo**
Selects a scanning speed for direct photo recording. The number of lines for the selected scanning speed is shown under the box.

(b) **Memory Photo**
Selects number of scanning lines for memory photo recording.
Normal: For 640 × 480 pixel image data
→960 lines (16/19 s photographing time)
For 1280 × 960 pixel image data
→960 lines (16/19 s photographing time)
For 2560 × 1920 pixel image data
→1920 lines (32/38 s photographing time)
Enhance: For 640 × 480 pixel image data
→960 lines (16/19 s photographing time)
For 1280 × 960 pixel image data
→1920 lines (32/38 s photographing time)
For 2560 × 1920 pixel image data
→1920 lines (32/38 s photographing time)
(Scanning time is shown as the value at 60 Hz/50 Hz power line frequency.)

(3) **BRIGHTNESS/CONTRAST** block
Sets brightness and contrast for photo recording. These are compensation factors for brightness and contrast adjusted in the scanning image. Adjust these values if a photograph does not have adequate brightness or contrast.

(4) **FILM Window**

(a) **Film Speed**

Selects a film speed (sensitivity) of the film. The brightness setting is changed internally according to the selected film speed.

(b) **Photo Size**

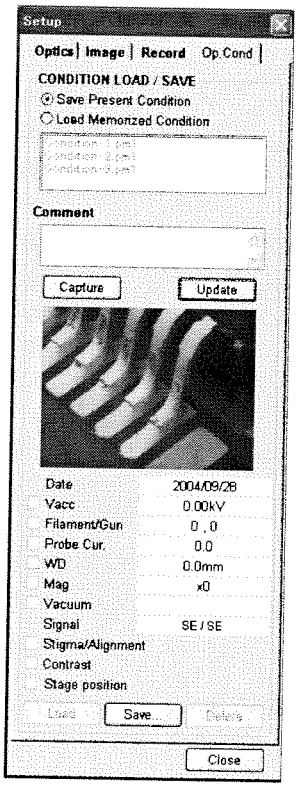
Selects a size of the film. The magnification is adjusted internally according to the selected size.

×1.0: for 4×5-inch instant film
×0.8: for type 107 or 105 instant film
×0.6: for type 120 negative film

2.3.9.4 Op. Cond Tab

This function is provided for saving and loading conditions of the electron optical column.

Save



Load

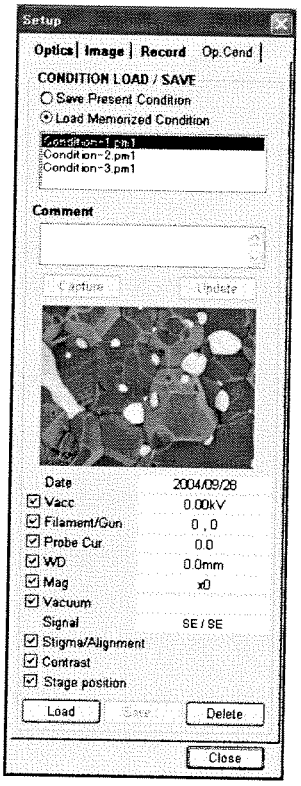


Fig. 2.3-46 Setup Window - Op.Cond Tab

For details of operation, refer to < 3.9.6 Operating Condition Memory >.

2.3.10 Captured Image Window

Captured images are displayed as thumbnails on this window.
It opens when you have captured an image. Also it will open by selecting **Captured Image** command from **Window** menu or using the short-cut key (Ctrl + L).
The yellow border shows the present selected image. Tool buttons placed on the window are effective for the selected image. To select multiple images, click thumbnails while pressing down the Ctrl key. The window shows up to 16 images (Up to 100 images can be shown by setting change). When 7 or more images are placed, a scrollbar will be shown and images can be scrolled horizontally.
The max number of image capturing is set to 16 images, when being shipped from the factory. Refer to 3.6.3 Image Capture (5) Setting change for the max number of image capturing.

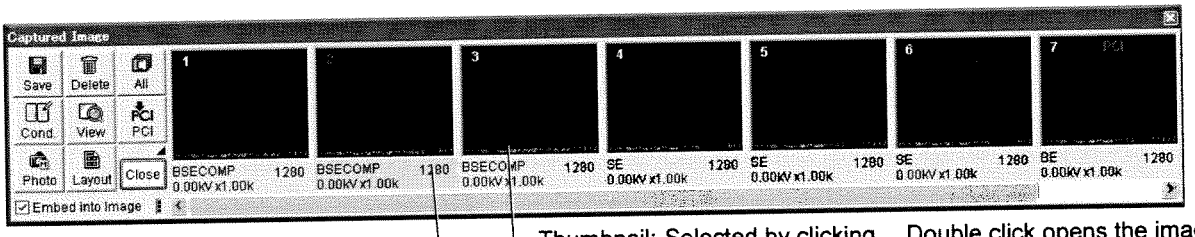


Fig. 2.3-47 Captured Image Window

Save button: Saves the selected image. If started when multiple images are selected, these are saved at once using All save option. The notation "Saved" is put on the already saved image thumbnails.

Delete button: Deletes the selected image.

All button: Selects all thumbnail buttons.

View button: Opens the selected image on the **viewer** window.

Layout button: Opens the **Report Generation** window for printing the image. To add other captured images on the sheet of the **Report Generation** window, double-click the image.

Cond. button: Opens the **Op. Cond** tab of the **Setup** window under the image and column condition when the image was captured.

Photo button: Starts memory photographing of the selected image.

Move button: Moves the stage to the position where the selected image was captured. It is effective for the Type II motorized stage.

PCI button: Transfers the selected image to "Quartz PCI" database program.
It is effective when the "Quartz PCI" has been installed.
The notation "**PCI**" is put on the already transferred image thumbnails.

Close button: Closes the window. Closing the window does not clear thumbnails.
You can open them again.

Embed into Image : When the box is checked, auto data display at the time of capture and data written with the Data Entry function are recorded with the image.

: Vertical/horizontal display switching button
Clicking this button changes the **Captured Image** between vertical/horizontal display formats.

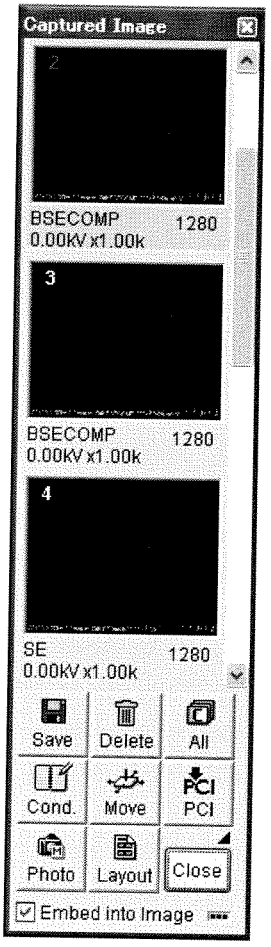


Fig. 2.3-48 Vertical Display Captured Image Window

See <3.6.3 Image Capture>.
See <3.6.6 Saving Captured Images>.
See <3.6.7 Taking Photographs (Option)>.
See <3.9.10 Printing Images Using Report Generation Function>.

2.3.11 SEM Data Manager Window

SEM Data Manager is an image-filing program with an easy-to-operate database function. Images are registered to the database automatically when saved.
For details, refer to <3.11 Managing Image Data (SEM Data Manager)>.

2.3.12 Alignment Window

The **Alignment** window is used for alignment operations.

To open the window, click the **Align** button on the Control panel or select the **Alignment** command from the **Operate** menu. When the window is opened with the **Align** button, **Aperture Alignment** starts as the default setting.
Refer to <3.4.2 Axial Alignment>.

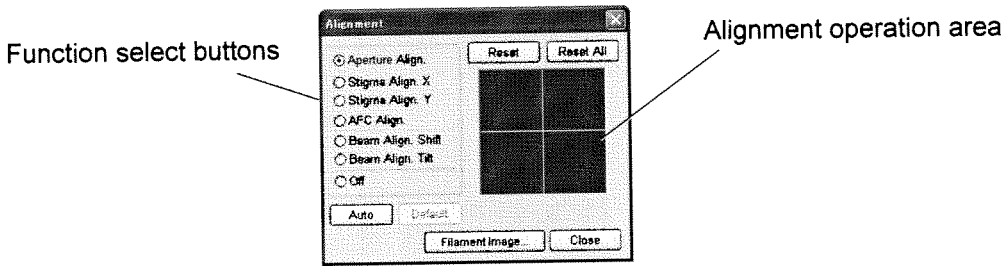


Fig. 2.3-49 Alignment Window

- Function select buttons: Starts each alignment function. **Off** stops functions.
- **Reset** button: Resets alignment of the selected function.
- **Reset All** button: Resets alignment of all functions.
- Alignment operation area: This area is used for adjustment operation. When the mouse area pointer is , you can make adjustment both in X and Y direction by moving the mouse while pressing the left button. When the mouse pointer is or , adjustment is restricted in X or Y direction.
- **Auto** button: The **Auto** button is enabled with the alignment mode is **Aperture Align.**, **Beam Align. Tilt**, **Beam Shift**, **Stigma Align. X**, and **Stigma Align. Y**.
  If the alignment mode is **Aperture Align.**, **Stigma Align. X**, or **Stigma Align. Y**, this function executes the automatic axial alignment (**AAA**); if the alignment mode is **Beam Align. Tilt** or **Beam Align. Shift**, this function executes the automatic beam alignment (**ABA**). If the automatic axial alignment (**AAA**) is run, the alignment mode will be automatically turned off. Also, the automatic axial alignment (**AAA**) cannot run in the Dual/Full screen mode.

- **Default** button: The **Default** button is enabled when the alignment mode is either **Stigma Align. X** or **Stigma Align. Y**. If the alignment mode is **Stigma Align. X**, sets the stigma X alignment data to the default value, and the X of stigma to the mid-point. If the alignment mode is **Stigma Align. Y**, sets the stigma Y alignment data to the default value, and the Y of stigma to the mid-point.
- **Filament Image** button Opens the **Filament Image** window and changes the observed image to the filament image.
  This function is used to perform optimal axis adjustments using a filament image.

2.3.13 Image Adjustment Window

It is possible to adjust Focus, Stigma, Bright/Cont and Image Shift that are usually adjusted by mouse operation and operational panel.
By this window, it is possible to adjust Focus, Stigma, Bright/Cont and Image Shift that are usually adjusted by mouse operation and operational panel.
It can also use Tilt Compensation function.
That function is useful to observe the inclined sample.

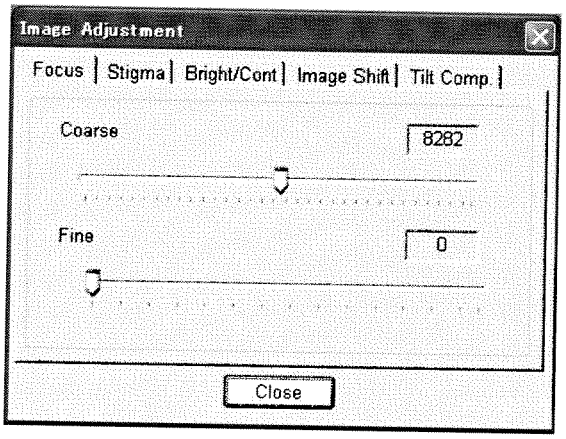


Fig. 2.3-50 Image Adjustment Window

2.3.14 CD Measurement Window (Option)

This window, which is used for measurement purposes, can be launched by clicking the **Measure** Measure button in the **Tool** Button area on the Operation Panel or by selecting **CD Measurement** from the **Analysis** menu.
Refer to the operation manual of **CD Measurement** option.

2.3.15 Login Setting Window

It opens by selecting **Login Setting** command from **Option** menu. This is available only when logged in with the login name [S-3400].
You can create or change login names and their password for each user.

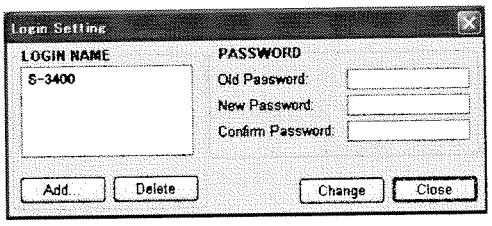


Fig. 2.3-51 Login Setting Window

Refer to <3.9.16 Setting Login Name>.

2.3.16 Oblique Image Window

The **Oblique Image** window is used to display an oblique image. To open the window, select the **Oblique** command from the **Analysis** menu.

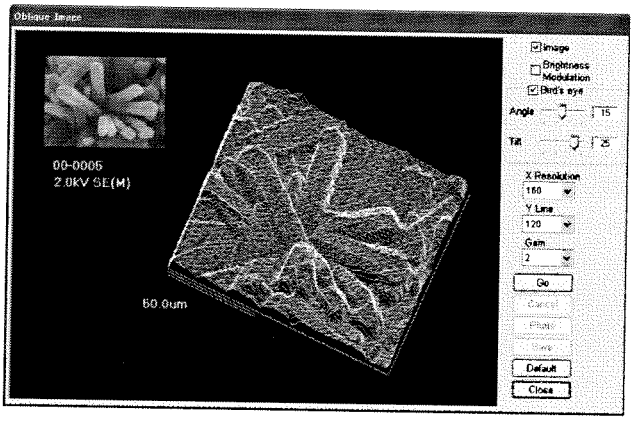


Fig. 2.3-52 Oblique Image Window

Refer to <3.9.13 Oblique Image>.

2.3.17 Password Setting Window

Use the **Password Setting** window for setting or changing the password of the login name for current user.
To open this window, select the **Password Setting** command from the **Option** menu.

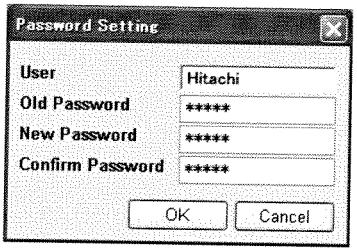


Fig. 2.3-53 Password Setting Window

Refer to <3.9.15 Password Setting>.

2.3.18 Image Save Window

The **Image Save** window is used for saving scanning images or captured images.
This window opens when the **Direct Save** button of the Control Panel, the **Direct Save** command of the **File** menu, or the **Save** button of the Captured Image window is clicked.

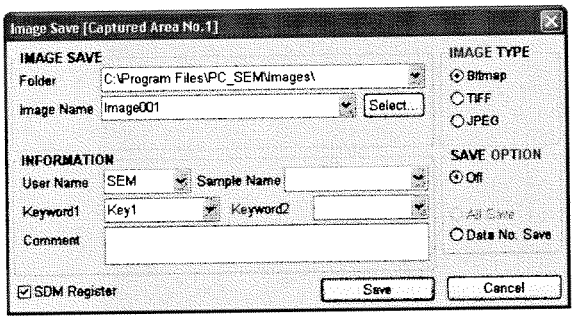


Fig. 2.3-54 Image Save Window

See <3.6.5 Saving a Scanning Image (Direct Save)>.
See <3.6.6 Saving Captured Images>.

NOTICE: The **SDM Register** check box should be checked if you wish to automatically register saved images to the **SEM Data manager** database. Remove the check when registration is not necessary, for example when the PCI is be used for data archiving.

2.3.19 Signal Processing Window

Signal processing is applied to the scanning image in real time. It is digital processing.
This window is displayed when selecting **Signal Processing** from **Image** menu.
Reference: 3.9.5 Signal Processing

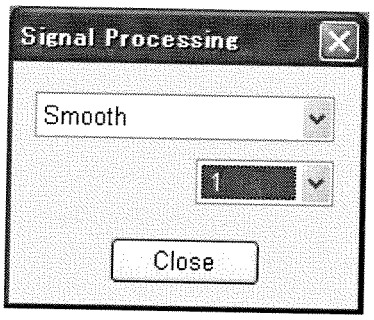


Fig. 2.3-55 Signal Processing Window

(1) Signal processing selective box
Selects the type of signal processing.

- Smooth: Reduces snow noise. Effective works especially in case of high magnification image.
  For low magnification images having fine structures, it may cause some degradation of sharpness. Two processing intensities are selectable.
- Sharpen: Increases sharpness of scanning image. Two processing intensities are selectable. It may increase noise when the original image contains snow noise.
- Edge Enhance: Sharpen edges. This processing is stronger than Sharpen.
  Two processing intensities are selectable
- Invert: Color inversion. Results in negative image.
- Gamma: Gamma correction. -5 to +5 selectable.

(2) Intensity selective box
Selects a processing intensity.

NOTICE: With dual display mode, Signal Processing cannot be used.
It is possible to apply similar spatial filtering to saved images using SEM Data Manager.

2.3.20 Opt. Signal Processing Window

The **Opt. Signal Processing** window is used to apply analog processing to signals of an optional detector.

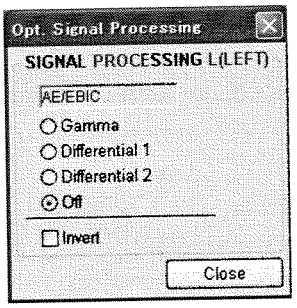


Fig. 2.3-56 Opt. Signal Processing Window

Refer to <3.9.5 Signal Processing>.

2.3.21 Split/Dual Mag Window

Split Screen mode displays two images in the viewing area, and allows images having different signals and at different magnifications to be displayed. To open this window, select the Split DM command from the Scan menu.
For switching detectors, click the **Detector** button so that detector-setting control will expand and display a menu.

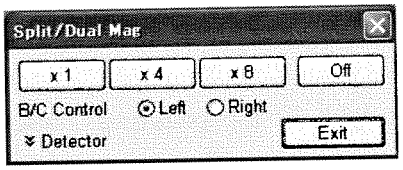


Fig. 2.3-57 Split/Dual Mag Window

Refer to <3.9.2 Split Screen and Dual Mag mode>.

2.3.22 Histogram Window

A histogram of the current image can be shown.
To show histogram, select **Histogram** from **Image** menu.
This function periodically calculates and displays a histogram of the displayed image.

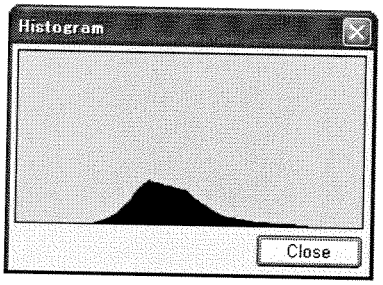


Fig. 2.3-58 Histogram Window

2.3.23 Using Short-cut Keys

Short-cut keys are available for execution of many commands.

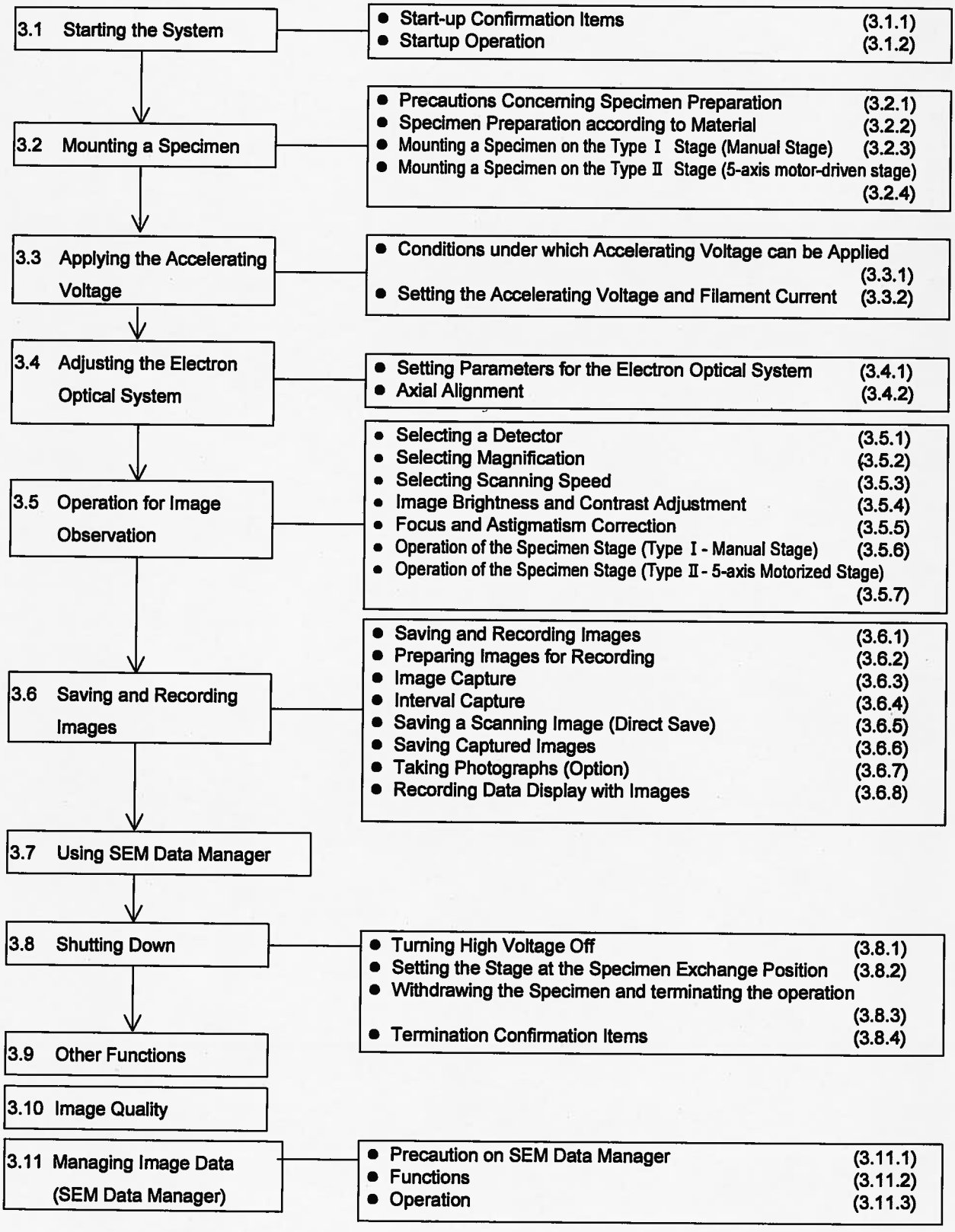
(1) Using short-cut keys
Input **Alt** + [underlined character in a main menu command] opens the pull-down menu.
And then, [underlined character in a pull-down menu] executes the command.
For example, **Alt** + **F** opens the **File** menu and **S** key executes the **Direct Save** command.
While a pull-down menu is open, **arrow** keys ↑ (←) ↓ (→) select commands in order.
The Enter key executes the selected command.

(2) Using Ctrl + ~ keys or Functions keys
Some frequently used commands are executed using this type of short-cut keys.
They are;

Ctrl + O:	Open SEM Data Manager
Ctrl + P:	Print
Ctrl + C	Copy Image
Ctrl + L:	Open **Captured Image** window
F1:	Help can be opened
F2:	Activates the Degauss function
F5:	Runs or stops scanning alternately

3. OPERATION

Shown below is the procedural flow of typical S-3400N SEM operation. For details, refer to each subsection.



3.1 Starting the System

3.1.1 Start-up Confirmation Items

Before starting the system, check the following items:

(1) Check the amount and quality of oil in the rotary pump.
See 4.2.1 Oil Change.

(2) Make sure that the vacuum plumbing in the evacuation system are not loose or disconnected.

(3) Close the drain cock of the compressor.
See 4.3.1 Daily Inspection.

(4) Is the compressor stop valve open?
See 4.3.4 Location and Functions of Major Components.

(5) Is the breaker on the customer-provided power distribution board turned on?

(6) Are all breakers on the system power distribution board turned on?

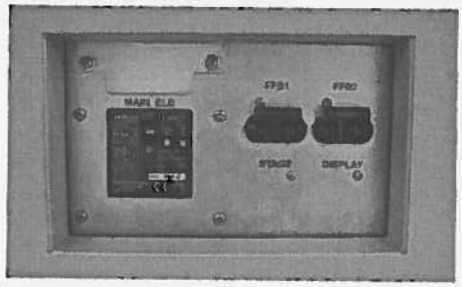


Fig. 3.1-1 System Power Distribution Board

3.1.2 Start-up Operation

(1) Rotate the key switch on the EVAC Panel to **START** and then release it. The system will start.

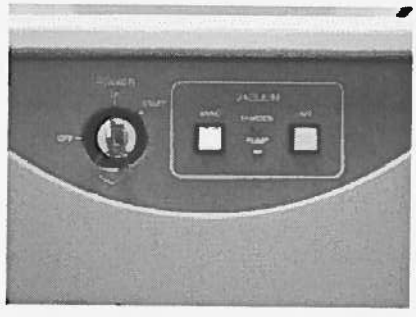


Fig. 3.1-2 Starting the System

(4) In case of Type II stage, message shown in Fig. 3.1-4 or Fig. 3.1-5 is displayed while the initialization of the stage is being executed.

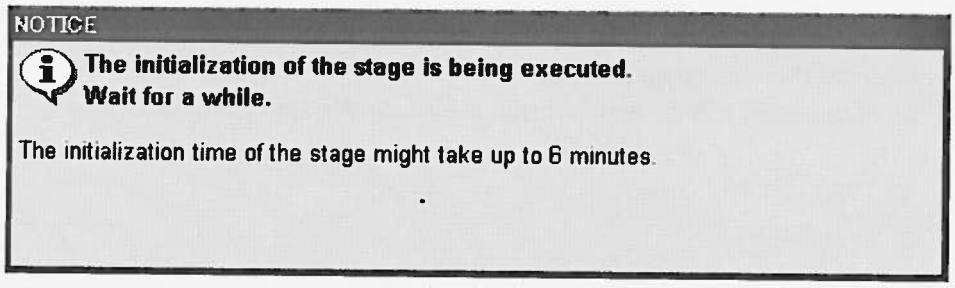


Fig. 3.1-4 Message Window (1)

In case of interrupting the initialization of the stage by clicking the **Stop** button, complete the initialization of the stage by clicking the **HOME Z65** button. The buzzer rings while the stage is moving.

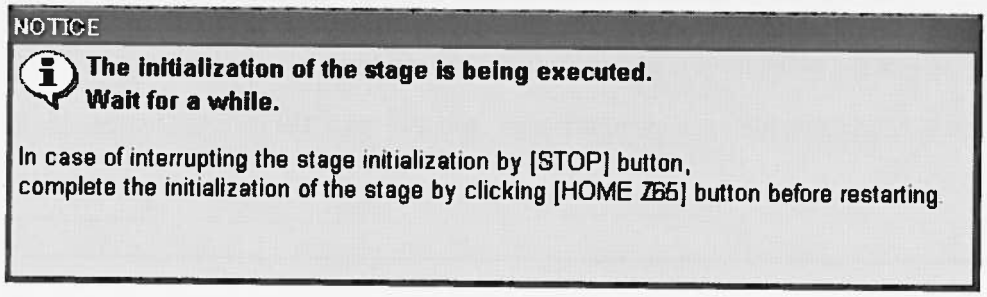


Fig. 3.1-5 Message Window (2)

⚠ **CAUTION:** For Type II stage, the stage automatically moves to the initialization position when logging on the operation program for S-3400N.
To avoid injury to hands or fingers, do not touch the operating parts while the stage is moving.

IMPORTANT: Do not insert the detector while initializing the stage. The initialization of the stage might not be completed and GUI might not be able to operate.

3.2 Mounting a Specimen

3.2.1 Precautions Concerning Specimen Preparation

During specimen preparation, observe the following.

(1) Wear clean gloves when exchanging specimens. Holding the specimen or specimen stub with bare hands should be avoided.

(2) Avoid using an excessive amount of conductive paste to fix a specimen on the specimen stub. Ensure that the paste has dried before placing the specimen in the chamber. Too much paste can release a large quantity of gas into the vacuum, which can cause the vacuum level to decline and result in contamination.

(3) When using double-sided adhesive tape to fix a specimen to the stub, use the least possible amount so as to minimize out-gassing. The use of double-sided adhesive tape may also cause specimen drift.

(4) Mounting a specimen containing an excessive amount of water or oil can cause contamination in the column, which should be avoided.

3.2.2 Specimen Preparation according to Material

The method of specimen preparation varies with different materials. Listed below are typical preparation methods for various types of specimens.

(1) Conductive specimens such as metals:
These types of specimens can be observed without preparation. However, coating with heavy metals by using a vacuum evaporator, an ion sputtering or magnetron-sputtering unit may result in better contrast.

(2) Non-conductive specimens such as semiconductors, fibrous specimens and polymeric materials:
When imaging a specimen without coating, the recommended procedure is to use either the low-vacuum mode or a low accelerating voltage. If the specimen needs to be imaged at high magnification, mount the specimen onto a stub, and then coat the specimen with a metal coating using a recommended procedure. If a high magnification image is required of micro-structures, the metal coating may be visible. Care should be taken to avoid this problem.

(3) Biological specimens:
Biological specimens can be observed in the low-vacuum mode without prior treatment. For high magnification observation, dry the specimen by using a method such as critical point drying, freeze drying or other drying techniques, then coat the specimen with conductive material.

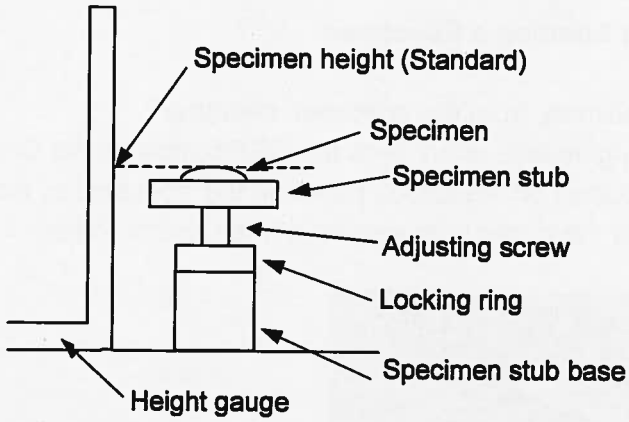


Fig. 3.2-2 Measuring the Specimen Height

IMPORTANT:	If the specimen is tilted or the Stage Z is short, the specimen can touch the objective lens or the backscattered electron detector that is provided on the underside of the objective lens, which can result in damage to the specimen, objective lens or the backscattered electron detector.

3.2.3.3 Moving the Stage to the Specimen Exchange Position

Align the X, Y, R, T, and Z knobs of the specimen stage to the specimen exchange position (the specimen exchange position is indicated on the upper face of the specimen stage).

Specimen replacement position	X: 30 mm	Y: 20 mm	Z: 35 mm
	R: 0°	T: 0°	

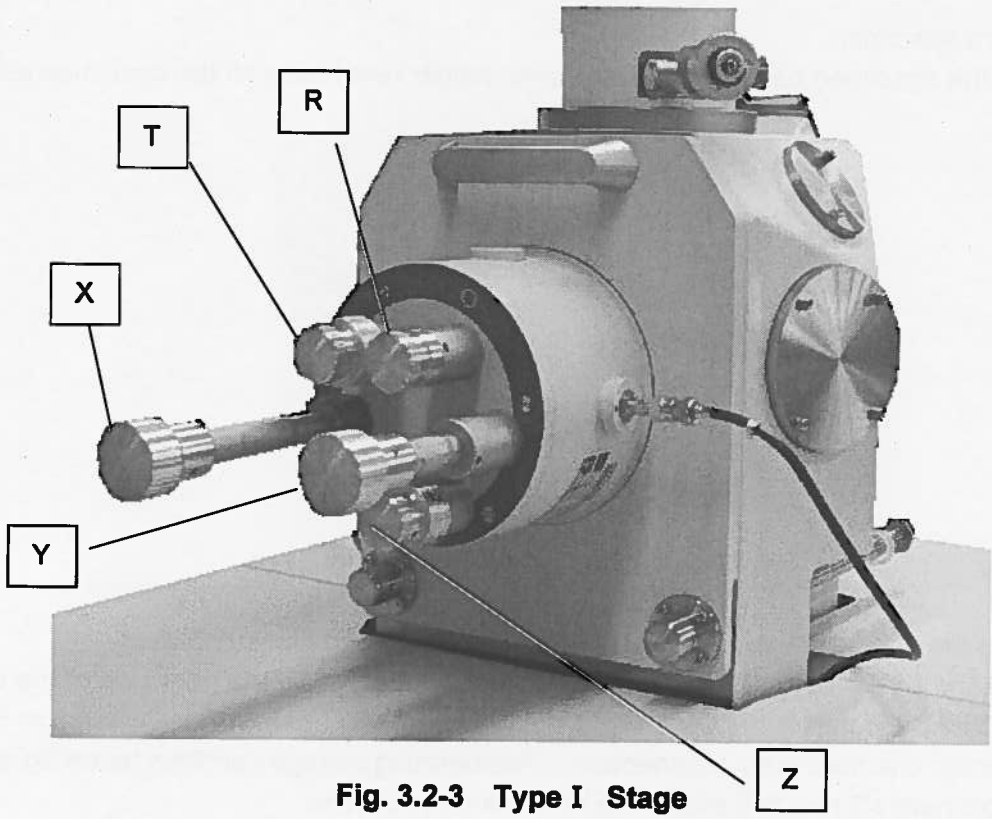


Fig. 3.2-3 Type I Stage

IMPORTANT: Do not touch the operation parts such as gears and driving screws and note that clothes are never placed when you bring the hand close to the movement mechanism in the specimen stage by the specimen exchange etc.

EVAC Panel

Control Panel

Fig. 3.2-6 Operating the EVAC Button (Evacuating the specimen chamber)

⚠ **CAUTION:** When pushing the specimen stage into the specimen chamber, be careful that your fingers are not caught between the stage and the specimen chamber.

IMPORTANT: Ensure that the stage door is firmly against the chamber before the **EVAC** button is pushed. The chamber cannot be evacuated unless the specimen stage has a tight fit with the chamber.

3.2.4.2 Specimen Exchange (Removing the Specimen from the Specimen Chamber)

(1) Click the **OFF** button on the Control Panel to shut the accelerating voltage off.

(2) Press the **AIR** button on the EVAC Panel or click the **AIR** button on the upper right section of the Control Panel. Air is introduced into the specimen chamber. The Specimen Setting window appears. After confirming the content of the window, click the **Specimen Setting** button.

EVAC Panel

Control Panel

Fig. 3.2-8 AIR Button (Introducing air into the specimen chamber)

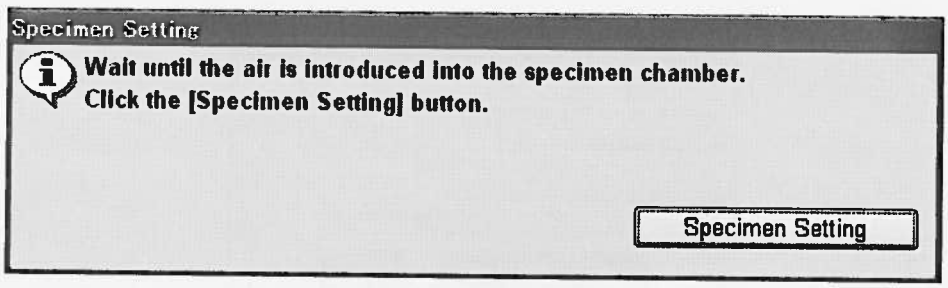


Fig. 3.2-9 Specimen Setting Window

When installing the Faraday cup (option)
Draw out the Faraday cup from the specimen chamber. The **Specimen Setting** button becomes effective. And then, click the **Specimen Setting** button.

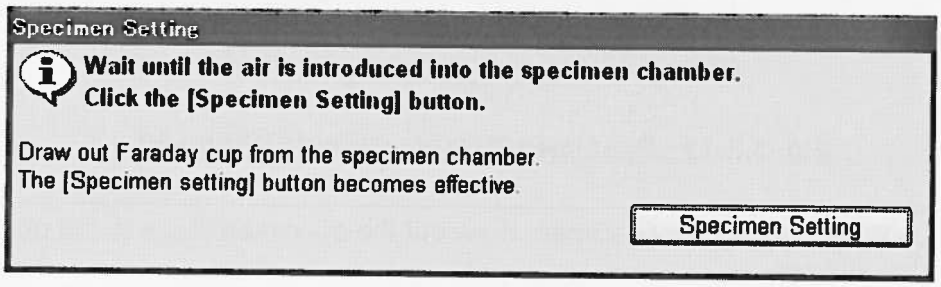


Fig. 3.2-10 Specimen Setting Window (When installing the Faraday cup)

3.2.4.3 Setting the Specimen Size and Height

(1) **Specimen/Detector Setting** window appears.
Set the specimen **Size** and **Height** with this window.

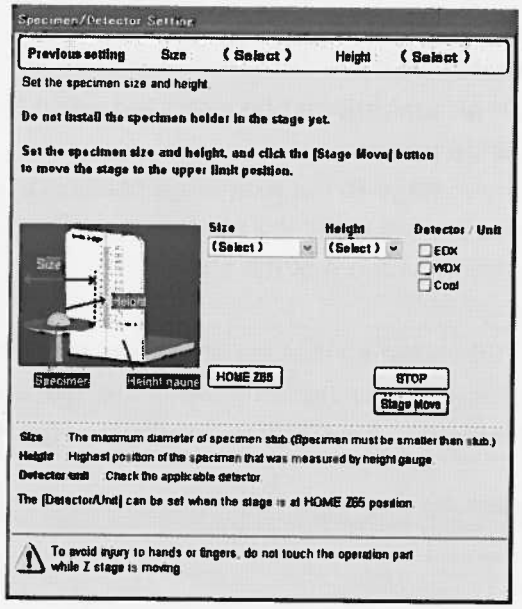


Fig. 3.2-14 Specimen/Detector Setting Window 2

(2) Measure the specimen **Size** and **Height**.
Use the height gauge to measure the highest point of the specimen. This value is the specimen height. When putting two or more specimens, measure the highest specimen of them. The specimen **Size** is the size of the specimen or specimen stub. When the specimen is larger than the specimen stub, the specimen size becomes specimen **Size**.

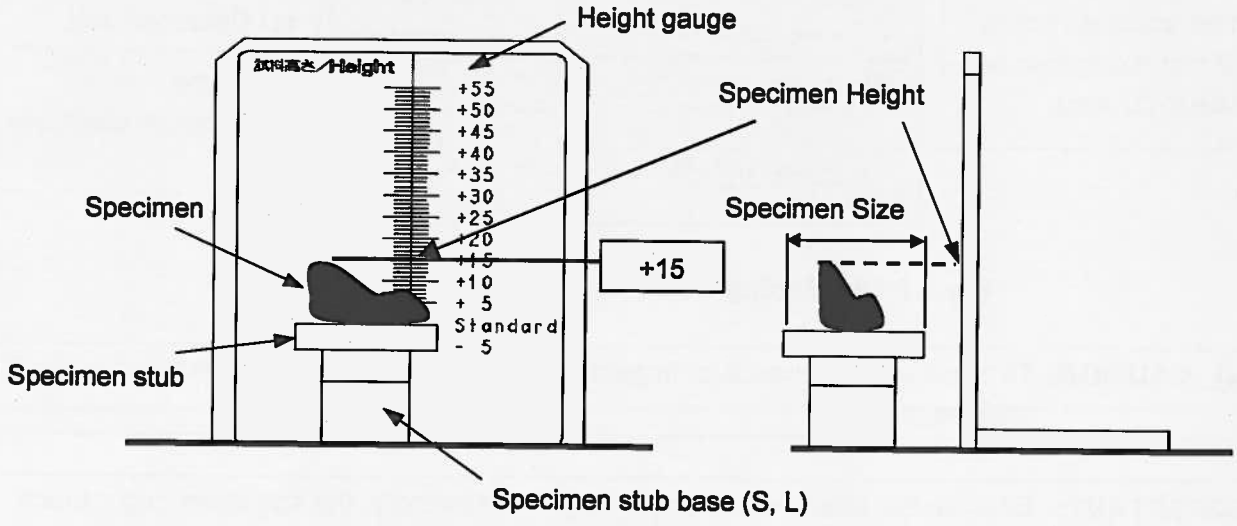


Fig. 3.2-15 Example of Measuring Specimen Height

(4) Move Specimen stage Z-axis to the upper limit position.
Do not install the specimen holder in the stage yet.
Confirm that the stage was pulled forward completely.
Click the **Stage Move** button so that the stage moves to the upper limit position. The buzzer keeps ringing while the stage is operating. Click the **STOP** button when you want to stop the movement of the stage.
The buzzer sound is stopped when the stage moves to the upper limit position, and the **Specimen/Detector Setting** window changes as shown in Fig. 3.2-17.

IMPORTANT: Click the **Stage Move** button with the specimen stage pulled forward completely. When the stage is moved to the upper limit position with specimen holder installed in the stage and inserted into the specimen chamber, the specimen might touch the check gauge or the BSE detector and damage them.

⚠ **CAUTION:** To avoid injury to hands or fingers, do not touch the operation part while Z stage is moving.

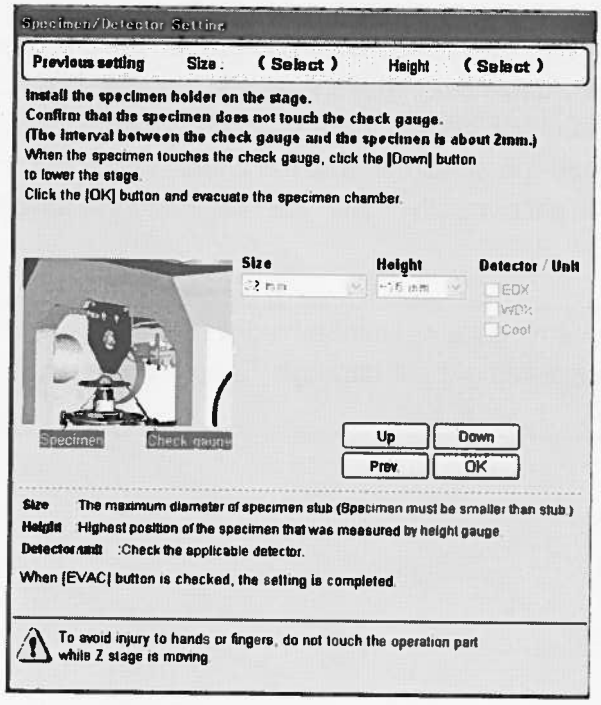


Fig. 3.2-17 Specimen/Detector Setting Window 3

In the case of wrong **Height** setting, the specimen will touch the check gauge. Click the **Back** button on the Specimen/Detector Setting window to return to the setting screen and set the **Height** again.
When adjusting the gap a little, click the **Down** button to change the **Height** setting. Clicking the **Down** button can lower the stage Z-axis by 1 mm. At this time, specimen **Height** on the GUI is automatically changed.
If the stage Z-axis is lowered too much, click the **Up** button to raise the stage Z-axis and adjust it. Clicking the **Up** button can raise the stage Z-axis by 1 mm.

(7) After confirming the setting of specimen height, click the **OK** button.

(8) Evacuate air from the specimen chamber. Press the **EVAC** button on the front of the **EVAC** panel or click the **EVAC** button on the control panel to start evacuating the specimen chamber. The **EVAC** switch blinking changes into a steadily lit state in about 2 minutes, and the specimen can be observed by applying an accelerating voltage.

EVAC Panel

Control Panel

Fig. 3.2-20 EVAC Button (Evacuating the specimen chamber)

⚠ **CAUTION:**	When changing the specimen, operate the stage with the knob and be careful that your fingers are not caught between the stage and the specimen chamber.

IMPORTANT:	Do not touch the moving parts such as gears and driving screws nor get your clothes caught in the mechanism when you bring the hand close to the movement mechanism in the stage at the specimen exchange, etc.

IMPORTANT:	The specimen chamber cannot be evacuated unless the stage is set firmly in the specimen chamber.

3.3 Applying the Accelerating Voltage

3.3.1 Conditions under which Accelerating Voltage can be Applied

If **E.Beam** block at the left top position on the **Control Panel** is grayed out, the accelerating voltage can not applied, wait until the **ON** button is activated with the evacuation of the chamber is completed.
When the accelerating voltage is on, the accelerating voltage indicator shows the currently set accelerating voltage and the emission current (in μA). The top left button should indicate **OFF**.

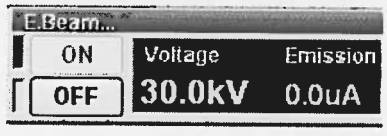


Fig. 3.3-1 E.Beam Block (ON Active)

3.3.2 Setting the Accelerating Voltage and Filament Current

There are four ways of applying an accelerating voltage:

(1) Click **E.Beam** block, open **Setup** window, and press the **ON** button in the **Optics** tab.

Fig. 3.3-2 Applying the Accelerating Voltage (a)

(2) Press the left **ON** button in **E.Beam** block.

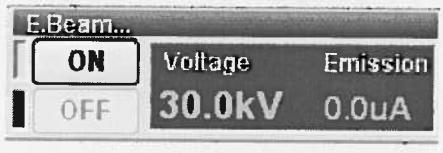


Fig. 3.3-3 Applying the Accelerating Voltage (b)

(a) For accelerating voltage, select the desired accelerating voltage level from the list displayed in the accelerating voltage **Vacc** input section. If necessary, the Up/Down buttons can be used to set the defined value in 100 V increments. If desired, a specific numerical value can be entered from the keyboard (use the Enter key to set the value).

(b) To set a filament current, select the **Detail** button on the **Cond.** tab in the Control Panel, and select **Mid**, then press **AFS**.

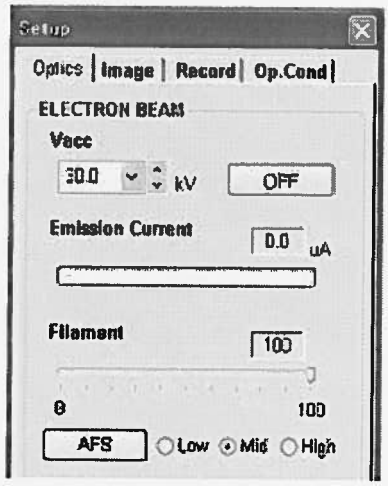


Fig. 3.3-6 Setting a Filament Current

NOTICE: The filament current, **Filament**, can be set automatically by pressing either the Auto Filament Saturation **AFS** function or the Auto Beam Setting **ABS** button.

NOTICE: Because the previous setting value is memorized in **Filament**, **AFS** need not be done every time. Execute it when Filament setting changes.

Also, the filament current **Filament** can be adjusted on a customized basis by moving the slider. Normally, Hitachi recommends the use of an automatically set filament current by the Auto Filament Saturation **AFS** or the Auto Beam Setting **ABS**.
When the **AFS** function is running, the screen freezes, and a message appears. When the screen changes to a RUN state, it is an indication that the auto adjustment has finished.

NOTICE: The Auto Filament Saturation **AFS** should be set to **High** for high magnification imaging, and **Low** to ensure long filament life.

3.4 Adjusting the Electron Optical System

3.4.1 Setting Parameters for the Electron Optical System

Parameters for the electron optical system can be set in two locations:

(1) **Cond.** Tab (on the Control Panel)
On the **Cond.** tab, accelerating voltage **Vacc**, **Probe Current**, focusing position **WORKING DISTANCE**, and **Detail** can be set and selected.

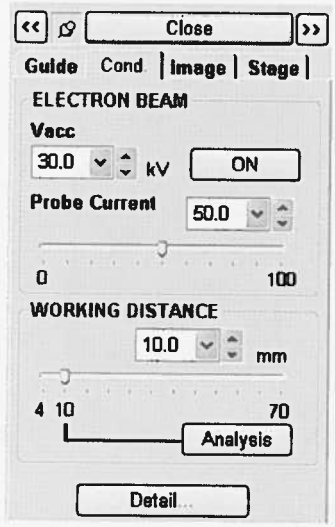


Fig. 3.4-1 Setting Electron Optical System Parameters on the Cond. Tab

(c) Auto Beam Setting (**ABS**)
ABS combines the automation functions of **AFS** (Auto Filament Saturation), **ABA** (Auto Beam Alignment), **ABCC** (Auto Brightness Contrast), and **AFC** (Auto Focus Control) to produce good-quality SEM images. This feature can be helpful when steps such as the setting the filament current and the adjusting the gun alignment axes after a filament is replaced. For details, see the individual Auto functions. After the **ABS** function is activated, the **Auto Gun Bias** function is set to the checkmarked conditions. See the following sections:

3.4.2.2 Axial Alignment Items in Detail
3.3.2 Setting the Accelerating Voltage and Filament Current
3.5.4 Image Brightness and Contrast Adjustment
3.5.5 Focus and Astigmatism Correction

(d) Setting the **Probe current**
Click the button to select the desired probe current level from 0 to 100, from a displayed list. The lower the probe current setting, the higher the resolution that can be obtained. For observing low-contrast specimens and performing X-ray analyses, the Probe Current level should be set high to produce a large amount of probe current. The default is 50.
Small adjustments can be made by using the Up/Down buttons to change the probe current in 0.1 increments. A numerical value can be entered directly from the keyboard (use the Enter key to set).

(e) Setting a **WD** (Working Distance)
Working Distance (WD) refers to the distance between the bottom of the objective lens and the surface of the specimen. The scale on the Z-axis of the specimen stage corresponds to the Working Distance.

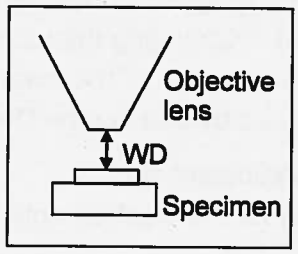


Fig. 3.4-3 Definition of WD

3.4.2 Axial Alignment

To fully exploit the capabilities of the system, it is necessary to perform axis alignment on the electron optical system.
The chart below shows axis alignment procedures. The required items should be adjusted after imaging conditions are modified.

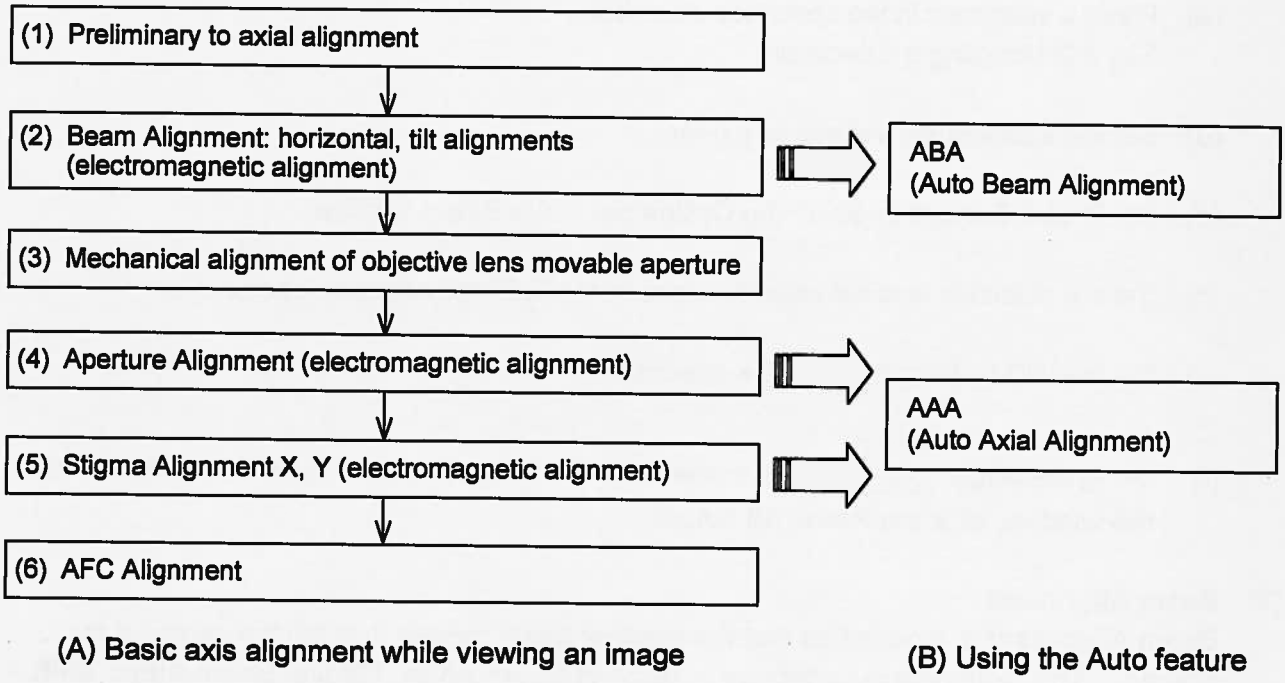


Fig. 3.4-4 Axis Alignment Procedures

Method (A), shown on the left side of Fig. 3.4-4, is a basic axis alignment method that allows you to perform alignments by moving a knob on the Control Panel while viewing an image. In the electromagnetic alignment part (**Beam Alignment horizontal, tilt alignment, Aperture Alignment adjustment, Stigma Alignment, and X, Y alignment**) can also be aligned by using Method (B), which combines the Auto features.

3.4.2.1 Items Requiring Axial Alignment

The list below shows when an axial alignment is needed and what specific items need to be adjusted. For further details, see <3.4.2.2 Axial Alignment Items in Detail>.

- After a filament is replaced: Adjust all items.
- After the position of the objective movable aperture has been changed:
  Adjust items (3) to (5).
- When the accelerating voltage or probe current is changed:
  Adjust items (4) and (5).
- Adjustment of Auto Focus is not suitable well :
  Adjust item (6).

- After the alignment process is finished, click the **Off** radio button on the **Alignment** window.
- Adjust the contrast so that the screen will be at the best possible brightness to view images.

(b) Using the Auto feature

This method allows you to perform alignment using **ABA** (Auto Beam Alignment) on both **Beam Align. Shift** and **Beam Align. Tilt**.

- Click the **Beam Align. Shift** radio button.
- Click the **Auto** button shown in the figure below:

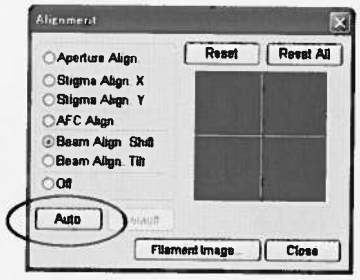


Fig. 3.4-6 Selecting the Auto Beam Alignment

- **ABA** (Auto Beam Alignment) is performed, and an alignment is accomplished.
- Click the **Beam Align. Tilt** radio button.
- Similarly, click the **Auto** button.
- The **ABA** is performed, after which the Beam Alignment process terminates.

NOTICE: If an image fails to show even when the contrast to is set to a maximum, redo the beam alignment as follows: click **Reset All**, set the Probe Current to approximately 80, perform a beam alignment, and then set the Probe Current to a level required by the operating condition (default: 50).

(4) **Aperture Alignment**

The **Aperture Alignment** is designed so that the electron beam will pass through the center of the objective lens and objective lens movable aperture. If this alignment is not performed precisely, focusing operations can shift the image, resulting in inadequate resolution or image quality.

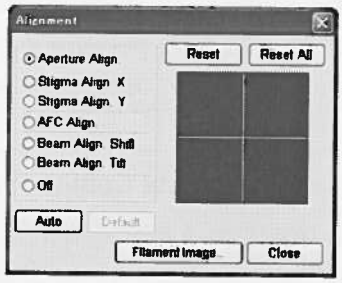


Fig. 3.4-8 Aperture Alignment Menu

NOTICE: For normal observation, axial alignments should be performed using the Electromagnetic Alignment. If the objective lens movable aperture is moved, reset the aperture alignment to a mid-point. After that, use the objective lens movable aperture to make adjustments so that the brightness of the image will be at a maximum. In subsequent normal observations, axial alignments should be performed using the Electromagnetic Alignment.

(a) Basic axial alignment by viewing an image

- Set the magnification factor from 1,000× to 5,000×. Move a spot on the specimen to near the center of the image.
- Perform focus and stigmation adjustments.
- On the **Alignment** window, click the **Aperture Align.** radio button to bring up the Aperture Alignment mode in which the focus and the image position fluctuate periodically.
- Using either the **STIGMA/ALIGNMENT** knob on the Manual Operation Knobset or the alignment operation area in the **Alignment** window, move the mouse while holding down the left button of the mouse, and move the crosshairs so that the motion of the image is minimized.
- Increase the magnification factor to 5000× or higher to perform final Aperture alignments.
- After the adjustment process is finished, click the **Off** radio button on the **Alignment** window.

(5) **Stigma Alignment X, Y** adjustments

The **Stigma Alignment** function is designed to ensure that the image will not move during the stigma correction process. This function is also necessary for the accurate operation of Auto Stigma.

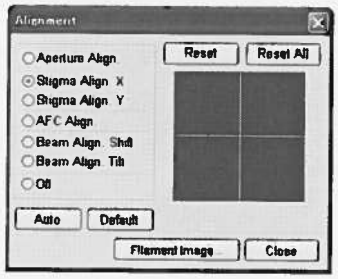


Fig. 3.4-10 Selecting the Stigma Alignment

(a) Basic axial alignment that is performed while viewing an image

- Set the magnification between 1,000× to 5,000×. Move a salient spot on the specimen to near the center of the image.
- Perform focus and stigmation alignments.
- On the **Alignment** window, click the **Stigma Align. X** radio button so that the image will move periodically.
- Either adjust the **STIGMA/ALIGNMENT** knob on the Manual Operation knobset or move the mouse while holding down on the left button of the mouse in the Alignment Operation area on the **Alignment** window to minimize the motion of the image.
- Similarly, click the **Stigma Align. Y** radio button on the **Alignment** window to minimize the motion of the image.
- After the alignment process is finished, click the **Off** radio button.

NOTICE: To improve the effectiveness of the electron optical axis alignment process, click the **DeGauss** button after focusing adjustment is finished (or press the function key **F2**), and then perform an electromagnetic alignment.

(6) **AFC Alignment** adjustments

The **AFC Alignment** function is designed to the electron beam will pass through the center of the objective lens. This function is also necessary for the accurate operation of Auto Focus and the Auto Stigma and Focus.

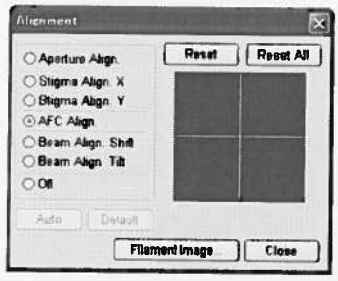


Fig. 3.4-12 Selecting the AFC Alignment

- Set the magnification between 1,000× to 5,000×. Move a salient spot on the specimen to near the center of the image.
- Perform focus and stigmation alignments.
- On the **Alignment** window, click the **AFC Align.** radio button so that the image will move periodically.
- Either adjust the **STIGMA/ALIGNMENT** knob on the Manual Operation knobset or move the mouse while holding down on the left button of the mouse in the Alignment Operation area on the **Alignment** window to minimize the motion of the image.
- After the alignment process is finished, click the **Off** radio button.

3.5 Operation for Image Observation

Follow the operation below for observation of a scanning image.

3.5.1 Selecting a Detector

A detector can be selected by using the **DETECTOR** block located in the **Image** tab on the Operation Panel. One of the following detectors can be selected: a secondary electron detector (**SE**), a backscattered electron detector (**BSE**), or (**Option**) other detectors. If the **ABCC Link** is checked, changing detector settings automatically causes contrast and brightness adjustments.

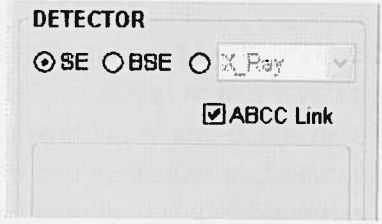


Fig. 3.5-1 Selecting a Detector

IMPORTANT: Changing detectors causes a substantial change in the brightness of the image. If the **ABCC Link** check box in the **Image** tab of the Operational panel has been checked, ABCC will start automatically when detector selection is changed. Image brightness will be adjusted to an adequate value.

IMPORTANT: In high magnification observation, the image shifts by several micrometers due to the characteristics of the detectors when the detector is changed.

3.5.1.2 Backscattered Electron Detector (BSE)

For conducting observations, a backscattered electron detector is normally used in the low-vacuum mode.
The backscattered electron detector picks up the electrons reflected from the specimen by means of a semiconductor sensor attached to the underside of the objective lens. The semiconductor sensor is comprised of a doughnut-shaped 4-way split element that has a hole through which the primary electron beam can pass, and a 3D imaging sensor that detects low-angle reflection electrons. By putting detected signals through computational processing, the semiconductor sensor provides image observations in three detection modes: composition (**COMP**), topology (**TOPO**), and stereo (**3D**) modes.

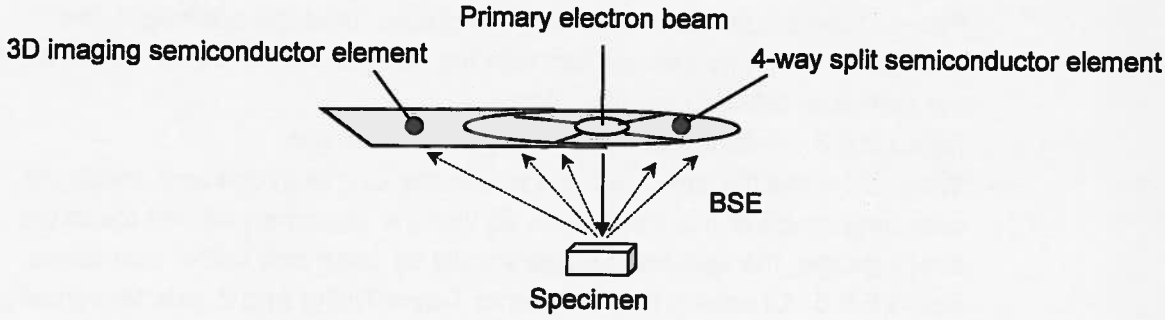


Fig. 3.5-3 Signal Detection by Backscattered Electron Detector

(1) **Setting the backscattered electron detector (BSE)**
Selecting the **BSE** option in the **DETECTOR** block produces a **BSE** image. This menu can be used to set the type of **BSE** signal, **COMP**, **TOPO** or **3D**, and the amount of gains to be produced.

Fig. 3.5-5 BSE Menu

(a) **COMP** mode
The **COMP** mode allows the observation of a composition image by exploiting the atomic number effect that the lighter the atomic weight of an element, the darker is the backscattered electron signal, and the heavier the element, the brighter the signal. Pressing the **COMP** mode button again reverses the composition image, from black to white and from white to black, and this is repeated each time the button is pressed.

Fig. 3.5-6 COMP Mode

(b) **TOPO** mode
Based on the difference in signal between oppositely disposed detector sensors, this mode permits the observation of topographic images. Each pressing of the **TOPO** mode button changes the direction of shading by 90 degrees.

Fig. 3.5-7 TOPO Mode

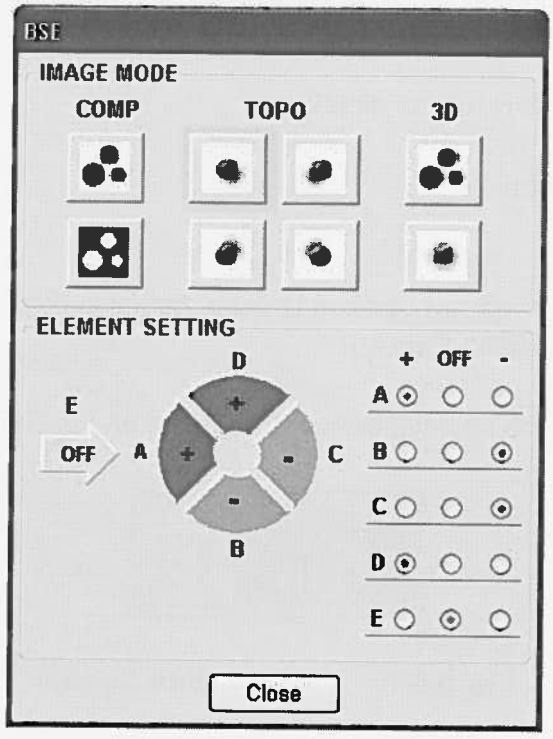


Fig. 3.5-9 BSE Window

IMAGE MODE: This button switches between detection modes, similar to pressing the **COMP/TOPO/3D** buttons in the **DETECTOR** block.

ELEMENT SETTING: Either select radio buttons **A-E** or click elements in the detector sensor diagram to set each element to **+/-/OFF**.

3.5.1.3 Other Detectors (Option)

By selecting a detector other than SE/BSE in the **DETECTOR** block, it is possible to observe images based on the different detector. Optional detectors that are installed can be selected from a pull-down menu.

NOTICE:	Different detectors can be selected by setting a 2-screen display mode by selecting **Dual** in the image display size block in the **Image** tab on the Operation Panel. This feature allows you to compare images from different detectors in realtime or display a composite image from different detectors. For further details, see Section 3.9.3 Signal Selection and Color Mixing.

3.5.2.2 Notes on Using the Lowest Magnification and Conducting Observations at a Low Magnification

(1) Range of minimum magnifications

Table 3.5-2 shows available minimum magnifications for the various observation parameters. The minimum magnification is subject to restrictions by WD and accelerating voltage, scan speed.

Table 3.5-2 Minimum Magnification

Vacc(kV) \ WD(mm)	3.5 and above		9.5 and above		13.5 and above		19.5 and above		29.5 and above		39.5 and above		49.5 and above		55.5 and above	
	TV/Fast	Slow	TV/Fast	Slow	TV/Fast	Slow	TV/Fast	Slow	TV/Fast	Slow	TV/Fast	Slow	TV/Fast	Slow	TV/Fast	Slow
30.0 to 28.1	80	55	45	32	37	25	27	19	20	14	15	11	13	9	12	9
28.0 to 26.1	80	55	45	32	35	25	27	19	19	13	15	11	12	9	12	8
26.0 to 24.1	80	55	42	30	35	25	25	18	18	13	14	10	12	9	11	8
24.0 to 22.1	75	50	42	30	32	23	25	17	18	13	14	10	12	8	11	8
22.0 to 20.1	65	47	42	30	30	21	23	17	17	12	13	10	11	8	10	7
20.0 to 16.1	65	47	40	27	30	21	23	16	16	11	13	9	11	8	10	7
16.0 to 16.1	65	45	35	25	30	20	21	15	15	11	12	9	10	7	10	7
16.0 to 14.1	60	42	35	25	27	19	20	14	14	10	11	8	10	7	9	6
14.0 to 12.1	60	42	32	23	25	17	19	13	14	10	11	8	9	6	9	6
12.0 to 10.1	55	37	30	20	23	16	17	12	13	9	10	7	8	6	8	6
10.0 to 6.1	45	32	27	19	21	15	16	11	11	8	9	7	7	5	7	5
8.0 to 6.1	42	30	23	16	18	13	14	10	10	7	8	6	7	5	7	6
6.0 to 4.1	35	25	20	14	15	11	12	9	9	6	7	5	6	5	6	5
4.0 to 2.1	35	25	20	14	15	11	12	9	9	6	7	5	6	5	6	5
2.0 to 0.3	35	25	20	14	15	11	12	9	9	6	7	5	6	5	6	5

NOTICE: The light and dark gray observation conditions shown in Table 3.5-2 permit wide FOV observations, which are suitable for searching for a specimen. Under such conditions, observations should be conducted by changing the objective lens movable aperture to No. 1 or 0.

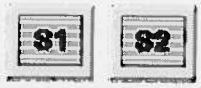
NOTICE: **Auto magnification fraction adjustment**
The auto fraction adjustment calculates and sets nearest even value magnification when capturing an image or directly photographing.

To enable the auto magnification fraction adjustment, check the mark at **Magnification Fraction Adjust** check box on **Optional Setup** window - **General** tab.

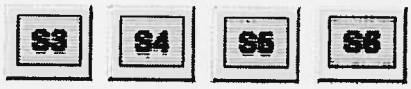
Note that, it will be set to preset magnification if the most recent magnification operation was magnification preset.

(3) **Fast Scanning:** 

Fast Scanning runs with half the speed of TV scanning. It is also convenient for a field search of the specimen, coarse focus, etc.
This is the highest possible scanning speed under the full screen mode.
The quality (S/N ratio) of the image is improved by frame averaging.
Two fast scanning speeds, FAST1 and FAST2, operate at the same speed but allow different number of frames to be averaged for each. To set the number of frames to be averaged, use the **Image** tab in the **Setup** window. In the **FAST SCAN AVERAGING** area, set FAST1 and FAST2 values. Recommended numbers are 2 or 4 for FAST1 and 4 or 8 for FAST2.

(4) **Slow Scanning:** 

Slow1 and Slow2 are relatively fast slow scans.
These two speeds are asynchronous to AC line frequency. It may cause some field magnetic disturbance at high magnification and/or low kV condition.
Use for a field search of the specimen, coarse focus, etc.
Slow1: About 1 s/frame (Full screen) About 0.5 s/frame (Small screen)
Slow2: About 4 s/frame (Full screen) About 2 s/frame (Small screen)

(5) **Slow Scanning:** 

Use these for observation, fine focus, and astigmatism correction. Finest image quality may be attainable.

Slow3: 20 s/frame (Full screen) 10 s/frame (Small screen)
Slow4: 40 s/frame (Full screen) 20 s/frame (Small screen)
Slow5: 80 s/frame (Full screen) 40 s/frame (Small screen)
Slow6: 160 s/frame (Full screen) 80 s/frame (Small screen)

(6) **Reduce Area Scanning:** 

Three reduced area scanning speeds are available.

(a) Reduce1:
The scan speed is approximately equal to the TV scanning rate. It is, therefore, suitable for searching the field, focus and astigmatism correction.
To move the scanning area box, place the mouse cursor over the border of the reduced area window. While the mouse cursor is changed to the Move indicator (intersecting arrows), press the left button and drag the scanning area box to a desired place.

(b) Reduce2:
Scanning speed is the same as Slow3 while the frame speed is 4 times faster.
It is suitable for final focus and astigmatism correction. The scanning area can be moved with the same operation as mentioned above.

(2) Manual adjustment using the mouse on the GUI
Select the **Image adjust** from the **Mouse Mode** by clicking the mouse wheel button on the image displayed.
The cursor changes to the B/C cursor  . Drag the mouse while holding down the left button to adjust brightness; and while holding down the right button to adjust contrast.
Drag it to the right to increase and to the left to decrease brightness or contrast.
Sensitivity of mouse operation can be adjusted on the **Mouse Op.** tab in the **Optional Setup** window.
Additionally, you can adjust the brightness and contrast using the scrollbars.
Checking the **Show Scrollbar** check box on the **Cond.** tab in the **Operation panel** enables using these scrollbars.
Refer to <3.9.14 Optional Setting>.

(3) Using the Manual Operation Panel
Use **Brightness** and **Contrast** knobs on the manual operation panel. In the **Dual Screen** mode, the image selected by the **Image Adj.** radio button in the lower section of the Control Panel changes.
Refer to <2.2.3 Manual Operation Panel>.

(4) B/C Monitor mode
A waveform and reference lines are displayed for monitoring contrast (amplitude of the waveform) and brightness (vertical level of the waveform).
When clicking the **MonitB** 

button of the Adjustment control block on the control panel, the signal waveform is displayed. Adjusting brightness causes the waveform to move vertically; adjusting contrast changes the amplitude of the waveform.
When the maximum and minimum values of the waveform are adjusted to fit within the upper and lower reference lines, appropriate brightness and contrast will be obtained.

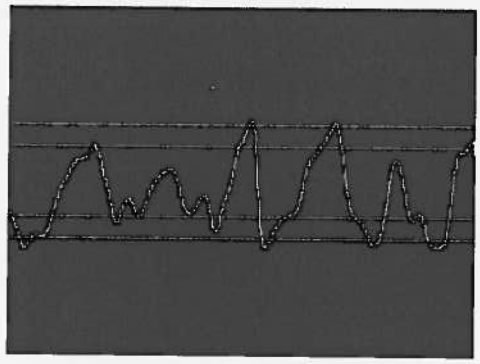
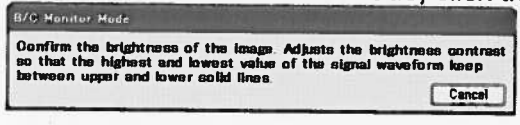


Fig. 3.5-16 B/C Monitor

Alternatively, select **BC Monitor** from the **Operate** menu to bring up the B/C Monitor mode.
To terminate B/C Monitor mode, click the **Cancel** button in the B/C Monitor mode message



or click one of the Scanning Speed buttons.

(b) Adjust the stigmators X and Y alternately for the sharpest image.

Fig. 3.5-19 Stigma Adjustment

(c) Focus again and check image drift and sharpness.

(d) Repeat steps (a) to (c) until adjustments are completed.

NOTICE: If it takes a long time to focus and correct astigmatism, you may end up with specimen damage due to electron beam irradiation and/or contamination.
If the specimen is beam- or contamination-sensitive, we suggest the following techniques:

(1) Reduce probe current.

(2) Use another area on the specimen for focusing purposes. After focusing, return to the area of interest, adjust the final focus quickly, and then capture or record the image.

(2) Auto Focus function

Click the **Focus** ▼ Focus button of the Auto control block on the Control panel or select the **Auto Focus** command from the **Operate** menu to start Auto Focus.
When magnification is lower than 5,000×, coarse focus (search using a wide focus range) is carried out. Fine focus (search using a narrow focus range) is carried out at magnifications higher than 5,000×.
Fine focus works correctly under conditions where the image is not clear but visible.
The result of Auto Focus depends on the surface structures of the specimen. When there is little or no surface detail on the specimen, or when the specimen is charged, Auto Focus does not operate properly.

(5) Manual astigmatism correction

Manual astigmatism correction can be done using the knobs on the manual operation panel or with the mouse operation in the **Scanning Image** window.

(a) Knob operation

Use **Stigma** control knobs **X** and **Y** on the operation panel.

(b) Mouse operation

Select the **Image adjust** from the **Mouse Mode** by clicking the mouse wheel button on the image displayed.

Move the mouse cursor to the top left quadrant of the image, where the mouse cursor is changed to the STIGMA cursor  . Drag the mouse while holding down the left button for X or the right button for Y correction. Repeat X and Y corrections, and focus, for a final result.

Sensitivity of mouse operation can be adjusted on the **Mouse Op.** tab in the **Optional Setup** window.

Astigmatism corrections can be done with the X and Y scrollbars as well.

Checking the **Show Scrollbar** check box on the **Cond.** tab in the operation panel enables use of these scrollbars.

NOTICE: If the image moves while correcting astigmatism, carry out Stigma Alignment. Refer to <3.4.2 Axial Alignment>.

(c) Dynamic stigma monitor

The dynamic stigma monitor is a mode that changes the amount of stigma correction according to the image scanning position. Because only the part of the image for which stigma correction is at optimum is in focus, adjustments are performed so as to bring the in-focus point to the center of the image. This mode is useful for observing a specimen that indicates the presence of a structure in the entire image at a high magnification. If the specimen surface contains few micro-structures or has a skewed structure, it may be difficult to identify an in-focus position.

Selecting the **Dynamic Stigma Monitor** from the **Operate** menu causes the execution of the dynamic stigma monitor mode. Because this mode works well at a magnification of 5,000× or higher, any low-magnification setting when the mode is selected will automatically be preset to 5,000×. Any magnification equal to or greater than 5,000x will remain unchanged.

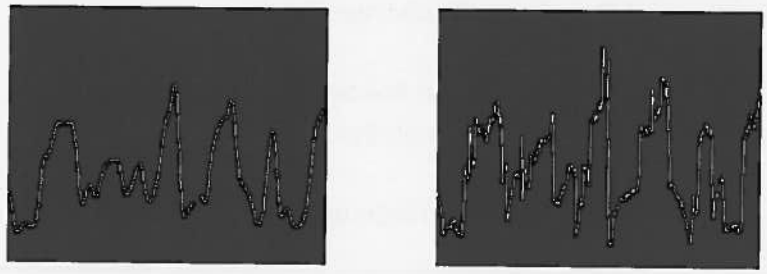
Running the dynamic stigma monitor displays a circle and a crossbar on the observation image, as illustrated in the following figure.

(6) Focus Monitor mode

A waveform is displayed for monitoring the focus. The magnification is set at 1,000×.

To start the Focus Monitor, click the **MonitF** 

button of the Adjustment control block on the Control panel and focus the image so that the waveform shows sharp peaks.

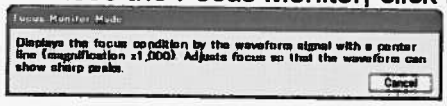


Defocused Focused

Fig. 3.5-22 Focus Monitor Mode

The sensitivity of the focusing knob and mouse operation will be the same as that at a low magnification (1,000×), which allows you to search the variable focusing range with a minimum amount of operation.

To close the Focus Monitor, click the **Cancel** button in the **Focus Monitor Mode** message



or click one of the **Scanning Speed** buttons.

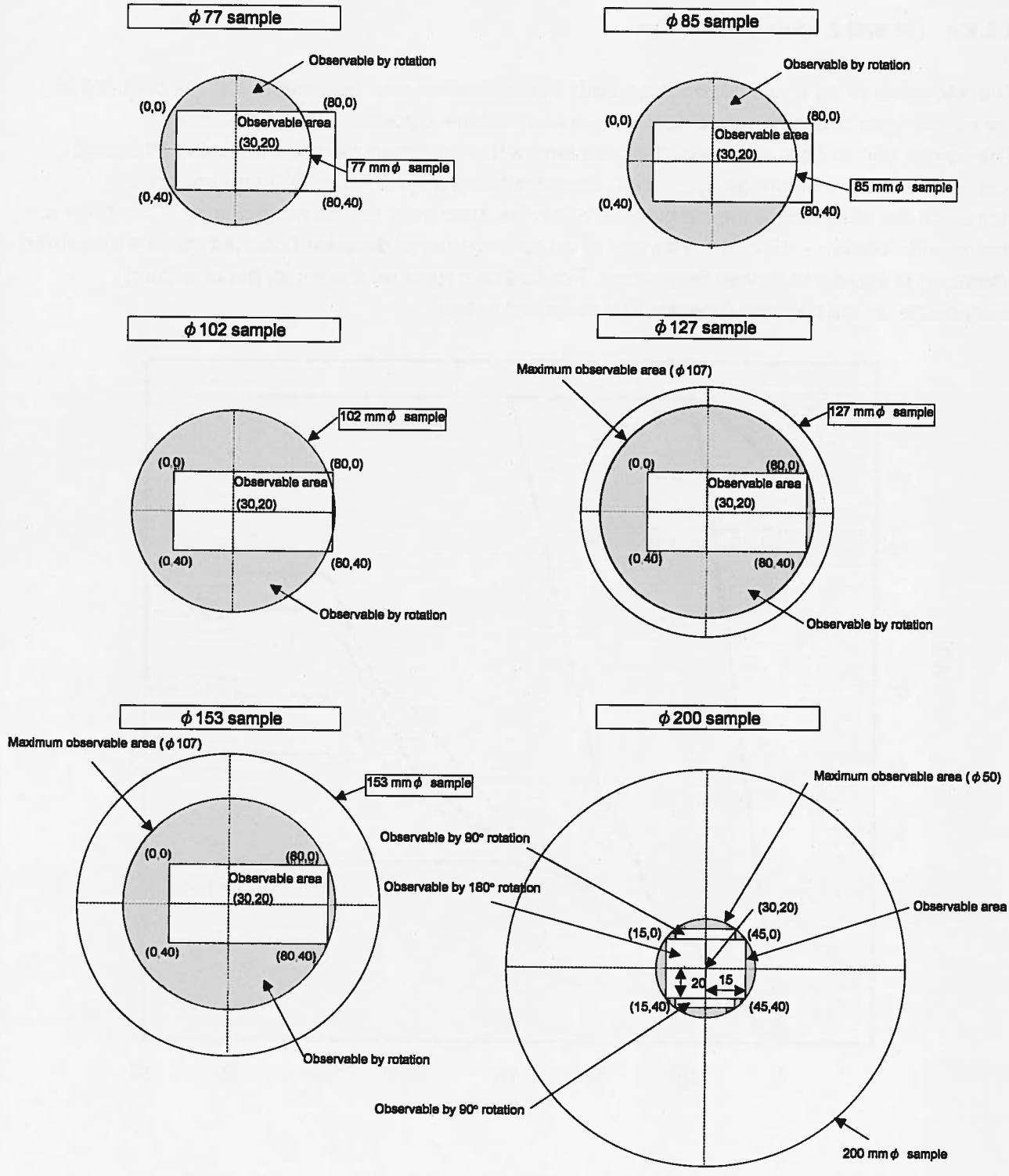


Fig. 3.5-23 Observable Ranges in X and Y Directions by Specimen Size (Type Ⅰ stage - not using an optional detector)

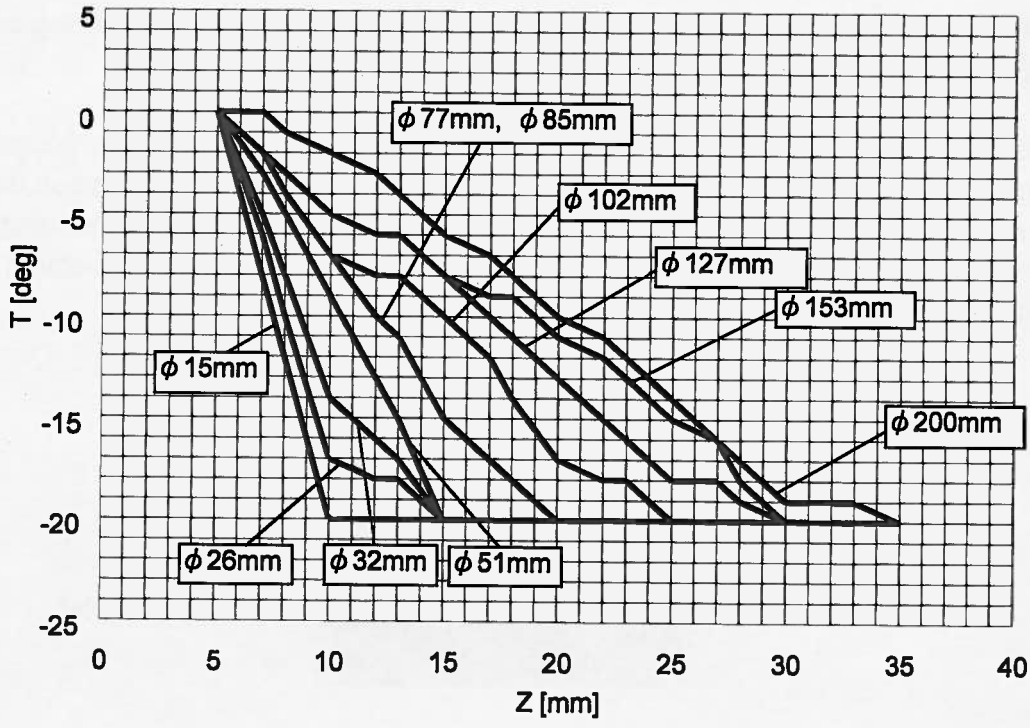


Fig. 3.5-25 Allowable Angle of Tilt (Type I) with respect to the Z-axis (Negative angle of tilt)

IMPORTANT:	Set Z and T within the allowable range; otherwise, the specimen may strike the objective lens or BSE detector and cause damage to both specimen and them.

3.5.6.5 Operating the Z-axis (Varying the Working Distance [WD])

Turning the Z-axis knob, counterclockwise moves the specimen toward the objective lens, and reduces the WD. Conversely, turning the Z-axis knob clockwise moves the specimen away from the objective lens, and increases the WD. The value of the WD can be read off from the scale provided on the Z-axis knob.
Readings from the scale are valid when the combined height of the specimen base on which the specimen is loaded and the specimen base stand is set at the Standard position on the height gauge.

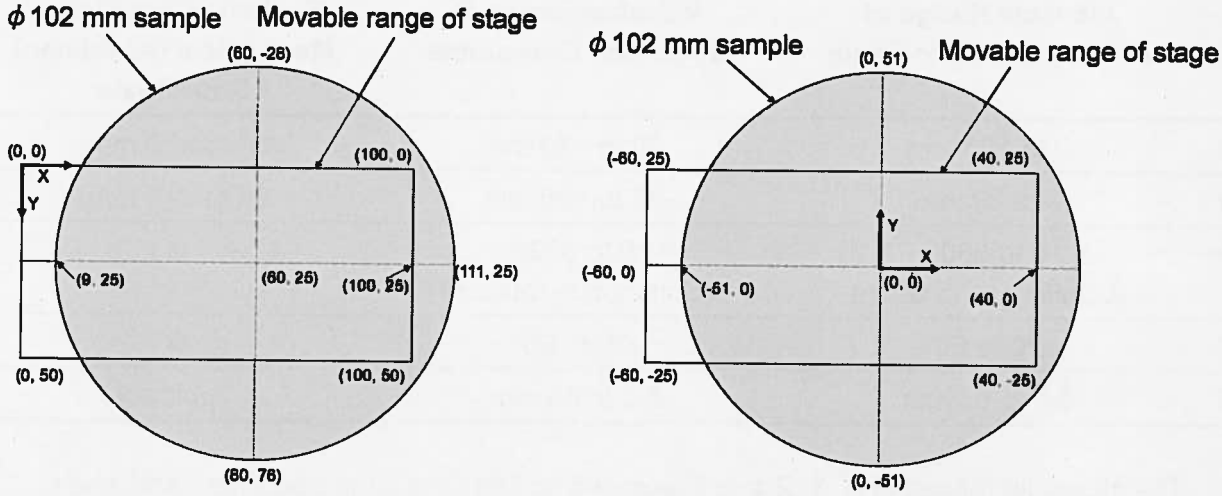
3.5.7 Operation of the Specimen Stage (Type Ⅱ - 5-axis Motorized Stage)

The S-3400N Type Ⅱ SEM provides a 5-axis motorized stage.

3.5.7.1 Coordinate Notation

S-3400N utilizes two coordinate notation systems, **Stage (Mechanical) Coordinate and Sample Coordinate**. The **Sample Coordinate** system will be better for using the **Rotation Assist** function. The **Stage Coordinate** system is also available for users familiar with previous Hitachi SEMs using the **Stage Coordinate** system.

(1) Relationship of stage and **Sample Coordinates**
Following is an example of a 5-inch diameter sample.
On the **Stage Coordinate** system, the center of the sample is (X=60, Y=25 mm) and the origin is at the upper-left corner of XY movable area.
On the **Sample Coordinate** system, the center of the sample is the origin (X=0, Y=0 mm) and the origin fits to it.



Stage coordinates (mechanical coordinates) Sample coordinates

Fig. 3.5-27 Relationship between the Two Coordinate Systems

(2) Switching coordinate systems
Open the **Optional Setup** window by selecting **Stage** in **Optional Setup** menu.
On the **COORDINATE** block, select **Sample** or **Stage**. **OK** button will update the coordinate system.

Table 3.5-5 Movable Range of X and Y by Specimen Size (Type Ⅱ Stage)

	Movable Range of X	Movable Range of Y
φ15 mm	52 to 68	17 to 33
φ26 mm	46.5 to 73.5	11.5 to 38.5
φ32 mm	43.5 to 76.5	8.5 to 41.5
φ51 mm	34 to 86	0 to 50
φ15 mm × 4	34 to 86	0 to 50
φ77 mm	21 to 99	0 to 50
φ85 mm	17 to 100	0 to 50
φ102 mm	0 to 100	0 to 50
φ127 mm	0 to 100	0 to 50
φ153 mm	0 to 100	0 to 50
φ200 mm	30 to 60	7 to 44
□50 × 5 mm	34.5 to 85.5	22 to 28
□30 × 10 mm	44.5 to 75.5	19.5 to 30.5
EBSP Holder	20 to 90	21 to 29

For motion ranges along the T and Z axes, see 3.5.7.12 Movable Range and Limitation by Optional Detectors in the text below.

3.5.7.3 Operation Methods Used to Move the Specimen Stage

The following operation methods are available to move the stage.

- Operation on the **Stage** tab of the **Operation panel** (all 5-axis)
- Manual operation using trackball (X and Y)
- Mouse operation on the image (all 5-axis)

The following additional auxiliary functions are also available:

- Position memory function (X, Y and R axes)
- Stage history function
  Memorizes position where capturing or photographing was performed, or manually registered and display the stage movement path and location of positions. Reset of stage to memorized positions is also possible.
- Image Navigation function
  Goes to assigned position on captured image or imported external image.

3.5.7.4 X, Y, and R Axes Operation

(1) Manual operation using trackball
Stage moves in the direction of trackball rotation.

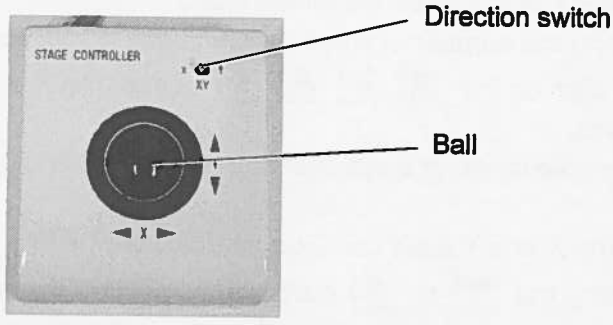


Fig. 3.5-30 Trackball

- Amount of stage motion by ball rotation is linked with magnification. To move a long distance, it is advisable to lower the magnification.
- The amount of stage motion with respect to the amount of ball rotation can also be varied in four steps by setting Operation Panel - **Stage** tab - **Speed** slider.
- Pushing the direction switch to the [X] side moves the stage only in the lateral direction; pushing it to the [Y] side moves the stage only in the vertical direction.
- Stage moving direction versus ball rotation direction can be reversed. Check the **Track Ball/Joy Stick** check box in the **REVERSE MODE** block of the **Stage** tab in the **Optional Setup** window.

For a description of custom settings of the stage, see 3.9.14 Optional Setting.

(2) Entering Absolute or Relative Coordinate Value
For X and Y axes, enter absolute coordinates for X and Y axes into **XY Display/Input** box and then the **Enter** key. When coordinate value out of the movable range is input, error message appears and input value is cancelled.
For R-axis, both absolute and relative value can be used. Select **Abs** (absolute) or **Rel** (relative) with **Abs/Rel** select buttons, and enter coordinate value into **R Display/Input** box and then click **Go** button. Range of R coordinate is 0 to 360 for absolute and -180 to +180 for relative value.
When the **Eucentric** check box is checked, X and Y axes move so that the present field of view is maintained after the stage is rotated (Eucentric rotation function).

(3) Continuous rotation (R-axis)
The R-axis is moved with the **Rotation** buttons. Press ↶ or ↷ button to move the R-axis continuously or click the buttons to move in steps.
A driving speed can be selected in four steps using the **Speed** slider.

The following specimen positions (mechanical coordinates) are available:

ϕ 15 mm × 4	ϕ 25.4 mm × 4	EBSP Holder
1 X=69 mm, Y=34 mm	1 X=74 mm, Y=39 mm	1 X=75 mm, Y=25 mm
2 X=51 mm, Y=34 mm	2 X=46 mm, Y=39 mm	F X=60 mm, Y=25 mm
3 X=69 mm, Y=16 mm	3 X=74 mm, Y=11 mm	2 X=45 mm, Y=25 mm
4 X=51 mm, Y=16 mm	4 X=46 mm, Y=11 mm	C X=23 mm, Y=25 mm
	F X=60 mm, Y=25 mm	
	F T=0° , Z=10 mm	

(8) Position display

The size of the specimen, its present position and rotation angle are displayed on the X/Y/R position display area.

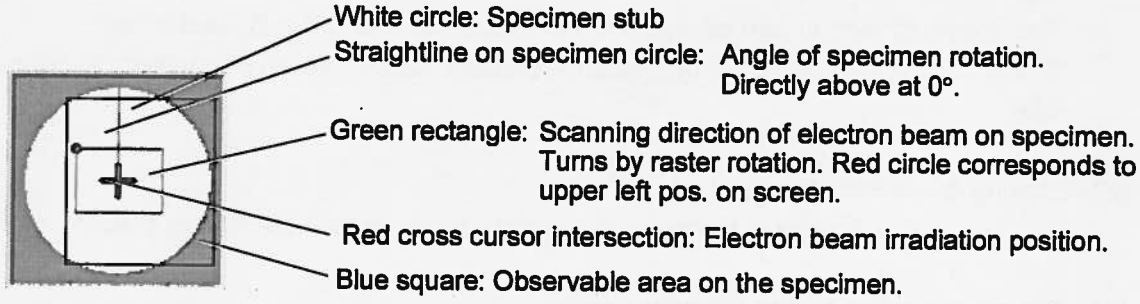


Fig. 3.5-32 Position Display

When sample and stage coordinates are selected, the following scale values apply; the example below applies to a ϕ 15 mm sample.

When the specimen is moved, the numbers associated with the vertical and horizontal axes at the intersection of the red cross represent the coordinates of the position that is being irradiated by the beam. The numbers change when the specimen size is changed.

Moreover, Pointed area in the observation area (in the square blue) by clicking the left button move to the center of view. By clicking right button in sample position monitor, the specimen stage move to the sample exchange position.

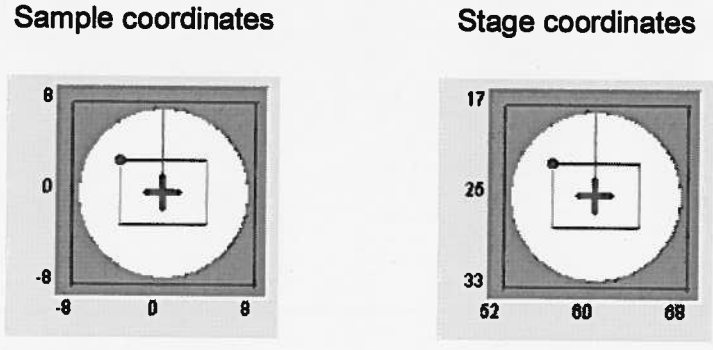


Fig. 3.5-33 Differences of values displayed in sample position monitor

3.5.7.6 Mouse Operation of Stage on the Scanning Image

Use the **Mouse Mode** on the **Option** menu or the **Mouse Mode** on the pop-up menu to activate the stage (X/Y/R/Z/T) and image shift operation mode (the condition in which the Stage Move tool shown in the figure below is displayed).
(Stage X/Y/R and Stage X/Y mode are also available.)

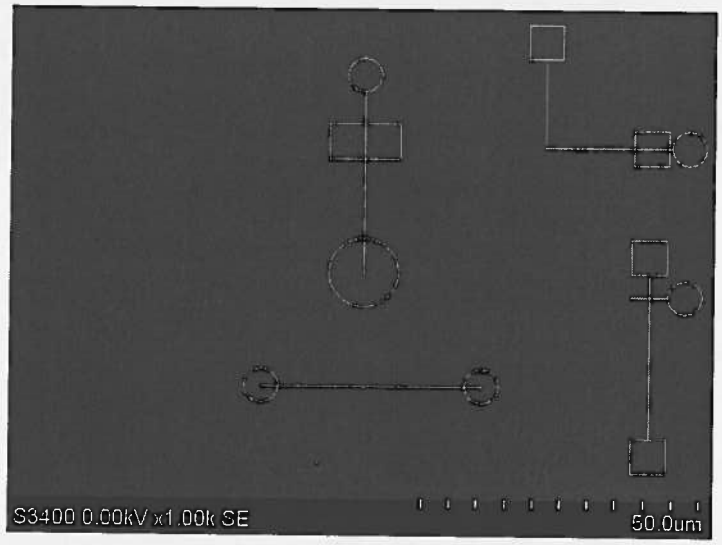


Fig. 3.5-34 Image Shift/Stage Move Tools

NOTICE: Move the mouse cursor to X and Y axes tool, and the tool change to an intersecting arrow mark. Then the mouse wheel button is clicked, color density of the tool will change by 5 stages. You can use by favor color.

(1) X, Y continuous driving (joystick-like operation)

Move the mouse pointer to the circle at the center. It changes to XY mark.
Press the left button down and move the mouse in the direction you wish to move the image. Stage moves in the mouse drag direction while holding down the button. When you drag the mouse far from the center, the stage moves faster. The speed is also linked with magnification so as to keep image moving speed constant.
The direction and speed can be changed while pressing down the button.

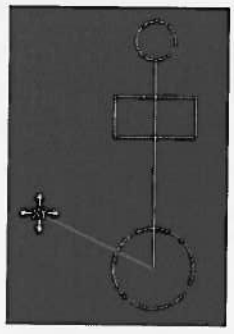


Fig. 3.5-35 Continuous Motion of XY

(5) Electrical image shift

The Electrical Image Shift function moves the scanning image electrically. It is useful at high magnifications where mechanical stage motion is not desired.

To move the image with Electrical Image Shift, use the same operation as in the above (2) but use right button instead of left button. When you press right button, the mouse pointer will change to Beam mark 

. Move the mouse to an end point while holding down the right button (a red line is drawn), and release it.

Image Shift knobs on the manual operation knobset are also available. The knobs are easy to operate.

(6) R-axis operation to a specified angle

On the circle of the R-axis tool, the mouse pointer will be changed as shown below.

Press down the left button and move the mouse while holding down the button. The tool rotates following the mouse and the rotation angle is shown in the indicator box.

Then release the button. Stage will be rotated to the angle specified in the indicator box.

The angle value is the absolute angle.

The eucentric rotation function is effective when the **Eucentric** check box in the **Stage** tab is checked.

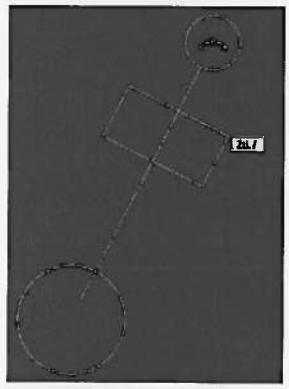


Fig. 3.5-38 R-axis Moving Tool (angle specification)

(9) Z-axis continuous driving
On the rectangles at the top and bottom of Z-axis tool, mouse pointer will be changed as shown below.

Fig. 3.5-41 Z-axis Moving Tool (continuous move)

Press down the left button on one of the rectangles. The stage will go up or down continuously while holding the button down. On the top rectangle, stage moves to a shorter Z, and on the bottom, to a longer Z.
Z motion will stop when it reaches the end of allowable range calculated using the present Tilt angle.

(10) Tilt-axis operation to a specified coordinate
On the circle of the Tilt-axis tool, mouse pointer will be changed as shown below.

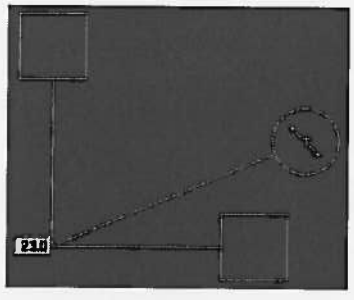
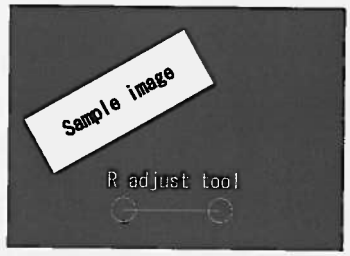


Fig. 3.5-42 Tilt-axis Moving Tool (coordinates specification)

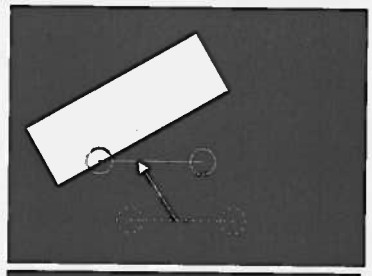
Press down the left button and move the mouse up or downward while holding down the button. The circle moves following the mouse and the Tilt-axis value is shown in the indicator box. Then release the button. Stage will go to the Tilt angle specified in the indicator box.
The change of Tilt is limited to a range allowable for the present Z value.

(12) Rotation adjust tool

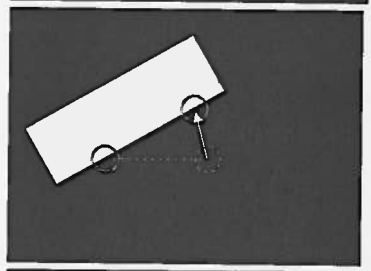
The rotation adjust tool is convenient for adjusting an image to horizontal.



Move the mouse at about the center of the tool. Mouse pointer will be changed to array mark  . Press down the left button and move the tool to fit an end to the inclined line part to be rotated to horizontal.



Press down the left button in the circle of another end and fit the tool to the line part.



Release the mouse button. R-axis will rotate and the line part is adjusted to horizontal.

The eucentric rotation function is effective when the Eucentric check box in the Stage tab is checked.

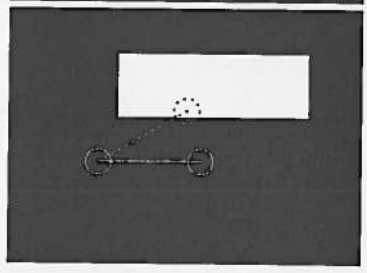


Fig. 3.5-44 Rotation Adjust Tool

IMPORTANT:	Using right button instead of left button drives raster rotation with just the same manner of operation. It is necessary to set raster rotation to operate the raster rotation function.

3.5.7.7 Position Memory Function

The stage coordinates, both absolute and relative, can be memorized and retrieved.
200 absolute coordinates (20 points on each of 10 pages) and 20 relative coordinates can be saved in total. Three axes, X, Y, and R, can be registered.
Click the **Memory** button on the **Stage** tab. The following **Position Memory** window will open.

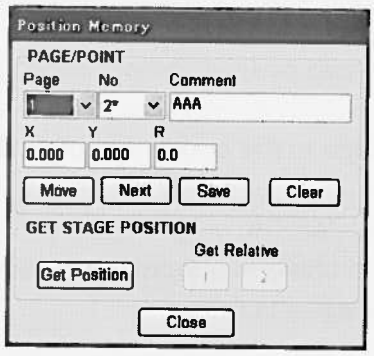


Fig. 3.5-46 Position Memory Window

(1) Registration of absolute stage coordinates at the present stage position
Select a **Page** and **No.**, then click **Get Position** button. The present coordinates are then indicated in the **X**, **Y** and **R** boxes. Input any comments in the **Comment** box, and click the **Save** button.

(2) Registration of absolute stage coordinates by direct input
Select a **Page** and **No.**, and input values to the **X**, **Y** and **R** boxes using the keyboard followed by the **Enter** key. Input any comments in the **Comment** box, and click the **Save** button.

(3) Registration of relative stage coordinates using the present stage positions

(a) Select **Rel** from **Page**, and select **No.**

(b) Move the stage (using RISM) to the first position and click the **Get Relative-1** button.

(c) Move the stage to the second position and click the **Get Relative-2** button.
The relative coordinates between the first and the second positions are calculated and indicated in **X**, **Y** and **R** boxes.

(d) Input comments in the **Comment** box and click the **Save** button.

3.5.7.8 Stage History Function

Displays present position and registered positions on a specimen picture with trajectory lines showing the order of registration.
Click the **Disp** button in the X/Y/R block on the **Stage** tab. The **Stage History** window will open.

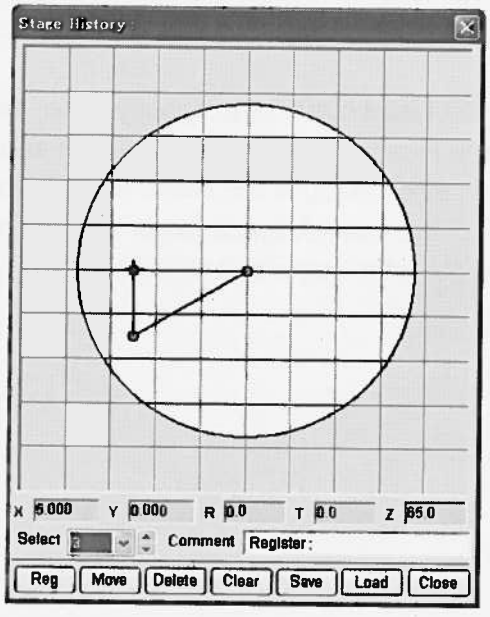


Fig. 3.5-47 Stage History Window

(1) Display
The white circle represents the stub size. The red cross indicates beam irradiation point. The green points are registered points. And the blue point is selected point.
Lines connecting registered points show the stage movement history.
The **Comment** field automatically shows the conditions under which the information was recorded, such as Register (registered using the **Reg** button), Capture, or Photo. Appropriate comments should be entered after these indicators.

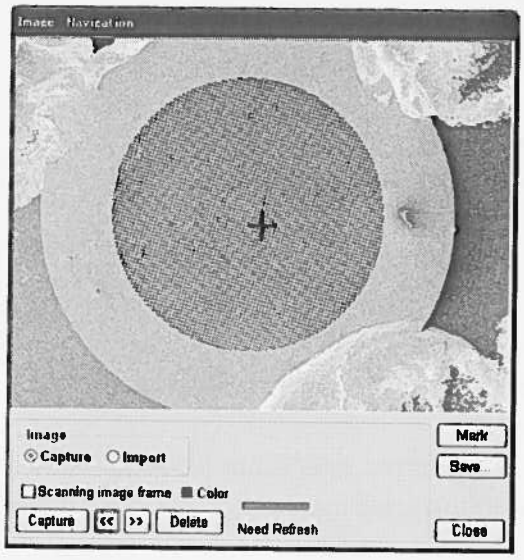
(2) Registration
Stage coordinates are registered automatically by capturing, photographing and moving to home or specimen exchange position.
Also clicking the **Reg** button on the window or **Regist** button in the **X/Y/R** block on the **Stage** tab registers present stage position.

(3) Retrieving registered stage coordinates
To retrieve a registered coordinate and go to the position, select a point by clicking the point on the display, or select its number in the **Select** box. The selected point is changed to blue color. Click the **Move** button to go to the position representing the selected point.

3.5.7.9 Image Navigation

The Image Navigation function moves the stage to the position pointed out on the navigation images.
Captured SEM images at low magnification as well as imported externally created images, such as optical microscope images or drawings, are available as navigation images. In this case, alignment operations are needed to ensure that the drawing (photo) to be used and the specimen being observed match in their relative geometry.
SEM images and imported images can be used in 10 images each. Navigation images to be used can be switched at any time.

SEM image



Imported image

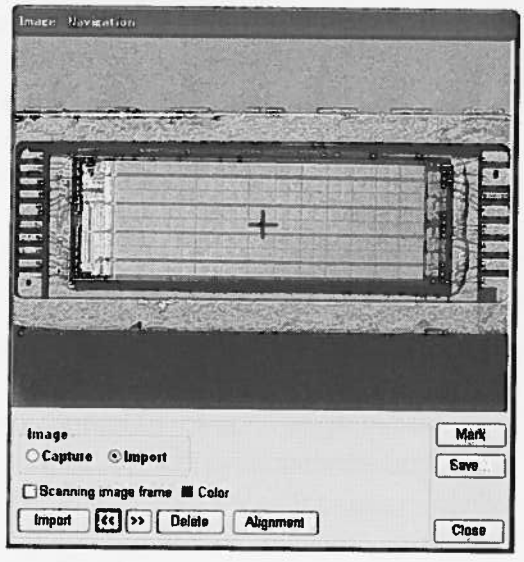


Fig. 3.5-48 Image Navigation Window

(1) Starting image navigation
The **Navigate** button on the **Stage** tab opens **Image Navigation** window.

(2) Using Captured SEM images
Select **Capture** at **Capture/Import** selection.
Click the **Capture** button. The present displayed scanning image will be captured and shown on the **Image Navigation** window.
Up to 10 images, with different stage position or magnification, can be captured and you can use any one by selecting with [<<] [>>] buttons.

(5) Alignment operation
To use imported images for navigation, alignment operation is necessary.
Select two alignment points on a navigation image. These two points shall be separated left - right or upper - lower side of the image center.

(a) Select the object, which corresponds to the first alignment position on scanning image.

(b) Click the **Alignment** button on the **Image Navigation** window.

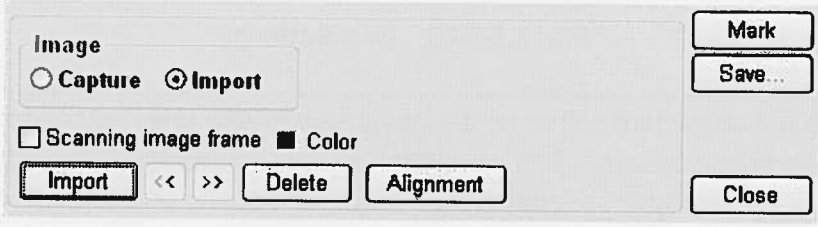


Fig. 3.5-49 Alignment Box

A message [Move a remarkable object to the center of image and click the **1st.** button, click the position in the navigation image corresponding to the selected object by mouse.] will be shown. Close the message by **OK** button. Adjust the stage so the selected object goes to the center of image and then click the **1st.** button.

Fig. 3.5-50A 1st Setting

(c) Find the first alignment point in the navigation image and click it.
The next message [Move a selected object to the center of image and click the **2nd.** button, click the position in the navigation image corresponding to the remarkable object by mouse.] will appear. Close the message by **OK** button.
Search the object, which corresponds to the second alignment position on scanning image, and move it to the center of image.

(9) Display of scanning image frame
Scanning image frame is displayed on the navigation image.
Scanning image frame check box : Shows (checked) or hides (unchecked) the scanning image frame.
Color check box : Switch the color of the scanning image frame. Change the color displayed by clicking the color check box.

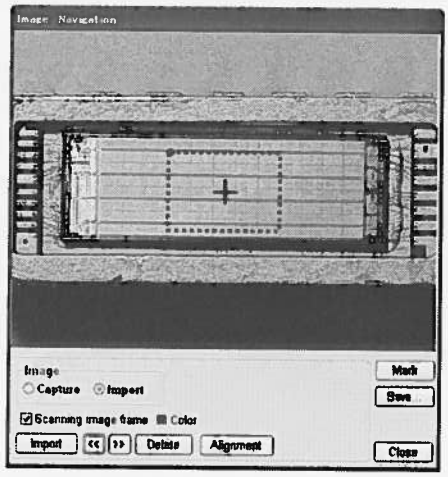


Fig. 3.5-51 Scanning image frame

NOTICE:
- In the following cases, scanning image frame is hidden:
  (a) When there is no image on the navigation image.
  (b) SEM image: When the precious image becomes unregistered.
  (c) Imported image: When alignment operation has not ended.
  (d) When the R, or T-axis for the stage is moved (for raster rotation, changing angles does not hide a scanning image frame).
  (e) When scanning image is not displayed on the navigation image.
  (f) When scanning image is larger than the navigation image.

(10) Using both imported and SEM images
Valid (with a green **Need Refresh** window) SEM images and properly aligned imported images can be switched at any time for navigation purposes.

(11) Deleting a navigation image
Clicking the **Delete** button deletes the image that is currently displayed as a navigation image.

NOTICE: For this auxiliary operation, a flat specimen should be used and the specimen height should be measured as accurately as possible using the height gauge. This series of operations will automatically move the R, Z, and T axes of the stage.

(3) Stage tilt calibration - Calibration necessary for each specimen exchange
When specimen height differs from the standard value and the specimen is tilted, the rotation and tilt center axes will shift. For accurate operation of the eucentric function, the specimen height must be measured and corrected at each specimen exchange.
Since the previous correction factor is retained, calibration is not necessary if the specimen height does not vary at each specimen exchange.
Carry out the calibration as follows.

(a) Insert a specimen. On the **Z/TILT** block, verify that the movable range of the Tilt-axis is 20° or greater.
Then search for a structure of interest near the specimen center.

(b) Click the **Calibration** button in the **Z/Tilt** area on **Z/TILT** block, then the **Stage Tilt Calibration** window will appear.

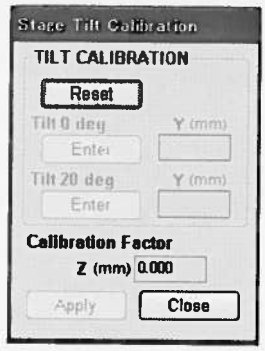


Fig. 3.5-52 Stage Tilt Calibration Window

(4) Calibration is necessary when accuracy is degraded.
Carry out the following three calibrations when accuracy of eucentricity is degraded.

(a) Rotation center
It measures the deviation of the rotation center from the beam irradiation point.
For this auxiliary operation, use a specimen base (height: 6 mm) on which no specimen is loaded. Use the **Stage** tab to set the specimen **Height** in the **SPECIMEN** block to Standard.

1) Insert a specimen, set WD at 10 mm, tilt at 0° and R at 0°, then search for a structure of interest near the specimen center.

2) Select **Stage Calibration - Rotation Center** command in the **Option** menu.
The **Rotation Center** window will open.

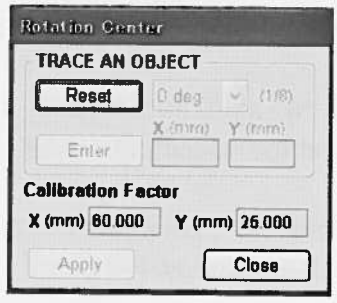


Fig. 3.5-54 Rotation Center Window

3) Click **Reset** button. The following message indicating steps of operation will be shown.

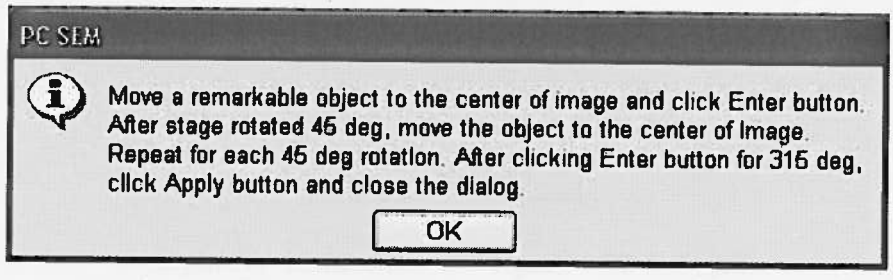


Fig. 3.5-55 Verifying the Operating Method

4) Bring the structure of interest to the image center, and click the **Enter** button.
The specimen rotates 45°. After it stops, search for the aforementioned structure of interest (although it shifts from the image center, it will be located within a range of about 300 µm). Bring this point to the image center and click the **Enter** button.

3) Click the **Reset** button. The following message indicating steps of operation will be shown.

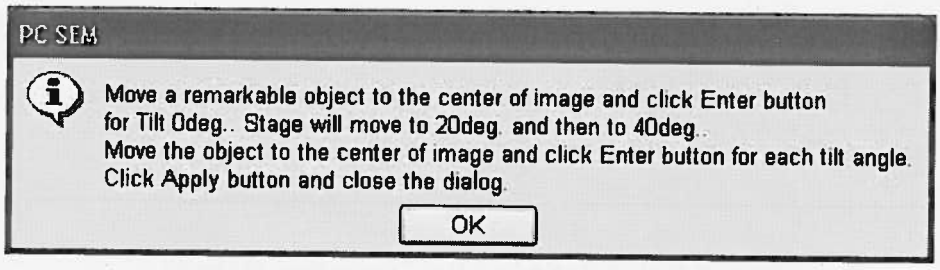


Fig. 3.5-57 Verifying the Operating Method

As described in the message, bring the point of interest to the image center at a magnification of about 500×, then click **Enter** button of Tilt 0°.

4) The stage will be moved to a tilt angle of 20°. Bring the point of interest to the image center and click **Enter** button of Tilt 20°.

5) The stage will be driven to a tilt angle of 40°. Again bring the point of interest to the image center and click **Enter** button of Tilt 40°.
A **Calibration Factor** is now calibrated and indicated. This value represents the deviation of specimen height from the reference position. Click **Apply** button, then click **Close** button to close the window.

(c) Z-axis compensation
It measures the shift of the stage caused by changing Z-axis position.
For this auxiliary operation, use a flat specimen, and measure the specimen height as accurately as possible with the height gauge and setting it.
Refer to 3.2.4.3 Setting the Specimen Size and Height.

1) Insert a specimen, set WD at 30 mm, tilt at 0° and R at 0°, then search for a structure of interest near the specimen center.

2) Select **Stage Calibration - Z Axis Comp** in the **Option** menu.
The following window appears:

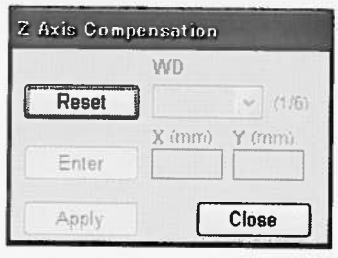


Fig. 3.5-58 Z Axis Compensation Window

3.5.7.11 Stopping Stage and Returning to Previous Stage Position

If an incorrect position specification must be canceled when the stage is moving to a coordinate specification or the stage keeps moving and does not stop for some reason, click the **STOP** button.

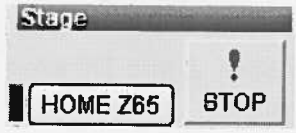


Fig. 3.5-60 STOP Button

To return to a previous position after moving stage using coordinate specifying operation, use **Undo - Stage Drive** menu. It is effective for only one previous position.
(The stage cannot be reset to two or more previous positions. The **Undo-Stage** is valid only on coordinate specification or stage memory motion.)

IMPORTANT:	Do not repeat clicking the **STOP** button. Clicking the button repeatedly can cause malfunction and damage the specimen or components inside the specimen chamber.

3.5.7.12 Movable Range and Limitation by Optional Detectors

(1) Movable range of the specimen stage for various specimen sizes
The movable range is limited when observing large size specimens.
Stage motion is limited to the movable range automatically designated by the computer.
The limit value is calculated using the size information set on the **Specimen/Detector Setting** window.
The following operating ranges apply:

- For small size specimen, X and Y limitation is specified so the movable range covers just the size of the specimen.
- For large size specimen, the movable range is limited to safety area. When optional detectors are inserted to their operating position, the safety area will be limited to narrower range.

IMPORTANT:	Always measure the height of a specimen using the supplied height gauge. In the **SPECIMEN** input field in the Operation Panel **Stage** tab, set the specimen size and height. Incorrect specimen size, height, or detector settings can damage the objective lens, the BSE detector located on the underside of the objective lens, or the specimen itself.

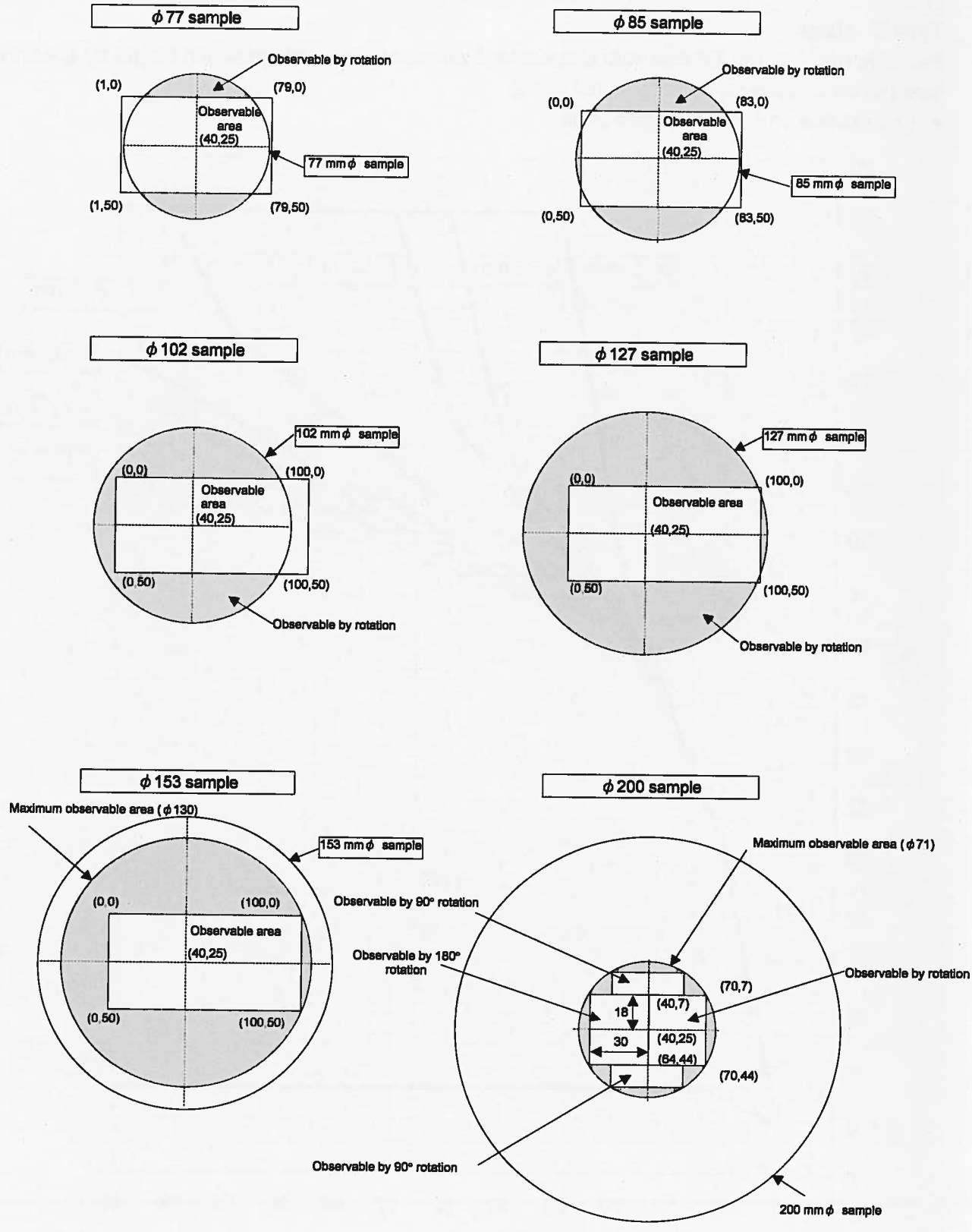


Fig. 3.5-62 X and Y Movable Ranges for the Type II Stage by Specimen Size (when an optional detector is not used)

- Restrictions on positive angles of tilt (when an optional detector is not used)

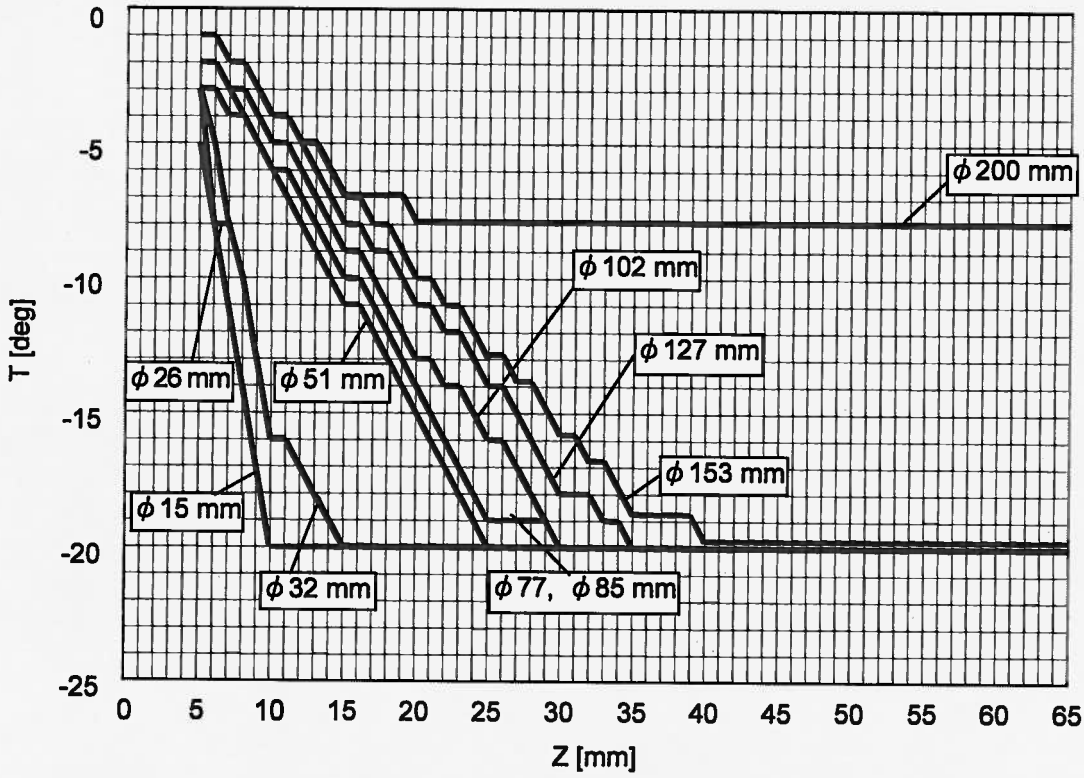


Fig. 3.5-64 Tiltable Angles with respect to Z-axis Positions (Type I Stage) (negative angles of tilt)

(3) Limitation and evacuation when an optional detector is inserted
Some optional detectors have sensor switches and are automatically sensed when they are inserted. For detectors not having such sensor switches, it is necessary to set detector in use correctly in the **Specimen/Detector Setting** window. If a detector having sensor switch is inserted when present stage position is out of allowable area, the stage will evacuate to the safe position as follows.

(a) EDX detector
No limitation required.

(b) WDX detector (made by Oxford Corporation) used:
φ5-inch (127 mm) specimens are restricted to X: 0.0 to 85.0 mm in mechanical coordinates.
φ6-inch (153 mm) specimens are restricted to X: 0.0 to 72.0 mm in mechanical coordinates.
φ8-inch (200 mm) specimens cannot be loaded.

NOTICE: If the stage positions (X, Y, Z, and T) are outside the movable range when a detector is inserted, and if a detector equipped with a detection sensor is inserted, the stage will be forced to undergo retraction motions.

3.6 Saving and Recording Images

3.6.1 Saving and Recording Images

It is possible to record images using conventional photo films and printers, and/or as image data files (to disk drive). There are four methods of image recording:

(1) Taking photographs (optional photo-recording unit is necessary)
For photographic image recording, you can use Direct Photo or Memory Photo recording. Memory Photo can produce multiple photographs from a given image.
See <3.6.7 Taking Photographs (Option)>.

(2) Saving images
Direct Saving, which saves an image on the scanning image display, and Captured Image Saving, which saves captured images, are available.
Also available is a Quick Save function, which can automatically save captured images under a specified name. Using these functions, it is possible to save images that are processed on **SEM Data Manager**.

(3) Printing images
Printing of images using Windows-supported printers is available.
Refer to <3.9.10 Printing Images Using Report Generation Function>.

(4) Copying images to other application software
Scanning Image can be copied to Windows-clipboard. You can use the image on application software by simply pasting it.
When the optional PCI image database software is installed, images are transferred directly to it without saving images.
Refer to <3.9.11 Copy Image>.

(5) Related information
Auto data display, and text and graphics written on the image using data entry functions are recorded with the image. A text file including image information such as operating condition, date and others is created when the image is saved. It is saved in the same directory as the image. The measurement function option allows you to save and output images by writing any text to them as well as incorporating the results of measurements (measured values and cursors).

NOTICE: For storing images, we suggest the use of external storage devices, as the storage capacity of PC hard drives is limited. Also, external storage devices are recommended for data backup.

(b) **Data Entry**
When recording scanning images, graphics and texts written using **Data Entry** function are recorded as they are shown on the scanning image.
When recording captured images using command buttons placed on the **Captured Image** window, graphics and texts written before starting capture are embedded into captured images and recorded.
Note that they may be different from present displayed data.
If data embedding is not necessary, uncheck the **Embed into Image** on the **Captured Image** window.
For details, refer to <3.6.8 Recording Data Display with Images>.

(c) **CD Measurement** data (option)
The measured data and cursors together with **Data Entry** data are saved, recorded, printed or copied with images.

3.6.3 Image Capture

Image Capture stores images using specified scanning mode and specified resolution.
Two methods, multi-frame integration and single frame slow scanning are available.
Max 16 images can be recorded temporarily (Up to 100 images can be shown by setting change).
Multi frame integration is effective for specimens susceptible to charge-up. Slow scan is advantageous in order to obtain high-resolution images.
To select conditions for image capture, use the following steps.

(1) Capture Resolution
Click either the » button in the upper right section of the Capture button on the Control panel or right-click the Capture button. Then, a pull-down menu for selecting capture resolution will appear. Select the desired resolution on this menu. The selected resolution is displayed on the Capture button as follows:

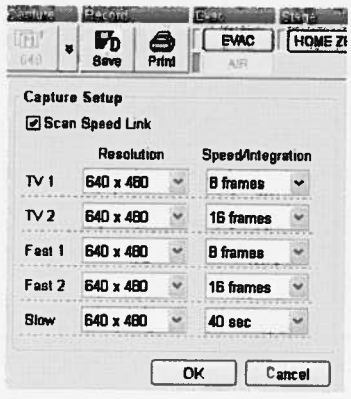


Fig. 3.6-1 List of Capture Settings

(2) Selecting the number of integration frames and the speed of slow scanning capture
Either click the » button in the upper right section of the Capture button on the Control Panel or right-click the Capture button to bring up a list of capture settings.

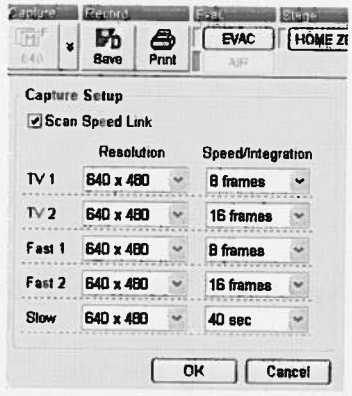


Fig. 3.6-2 Link to Scanning Speeds Selected

- **The Scanning Speed Link is check-marked:**
  Capturing is executed according to the current scanning speed settings.

- **TV 1/TV 2/Fast 1/Fast 2:**
  Select the desired number of integration frames (16 to 1024 frames) for the TV/Fast scanning capture process.
  The larger this number, the higher is image quality at the expense of an increased processing time. Under conditions of a high magnification rate and specimens that are susceptible to charging up, a high integration frame number can cause a reduction in the sharpness of the image due to image drifting during the integration.

- **Slow:**
  Select the desired scanning speed (10 to 320 s) for the slow scanning capture mode. (If the image cannot be captured within a specified time depending on the particular display mode in effect, the nearest possible condition will be employed for the execution of the scanning process. No matter what scanning speed is selected, the actual capturing speed in this mode will be in the Slow 1 to 6 range.

(3) Image Capture

To start Image Capture, click the **Capture** button on the **Control panel**. Image capture can be started either in RUN or FREEZE status.

(4) Displaying a captured image

After the scanning is finished, the **Captured Image** window opens and the captured image is added in the list as a thumbnail.

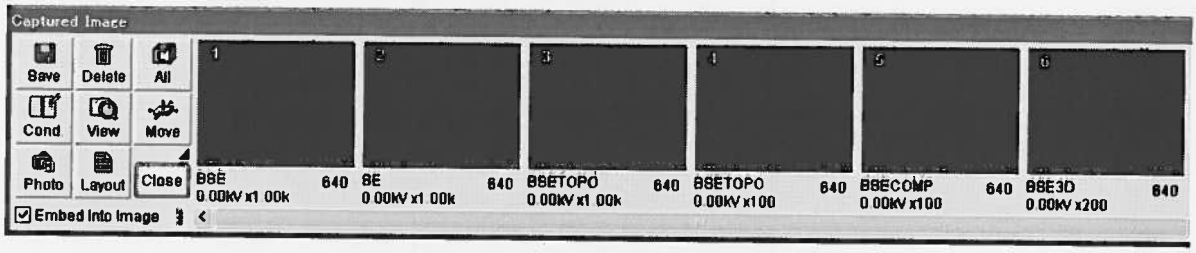


Fig. 3.6-4 Captured Image Window

The **Captured Image** window opens by using the Img List buttons in the lower part of the Operation panel, **Captured Image** command in the **Window** menu and the shortcut **Ctrl - L** at any time.
Refer to <2.3.10 Captured Image Window>.

(5) Setting change for the max number of image capturing

The max number of image capturing can be changed from 16 images to 100 images. (The max number of image capturing is set to 16 images when being shipped from the factory.)

The setting for the max number of image capturing can change at **Option** menu - **Optional Setup** - **General** tab - **IMAGE CAPTURE** block.

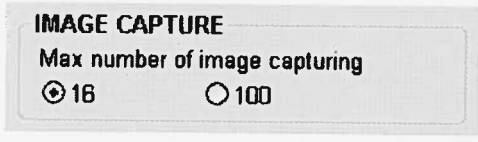


Fig. 3.6-5 IMAGE CAPTURE Block

NOTICE: The setting cannot change when **Captured Image** window has any image. The setting for the max number of image capturing can change without image in **Captured Image** window.

(1) Capturing conditions

Displays the resolution of the image to be captured, the scanning speed, the number of images to be captured, and the interval at which captures are to be performed.
To change any of the settings, click the **Set** button and display the **Interval Capture Setting** window.

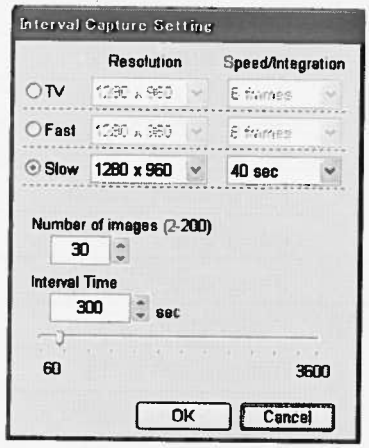


Fig. 3.6-7 Interval Capture Setting Window

(a) Setting the **Resolution**, **Speed/Integration**

The **Interval Capture Setting** window specifies the resolution for the image to be saved, and the Speed/Integration to be in effect during the capturing operation.
Table 3.6-1, 3.6-2, and 3.6-3 shows allowable resolution and speed/integration.

Table 3.6-2 Setting the Resolution and Speed/Integration of Fast Mode

Mode	Resolution	Speed/Integration	Minimum Interval Time [sec.]
Fast	640 × 480	Integration ×8	30
		Integration ×16	30
		Integration ×32	30
		Integration ×64	30
		Integration ×128	30
		Integration ×256	40
		Integration ×512	60
		Integration ×1024	100
	1280 × 960	Integration ×8	30
		Integration ×16	30
		Integration ×32	30
		Integration ×64	30
		Integration ×128	40
		Integration ×256	60
		Integration ×512	100
		Integration ×1024	180
	2560 × 1920	Integration ×8	30
		Integration ×16	30
		Integration ×32	40
		Integration ×64	60
		Integration ×128	100
		Integration ×256	180
		Integration ×512	350
		Integration ×1024	680

IMPORTANT: Interval capture at 5120 × 3840 resolution cannot be executed.

(b) Setting Number of images
Specifies the number of images to be captured. Allowable range: 2 to 200 images.

(c) Setting Interval Time
Interval refers to the length of time from the start of a capture to the start of another capture. Specifies an interval at which capture operations are started. Allowable range: 30 to 3600 seconds. The minimum allowable time varies depending on the smallest interval time associated with Resolution and Speed/Integration settings and the ON/OFF setting of image adjustment function.

(d) Clicking the **OK** button applies the Interval Capture Setting value to the capture condition in the **Interval Capture** window.

(2) Saving an image

(a) **Select** button
Clicking the **Select** button displays the folder in which the image is to be saved and a file name-setting window. In each file name for an image, a four-digit number representing the sequence number for the image is appended to a user-specified file name. The number 0001 is appended to the first image, and subsequent images are numbered in ascending order.

IMPORTANT: When an image is captured, in addition to a BMP file containing the image, a file with a TXT extension with the same file name is created. The TXT files contain the conditions under which a given image was captured.

(b) Embed into Image
Even if input data and an auto data display are displayed at the time of an image capture, by unchecking the **Embed into Image** check box, it is possible to save the image only. If the displayed data is to be saved together with the image, the check box should be left ON (checked).

(3) Image adjustment

(a) AFC
When checked, this function executes auto-focusing (fine) during the capture of an image.

(b) ABCC
When checked, this function executes auto-brightness and contrast adjustments during the capture of an image.

IMPORTANT: If either an AFC or ABCC error occurs during the execution of AFC or ABCC, the interval capture is canceled.
Checking AFC increases minimum interval time by 30 seconds.
Checking ABCC increases minimum interval time by 20 seconds.
By checking both AFC and ABCC, image adjustments are performed in ABCC/AFC/ABCC order, and minimum interval time is increased by 70 seconds.

3.6.5 Saving a Scanning Image (Direct Save)

The scanning image, simply frozen or captured, can be saved. Resolution of saved image is 1280 × 960 or 640 × 480 depending on present screen mode when saved just after freezing the image. When saved after capturing, resolution follows capture resolution.
Graphics and texts written using **Data Entry** function and **CD measurement** function are put on saved images when saved while they are shown on the image.

Click the **Direct Save** 

button on the control panel or select the **Direct Save** command from the **File** menu. The **Image Save [Direct Save]** window will open.

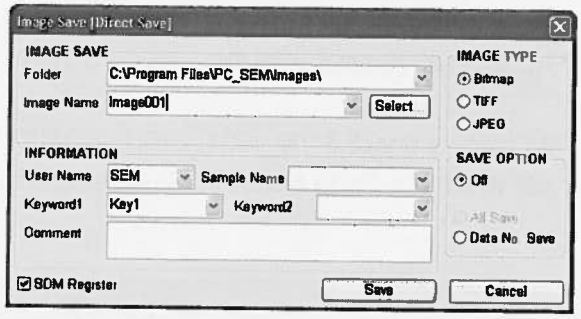


Fig. 3.6-9 Image Save [Direct Save] Window

(1) Select an image format on **IMAGE TYPE** area.
Bitmap: Windows bitmap
TIFF: TIFF (Tagged Image File Format)
JPEG: JPEG

(2) Set **SAVE OPTION** if necessary.
Off: Save one image only.
All Save: Effective when opened from **Captured Image** window. Saves all images selected in **Captured Image** window at a time.
File names [{Input File name} + _m {capture number}] are automatically generated.
Data No. Save: Puts a data number, which is specified in **Auto Data Display** setting to the end of file name when saving images.
This function is effective when saving plural captured images with one saving operation.
The **Auto Increment** shall be set for **Data Number** on **Setup** window - **Record** tab.
To enable auto Increment, set **Data Number** to ON, **Auto Increment** to ON and put "-" plus **number** to the end of the data number as shown on the following picture.

(3) Input INFORMATION.
User Name, **Sample Name**, **Keywords** can be selected from already used names or created newly. Entry of these items is not necessary but useful for selection of files in the **SEM Data Manager**.

(4) Set options.
The saved data is automatically registered to **SEM Data Manager** database when the **SDM Register** is checked.

(5) Specify folder and file name.
The button beside the Folder and Image Name input box opens a list of recently used names. You can select one of them and modify it. The **Select** button opens **Save Image** window. You can select or create folder and file name on it.
Click **Save** button to execute saving.
Note that for file names on Quick Save and All Save, only up to 251 characters is allowed.
Another function available to save the image under observation is Quick Save.
After an image is captured as described in <3.6.3>, Quick Save allows you to save images under a previously specified file name.
To set Quick Save, select **Quick Save** on the **File** menu. This will open the **Image Save [Quick Save]** window shown below:

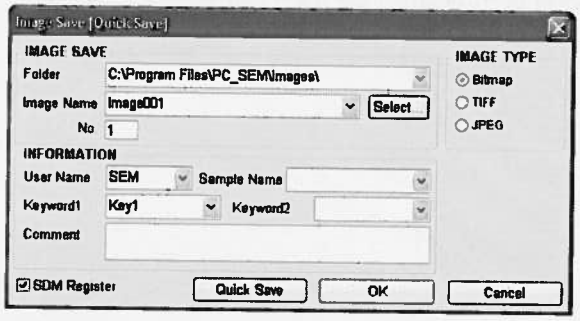


Fig. 3.6-12 Image Save [Quick Save] Window

On this window, enter **IMAGE TYPE**, **INFORMATION**, **SDM Register**, the destination folder, and a Image name. Quick Save indicates a file number below the file name. **Quick Save** saves files under a file name with a "qXXX" extension, where the letters XXX corresponds to the file number. File numbers are half-size numeric characters ranging from 1 to 999. Once **Quick Save** is executed, the file number is incremented by 1. When the file number reaches, 999, a message appears, prompting you to change file names.
After setting, the image can be saved without setting the file name etc. by the **Quick Save** Save button on the control panel.

3.6.7 Taking Photographs (Option)

To take a photograph of an image, use one of two modes: **Direct Photo** mode and **Memory Photo** mode.

Direct Photo:
Direct Photo mode takes a photograph while directly scanning the electron beam.

Memory Photo:
Memory photo mode can produce photographs of simply frozen or captured, or stored images. It is also possible to take a photograph of an image formed by using a Fast scan integration method, which is useful for observation of charge-sensitive samples. The Fast scan integration method can also embed auto data displays, characters that are input using the data entry function, and graphics.

3.6.7.1 Setting Photo Condition

To select the conditions for photo recording, open the **Setup** window - **Record** tab by clicking the **Setup** 

button on the tool button area of the **Operation panel**, or by selecting the **Photo Condition** command in the **Setup** menu.

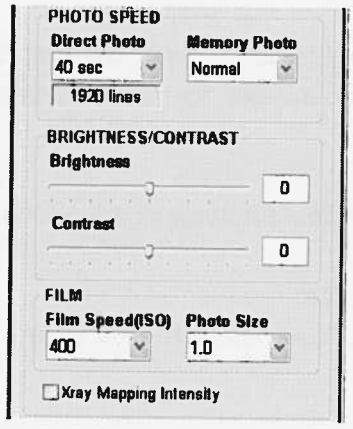


Fig. 3.6-14 Settings Window Record Tab

3.6.7.2 Direct Photo Recording

Direct Photo mode takes a photograph while directly scanning the electron beam.
It generally shows better image quality compared to the Memory Photo mode.

To start recording, click the **Photo** Photo button on the **Control panel** or select the **Direct Photo** command from the **File** menu.
The scanning speed and other conditions can be selected in the **Setup** window - **Record** tab.

3.6.7.3 Memory Photo Recording

Memory Photo mode can reproduce photographs of memorized or filed images. It is also possible to take a photograph of an image formed using Fast scan integration method, which is useful for observation of charge sensitive samples.

(1) Photographing frozen scanning image

To take a photograph of a frozen scanning image, click the **Memory Photo** Photo button on the **Control panel**, or select the **Memory Photo** command from the **File** menu.
In the case of recording a frozen image, the image resolution depends on screen size, 1280 × 960 pixels for full screen and 640 × 480 pixels for small and dual screen mode.

(2) Photographing images from the **Captured Image** window

It is also possible to take a photograph of a captured image by clicking the **Photo** Photo button in the **Captured Image** window.
On the window;

(a) Select an image by clicking a thumbnail. The selected image is shown with yellow bordering.

(b) Click the **Photo** Photo button in the **Captured Image** window.
When the Embed into Image has been checked, auto data display and texts and graphics written using Data Entry function are overlaid on image. (Note that the data is at the time capture was executed.)

(3) Photographing saved images

To take a photograph of a saved image from disk, use **SEM Data Manager**.

3.6.8.2 Captured Image Recording Using Buttons on the Captured Image Window

When images are captured, text and graphics shown on the image at the moment of starting capture are memorized as the data for the captured image. The memorized data will be recorded when the image is recorded using command buttons on the **Captured Image** window.

(1) To change entry data of the latest captured image, edit or add data and then click the **Update** button on the **DATA ENTRY** block. The memorized data for the captured image is then replaced with the new data.
It is not possible if the image has been refreshed by RUN operation.

(2) During a capture process, if data input is performed either to add or change data while the image is being displayed (with a CAP number displayed in yellow on the upper left edge of the image), and then if the image is saved (Direct Save) from either the menu or the Control Panel, photographed, printed, or sent to a PC, the data that is added will be added as data on the captured image.

(3) When the **Embed into Image** check box on **Record** tab of **Setup** window is checked, Auto Data Display on the bottom of the image is memorized for the captured image at the moment of starting capture. The memorized data will be recorded when the image is recorded using command buttons on the **Captured Image** window. If the check box is not checked, Auto Data Display text is not memorized even if it is shown on the image.

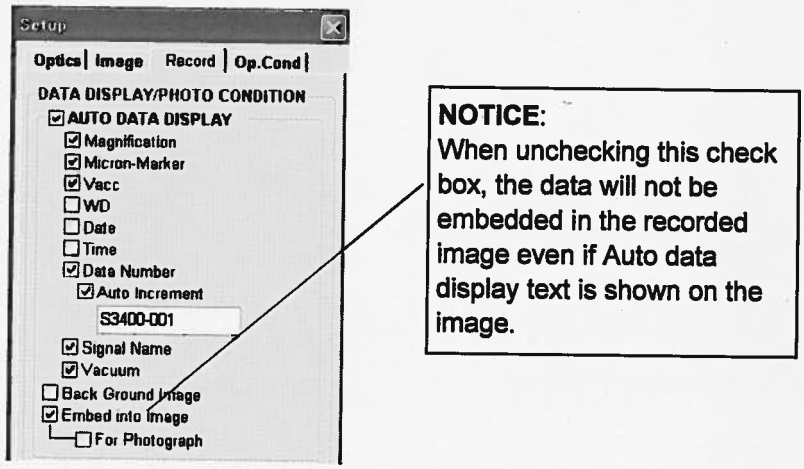
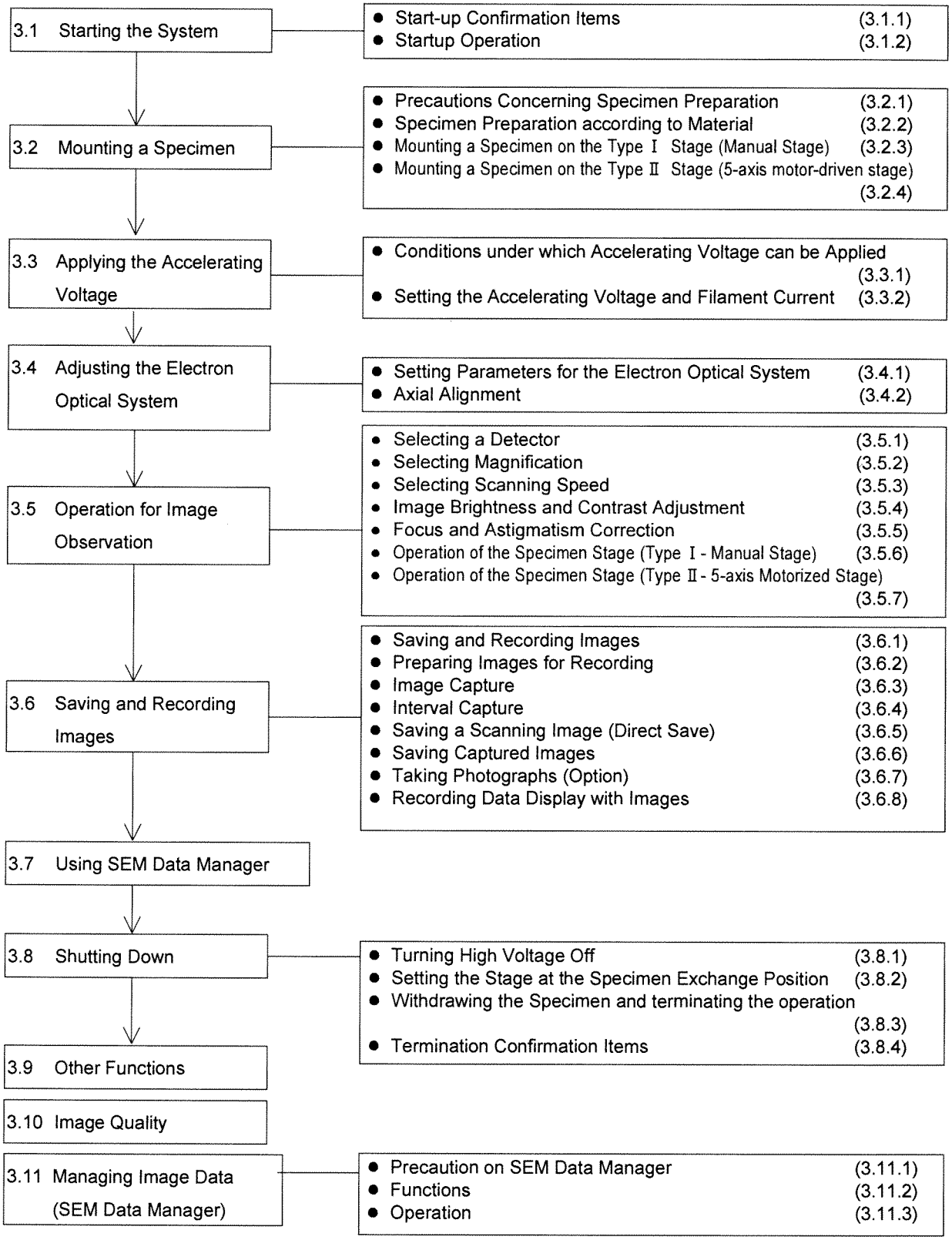


Fig. 3.6-16 Setup Window Record Tab

3. OPERATION

Shown below is the procedural flow of typical S-3400N SEM operation. For details, refer to each subsection.



3.1 Starting the System

3.1.1 Start-up Confirmation Items

Before starting the system, check the following items:

(1) Check the amount and quality of oil in the rotary pump.
See 4.2.1 Oil Change.

(2) Make sure that the vacuum plumbing in the evacuation system are not loose or disconnected.

(3) Close the drain cock of the compressor.
See 4.3.1 Daily Inspection.

(4) Is the compressor stop valve open?
See 4.3.4 Location and Functions of Major Components.

(5) Is the breaker on the customer-provided power distribution board turned on?

(6) Are all breakers on the system power distribution board turned on?

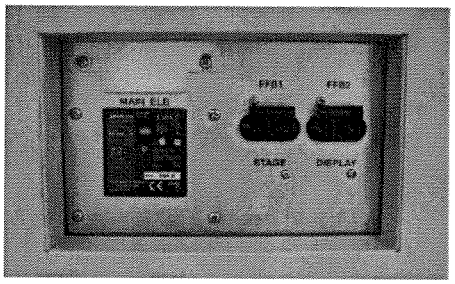


Fig. 3.1-1 System Power Distribution Board

3.1.2 Start-up Operation

(1) Rotate the key switch on the EVAC Panel to **START** and then release it. The system will start.

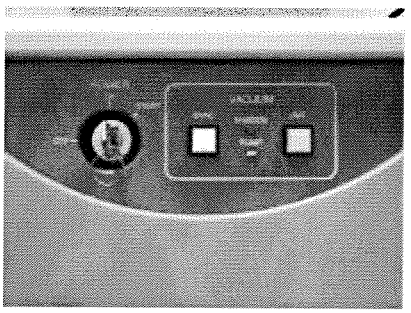


Fig. 3.1-2 Starting the System

(2) Windows will start up and request to key in **Ctrl + Alt + Delete** will appear. Press **Ctrl + Alt + Delete** simultaneously (This request message will be shown or not depending on network setting of SEM computer). The **logon** window will appear. Enter user name and password. The Windows XP will start. The following initial settings are made when the instrument is shipped from the factory.

User name: PC-SEM
Password: None
Reference: 2.3.1 Starting the PC and Logging in the S-3400N Program

NOTICE: When the system is delivered, the password for the Administrator account is set to hitachi.

(3) The S-3400N operation program will start up automatically and the **initial log-in** window appears.
The initial operation program log-in name and password are shown below.

Log-in name : S-3400
Password : None

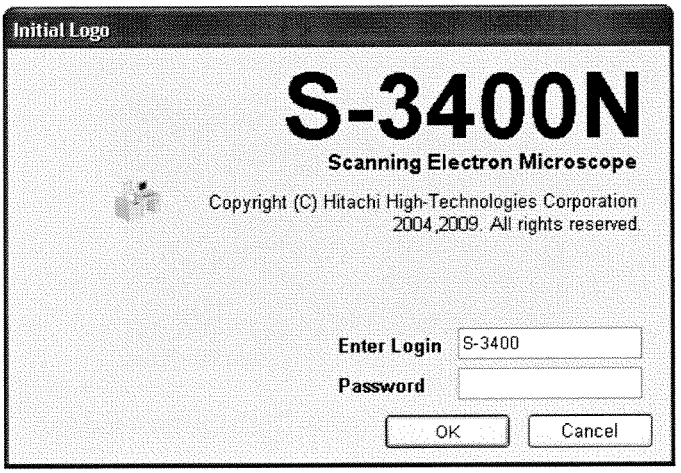


Fig. 3.1-3 Log-in Window

Input login name and password, then click the **OK** button. The SEM main window will open.
Refer to <3.9.15 Password Setting> and <3.9.16 Setting Login Name>.

(4) In case of Type Ⅱ stage, message shown in Fig. 3.1-4 or Fig. 3.1-5 is displayed while the initialization of the stage is being executed.

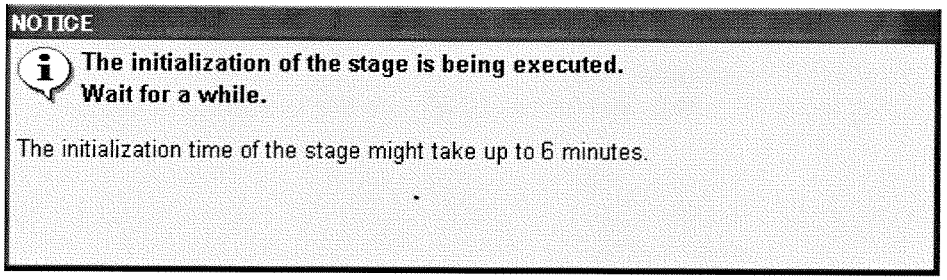


Fig. 3.1-4 Message Window (1)

In case of interrupting the initialization of the stage by clicking the **Stop** button, complete the initialization of the stage by clicking the **HOME Z65** button. The buzzer rings while the stage is moving.

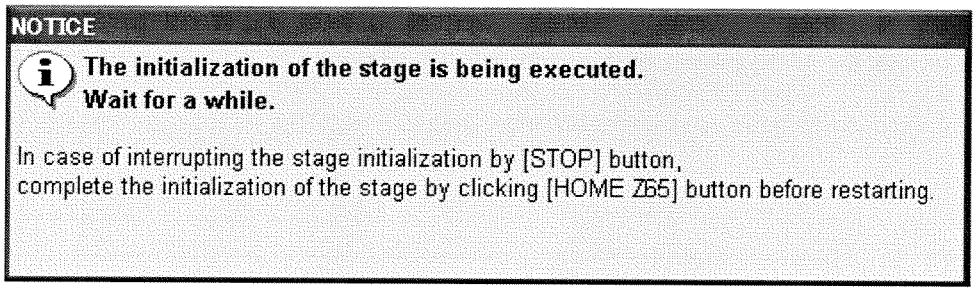


Fig. 3.1-5 Message Window (2)

⚠ **CAUTION:** For Type Ⅱ stage, the stage automatically moves to the initialization position when logging on the operation program for S-3400N.
To avoid injury to hands or fingers, do not touch the operating parts while the stage is moving.

IMPORTANT: Do not insert the detector while initializing the stage. The initialization of the stage might not be completed and GUI might not be able to operate.

(5) The **Specimen Setting** window is displayed. When observing the specimen, click the **AIR** button and introduce air into the specimen chamber.

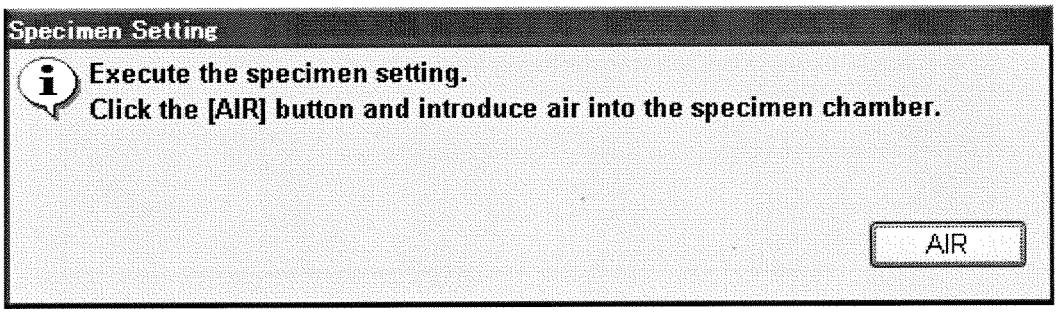


Fig. 3.1-6 Specimen Setting Window

(6) In case of using the specimen exchange chamber, click the **S.E.C** button.

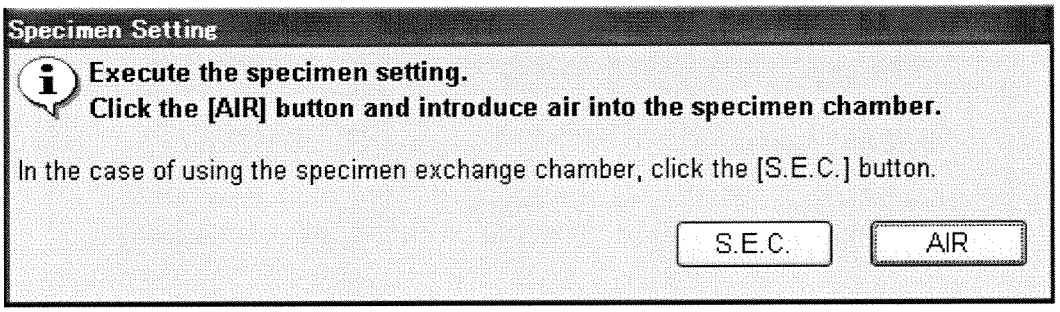


Fig. 3.1-7 Specimen Setting Window
(When using the specimen exchange chamber)

3.2 Mounting a Specimen

3.2.1 Precautions Concerning Specimen Preparation

During specimen preparation, observe the following.

(1) Wear clean gloves when exchanging specimens. Holding the specimen or specimen stub with bare hands should be avoided.

(2) Avoid using an excessive amount of conductive paste to fix a specimen on the specimen stub. Ensure that the paste has dried before placing the specimen in the chamber. Too much paste can release a large quantity of gas into the vacuum, which can cause the vacuum level to decline and result in contamination.

(3) When using double-sided adhesive tape to fix a specimen to the stub, use the least possible amount so as to minimize out-gassing. The use of double-sided adhesive tape may also cause specimen drift.

(4) Mounting a specimen containing an excessive amount of water or oil can cause contamination in the column, which should be avoided.

3.2.2 Specimen Preparation according to Material

The method of specimen preparation varies with different materials. Listed below are typical preparation methods for various types of specimens.

(1) Conductive specimens such as metals:
These types of specimens can be observed without preparation. However, coating with heavy metals by using a vacuum evaporator, an ion sputtering or magnetron-sputtering unit may result in better contrast.

(2) Non-conductive specimens such as semiconductors, fibrous specimens and polymeric materials:
When imaging a specimen without coating, the recommended procedure is to use either the low-vacuum mode or a low accelerating voltage. If the specimen needs to be imaged at high magnification, mount the specimen onto a stub, and then coat the specimen with a metal coating using a recommended procedure. If a high magnification image is required of micro-structures, the metal coating may be visible. Care should be taken to avoid this problem.

(3) Biological specimens:
Biological specimens can be observed in the low-vacuum mode without prior treatment. For high magnification observation, dry the specimen by using a method such as critical point drying, freeze drying or other drying techniques, then coat the specimen with conductive material.

(4) X-ray analysis specimens:
Generally, polish the surface of the specimen, then fix it to the specimen stub using carbon paste. Non-conductive specimens should be coated with carbon using a vacuum evaporator.

3.2.3 Mounting a Specimen on the Type I Stage (Manual Stage)

IMPORTANT: The specimen base that comes with the system is round. When loading an angular specimen, select an appropriate specimen base so that the entire specimen will fit on the base. Movable range limits are established by restricting the operating range for the X and Y axes to within the diameter of the specimen stand and by calculating the safe operating range for the Z and Tilt axes.
For example, if a square specimen measuring 50 mm on the edge is affixed onto a 50 mm-diameter specimen base and the specimen is rotated 45°, the size of the specimen in X and Y directions will be 70 mm, which means that the specimen cannot be protected safely if its size is set to 50 mm. In such a situation, use a 77-mm (3-inch) specimen base.

3.2.3.1 Setting the Specimen Stub

Combine the adjustable screw, locking ring, and specimen stub base, and screw the stub to the adjustable screw. Tighten the locking ring so that the adjustable screw will not become loose.

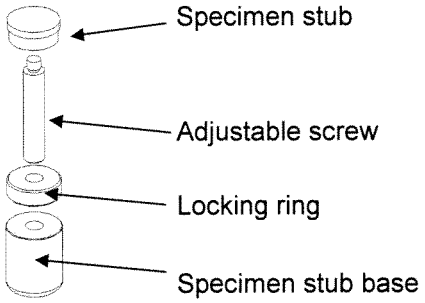


Fig. 3.2-1 Setting of the Specimen Stub

3.2.3.2 Measuring and Setting the Specimen Height

Loosen the locking ring for the specimen stub. Use an adjustment screw to align the highest position of the specimen to the **Standard** (45 mm) mark on the height gauge, and fix the specimen using the locking ring so that the adjustment screw will not become loose. The height of the specimen stub base from the bottom to the specimen surface is 45 mm.

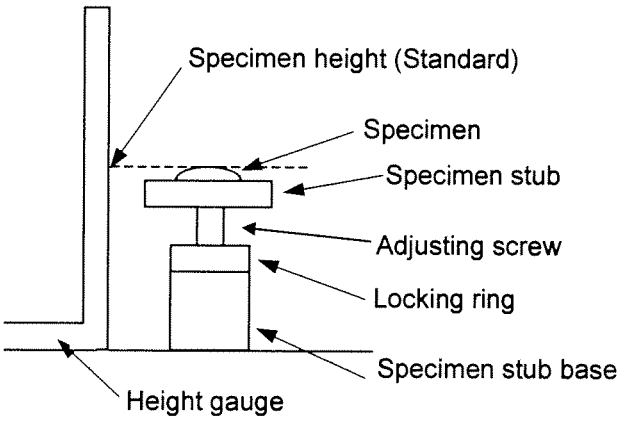


Fig. 3.2-2 Measuring the Specimen Height

IMPORTANT:	If the specimen is tilted or the Stage Z is short, the specimen can touch the objective lens or the backscattered electron detector that is provided on the underside of the objective lens, which can result in damage to the specimen, objective lens or the backscattered electron detector.

3.2.3.3 Moving the Stage to the Specimen Exchange Position

Align the X, Y, R, T, and Z knobs of the specimen stage to the specimen exchange position (the specimen exchange position is indicated on the upper face of the specimen stage).

Specimen replacement position	X: 30 mm	Y: 20 mm	Z: 35 mm
	R: 0°	T: 0°	

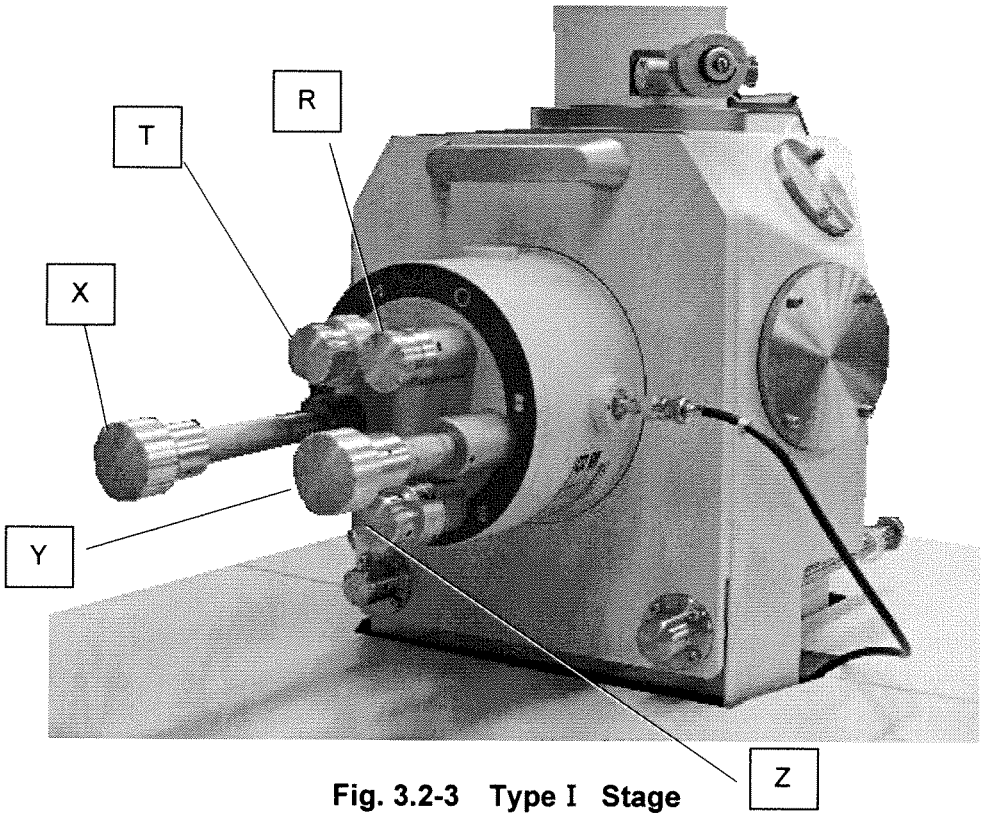
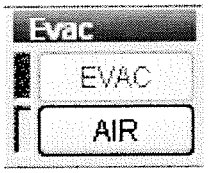


Fig. 3.2-3 Type I Stage

3.2.3.4 Procedure for Loading a Specimen

(1) Removing the specimen, from the specimen chamber
- If the accelerating voltage is on, click the **OFF** button on the Control Panel to shut it off.
- Press the **AIR** button on the **EVAC** panel on the front side of the main unit or click the **AIR** button located in the upper right section of the Control Panel.

EVAC Panel



Control Panel

Fig. 3.2-4 AIR Button (Introducing air into the specimen chamber)

- Air is introduced into the specimen chamber. Allow approximately 100 seconds for the specimen chamber to attain atmospheric pressure.
- Grasp the handle located on the front side of the specimen stage, and pull the specimen stage toward you to remove the specimen base.

(2) Loading a specimen
- Slide the specimen base into the specimen holder receptacle on the specimen stage.

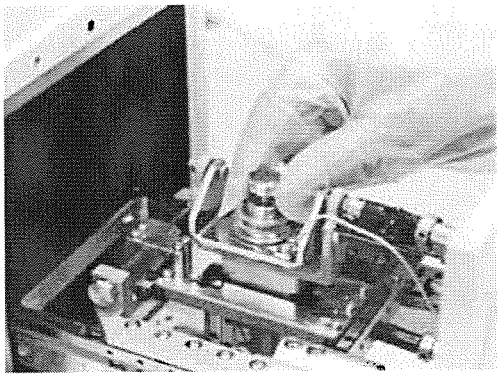
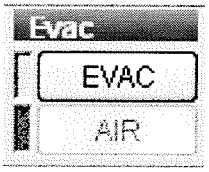


Fig. 3.2-5 Setting the Specimen Base

- Grasp the handle. Push the specimen stage into the specimen chamber.
- Press the **EVAC** button on the front EVAC Panel located on the front side of the unit or click **EVAC** located in the upper right section of the Control Panel. Evacuation of the specimen chamber then commences. Accelerating voltage can then be energized approximately 2 minutes after the **EVAC** button is pushed.

IMPORTANT: Do not touch the operation parts such as gears and driving screws and note that clothes are never placed when you bring the hand close to the movement mechanism in the specimen stage by the specimen exchange etc.

EVAC Panel



Control Panel

Fig. 3.2-6 Operating the EVAC Button (Evacuating the specimen chamber)

⚠ **CAUTION:** When pushing the specimen stage into the specimen chamber, be careful that your fingers are not caught between the stage and the specimen chamber.

IMPORTANT: Ensure that the stage door is firmly against the chamber before the **EVAC** button is pushed. The chamber cannot be evacuated unless the specimen stage has a tight fit with the chamber.

3.2.4 Mounting a Specimen on the Type Ⅱ Stage (5-axis motor-driven stage)

IMPORTANT: The specimen base comes with the system is round. When loading an irregularly shaped specimen, select an appropriate specimen stub so that the entire specimen will fit on the stub. Movable range limits are established by restricting the operating range for the X and Y axes to within the diameter of the specimen stub and by calculating the safe operating range for the Z and Tilt axes. For example, if a square specimen measuring 50 mm on the edge is affixed onto a 50 mm-diameter specimen base and the specimen is rotated 45°, the size of the specimen in X and Y directions will be 70 mm, which means that the specimen cannot be protected safely if its size is set to 50 mm. In such a situation, either use a 77-mm (3-inch) specimen base or specify a specimen setting (see3.2.4.3 Setting the Specimen Size and Height) of 77 mm (3-inch) rather than 50 mm (2-inch).

IMPORTANT: The height of a specimen should be measured with great care. Be sure to set the specimen size and height on the Stage Control menu. If they are not properly set, when the specimen is tilted or Stage Z is small, the specimen can touch the objective lens or the backscattered electron detector that is provided on the underside of the objective lens, potentially causing damage to the specimen, objective lens, and backscattered electron detector.

3.2.4.1 Mounting a Specimen

(1) Mount a specimen on the specimen stub.

(2) Fix the specimen stub to the specimen stub base (S, L).
Specimen stub base (S) : For a high specimen
Specimen stub base (L) : For a low specimen

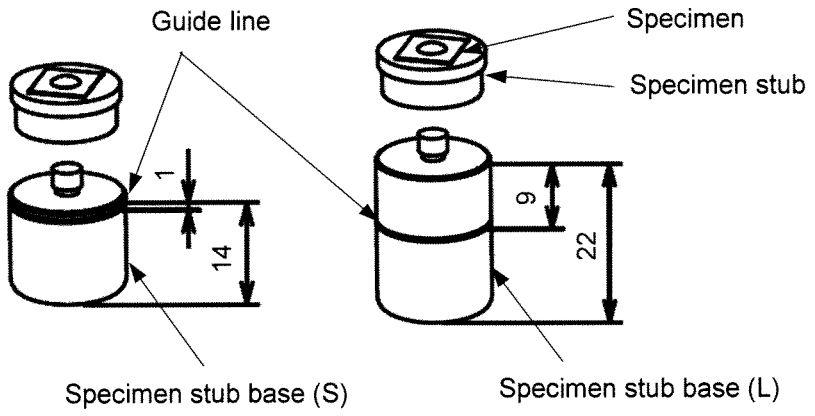


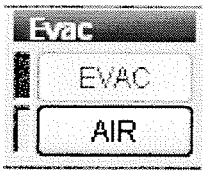
Fig. 3.2-7 Mounting a specimen on the specimen stub

3.2.4.2 Specimen Exchange (Removing the Specimen from the Specimen Chamber)

(1) Click the **OFF** button on the Control Panel to shut the accelerating voltage off.

(2) Press the **AIR** button on the EVAC Panel or click the **AIR** button on the upper right section of the Control Panel. Air is introduced into the specimen chamber. The Specimen Setting window appears. After confirming the content of the window, click the **Specimen Setting** button.

EVAC Panel



Control Panel

Fig. 3.2-8 AIR Button (Introducing air into the specimen chamber)

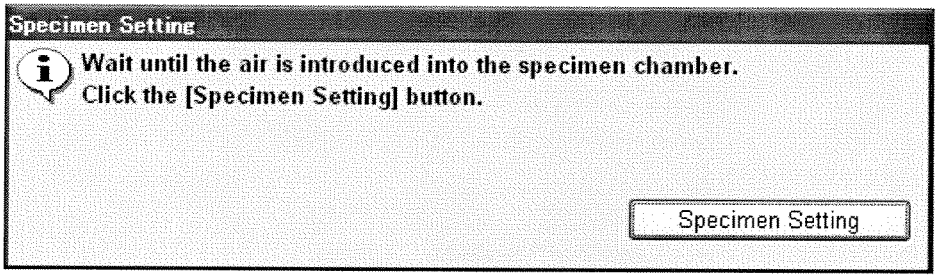


Fig. 3.2-9 Specimen Setting Window

When installing the Faraday cup (option)
Draw out the Faraday cup from the specimen chamber. The **Specimen Setting** button becomes effective. And then, click the **Specimen Setting** button.

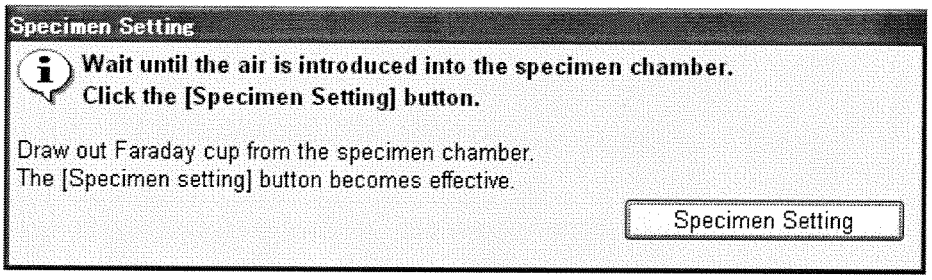


Fig. 3.2-10 Specimen Setting Window (When installing the Faraday cup)

(3) After introducing air into the specimen chamber, draw out the stage to the position where the stage stops completely.
[When executing observation]
Remove the specimen holder and click the **OK** button on the **Specimen/Detector Setting** window.
[When finishing observation]
Remove the specimen holder. Grip handles by both hands and insert the stage in the specimen chamber slowly. Click the **Exit SEM Manager** button to finish the program. Then, push the **EVAC** button to evacuate.

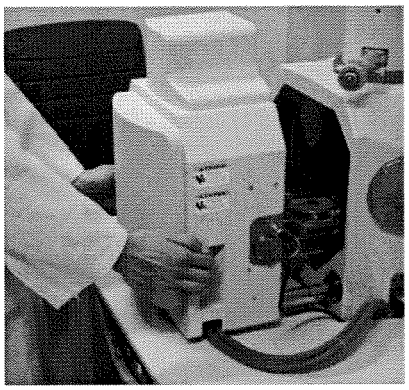


Fig. 3.2-11 Pulling out the Stage

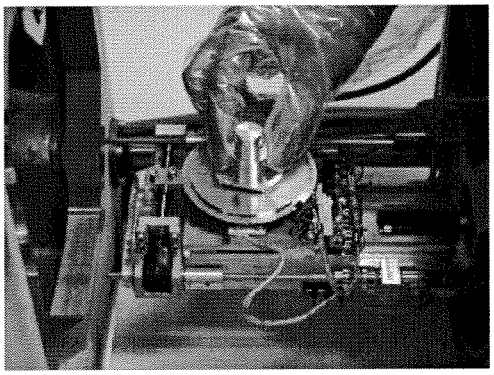


Fig. 3.2-12 Removing the Specimen Holder

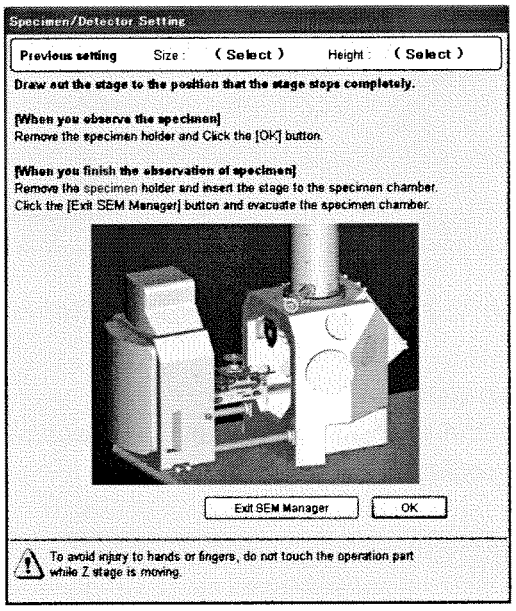


Fig. 3.2-13 Specimen/Detector Setting Window 1

IMPORTANT: When setting the specimen, draw out the specimen stage to the position where the stage stops completely.

3.2.4.3 Setting the Specimen Size and Height

(1) **Specimen/Detector Setting** window appears.
Set the specimen **Size** and **Height** with this window.

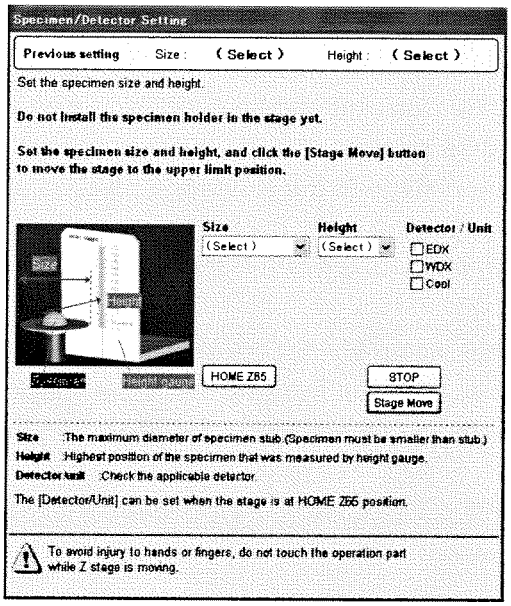


Fig. 3.2-14 Specimen/Detector Setting Window 2

(2) Measure the specimen **Size** and **Height**.
Use the height gauge to measure the highest point of the specimen. This value is the specimen height. When putting two or more specimens, measure the highest specimen of them. The specimen **Size** is the size of the specimen or specimen stub. When the specimen is larger than the specimen stub, the specimen size becomes specimen **Size**.

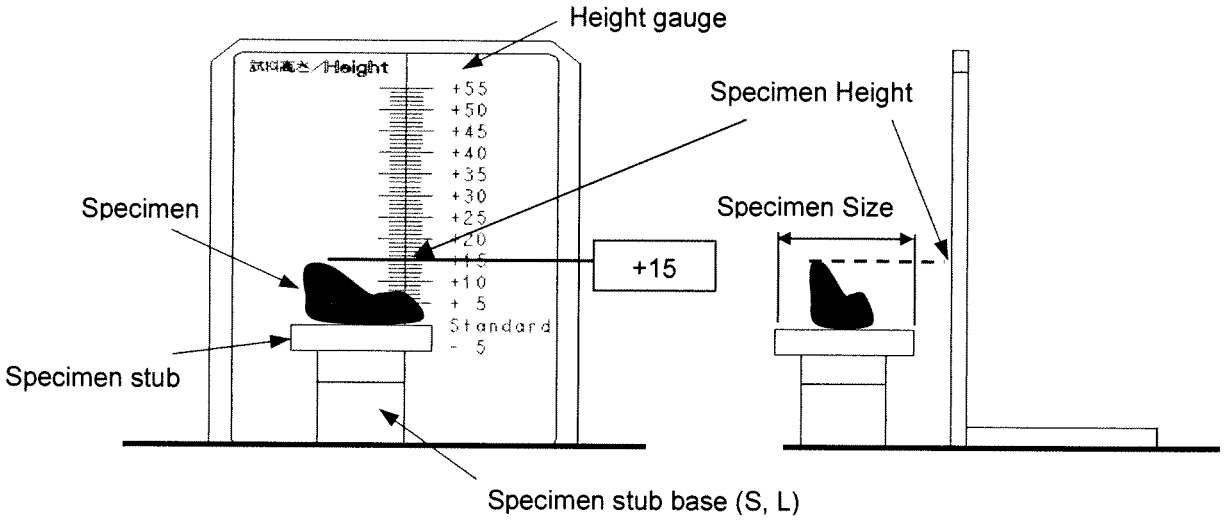


Fig. 3.2-15 Example of Measuring Specimen Height

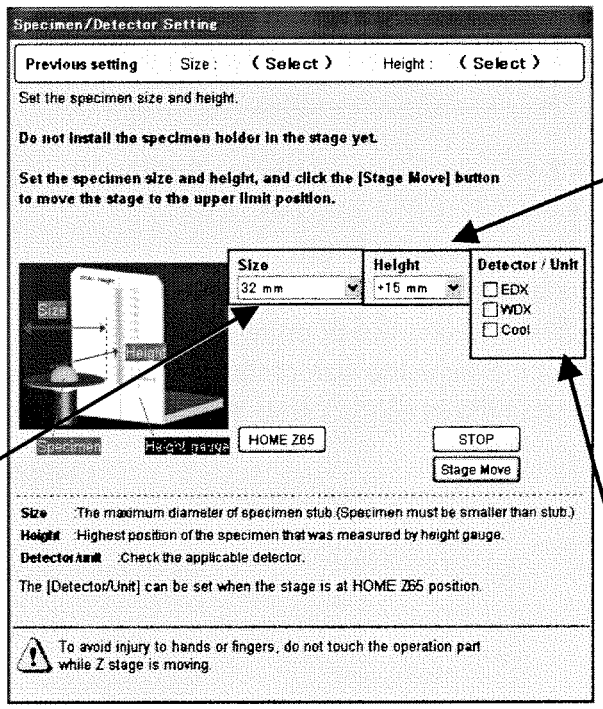
(3) Set the specimen with **Specimen/Detector Setting** window.

(a) Setting the specimen **Size**
The specimen size is selected from the pull-down list of the specimen **Size**.

(b) Setting the specimen **Height**
The specimen height measured with the height gauge is selected from the pull-down list of the specimen **Height**.

(c) Setting the **Detector/Unit**
The setting of **Detector/Unit** can be executed when the specimen stage is at the specimen exchange position.
Move the specimen stage to the exchange position by clicking **HOME Z65** button. The buzzer keeps ringing while the stage is operating. Click the **STOP** button when stopping the movement of the stage.

NOTICE: Click the **HOME Z65** button so that the specimen stage moves to the specimen exchange position when stopping temporarily the specimen stage by clicking the **STOP** button while moving the stage to the specimen exchange position.



(a) Size

If the specimen size is 32 mm in diameter, set Size to [32 mm].

(b) Height

If the specimen height measured using a specimen height gauge is [+15 mm], set Height to [+15 mm].

(c) Detector/Unit

Check the Detector/Unit check box used.

Fig.3.2-16 Setting Size and Height of the Specimen

⚠ CAUTION: To avoid injury to hands or fingers, do not touch the operating parts while the Z stage is moving.

IMPORTANT: Execute the specimen setting surely. If set wrongly, the specimen might touch the BSE detector when moving the specimen stage, and both might be damaged.

(4) Move Specimen stage Z-axis to the upper limit position.
Do not install the specimen holder in the stage yet.
Confirm that the stage was pulled forward completely.
Click the **Stage Move** button so that the stage moves to the upper limit position. The buzzer keeps ringing while the stage is operating. Click the **STOP** button when you want to stop the movement of the stage.
The buzzer sound is stopped when the stage moves to the upper limit position, and the **Specimen/Detector Setting** window changes as shown in Fig. 3.2-17.

IMPORTANT: Click the **Stage Move** button with the specimen stage pulled forward completely. When the stage is moved to the upper limit position with specimen holder installed in the stage and inserted into the specimen chamber, the specimen might touch the check gauge or the BSE detector and damage them.

⚠ **CAUTION:** To avoid injury to hands or fingers, do not touch the operation part while Z stage is moving.

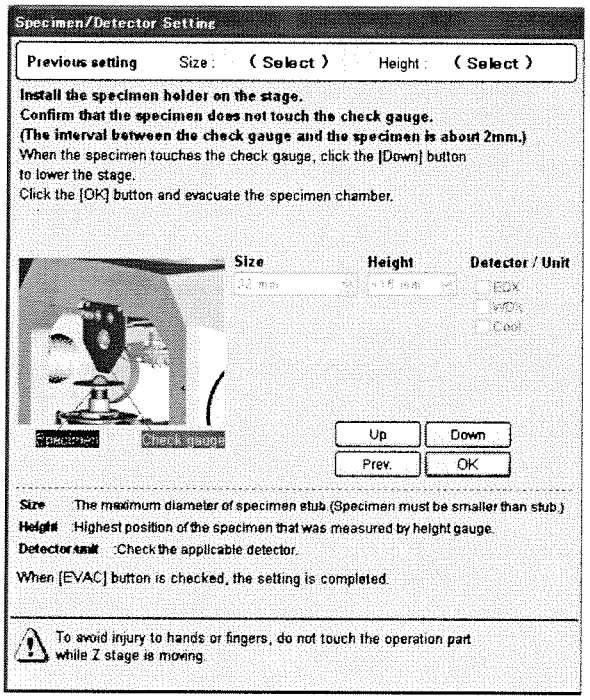


Fig. 3.2-17 Specimen/Detector Setting Window 3

(5) After confirming that the specimen stage has moved to the upper limit position, install the specimen holder in the stage.
Insert the specimen stub base into the specimen holder completely. The specimen stub base has a guide line. Insert the specimen stub base into the specimen holder up to the guideline.
And then, install the specimen holder in the stage.

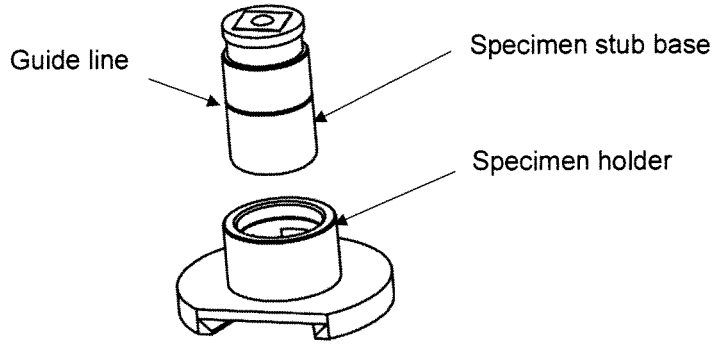


Fig. 3.2-18 Setting of the Specimen Stub Base to the Specimen Holder

(6) Make sure that the specimen **Height** is set properly.
Insert the stage slowly into the specimen chamber while holding the knobs at both sides of the stage. At this time, make sure that the specimen can go through without interfering with the check gauge. If the specimen does not touch the check gauge and the interval between the specimen and the check gauge becomes about 2 mm, height of the specimen is set correctly. Insert the stage into the specimen chamber during that status.

IMPORTANT:	When confirming the specimen height setting, the specimen might touch the check gauge and get the damage. Bring the specimen slowly toward the check gauge.

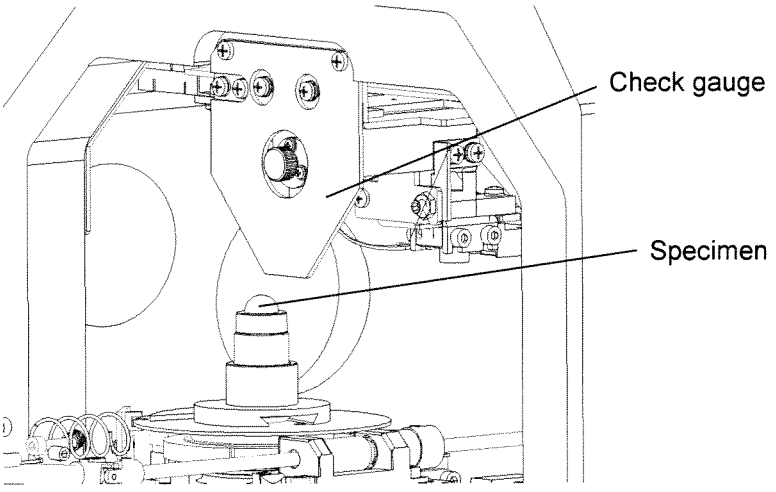


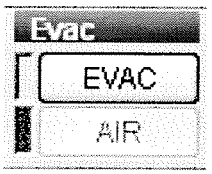
Fig. 3.2-19 Confirming the Height Setting

In the case of wrong **Height** setting, the specimen will touch the check gauge.
Click the **Back** button on the Specimen/Detector Setting window to return to the setting screen and set the **Height** again.
When adjusting the gap a little, click the **Down** button to change the **Height** setting. Clicking the **Down** button can lower the stage Z-axis by 1 mm. At this time, specimen **Height** on the GUI is automatically changed.
If the stage Z-axis is lowered too much, click the **Up** button to raise the stage Z-axis and adjust it. Clicking the **Up** button can raise the stage Z-axis by 1 mm.

(7) After confirming the setting of specimen height, click the **OK** button.

(8) Evacuate air from the specimen chamber. Press the **EVAC** button on the front of the **EVAC** panel or click the **EVAC** button on the control panel to start evacuating the specimen chamber. The **EVAC** switch blinking changes into a steadily lit state in about 2 minutes, and the specimen can be observed by applying an accelerating voltage.

EVAC Panel



Control Panel

Fig. 3.2-20 EVAC Button (Evacuating the specimen chamber)

⚠ **CAUTION:** When changing the specimen, operate the stage with the knob and be careful that your fingers are not caught between the stage and the specimen chamber.

IMPORTANT: Do not touch the moving parts such as gears and driving screws nor get your clothes caught in the mechanism when you bring the hand close to the movement mechanism in the stage at the specimen exchange, etc.

IMPORTANT: The specimen chamber cannot be evacuated unless the stage is set firmly in the specimen chamber.

IMPORTANT: When clicking **EVAC** button with the specimen setting uncompleted, the following NOTICE window appears. Click **AIR** button to set it again.

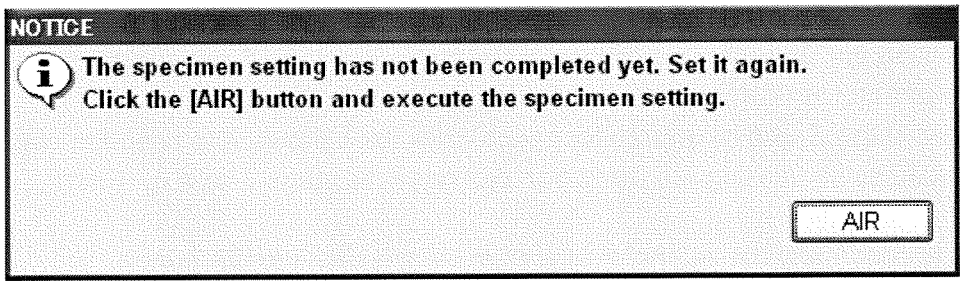


Fig. 3.2-21 NOTICE Window

IMPORTANT: The specimen Size and Height setting limits the movable area of the stage (Z and T direction) to protect the specimen and components inside the specimen chamber from damage by contact of both. If these setting are not correct, the BSE detector might be damaged.

NOTICE: When a specimen is observed using a specimen base for 80-mm high specimens, add -4 to the specimen height measured with the height gauge.
And if the height of the specimen itself is lower than 20 mm (outside the range of the scale on the height gauge), the observed image can be displayed as an image exceeding the focusing limit. If this happens, the accuracy of the magnification factor and the value of the micron-marker cannot be guaranteed. Therefore, observations should always be made by loading a specimen equal to or greater than 20 mm in height (within the range of the scale on the height gauge).

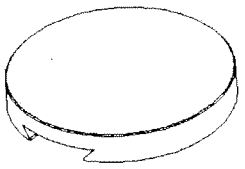


Fig. 3.2-22 Specimen Base for 80-mm High Samples

3.3 Applying the Accelerating Voltage

3.3.1 Conditions under which Accelerating Voltage can be Applied

If **E.Beam** block at the left top position on the **Control Panel** is grayed out, the accelerating voltage can not applied, wait until the **ON** button is activated with the evacuation of the chamber is completed.
When the accelerating voltage is on, the accelerating voltage indicator shows the currently set accelerating voltage and the emission current (in μA). The top left button should indicate **OFF**.

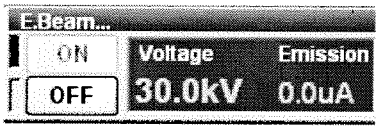


Fig. 3.3-1 E.Beam Block (ON Active)

3.3.2 Setting the Accelerating Voltage and Filament Current

There are four ways of applying an accelerating voltage:

(1) Click **E.Beam** block, open **Setup** window, and press the **ON** button in the **Optics** tab.

Fig. 3.3-2 Applying the Accelerating Voltage (a)

(2) Press the left **ON** button in **E.Beam** block.

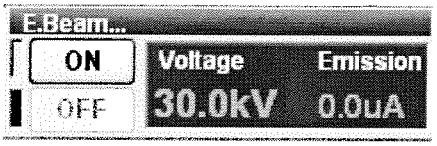


Fig. 3.3-3 Applying the Accelerating Voltage (b)

(3) Press **ON** on **ELECTRON BEAM** block on the **Cond.** tab on the Control Panel.

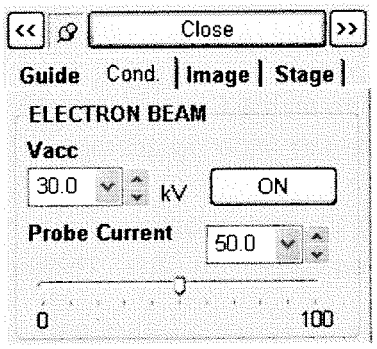


Fig. 3.3-4 Applying the Accelerating Voltage (c)

(4) Select the **Detail** button on the **Cond.** tab on the Control Panel, and press the **ON** button on the **ELECTRON BEAM** block.

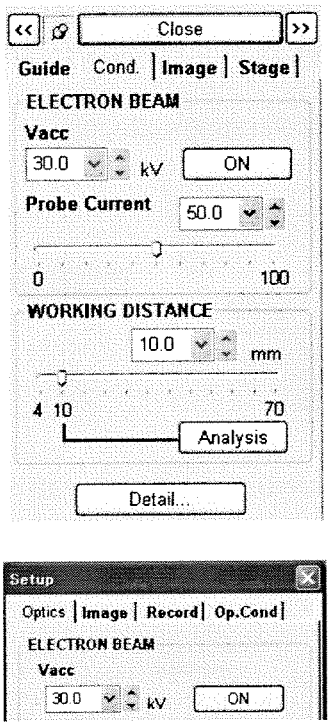


Fig. 3.3-5 Applying the Accelerating Voltage (d)

(a) For accelerating voltage, select the desired accelerating voltage level from the list displayed in the accelerating voltage **Vacc** input section. If necessary, the Up/Down buttons can be used to set the defined value in 100 V increments. If desired, a specific numerical value can be entered from the keyboard (use the Enter key to set the value).

(b) To set a filament current, select the **Detail** button on the **Cond.** tab in the Control Panel, and select **Mid**, then press **AFS**.

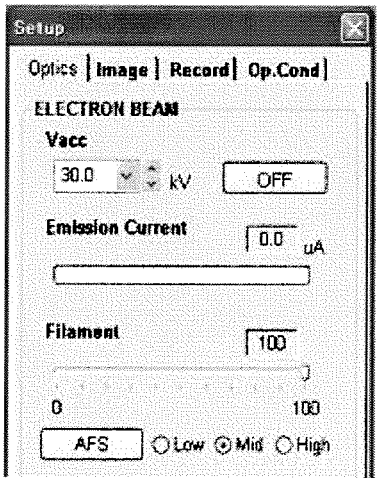


Fig. 3.3-6 Setting a Filament Current

NOTICE:	The filament current, **Filament**, can be set automatically by pressing either the Auto Filament Saturation **AFS** function or the Auto Beam Setting **ABS** button.

NOTICE:	Because the previous setting value is memorized in **Filament**, **AFS** need not be done every time. Execute it when Filament setting changes.

Also, the filament current **Filament** can be adjusted on a customized basis by moving the slider. Normally, Hitachi recommends the use of an automatically set filament current by the Auto Filament Saturation **AFS** or the Auto Beam Setting **ABS**.
When the **AFS** function is running, the screen freezes, and a message appears. When the screen changes to a RUN state, it is an indication that the auto adjustment has finished.

NOTICE:	The Auto Filament Saturation **AFS** should be set to **High** for high magnification imaging, and **Low** to ensure long filament life.

3.4 Adjusting the Electron Optical System

3.4.1 Setting Parameters for the Electron Optical System

Parameters for the electron optical system can be set in two locations:

(1) **Cond.** Tab (on the Control Panel)
On the **Cond.** tab, accelerating voltage **Vacc**, **Probe Current**, focusing position **WORKING DISTANCE**, and **Detail** can be set and selected.

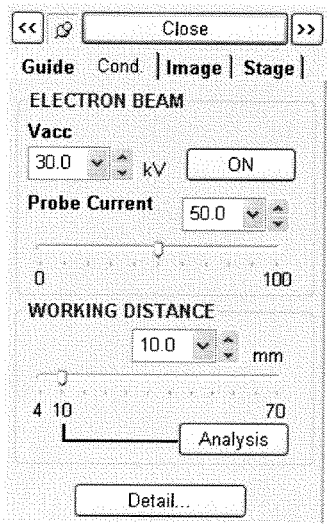


Fig. 3.4-1 Setting Electron Optical System Parameters on the Cond. Tab

(2) Setting electron optical system parameters on **Setup**
The **Setup** menu provides a consolidated view of all parameters related to the electron optical system, including **Vacc**, **Filament**, **Gun Bias**, **Probe Current**, **WORKING DISTANCE**, automated functions (**AFS** and **ABC**), and **DeGauss**.

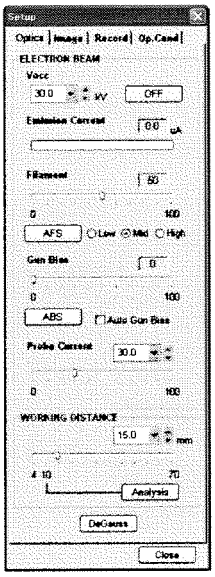


Fig. 3.4-2 Setup Window

The following methods can be used to set parameters:

(a) Setting an **Auto Gun Bias**
The **Auto Gun Bias** corrects the change in the emission current when the accelerating voltage etc. is changed. Therefore, observation with constant emission current can be executed.
Normally, set the **Auto Gun Bias** function (check the **Auto Gun Bias** check box) and use it.

(b) Setting a **Gun Bias**
The **Gun Bias** function adjusts the emission current by varying the bias voltage for the electron gun. The **Gun Bias** can be changed from 0 to 100 by dragging the slider. When increasing the emission current, set the **Gun Bias** to low value. Conversely, when decreasing the emission current, set the **Gun Bias** to high value. Set the **Gun Bias** to an appropriate value so that the emission current value can become 130 μA or less. Normally, observe the specimen by using the **Gun Bias** value that is set automatically by the **Auto Gun Bias** function.

(c) Auto Beam Setting (**ABS**)

ABS combines the automation functions of **AFS** (Auto Filament Saturation), **ABA** (Auto Beam Alignment), **ABCC** (Auto Brightness Contrast), and **AFC** (Auto Focus Control) to produce good-quality SEM images. This feature can be helpful when steps such as the setting the filament current and the adjusting the gun alignment axes after a filament is replaced. For details, see the individual Auto functions. After the **ABS** function is activated, the **Auto Gun Bias** function is set to the checkmarked conditions. See the following sections:

3.4.2.2 Axial Alignment Items in Detail
3.3.2 Setting the Accelerating Voltage and Filament Current
3.5.4 Image Brightness and Contrast Adjustment
3.5.5 Focus and Astigmatism Correction

(d) Setting the **Probe current**

Click the button to select the desired probe current level from 0 to 100, from a displayed list. The lower the probe current setting, the higher the resolution that can be obtained. For observing low-contrast specimens and performing X-ray analyses, the Probe Current level should be set high to produce a large amount of probe current. The default is 50.

Small adjustments can be made by using the Up/Down buttons to change the probe current in 0.1 increments. A numerical value can be entered directly from the keyboard (use the Enter key to set).

(e) Setting a **WD** (Working Distance)

Working Distance (WD) refers to the distance between the bottom of the objective lens and the surface of the specimen. The scale on the Z-axis of the specimen stage corresponds to the Working Distance.

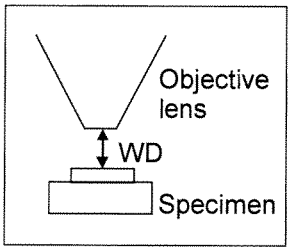


Fig. 3.4-3 Definition of WD

When a WD value is selected from the list which is displayed when the button is clicked, the current for the objective lens will be set so that the specimen is in focus at that WD (the actual position of the specimen can be adjusted by manipulating the Z-axis of the specimen stage).
For X-ray analysis, a WD value of 10 mm should always be used in order to maintain a fixed X-ray extraction angle in relation to the detector. First, for the focusing position, that is, **WORKING DISTANCE**, set the value of WD to 10 mm, and adjust the Z-axis of the specimen stage so that the specimen is in focus at that distance. In this manner, the geometry of the analysis point for the X-ray detector and the specimen can be set to the desired condition even when the specimen has substantial peaks and valleys on its surface.
Varying the WD changes the resolution, the focal depth, and tilt restrictions. The table below shows the relationship between WD, resolution, focal depth, and specimen tilt angle.

Table 3.4-1 Influence of WD

	Short ← WD →	Long
Resolution	High ← →	Low
Focal depth	Shallow ← →	Deep
Specimen tilt angle	Small ← →	Large

NOTICE: The longer the WD the greater is the sensitivity of the primary electron beam to floating magnetic fields. For this reason, in situations where a long WD is used, the floating magnetic field can produce image errors during high magnification imaging.

(f) Degaussing (**DeGauss**) operation
The degaussing operation is designed to remove residual magnetic fields from the objective lens magnetic field. Changing the focus extensively can cause the residual magnetic field to reduce the precision of the magnification factor and the WD indication factor. This can be minimized by clicking the **DeGauss** button such as:

- After changing the focus substantially
- Before adjusting the axes for the electron optical system (electromagnetic alignment)

Degaussing is performed automatically when any of the following operations is performed:

- Applying or modifying the accelerating voltage (changing the accelerating voltage by more than 3 kV)
- Setting the WD
- Changing the **Probe Current** mode

NOTICE: The function key **F2** can be used to perform degaussing operations without opening the **Setup** window.

3.4.2 Axial Alignment

To fully exploit the capabilities of the system, it is necessary to perform axis alignment on the electron optical system.
The chart below shows axis alignment procedures. The required items should be adjusted after imaging conditions are modified.

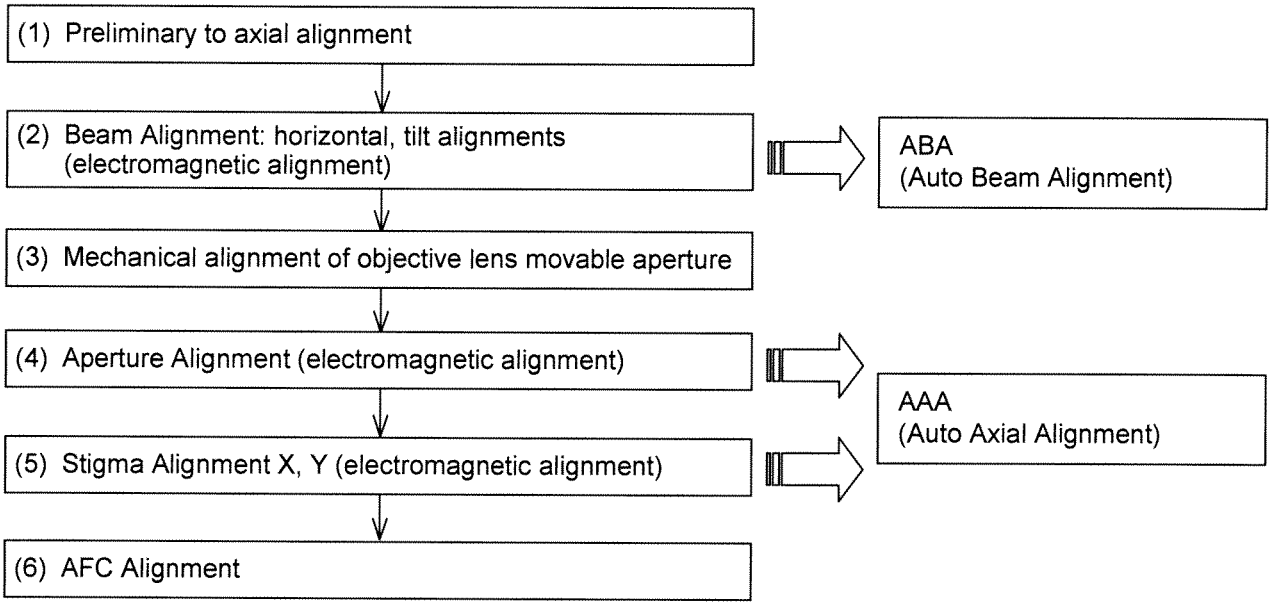


Fig. 3.4-4 Axis Alignment Procedures

Method (A), shown on the left side of Fig. 3.4-4, is a basic axis alignment method that allows you to perform alignments by moving a knob on the Control Panel while viewing an image. In the electromagnetic alignment part (**Beam Alignment horizontal, tilt alignment, Aperture Alignment adjustment, Stigma Alignment, and X, Y alignment**) can also be aligned by using Method (B), which combines the Auto features.

3.4.2.1 Items Requiring Axial Alignment

The list below shows when an axial alignment is needed and what specific items need to be adjusted. For further details, see <3.4.2.2 Axial Alignment Items in Detail>.

- After a filament is replaced: Adjust all items.
- After the position of the objective movable aperture has been changed:
  Adjust items (3) to (5).
- When the accelerating voltage or probe current is changed:
  Adjust items (4) and (5).
- Adjustment of Auto Focus is not suitable well :
  Adjust item (6).

3.4.2.2 Axial Alignment Items in Detail

(1) Preliminary checks before performing an axial alignment
Before commencing an axial alignment, the following preliminary steps should be performed:

(a) Place a specimen in the specimen chamber.
See 3.2 Mounting a Specimen.

(b) Set the accelerating voltage to 5.0 kV.

(c) Set **Probe Current** to 80 on the **Optics** tab of the **Setup** window.

(d) Set the objective lens movable aperture to the "0" position (open aperture).

(e) Set the WD to 10 mm; focus the specimen.

(f) Using the **Align** 

button on the Control Panel, start the **Alignment** window. On this window, click the **Reset All** button.

(2) **Beam Alignment**
Beam Alignment is required so that the electron beam passes through the center of the column. This alignment is performed in terms of **Beam Align. Tilt** and **Beam Align. Shift**.

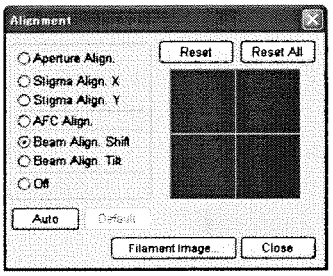


Fig. 3.4-5 Selecting the Beam Alignment

(a) Basic axial alignment method that can be performed while viewing an image
- Click the **Beam Align. Shift** radio button. If an image fails to appear, adjust the contrast and the brightness of the image.
- On the Manual Operation Knob, set either adjust the **STIGMA/ALIGNMENT** knob or move the mouse while holding down on the left mouse button in the Alignment Operation area on the **Alignment** window, and adjust the screen crosshairs to maximize the brightness of the observed image.
- Similarly, click the **Beam Align. Tilt** radio button, and adjust the screen crosshairs to maximize the brightness of the observed image.

- After the alignment process is finished, click the **Off** radio button on the **Alignment** window.
- Adjust the contrast so that the screen will be at the best possible brightness to view images.

(b) Using the Auto feature

This method allows you to perform alignment using **ABA** (Auto Beam Alignment) on both **Beam Align. Shift** and **Beam Align. Tilt**.

- Click the **Beam Align. Shift** radio button.
- Click the **Auto** button shown in the figure below:

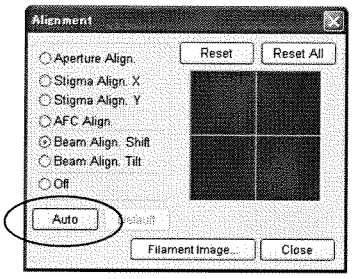


Fig. 3.4-6 Selecting the Auto Beam Alignment

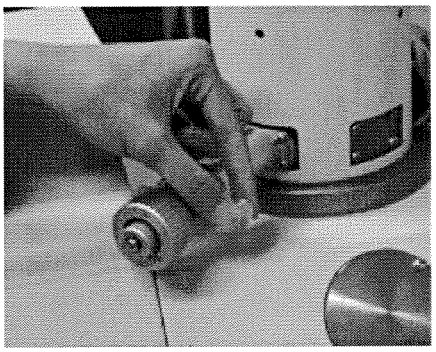
- **ABA** (Auto Beam Alignment) is performed, and an alignment is accomplished.
- Click the **Beam Align. Tilt** radio button.
- Similarly, click the **Auto** button.
- The **ABA** is performed, after which the Beam Alignment process terminates.

NOTICE: If an image fails to show even when the contrast to is set to a maximum, redo the beam alignment as follows: click **Reset All**, set the Probe Current to approximately 80, perform a beam alignment, and then set the Probe Current to a level required by the operating condition (default: 50).

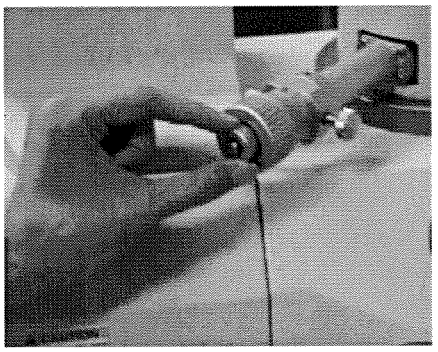
(3) Performing a mechanical axial alignment on the objective lens movable aperture

- Set the objective lens movable aperture. Normally, it is set to 3 or 4. Switch the objective lens movable aperture to 2 or 3 when more irradiation currents are required to observe the sample with low magnification or execute EDX analysis with the SDD detector.

  Aperture diameters 1: 150 µm
  2: 80 µm
  3: 50 µm
  4: 30 µm
- If the image becomes dark, adjust the contrast.
- Use relatively low magnification.
- Adjust the aperture hole adjustment X, Y knobs so that the brightness of the image is maximized.



X direction



Y direction

Fig. 3.4-7 Mechanical Axial Alignment on the Objective Lens Movable Aperture

NOTICE:	The **Beam Alignment** might shift after the position of the objective lens movable aperture is changed. In such a case, adjust the objective lens movable aperture again.

NOTICE:	For normal observation, axial alignments should be performed using the Electromagnetic Alignment. If the objective lens movable aperture is moved, reset the aperture alignment to a mid-point. After that, adjust mechanically the objective lens movable aperture to adjust the image so that its brightness will be at a maximum.

(4) **Aperture Alignment**

The **Aperture Alignment** is designed so that the electron beam will pass through the center of the objective lens and objective lens movable aperture. If this alignment is not performed precisely, focusing operations can shift the image, resulting in inadequate resolution or image quality.

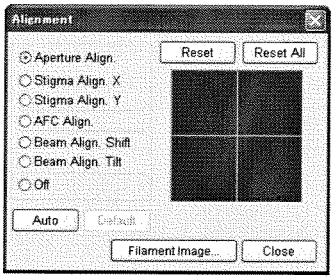


Fig. 3.4-8 Aperture Alignment Menu

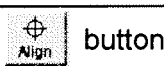
NOTICE: For normal observation, axial alignments should be performed using the Electromagnetic Alignment. If the objective lens movable aperture is moved, reset the aperture alignment to a mid-point. After that, use the objective lens movable aperture to make adjustments so that the brightness of the image will be at a maximum. In subsequent normal observations, axial alignments should be performed using the Electromagnetic Alignment.

(a) Basic axial alignment by viewing an image

- Set the magnification factor from 1,000× to 5,000×. Move a spot on the specimen to near the center of the image.
- Perform focus and stigmation adjustments.
- On the **Alignment** window, click the **Aperture Align.** radio button to bring up the Aperture Alignment mode in which the focus and the image position fluctuate periodically.
- Using either the **STIGMA/ALIGNMENT** knob on the Manual Operation Knobset or the alignment operation area in the **Alignment** window, move the mouse while holding down the left button of the mouse, and move the crosshairs so that the motion of the image is minimized.
- Increase the magnification factor to 5000× or higher to perform final Aperture alignments.
- After the adjustment process is finished, click the **Off** radio button on the **Alignment** window.

NOTICE: An accurate aperture alignment cannot be performed at a low magnification (1.000× or less). After making coarse adjustments at low magnification factor, the final adjustments should be made at 1,000× or higher. Prerequisite to an accurate aperture alignment is the correct focus adjustment.

NOTICE: If the focus is changed substantially for some reason, the recommended procedure is to click the **DeGauss** button, and then perform alignment adjustments. (The hot key, **F2** can be used to perform degaussing operations without opening the **Setup** window.)

NOTICE: Clicking the **Align** 

button on the Control Panel changes the normal image observation mode to the Aperture Alignment mode. If the image moves when adjusting focus, the aperture alignment mode should be performed.

(b) Using the Auto feature

Selecting the **Alignment** button and clicking the **Auto** button activates Auto Axial Alignment (**AAA**) function for the Aperture Alignment.

- Click the **Alignment** button.
- Click the **Auto** button shown in the figure below:

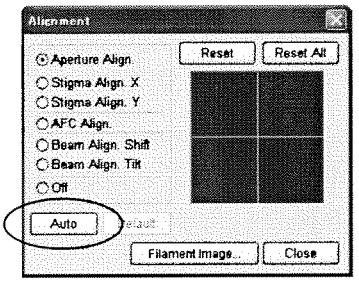


Fig. 3.4-9 Selecting the Auto Axial Alignment (AAA)

NOTICE: Depending on the particular magnification factor that was in effect during the execution of Auto Axial Alignment (**AAA**), with some WD conditions, the Auto feature may not work properly. In such a case, either run the Auto feature again after the condition is made right or perform the basic axial alignment method (A) by viewing the image.

(5) **Stigma Alignment X, Y** adjustments

The **Stigma Alignment** function is designed to ensure that the image will not move during the stigma correction process. This function is also necessary for the accurate operation of Auto Stigma.

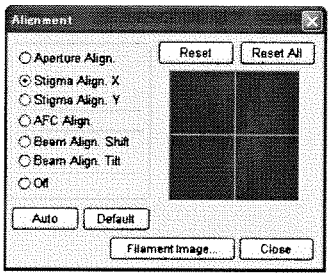


Fig. 3.4-10 Selecting the Stigma Alignment

(a) Basic axial alignment that is performed while viewing an image

- Set the magnification between 1,000× to 5,000×. Move a salient spot on the specimen to near the center of the image.
- Perform focus and stigmation alignments.
- On the **Alignment** window, click the **Stigma Align. X** radio button so that the image will move periodically.
- Either adjust the **STIGMA/ALIGNMENT** knob on the Manual Operation knobset or move the mouse while holding down on the left button of the mouse in the Alignment Operation area on the **Alignment** window to minimize the motion of the image.
- Similarly, click the **Stigma Align. Y** radio button on the **Alignment** window to minimize the motion of the image.
- After the alignment process is finished, click the **Off** radio button.

NOTICE: To improve the effectiveness of the electron optical axis alignment process, click the **DeGauss** button after focusing adjustment is finished (or press the function key **F2**), and then perform an electromagnetic alignment.

(b) Using the Auto feature
Select either the **Stigma Align. X** or **Stigma Align. Y** button and click the **Auto** button to run the stigma alignment auto axial alignment (**AAA**) process.

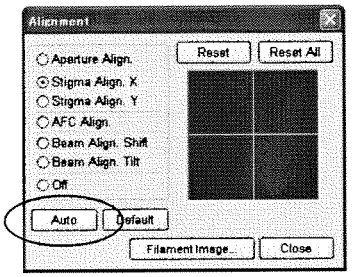


Fig. 3.4-11 Selecting the Auto Axial Alignment (AAA)

- Click the **Stigma Align. X** radio button.
- Click the **Auto** button shown in the figure below.
- Click the **Stigma Align. Y** radio button.
- Similarly, click the **Auto** button shown in the figure below.

NOTICE: Depending on the particular magnification factor that was in effect during the execution of Auto Axial Alignment (**AAA**), with some WD conditions, the Auto feature may not work properly. In such a case, either run the Auto feature again after the condition is made right or perform the basic axial alignment method (a) by viewing the image.

NOTICE: Stigma alignment can sometimes cause a shift in aperture alignment. In such a case, adjust (X/Y), and then perform an aperture alignment again.

(6) **AFC Alignment** adjustments

The **AFC Alignment** function is designed to the electron beam will pass through the center of the objective lens. This function is also necessary for the accurate operation of Auto Focus and the Auto Stigma and Focus.

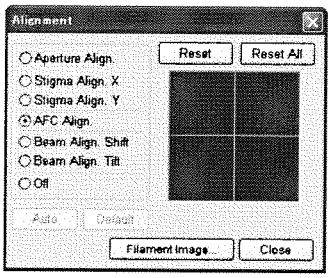


Fig. 3.4-12 Selecting the AFC Alignment

- Set the magnification between 1,000× to 5,000×. Move a salient spot on the specimen to near the center of the image.
- Perform focus and stigmation alignments.
- On the **Alignment** window, click the **AFC Align.** radio button so that the image will move periodically.
- Either adjust the **STIGMA/ALIGNMENT** knob on the Manual Operation knobset or move the mouse while holding down on the left button of the mouse in the Alignment Operation area on the **Alignment** window to minimize the motion of the image.
- After the alignment process is finished, click the **Off** radio button.

3.5 Operation for Image Observation

Follow the operation below for observation of a scanning image.

3.5.1 Selecting a Detector

A detector can be selected by using the **DETECTOR** block located in the **Image** tab on the Operation Panel. One of the following detectors can be selected: a secondary electron detector (**SE**), a backscattered electron detector (**BSE**), or (**Option**) other detectors. If the **ABCC Link** is checked, changing detector settings automatically causes contrast and brightness adjustments.

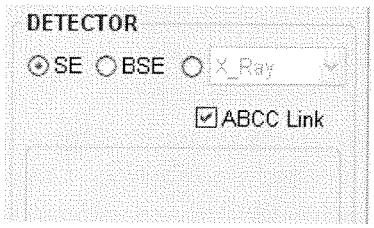


Fig. 3.5-1 Selecting a Detector

IMPORTANT: Changing detectors causes a substantial change in the brightness of the image. If the **ABCC Link** check box in the **Image** tab of the Operational panel has been checked, ABCC will start automatically when detector selection is changed. Image brightness will be adjusted to an adequate value.

IMPORTANT: In high magnification observation, the image shifts by several micrometers due to the characteristics of the detectors when the detector is changed.

As signals detected by a detector have the following characteristics, they should be selected according to the intended purpose:

Table 3.5-1 General Characteristics of Detector-dependent Signals

Detector	Characteristics	Application
SE (Secondary electron)	High resolution surface information High edge contrast Sensitive to specimen charging Not suitable for the low-vacuum mode	Useful for making morphological observations on the specimen surface
BSE (Backscattered electron)	Sensitive to compositional information Less sensitive to specimen charging Less edge contrast Permits observations in the low-vacuum mode	Useful in conducting observations with edge contrast suppressed, observing specimen composition information, or reducing the charge-up effect

3.5.1.1 Secondary Electron Detector (SE)

Selecting the **SE** option on the **DETECTOR** block produces an observation image detected by the secondary electron detector.
Because it uses a high voltage in its sensor, the secondary electron detector produces electric discharges and cannot be used in the low-vacuum mode. When the low-vacuum mode is on, a detector other than the secondary electron detector is automatically selected.
In **SE Bias** block, secondary electron collection efficiency can be changed by the slider, or the combo box from 0 to 100. It is recommended to use with adjusting to the images lighten most. The default value is 30, and the **Reset** button is pushed, it will return to a default value.

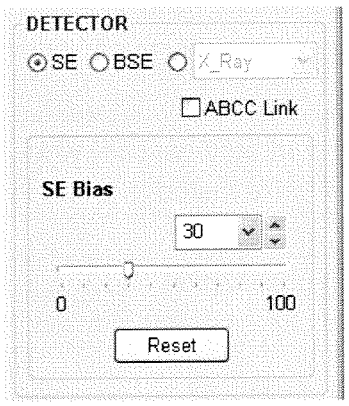


Fig. 3.5-2 DETECTOR Block

3.5.1.2 Backscattered Electron Detector (BSE)

For conducting observations, a backscattered electron detector is normally used in the low-vacuum mode.
The backscattered electron detector picks up the electrons reflected from the specimen by means of a semiconductor sensor attached to the underside of the objective lens. The semiconductor sensor is comprised of a doughnut-shaped 4-way split element that has a hole through which the primary electron beam can pass, and a 3D imaging sensor that detects low-angle reflection electrons. By putting detected signals through computational processing, the semiconductor sensor provides image observations in three detection modes: composition (**COMP**), topology (**TOPO**), and stereo (**3D**) modes.

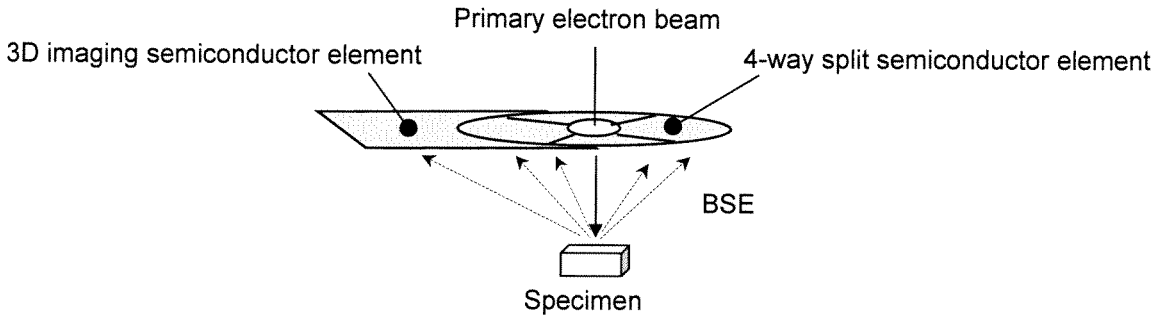


Fig. 3.5-3 Signal Detection by Backscattered Electron Detector

IMPORTANT: The BSE uses semiconductor elements in its detection unit. To prevent damage to the semiconductor elements and the specimen, the following precautions should be observed:

- The movable range for the stage must be observed strictly. In particular, a short WD or a high angle tilt can cause the stage or specimen to touch the detector, damaging the sensor.
  See 3.5.6 Operation of the Specimen Stage (Type I - Manual Stage).
- The specimen height should be set accurately by using the supplied height gauge.
  See 3.2.3.2 Measuring and Setting the Specimen Height.
- For the Type II stage, always measure the specimen height using the height gauge and set the specimen height in the **Stage** tab of the Operation Panel. If the actual specimen height is greater than the set height, the specimen can come into contact with the semiconductor sensor even within the software-defined movable range.
  See 3.2.4.3 Setting the Specimen Size and Height.
- When inserting the specimen stage use the Check gauge and check the operating range of the stage axes so that the specimen will not touch the check gauge; the specimen stage should be used only within that range.
  See 3.5.6.6 Checking the Ranges of T-axis Tilting and Z-axis Motion when Observing a Bulk Specimen.
- To prevent any contact between a specimen and the detector sensor, the Z (WD) should be used in a range greater than 5 mm.

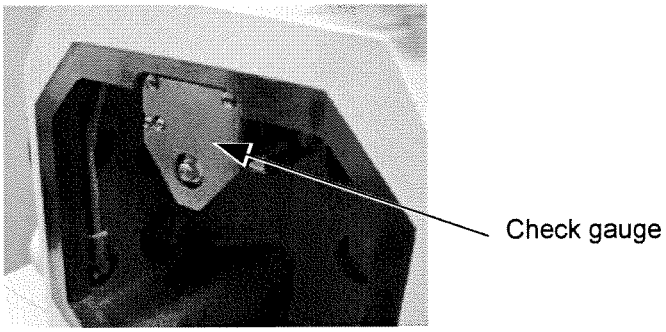


Fig. 3.5-4 Check Gauge

(1) **Setting the backscattered electron detector (BSE)**

Selecting the **BSE** option in the **DETECTOR** block produces a **BSE** image. This menu can be used to set the type of **BSE** signal, **COMP**, **TOPO** or **3D**, and the amount of gains to be produced.

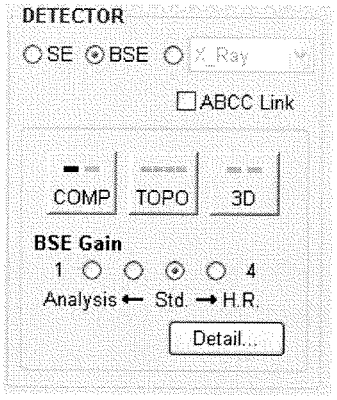


Fig. 3.5-5 BSE Menu

(a) **COMP** mode

The **COMP** mode allows the observation of a composition image by exploiting the atomic number effect that the lighter the atomic weight of an element, the darker is the backscattered electron signal, and the heavier the element, the brighter the signal. Pressing the **COMP** mode button again reverses the composition image, from black to white and from white to black, and this is repeated each time the button is pressed.

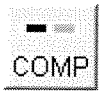


Fig. 3.5-6 COMP Mode

(b) **TOPO** mode

Based on the difference in signal between oppositely disposed detector sensors, this mode permits the observation of topographic images. Each pressing of the **TOPO** mode button changes the direction of shading by 90 degrees.

Fig. 3.5-7 TOPO Mode

(c) **3D** mode
This mode produces enhanced Topographic or 3D images with a mixture of specimen surface composition information and topology information. Each pressing of the **3D** mode button changes the intensity of shading.

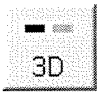


Fig. 3.5-8 3D Mode

For **BSE Gain**, normally select a level 3. If the amount of detected backscattered electrons is large and the image contrast appears to be too strong, change the Gain to 2 or 1. Conversely, if the image contrast is too low due to a low detection amount of backscattered electrons, the Gain setting should be changed to 4.

NOTICE: At a BSE Gain level or 4 or 3, depending on the characteristic of the detector, the observed image may drift sideways during fast scanning, such as in the TV or FAST scanning mode, resulting in an unclear image. In such a case, either select the SLOW scanning mode or increase the probe current so that the BSE Gain level can be set low.

(2) Detailed settings of the BSE
For detailed detector sensor settings, press the **Detail** button in the **DETECTOR** block to bring up a **BSE** window, which allows you to turn individual sensor signals on and off and select signal polarity reversal/non-reversal.

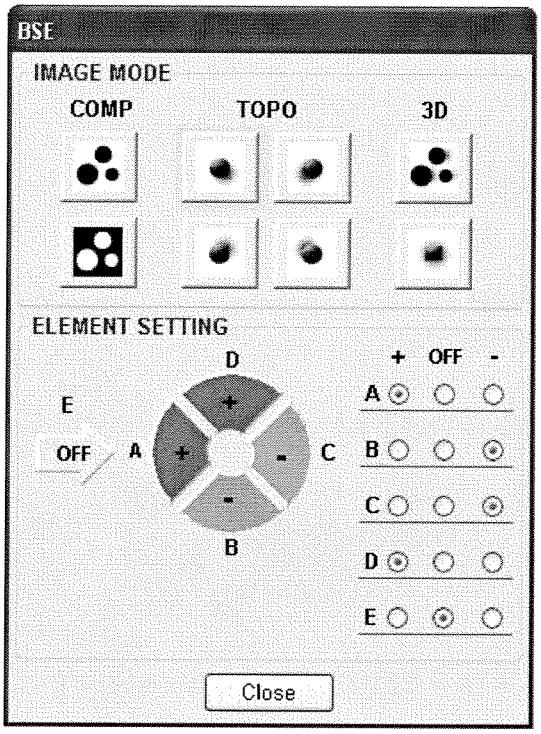


Fig. 3.5-9 BSE Window

IMAGE MODE: This button switches between detection modes, similar to pressing the **COMP/TOPO/3D** buttons in the **DETECTOR** block.

ELEMENT SETTING: Either select radio buttons **A-E** or click elements in the detector sensor diagram to set each element to **+/-/OFF**.

3.5.1.3 Other Detectors (Option)

By selecting a detector other than SE/BSE in the **DETECTOR** block, it is possible to observe images based on the different detector. Optional detectors that are installed can be selected from a pull-down menu.

NOTICE:	Different detectors can be selected by setting a 2-screen display mode by selecting **Dual** in the image display size block in the **Image** tab on the Operation Panel. This feature allows you to compare images from different detectors in realtime or display a composite image from different detectors. For further details, see Section 3.9.3 Signal Selection and Color Mixing.

3.5.2 Selecting Magnification

There are several ways to select a magnification.

3.5.2.1 Setting Magnification

(1) Manual Operation Panel
The **MAGNIFICATION** knob can be used to set a magnification.
See 2.2.3 Manual Operation Panel.

(2) Dragging the mouse in the Magnification control block on the Control panel.

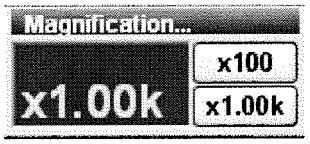


Fig. 3.5-10 Magnification Control

To increase magnification, drag the mouse to the right. To decrease magnification, drag the mouse to the left. For coarse changes, press the right button and for fine changes, the left button.

(3) Clicking the mouse button in the Magnification control block
Magnification increases in incremental steps by clicking the right button and decreases by clicking the left button.

(4) Using a pre-set magnification
Two preset buttons can be used to recall up to two pre-defined magnifications.
A magnification can be preset by either clicking **Mag. Preset Setup** on the **Setup** menu, clicking the title area on the magnification control block, or right-clicking the **Preset** button.

3.5.2.2 Notes on Using the Lowest Magnification and Conducting Observations at a Low Magnification

(1) Range of minimum magnifications
Table 3.5-2 shows available minimum magnifications for the various observation parameters. The minimum magnification is subject to restrictions by WD and accelerating voltage, scan speed.

Table 3.5-2 Minimum Magnification

Vacc(kV) \ WD(mm)	3.5 and above		9.5 and above		13.5 and above		19.5 and above		29.5 and above		39.5 and above		49.5 and above		55.5 and above	
	TV/Fast	Slow	TV/Fast	Slow	TV/Fast	Slow	TV/Fast	Slow	TV/Fast	Slow	TV/Fast	Slow	TV/Fast	Slow	TV/Fast	Slow
30.0 to 28.1	80	55	45	32	37	25	27	19	20	14	15	11	13	9	12	9
28.0 to 26.1	80	55	45	32	35	25	27	19	19	13	15	11	12	9	12	8
26.0 to 24.1	80	55	42	30	35	25	25	18	18	13	14	10	12	9	11	8
24.0 to 22.1	75	50	42	30	32	23	25	17	18	13	14	10	12	8	11	8
22.0 to 20.1	65	47	42	30	30	21	23	17	17	12	13	10	11	8	10	7
20.0 to 18.1	65	47	40	27	30	21	23	16	16	11	13	9	11	8	10	7
18.0 to 16.1	65	45	35	25	30	20	21	15	15	11	12	9	10	7	10	7
16.0 to 14.1	60	42	35	25	27	19	20	14	14	10	11	8	10	7	9	6
14.0 to 12.1	60	42	32	23	25	17	19	13	14	10	11	8	9	6	9	6
12.0 to 10.1	55	37	30	20	23	16	17	12	13	9	10	7	8	6	8	6
10.0 to 8.1	45	32	27	19	21	15	16	11	11	8	9	7	7	5	7	5
8.0 to 6.1	42	30	23	16	18	13	14	10	10	7	8	6	7	5	7	5
6.0 to 4.1	35	25	20	14	15	11	12	9	9	6	7	5	6	5	6	5
4.0 to 2.1	35	25	20	14	15	11	12	9	9	6	7	5	6	5	6	5
2.0 to 0.3	35	25	20	14	15	11	12	9	9	6	7	5	6	5	6	5

(2) Notes on operating at low magnifications
In the light gray range shown in Table 3.5-2, depending on observation conditions (low accelerating voltages and low-magnification, and use of No. 4, or 3 objective lens movable aperture), shadows appear on the edge of the image as illustrated in Fig. 3.5-11. These shadows appear because of interference of electron beam with the objective lens movable aperture and the orifice unit. The problem can be minimized by increasing the hole diameter for the objective lens movable aperture (No. 1 or 0).

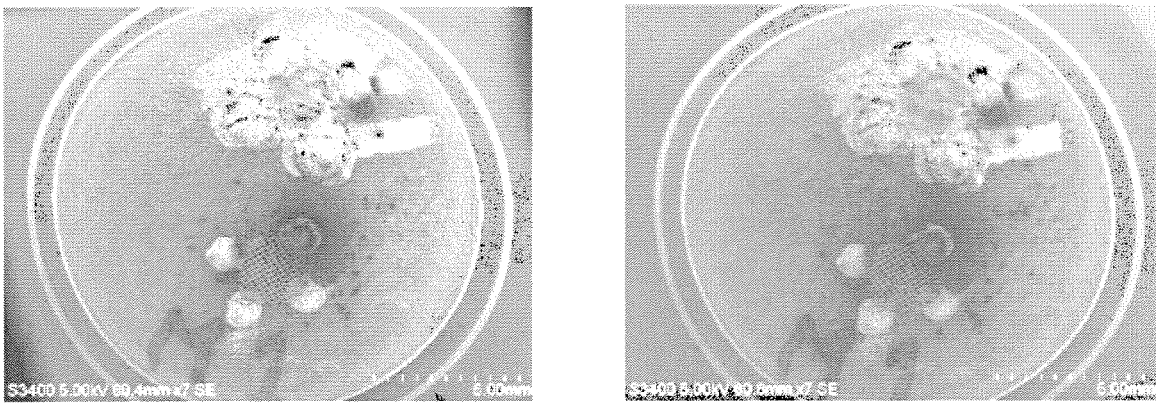


Fig. 3.5-11 Interference Shadow from Objective Lens Movable Aperture
Left: shadow present, Right: no shadow (objective lens movable aperture No. 0)

In the dark gray range shown in Table 3.5-2, depending on observation conditions (low accelerating voltages and low-magnification), the image shows a round clipping as illustrated in Fig. 3.5-12. This problem arises when the electron beam undergoes wide-angle deflection oscillations in order to display the specimen at an extremely low magnification.

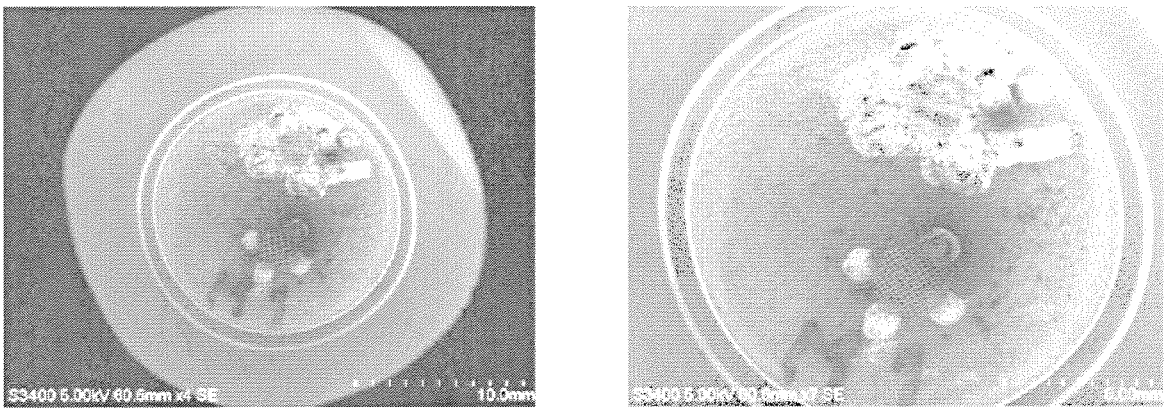


Fig. 3.5-12 Round Clipping Image under an Extremely Low Magnification
Left: clipping image, Right: no clipping

NOTICE: The light and dark gray observation conditions shown in Table 3.5-2 permit wide FOV observations, which are suitable for searching for a specimen. Under such conditions, observations should be conducted by changing the objective lens movable aperture to No. 1 or 0.

NOTICE: **Auto magnification fraction adjustment**
The auto fraction adjustment calculates and sets nearest even value magnification when capturing an image or directly photographing.

To enable the auto magnification fraction adjustment, check the mark at **Magnification Fraction Adjust** check box on **Optional Setup** window - **General** tab.

Note that, it will be set to preset magnification if the most recent magnification operation was magnification preset.

3.5.3 Selecting Scanning Speed

Thirteen scanning speeds are available with four buttons.
To select a scanning speed, click one of the Scan speed icons on the Control panel.
Two scanning speeds are assigned to each button. They are set alternately by clicking the button. The assignment of scanning speeds to four buttons can be customized.
Refer to <2.3.6.3 Scan Control>.

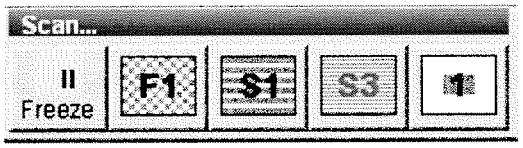
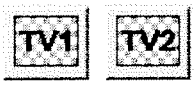


Fig. 3.5-13 Scanning Control Block

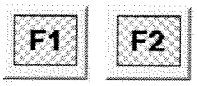
(1) **Run/Freeze** button

Run  **/ Freeze**  button is used to start/stop the beam scanning.

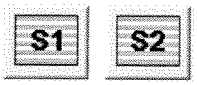
- The electron beam repeatedly scans on the specimen when clicking the **Run** button with the beam scanning stopped. And, the image displayed is updated along with the scanning. At this time, "Run" with yellow blinks in the upper left of the image, and the **Run** button changes into the **Freeze** button.
- When clicking the **Freeze** button during scanning, scanning continues until it reaches the end of the frame and then stops. "Going to Freeze" has been shown in the upper left section of the image until the scanning stops. It becomes "Freeze" when the scanning finishes. The **Freeze** button changes into the **Run** button.
- In the case of the slow scan mode, click the **Freeze** button again while displaying "Going to Freeze" so that the scanning stops before it comes to the end of frame. The display in the upper left section of the image becomes "Freeze" when the scanning stops. The **Freeze** button changes into the **Run** button.

(2) **TV Scanning**: 

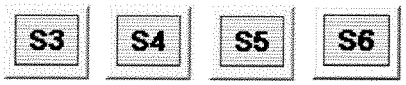
TV Scanning of flicker-free images is convenient for a field search of the specimen, coarse focus, etc. The quality (S/N ratio) of the image is improved by frame averaging.
Two TV scanning speeds, TV1 and TV2, operate at the same speed but allow different number of frames to be averaged for each.
To set the number of frames to be averaged, use the **Image** tab in the **Setup** window.
In the **FAST SCAN AVERAGING** area, set TV1 and TV2 values. Recommended numbers are 4 for TV1 and 8 or 16 for TV2. The higher the number of frames, the better the attainable image quality.

(3) **Fast Scanning**: 

Fast Scanning runs with half the speed of TV scanning. It is also convenient for a field search of the specimen, coarse focus, etc.
This is the highest possible scanning speed under the full screen mode.
The quality (S/N ratio) of the image is improved by frame averaging.
Two fast scanning speeds, FAST1 and FAST2, operate at the same speed but allow different number of frames to be averaged for each. To set the number of frames to be averaged, use the **Image** tab in the **Setup** window. In the **FAST SCAN AVERAGING** area, set FAST1 and FAST2 values. Recommended numbers are 2 or 4 for FAST1 and 4 or 8 for FAST2.

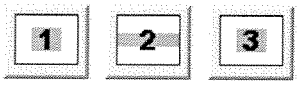
(4) **Slow Scanning**: 

Slow1 and Slow2 are relatively fast slow scans.
These two speeds are asynchronous to AC line frequency. It may cause some field magnetic disturbance at high magnification and/or low kV condition.
Use for a field search of the specimen, coarse focus, etc.
Slow1: About 1 s/frame (Full screen) About 0.5 s/frame (Small screen)
Slow2: About 4 s/frame (Full screen) About 2 s/frame (Small screen)

(5) **Slow Scanning**: 

Use these for observation, fine focus, and astigmatism correction. Finest image quality may be attainable.

Slow3: 20 s/frame (Full screen) 10 s/frame (Small screen)
Slow4: 40 s/frame (Full screen) 20 s/frame (Small screen)
Slow5: 80 s/frame (Full screen) 40 s/frame (Small screen)
Slow6: 160 s/frame (Full screen) 80 s/frame (Small screen)

(6) **Reduce Area Scanning**: 

Three reduced area scanning speeds are available.

(a) Reduce1:
The scan speed is approximately equal to the TV scanning rate. It is, therefore, suitable for searching the field, focus and astigmatism correction.
To move the scanning area box, place the mouse cursor over the border of the reduced area window. While the mouse cursor is changed to the Move indicator (intersecting arrows), press the left button and drag the scanning area box to a desired place.

(b) Reduce2:
Scanning speed is the same as Slow3 while the frame speed is 4 times faster.
It is suitable for final focus and astigmatism correction. The scanning area can be moved with the same operation as mentioned above.

(c) Reduce3:
Image size is the same as Reduce1 and a slower horizontal scanning speed is utilized. It is useful for optional detector signals having low frequency bandwidth such as BSE detector or ESED.

3.5.4 Image Brightness and Contrast Adjustment

Image brightness and contrast can be adjusted both manually and automatically.
B/C Monitor mode is also available for manual adjustment.
A histogram of present image can be shown for reference of adjustment.

(1) Auto adjustment (**ABCC**)

Click the **B/C** 

button of the Auto control block on the Control panel or select the **ABCC** command from **Operate** menu to start auto-adjustment.
If the results of ABCC are not adequate, you can change the reference brightness and contrast on the **Image** tab in the **Setup** window.

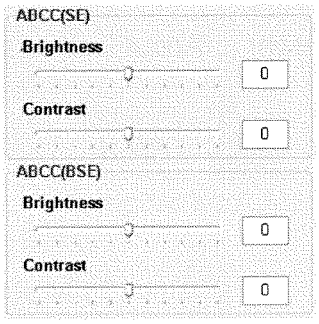


Fig. 3.5-14 Adjusting the Auto Setup Level

When the **Dual Screen** mode is used, **ABCC** is applied to the signal of the selected screen by the **Signal** (A/B) selection on the **Control panel**.

Fig. 3.5-15 Selecting the Image to Adjust

(2) Manual adjustment using the mouse on the GUI
Select the **Image adjust** from the **Mouse Mode** by clicking the mouse wheel button on the image displayed.
The cursor changes to the B/C cursor  . Drag the mouse while holding down the left button to adjust brightness; and while holding down the right button to adjust contrast.
Drag it to the right to increase and to the left to decrease brightness or contrast.
Sensitivity of mouse operation can be adjusted on the **Mouse Op.** tab in the **Optional Setup** window.
Additionally, you can adjust the brightness and contrast using the scrollbars.
Checking the **Show Scrollbar** check box on the **Cond.** tab in the **Operation panel** enables using these scrollbars.
Refer to <3.9.14 Optional Setting>.

(3) Using the Manual Operation Panel
Use **Brightness** and **Contrast** knobs on the manual operation panel. In the **Dual Screen** mode, the image selected by the **Image Adj.** radio button in the lower section of the Control Panel changes.
Refer to <2.2.3 Manual Operation Panel>.

(4) B/C Monitor mode
A waveform and reference lines are displayed for monitoring contrast (amplitude of the waveform) and brightness (vertical level of the waveform).
When clicking the **MonitB** 

button of the Adjustment control block on the control panel, the signal waveform is displayed. Adjusting brightness causes the waveform to move vertically; adjusting contrast changes the amplitude of the waveform.
When the maximum and minimum values of the waveform are adjusted to fit within the upper and lower reference lines, appropriate brightness and contrast will be obtained.

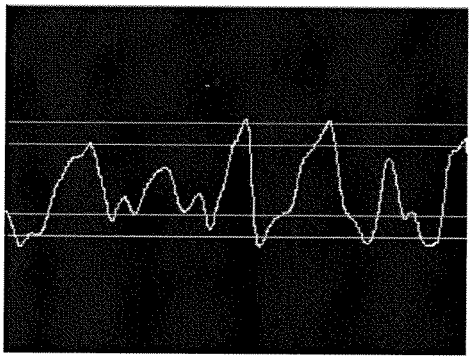
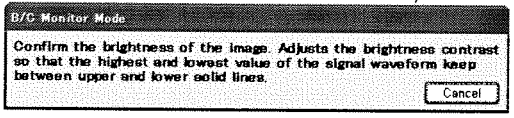


Fig. 3.5-16 B/C Monitor

Alternatively, select **BC Monitor** from the **Operate** menu to bring up the B/C Monitor mode.
To terminate B/C Monitor mode, click the **Cancel** button in the B/C Monitor mode message



or click one of the Scanning Speed buttons.

(5) Histogram display
A histogram of the current image can be shown.
To show histogram, select **Show Histogram** from **Image** menu.
This function periodically calculates and displays a histogram of the displayed image.

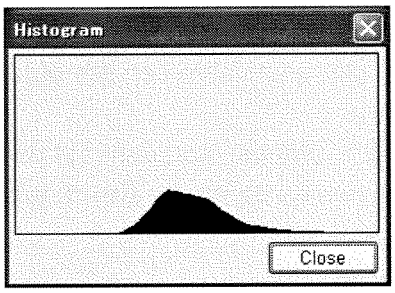


Fig. 3.5-17 Histogram

3.5.5 Focus and Astigmatism Correction

Focus and astigmatism correction can be done manually and automatically.
Focus Monitor mode is available for manual focusing.

(1) General method for focusing and astigmatism correction
Focusing and astigmatism corrections are related to each other and need to be repeated alternately. Use the following process to complete adjustments.

(a) Focus the image. When there is no astigmatism, the sharpest image is obtained at the best-focus point.

When there is astigmatism, the image looks like its stretching in one direction at an over focused or under-focused condition, and uniformly focused at the best-focus point.

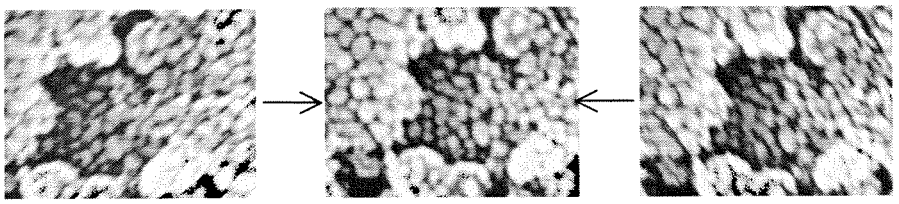


Fig. 3.5-18 Adjusting the Focus

(b) Adjust the stigmators X and Y alternately for the sharpest image.

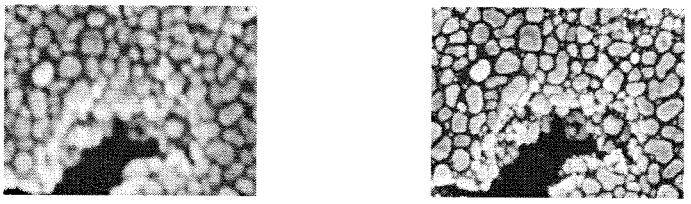


Fig. 3.5-19 Stigma Adjustment

(c) Focus again and check image drift and sharpness.

(d) Repeat steps (a) to (c) until adjustments are completed.

NOTICE: If it takes a long time to focus and correct astigmatism, you may end up with specimen damage due to electron beam irradiation and/or contamination.
If the specimen is beam- or contamination-sensitive, we suggest the following techniques:
(1) Reduce probe current.
(2) Use another area on the specimen for focusing purposes. After focusing, return to the area of interest, adjust the final focus quickly, and then capture or record the image.

(2) Auto Focus function

Click the **Focus** button of the Auto control block on the Control panel or select the **Auto Focus** command from the **Operate** menu to start Auto Focus.
When magnification is lower than 5,000×, coarse focus (search using a wide focus range) is carried out. Fine focus (search using a narrow focus range) is carried out at magnifications higher than 5,000×.
Fine focus works correctly under conditions where the image is not clear but visible.
The result of Auto Focus depends on the surface structures of the specimen. When there is little or no surface detail on the specimen, or when the specimen is charged, Auto Focus does not operate properly.

(3) Manual Focus

Manual focusing can be done using the control knobs on the operation panel or the mouse in the **Scanning Image** window.

(a) Knob operation

Use Focus control knobs COARSE and FINE on the manual operation panel.

(b) Mouse operation

Select the **Image adjust** from the **Mouse Mode** by clicking the mouse wheel button on the image displayed.

Move the mouse cursor to the lower half of the image, where the mouse cursor is changed to the Focus cursor  . Move the mouse while holding down the left button for fine focus or the right button for coarse focus. Move to the right for a shorter focal length and to the left for a longer focal length.

Checking  the **Show Scrollbar** check box on the **Cond.** tab of the Operation Panel brings up the scrollbar  (Coarse),  (Fine). Adjustments can also be performed by operating the bar.

The Focus Monitor mode allows you to monitor the state of focusing in waveforms.

Use the **Mouse Op.** tab in the **Optional Setup** window to adjust the sensitivity of mouse operation and to enable/disable mouse adjustments.

Reference: 3.9.14 Optional Setting.

(4) Auto Stigma and Focus

Click the **Stig** 

button of the Auto control block on the control panel or select the **Auto Stigma and Focus** command from **Operate** menu to start Auto Stigma and Focus.

It is recommended to use this function at magnifications higher than 5,000×. The results of Auto Stigma depend on the surface structure of the specimen. When the specimen is charged up or when there is no surface detail on the specimen, Auto Stigma does not operate properly.

NOTICE: The accuracy of **Auto Focus** and **Auto Stigma and Focus** disimprove if the **AFC Alignment adjustment** is not correctly done. In that case, adjust **AFC Alignment**. See 3.4.2.2 Axial Alignment Items in Detail.

(5) Manual astigmatism correction

Manual astigmatism correction can be done using the knobs on the manual operation panel or with the mouse operation in the **Scanning Image** window.

(a) Knob operation

Use **Stigma** control knobs **X** and **Y** on the operation panel.

(b) Mouse operation

Select the **Image adjust** from the **Mouse Mode** by clicking the mouse wheel button on the image displayed.

Move the mouse cursor to the top left quadrant of the image, where the mouse cursor is changed to the STIGMA cursor  . Drag the mouse while holding down the left button for X or the right button for Y correction. Repeat X and Y corrections, and focus, for a final result.

Sensitivity of mouse operation can be adjusted on the **Mouse Op.** tab in the **Optional Setup** window.

Astigmatism corrections can be done with the X and Y scrollbars as well.

Checking the **Show Scrollbar** check box on the **Cond.** tab in the operation panel enables use of these scrollbars.

NOTICE: If the image moves while correcting astigmatism, carry out Stigma Alignment. Refer to <3.4.2 Axial Alignment>.

(c) Dynamic stigma monitor

The dynamic stigma monitor is a mode that changes the amount of stigma correction according to the image scanning position. Because only the part of the image for which stigma correction is at optimum is in focus, adjustments are performed so as to bring the in-focus point to the center of the image. This mode is useful for observing a specimen that indicates the presence of a structure in the entire image at a high magnification. If the specimen surface contains few micro-structures or has a skewed structure, it may be difficult to identify an in-focus position.

Selecting the **Dynamic Stigma Monitor** from the **Operate** menu causes the execution of the dynamic stigma monitor mode. Because this mode works well at a magnification of 5,000× or higher, any low-magnification setting when the mode is selected will automatically be preset to 5,000×. Any magnification equal to or greater than 5,000x will remain unchanged.

Running the dynamic stigma monitor displays a circle and a crossbar on the observation image, as illustrated in the following figure.

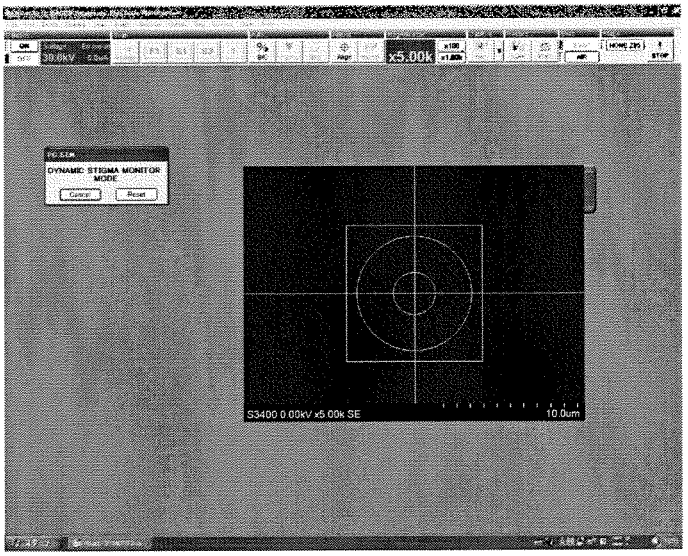


Fig. 3.5-20 Dynamic Stigma Monitor

When placed on the observation image, the cursor becomes a cross-hair cursor. Clicking an in-focus point on the image moves the selected in-focus point to the center. Alternatively, the stigma knobs X and Y can be used to align the in-focus point with the center of the image.

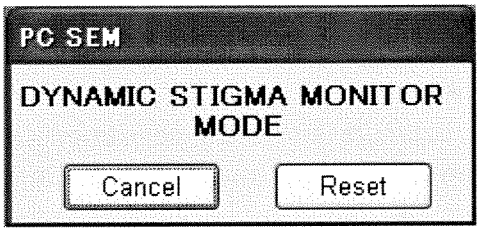


Fig. 3.5-21 Monitor Mode Window

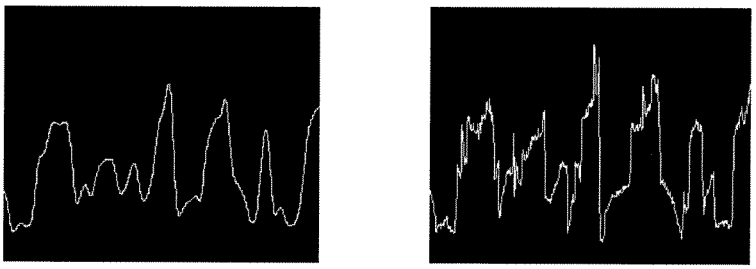
On the **Monitor Mode** window, clicking the **Reset** button moves the in-focus point to the first point at which the dynamic stigma monitor mode was turned on. Clicking the **Cancel** button turns off the dynamic stigma monitor mode.

(6) Focus Monitor mode

A waveform is displayed for monitoring the focus. The magnification is set at 1,000×.

To start the Focus Monitor, click the **MonitF** 

button of the Adjustment control block on the Control panel and focus the image so that the waveform shows sharp peaks.

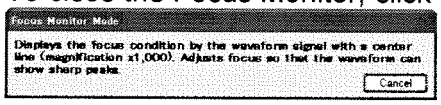


Defocused Focused

Fig. 3.5-22 Focus Monitor Mode

The sensitivity of the focusing knob and mouse operation will be the same as that at a low magnification (1,000×), which allows you to search the variable focusing range with a minimum amount of operation.

To close the Focus Monitor, click the **Cancel** button in the **Focus Monitor Mode** message



or click one of the **Scanning Speed** buttons.

3.5.6 Operation of the Specimen Stage (Type I - Manual Stage)

The S-3400N Type I SEM provides a 5-axis manual stage.

3.5.6.1 Movable Range and Specimen Exchange Position

The following table shows movable range and specimen exchange position.
The specimen exchange position is indicated on the label on the stage.

Table 3.5-3 Movable Range of the Stage and the Specimen Exchange Position

	Movable Range	Specimen Exchange Position
X	0 to 80 mm	30 mm
Y	0 to 40 mm	20 mm
R	0 to 360° (Continuous rotation)	0°
T	-20 to 90°	0°
Z	5.0 to 35 mm	35 mm

3.5.6.2 Restriction on the Motion of the X and Y axes

(1) Restrictions on specimens measuring 6-inch or less across
There are no restrictions on the motion of the X and Y axes with regard to specimen measuring 6-inch (153 mm in diameter) across or less.
However, if an optional signal detector is attached or inserted restrictions on the X and Y-motions may arise. For details, see the operation manual on the optional detector.

(2) Restrictions on ϕ8-inch specimens
ϕ8-inch (200 mm): 30 mm$\leqq$X$\leqq$45 mm

3.5.6.3 Allowable Range of Observation and Motion of the Tilt-axis by Specimen Size

The figure on the following page shows observable ranges in X and Y directions by specimen size.
For ϕ8-inch (200 mm) specimens, the range over which the X-axis can be moved is limited to 30 mm - 45 mm; therefore, a specimen can be observed only in that range.

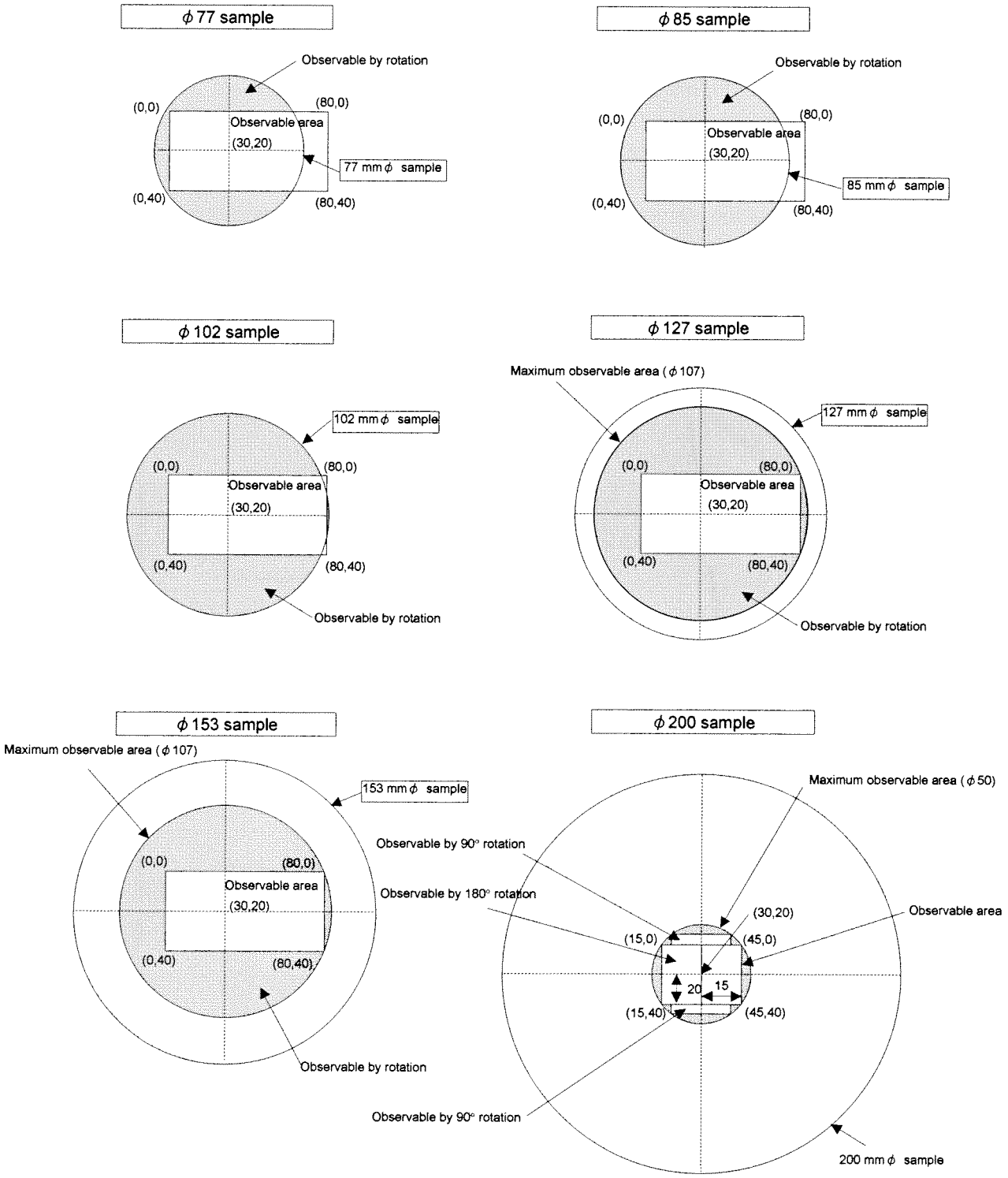


Fig. 3.5-23 Observable Ranges in X and Y Directions by Specimen Size (Type Ⅰ stage - not using an optional detector)

3.5.6.4 Tilt and Z Axes Limitations

The allowable tilting angle depends on both Z-axis position and specimen size. A diagram of the relationship between allowable tilt angles for various Z positions is shown below.
The values shown here represent the case where the specimen height is set in the Standard position by using a height gauge. The allowable tilting angles for ϕ200 mm specimens represent the case where the range over which the specimen can be moved in an X direction is restricted to 30 mm – 45 mm. The use of an optional signal detector (inserted into the specimen chamber) is subject to further restrictions. For further details on this topic, the operating instructions on the optional detector should be consulted.

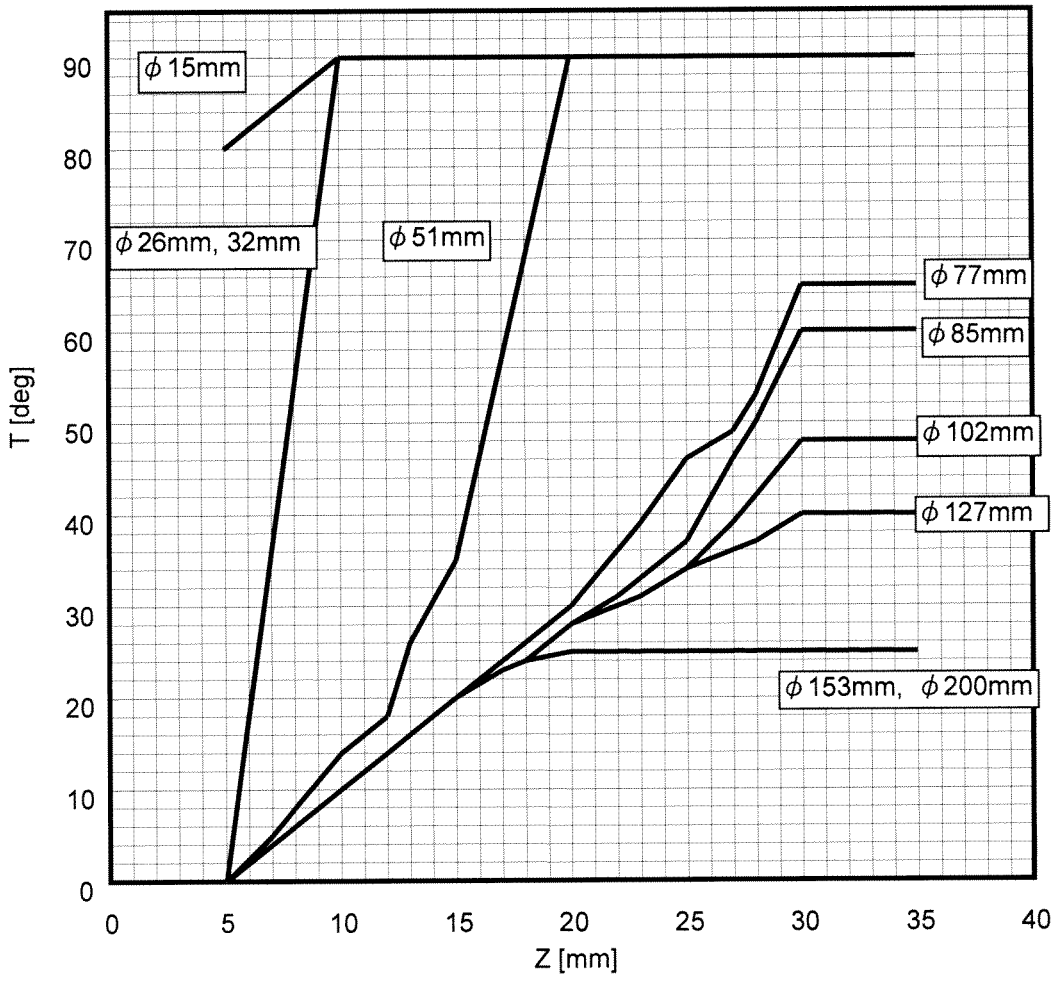


Fig. 3.5-24 Allowable Angle of Tilt (Type Ⅰ) with respect to the Z-axis (positive angle of tilt)

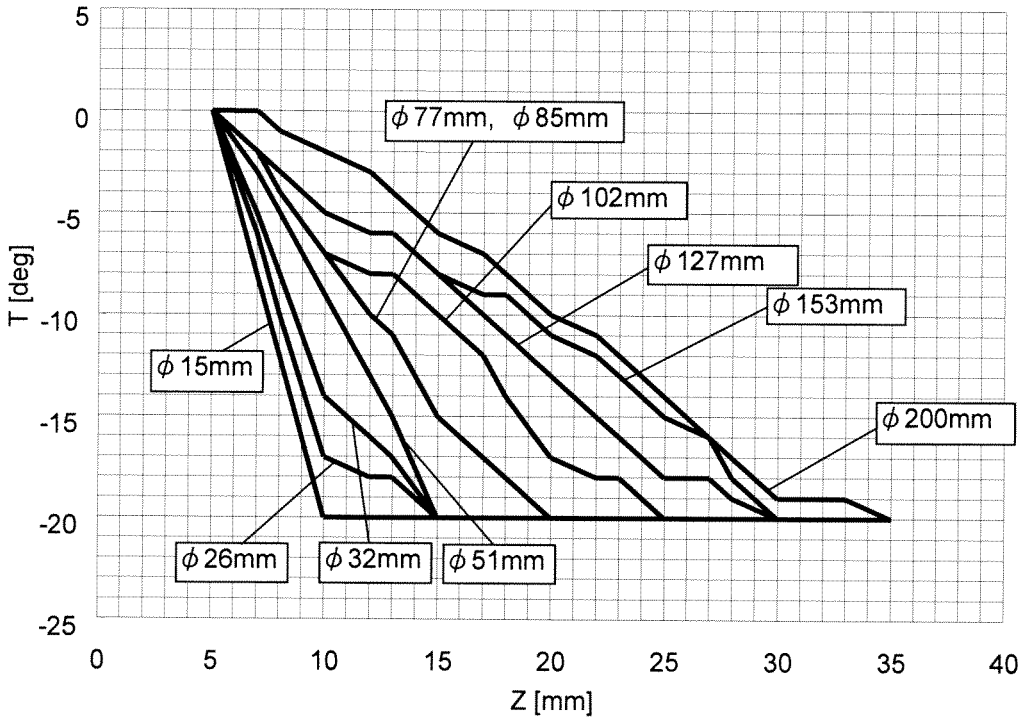


Fig. 3.5-25 Allowable Angle of Tilt (Type Ⅰ) with respect to the Z-axis (Negative angle of tilt)

IMPORTANT:	Set Z and T within the allowable range; otherwise, the specimen may strike the objective lens or BSE detector and cause damage to both specimen and them.

3.5.6.5 Operating the Z-axis (Varying the Working Distance [WD])

Turning the Z-axis knob, counterclockwise moves the specimen toward the objective lens, and reduces the WD. Conversely, turning the Z-axis knob clockwise moves the specimen away from the objective lens, and increases the WD. The value of the WD can be read off from the scale provided on the Z-axis knob.
Readings from the scale are valid when the combined height of the specimen base on which the specimen is loaded and the specimen base stand is set at the Standard position on the height gauge.

3.5.6.6 Checking the Ranges of T-axis Tilting and Z-axis Motion when Observing a Bulk Specimen

When observing a specimen that is higher than the Standard position on the height gauge or a bulk specimen, the check gauge should be used when inserting the specimen stage so that the specimen will not touch the check gauge, and the stage should be used within those ranges. The check gauge has a shape similar to an objective lens and the backscattered electron detector combined.

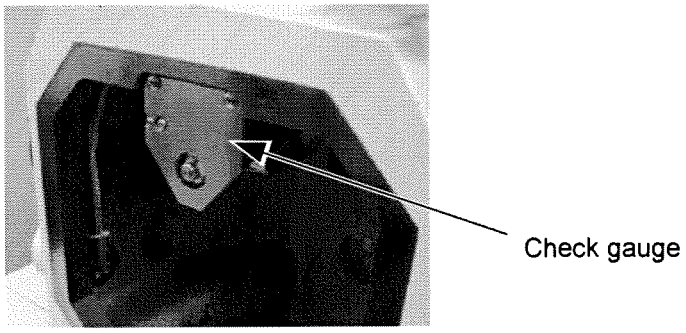


Fig. 3.5-26 Check Gauge

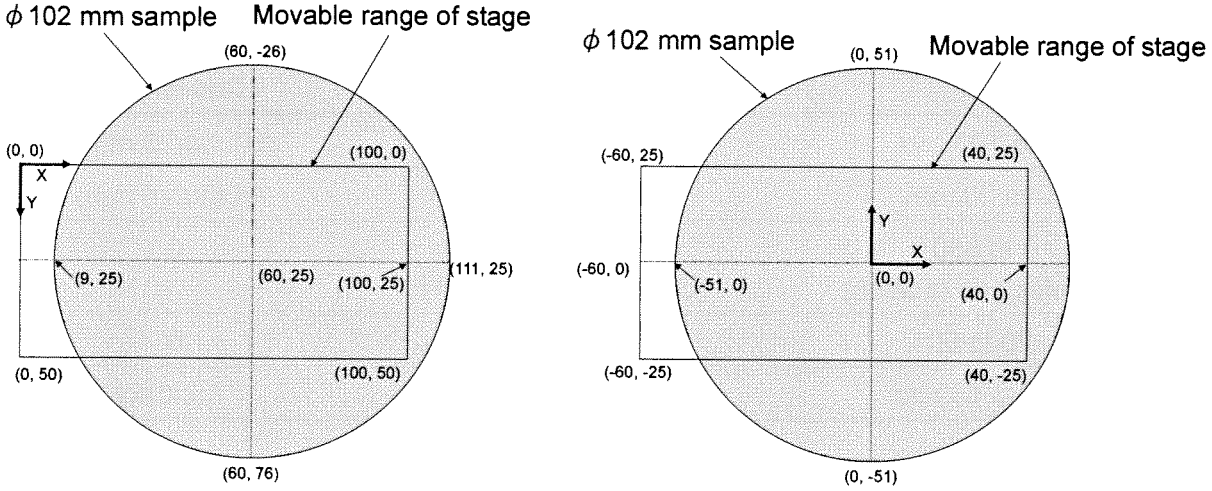
3.5.7 Operation of the Specimen Stage (Type Ⅱ - 5-axis Motorized Stage)

The S-3400N Type Ⅱ SEM provides a 5-axis motorized stage.

3.5.7.1 Coordinate Notation

S-3400N utilizes two coordinate notation systems, **Stage (Mechanical) Coordinate and Sample Coordinate**. The **Sample Coordinate** system will be better for using the **Rotation Assist** function. The **Stage Coordinate** system is also available for users familiar with previous Hitachi SEMs using the **Stage Coordinate** system.

(1) Relationship of stage and **Sample Coordinates**
Following is an example of a 5-inch diameter sample.
On the **Stage Coordinate** system, the center of the sample is (X=60, Y=25 mm) and the origin is at the upper-left corner of XY movable area.
On the **Sample Coordinate** system, the center of the sample is the origin (X=0, Y=0 mm) and the origin fits to it.



Stage coordinates (mechanical coordinates)　　Sample coordinates

Fig. 3.5-27 Relationship between the Two Coordinate Systems

(2) Switching coordinate systems
Open the **Optional Setup** window by selecting **Stage** in **Optional Setup** menu.
On the **COORDINATE** block, select **Sample** or **Stage**. **OK** button will update the coordinate system.

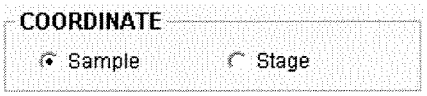


Fig. 3.5-28 COORDINATE Block

NOTICE: The sample coordinate is not rotated with the sample when the sample is rotated. The sample coordinate is not exactly the coordinate of the sample.

3.5.7.2 Movable Range and Specimen Exchange Position

(1) Movable Range and Specimen Exchange Position
The following table shows the movable range and the specimen exchange position. Mechanical coordinate and specimen coordinates are selectable for X and Y axes. The specimen coordinate is (0, 0) at the center of the specimen holder.

Table 3.5-4 Operating Ranges and Specimen Exchange Position (Type Ⅱ)

	Movable Range of Mechanical Coordinate	Movable Range of Specimen Coordinate	Exchange Position of Mechanical (specimen) Coordinate
X	0 to 100 mm	-60 to +40 mm	60 mm (0 mm)
Y	0 to 50 mm	-25 to +25 mm	25 mm (0 mm)
R	0 to 360° (Continuous rotation)	0 to 360° (Continuous rotation)	0°
T	-20 to 90°	-20 to 90°	0°
Z	5.0 to 65 mm	5.0 to 65 mm	Arbitrary

The allowable ranges of X, Y, Z and T axes are limited for a large specimen, and when optional detectors are in position.
Motion of each axis is limited to within the allowable range by computer control. There is no risk of striking the objective lens if the correct specimen size, height, and detectors being used are set correctly.
The table below shows movable ranges along the X and Y axes (in stage coordinates) by specimen size.

Table 3.5-5 Movable Range of X and Y by Specimen Size (Type II Stage)

	Movable Range of X	Movable Range of Y
ϕ 15 mm	52 to 68	17 to 33
ϕ 26 mm	46.5 to 73.5	11.5 to 38.5
ϕ 32 mm	43.5 to 76.5	8.5 to 41.5
ϕ 51 mm	34 to 86	0 to 50
ϕ 15 mm × 4	34 to 86	0 to 50
ϕ 77 mm	21 to 99	0 to 50
ϕ 85 mm	17 to 100	0 to 50
ϕ 102 mm	0 to 100	0 to 50
ϕ 127 mm	0 to 100	0 to 50
ϕ 153 mm	0 to 100	0 to 50
ϕ 200 mm	30 to 60	7 to 44
□50 × 5 mm	34.5 to 85.5	22 to 28
□30 × 10 mm	44.5 to 75.5	19.5 to 30.5
EBSP Holder	20 to 90	21 to 29

For motion ranges along the T and Z axes, see 3.5.7.12 Movable Range and Limitation by Optional Detectors in the text below.

3.5.7.3 Operation Methods Used to Move the Specimen Stage

The following operation methods are available to move the stage.

- Operation on the **Stage** tab of the **Operation panel** (all 5-axis)
- Manual operation using trackball (X and Y)
- Mouse operation on the image (all 5-axis)

The following additional auxiliary functions are also available:

- Position memory function (X, Y and R axes)
- Stage history function
  Memorizes position where capturing or photographing was performed, or manually registered and display the stage movement path and location of positions. Reset of stage to memorized positions is also possible.
- Image Navigation function
  Goes to assigned position on captured image or imported external image.

The figure below illustrates the **Stage** tab on the Operation Panel:

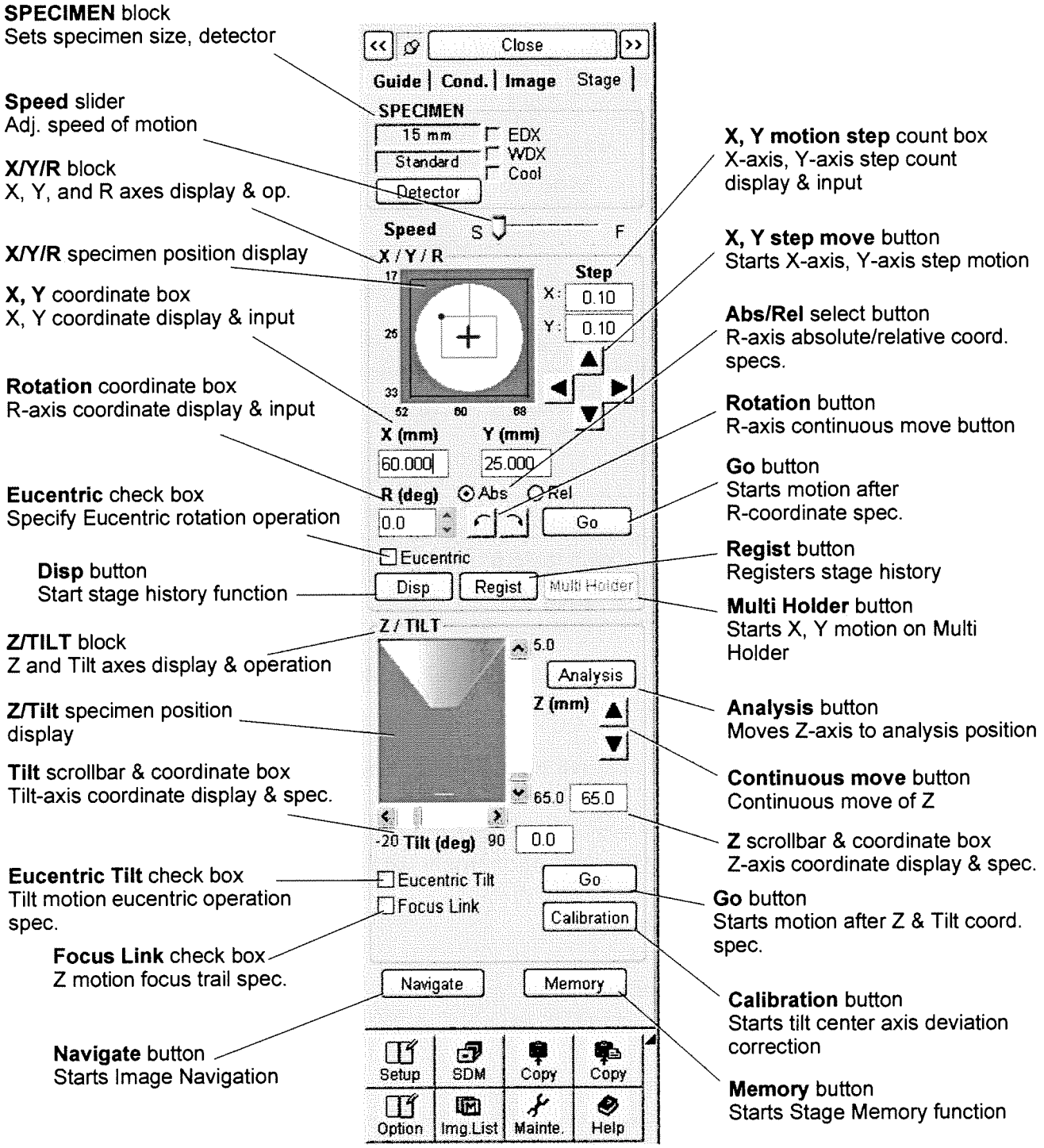


Fig. 3.5-29 Stage Operation Panel

3.5.7.4 X, Y, and R Axes Operation

(1) Manual operation using trackball
Stage moves in the direction of trackball rotation.

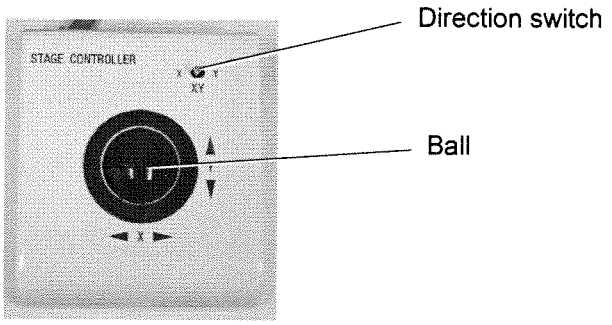


Fig. 3.5-30 Trackball

- Amount of stage motion by ball rotation is linked with magnification. To move a long distance, it is advisable to lower the magnification.
- The amount of stage motion with respect to the amount of ball rotation can also be varied in four steps by setting Operation Panel - **Stage** tab - **Speed** slider.
- Pushing the direction switch to the [X] side moves the stage only in the lateral direction; pushing it to the [Y] side moves the stage only in the vertical direction.
- Stage moving direction versus ball rotation direction can be reversed. Check the **Track Ball/Joy Stick** check box in the **REVERSE MODE** block of the **Stage** tab in the **Optional Setup** window.

For a description of custom settings of the stage, see 3.9.14 Optional Setting.

(2) Entering Absolute or Relative Coordinate Value
For X and Y axes, enter absolute coordinates for X and Y axes into **XY Display/Input** box and then the **Enter** key. When coordinate value out of the movable range is input, error message appears and input value is cancelled.
For R-axis, both absolute and relative value can be used. Select **Abs** (absolute) or **Rel** (relative) with **Abs/Rel** select buttons, and enter coordinate value into **R Display/Input** box and then click **Go** button. Range of R coordinate is 0 to 360 for absolute and -180 to +180 for relative value.
When the **Eucentric** check box is checked, X and Y axes move so that the present field of view is maintained after the stage is rotated (Eucentric rotation function).

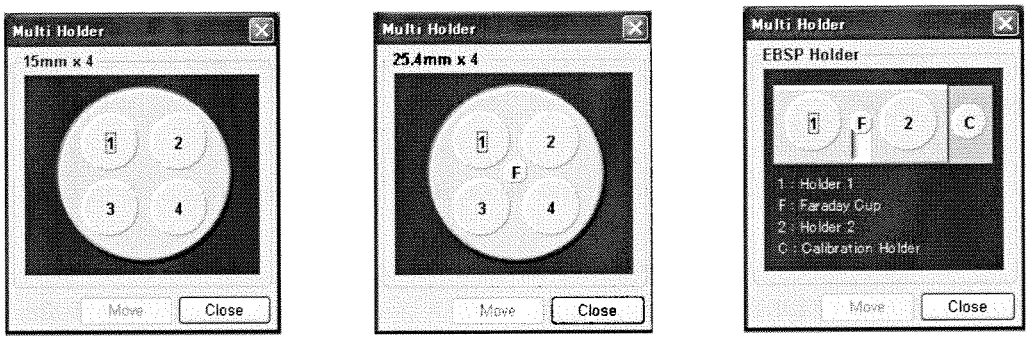
(3) Continuous rotation (R-axis)
The R-axis is moved with the **Rotation** buttons. Press ↶ or ↷ button to move the R-axis continuously or click the buttons to move in steps.
A driving speed can be selected in four steps using the **Speed** slider.

(4) Mouse operation on the scanning image
Operation of all 5-axis by using the mouse is available.
Refer to <3.5.7.6 Mouse Operation of Stage on the Scanning Image>.

(5) Moving the X and Y axes in defined steps
By entering the number of steps by which the X and Y axes are to be moved in the [Step] box and clicking the ◀ ▶ ▲ ▼ button, the X and Y axes can be moved in 1-step increments.
The allowable range of steps that can be entered is 0.01 to 10 mm.

(6) Moving the X and Y axes continuously
By pressing the ▶ or ◀ button while holding down on the [Shift] key on the keyboard, it is possible to move the stage continuously in the lateral direction. Alternatively, press the ▲ or ▼ button to move the stage continuously in the vertical direction.

(7) Moving the X and Y axes on the Multi Holder
Selecting ϕ 15 mm × 4, ϕ 25.4 mm × 4, and EBSP Holder as a specimen size enables the **Multi Holder** button in the X/Y/R block. Clicking the **Multi Holder** button brings up the **Multi Holder** window shown below so that the X and Y axes can be moved between the specimens loaded on the Multi Holder (the R-axis remains fixed at 0°).



ϕ 15 mm × 4 ϕ 25.4 mm × 4 EBSP Holder

Fig. 3.5-31 Multi Holder Windows

In Fig. 3.5-31, items 1, 2, 3, 4, F, and C represent specimen positions on the Multi Holder. Clicking any of these items selects the specimen that is indicated in Blue. Clicking the **Move** button at this point moves the X and Y axes to the selected specimen position. If the R-axis is not 0°, clicking an item resets the R-axis to 0°. When selecting the F (Faraday cup) position of 25.4 mm × 4 Multi Holder, T and Z in addition to X, Y, and R axes move.

The following specimen positions (mechanical coordinates) are available:

ϕ 15 mm × 4	ϕ 25.4 mm × 4	EBSP Holder
1 X=69 mm, Y=34 mm	1 X=74 mm, Y=39 mm	1 X=75 mm, Y=25 mm
2 X=51 mm, Y=34 mm	2 X=46 mm, Y=39 mm	F X=60 mm, Y=25 mm
3 X=69 mm, Y=16 mm	3 X=74 mm, Y=11 mm	2 X=45 mm, Y=25 mm
4 X=51 mm, Y=16 mm	4 X=46 mm, Y=11 mm	C X=23 mm, Y=25 mm
	F X=60 mm, Y=25 mm	
	F T=0° , Z=10 mm	

(8) Position display

The size of the specimen, its present position and rotation angle are displayed on the X/Y/R position display area.

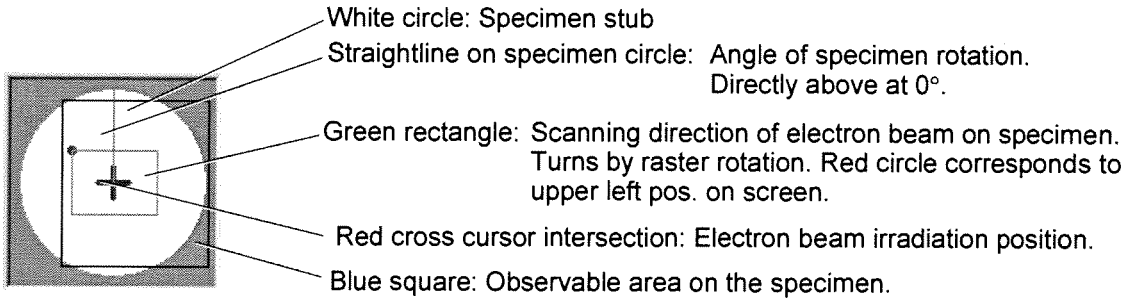


Fig. 3.5-32 Position Display

When sample and stage coordinates are selected, the following scale values apply; the example below applies to a ϕ 15 mm sample.
When the specimen is moved, the numbers associated with the vertical and horizontal axes at the intersection of the red cross represent the coordinates of the position that is being irradiated by the beam. The numbers change when the specimen size is changed.
Moreover, Pointed area in the observation area (in the square blue) by clicking the left button move to the center of view. By clicking right button in sample position monitor, the specimen stage move to the sample exchange position.

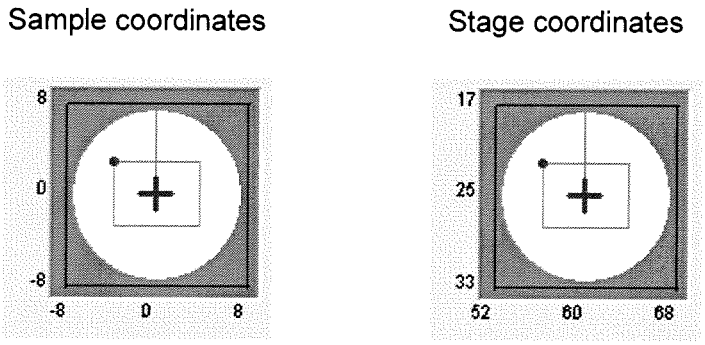


Fig. 3.5-33 Differences of values displayed in sample position monitor

3.5.7.5 Z and Tilt Axes Operation

(1) Operation using the **Z/TILT** block of the **Stage** tab on the Operation Panel (coordinates specifications)
When moving Z and Tilt axes by specifying a set of coordinates, use the Z and Tilt scrollbars to specify coordinates, and then click the **Go** button. Z and Tilt axes coordinates can be set by input from the keyboard and then press **Enter** key.

(2) Operation using the **Z/TILT** block of the **Stage** tab on the Operation Panel (continuous motion)
It is possible to move the Z-axis continuously by holding down on the Continuous Move ▲ ▼ button.
The speed of motion can be specified in four steps using the **Speed** slider.
Similar operations can also be performed using the mouse on the screen, to be described later.

(3) Moving to an analysis position.
By clicking the **Analysis** button, it is possible to move to the analysis position of WD=10 mm.

(4) Mouse operation on the scanning image
It is advisable to use mouse operation on the scanning image for continuous operation of Z or Tilt-axis.
For further details, see 3.5.7.6 Mouse Operation of Stage on the Scanning Image.

IMPORTANT:	Incorrect specimen size, height, and detector settings can damage the objective lens or the semiconductor BSE located on the underside of the objective lens, as well as the specimen itself.

IMPORTANT:	To avoid inadvertently disabling the **Stop** button, the **Go** button should not be pressed continuously when the stage is in motion.

3.5.7.6 Mouse Operation of Stage on the Scanning Image

Use the **Mouse Mode** on the **Option** menu or the **Mouse Mode** on the pop-up menu to activate the stage (X/Y/R/Z/T) and image shift operation mode (the condition in which the Stage Move tool shown in the figure below is displayed).
(Stage X/Y/R and Stage X/Y mode are also available.)

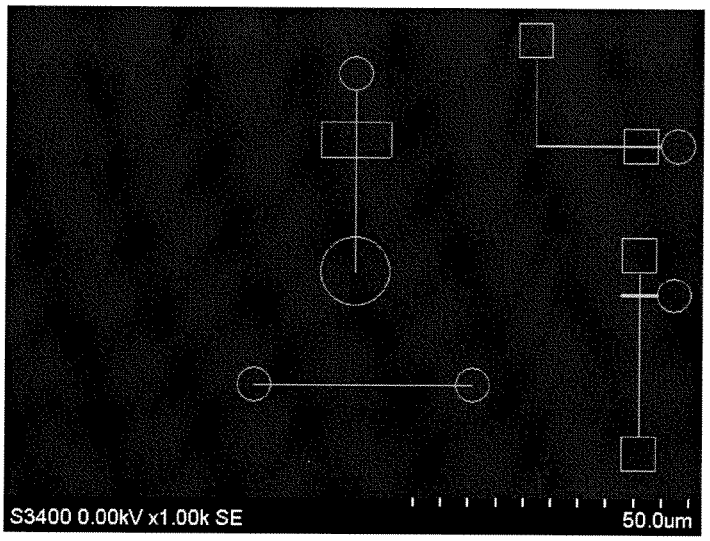


Fig. 3.5-34 Image Shift/Stage Move Tools

NOTICE: Move the mouse cursor to X and Y axes tool, and the tool change to an intersecting arrow mark  . Then the mouse wheel button is clicked, color density of the tool will change by 5 stages. You can use by favor color.

(1) X, Y continuous driving (joystick-like operation)

Move the mouse pointer to the circle at the center. It changes to XY mark  .
Press the left button down and move the mouse in the direction you wish to move the image. Stage moves in the mouse drag direction while holding down the button. When you drag the mouse far from the center, the stage moves faster. The speed is also linked with magnification so as to keep image moving speed constant.
The direction and speed can be changed while pressing down the button.

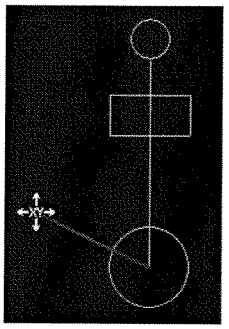


Fig. 3.5-35 Continuous Motion of XY

(2) Dragging the image

At the outside of tools, where the mouse pointer is MOVE mark 

, place the mouse cursor at a start point on the scanning image. Move the mouse to an end point holding down the left button (a red line is drawn), and release it. The stage is then driven so that the image at the start point moves to the end point.

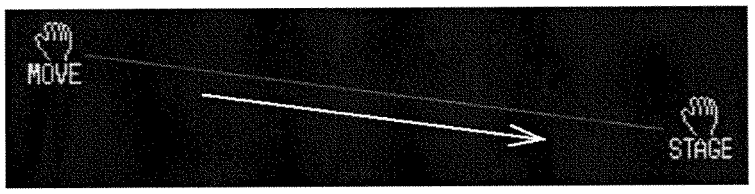


Fig. 3.5-36 Motion by XY Specification

(3) RISM function with mouse dragging

If the end point of the above operation is near the center of the image, the red line is changed to a yellow line and the end point is positioned at the center of the image. When the left mouse button is released, the stage is driven so that the image at the start point moves to the center of the viewing screen with the help of the electrical image shift.

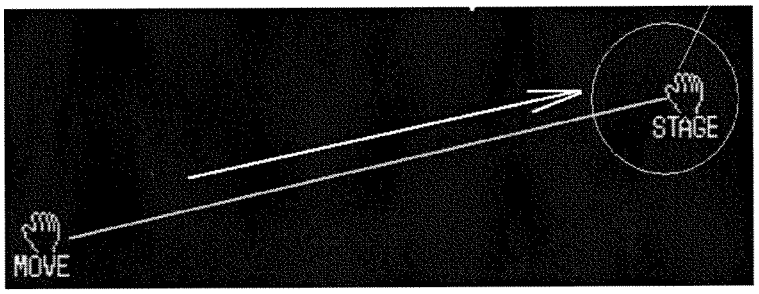


Fig. 3.5-37 RISM Function

(4) RISM function with mouse clicking

Alternately, simply clicking the left button of the mouse starts a similar motion. In this operation, only the stage is driven, without electrical image shift.

NOTICE: The RISM (Rapid Image Shift Mode) function moves a point of interest to the center of the viewing screen. The stage motion and electrical image shift are combined for better positioning accuracy. When the distance from the point of interest to the center of the image display is within the range of the electrical image shift, beam shift is used without stage movement. The RISM function is useful for going to higher magnification without losing the field of interest.
RISM is meant to be used at low and medium magnification levels.

(5) Electrical image shift

The Electrical Image Shift function moves the scanning image electrically. It is useful at high magnifications where mechanical stage motion is not desired.

To move the image with Electrical Image Shift, use the same operation as in the above (2) but use right button instead of left button. When you press right button, the mouse pointer will change to Beam mark 

. Move the mouse to an end point while holding down the right button (a red line is drawn), and release it.

Image Shift knobs on the manual operation knobset are also available. The knobs are easy to operate.

(6) R-axis operation to a specified angle

On the circle of the R-axis tool, the mouse pointer will be changed as shown below.

Press down the left button and move the mouse while holding down the button. The tool rotates following the mouse and the rotation angle is shown in the indicator box.

Then release the button. Stage will be rotated to the angle specified in the indicator box.

The angle value is the absolute angle.

The eucentric rotation function is effective when the **Eucentric** check box in the **Stage** tab is checked.

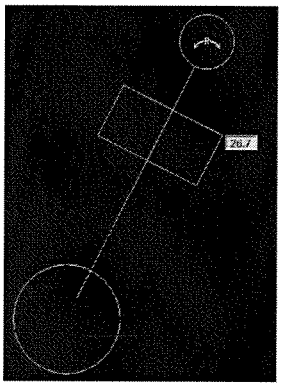


Fig. 3.5-38 R-axis Moving Tool (angle specification)

(7) R-axis continuous driving
On the rectangles of the R-axis tool, mouse pointer will be changed as shown below.

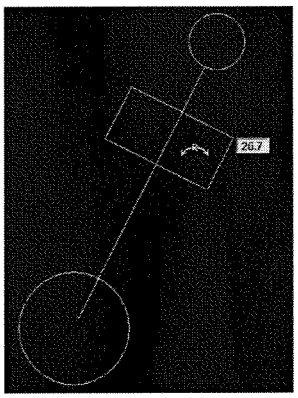


Fig. 3.5-39 R-axis Moving Tool (continuous move)

Press down the left button on one of the rectangles. Stage will be rotated continuously while holding the button down. On the right side rectangle, stage rotates clockwise, and on the left side, counterclockwise.
The eucentric rotation function is not effective when using this selection.

(8) Z-axis operation to a specified coordinate
On the circle of the Z-axis tool, mouse pointer will be changed as shown below.

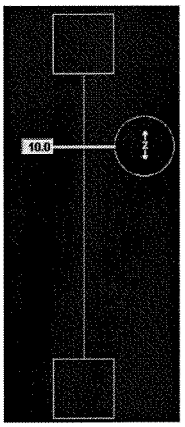


Fig. 3.5-40 Z-axis Moving Tool (coordinates specification)

Press down the left button and move the mouse up or downward while holding down the button. The circle moves following the mouse and the Z-axis value is shown in the indicator box. Then release the button. Stage will go to the Z position specified in the indicator box.
The change of Z is limited to a range allowable for the present Tilt angle.

(9) Z-axis continuous driving
On the rectangles at the top and bottom of Z-axis tool, mouse pointer will be changed as shown below.

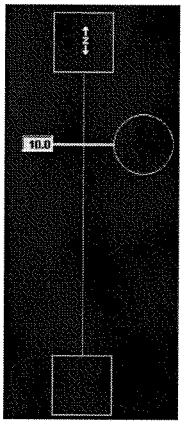


Fig. 3.5-41 Z-axis Moving Tool (continuous move)

Press down the left button on one of the rectangles. The stage will go up or down continuously while holding the button down. On the top rectangle, stage moves to a shorter Z, and on the bottom, to a longer Z.
Z motion will stop when it reaches the end of allowable range calculated using the present Tilt angle.

(10) Tilt-axis operation to a specified coordinate
On the circle of the Tilt-axis tool, mouse pointer will be changed as shown below.

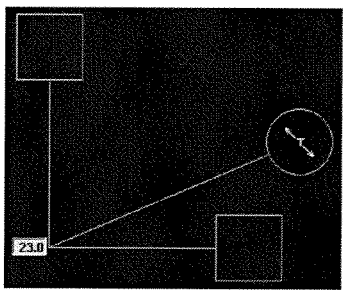


Fig. 3.5-42 Tilt-axis Moving Tool (coordinates specification)

Press down the left button and move the mouse up or downward while holding down the button. The circle moves following the mouse and the Tilt-axis value is shown in the indicator box. Then release the button. Stage will go to the Tilt angle specified in the indicator box.
The change of Tilt is limited to a range allowable for the present Z value.

(11) Tilt-axis continuous driving
On the rectangles at the top and bottom of Tilt-axis tool, mouse pointer will be changed as shown below.

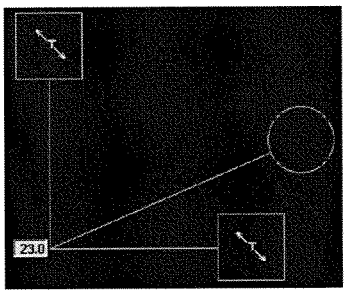
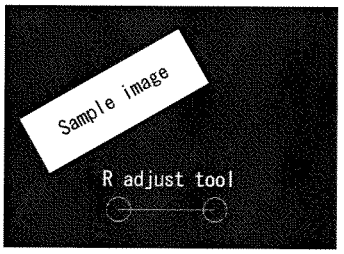


Fig. 3.5-43 Tilt-axis Moving Tool (continuous move)

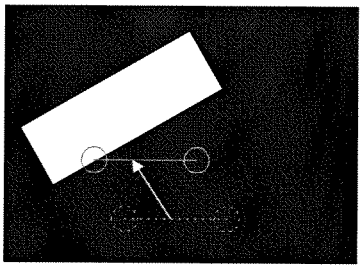
Press down the left button on one of the rectangles. Tilt-axis will move continuously while holding the button down. On the top rectangle, tilt angle is increased and on the bottom, decreased.
Tilting will stop when it reaches the end of allowable range calculated using the present Z angle.

(12) Rotation adjust tool

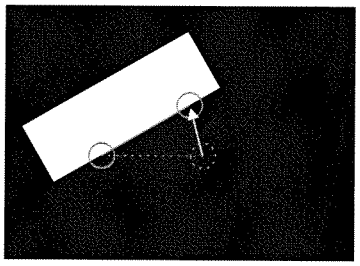
The rotation adjust tool is convenient for adjusting an image to horizontal.



Move the mouse at about the center of the tool. Mouse pointer will be changed to array mark  . Press down the left button and move the tool to fit an end to the inclined line part to be rotated to horizontal.



Press down the left button in the circle of another end and fit the tool to the line part.



Release the mouse button. R-axis will rotate and the line part is adjusted to horizontal.

The eucentric rotation function is effective when the Eucentric check box in the Stage tab is checked.

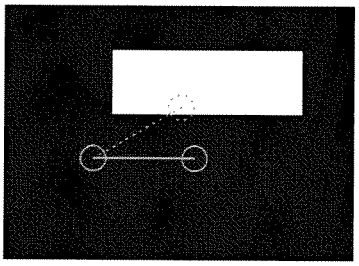


Fig. 3.5-44 Rotation Adjust Tool

IMPORTANT:	Using right button instead of left button drives raster rotation with just the same manner of operation. It is necessary to set raster rotation to operate the raster rotation function.

(13) To move tools

The Z, Tilt and R adjust tools can be placed anywhere in the scanning image.
The mouse pointer will be changed as shown below when mouse is moved to about the center of vertical line part of Z tool, near the intersecting point of Tilt tool, and center of horizontal line part of R adjust tool.

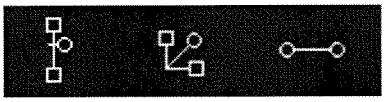


Fig. 3.5-45 Movable Tools

Press down the left button and move tools while holding down the button.

3.5.7.7 Position Memory Function

The stage coordinates, both absolute and relative, can be memorized and retrieved.
200 absolute coordinates (20 points on each of 10 pages) and 20 relative coordinates can be saved in total. Three axes, X, Y, and R, can be registered.
Click the **Memory** button on the **Stage** tab. The following **Position Memory** window will open.

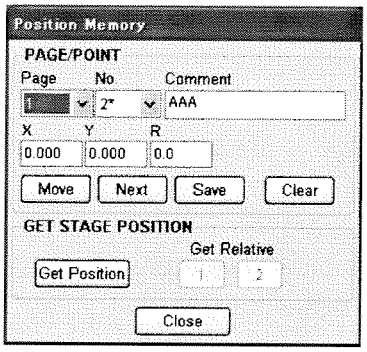


Fig. 3.5-46 Position Memory Window

(1) Registration of absolute stage coordinates at the present stage position
Select a **Page** and **No.**, then click **Get Position** button. The present coordinates are then indicated in the **X**, **Y** and **R** boxes. Input any comments in the **Comment** box, and click the **Save** button.

(2) Registration of absolute stage coordinates by direct input
Select a **Page** and **No.**, and input values to the **X**, **Y** and **R** boxes using the keyboard followed by the **Enter** key. Input any comments in the **Comment** box, and click the **Save** button.

(3) Registration of relative stage coordinates using the present stage positions

(a) Select **Rel** from **Page**, and select **No.**

(b) Move the stage (using RISM) to the first position and click the **Get Relative-1** button.

(c) Move the stage to the second position and click the **Get Relative-2** button.
The relative coordinates between the first and the second positions are calculated and indicated in **X**, **Y** and **R** boxes.

(d) Input comments in the **Comment** box and click the **Save** button.

(4) Registration of relative stage coordinates by direct input

(a) Select **Rel** from **Page**, and select **No.**

(b) Input coordinates in **X**, **Y** and **R** boxes using the keyboard followed by the Enter key. Input any comments in the **Comment** box and click the **Save** button.

(5) Moving the stage to a memorized position
To move the stage to a memorized position, select a **Page** and **No.**, and click the **Move** button.
The **Next** button moves the stage to the coordinate of next number.

(6) Moving the stage by relative movement
To move the stage by a relative movement from the present position, select **Rel** from **Page**, and select **No.** Then, click the **Move** button.

(7) Clearing of registered data
Select a **Page** and **No.**, and click the **Clear** button.

IMPORTANT:	Register the stage coordinates with the image shift reset. The registration position might shift by the image shift. Refer to 2.3.7.10 IMAGE SHIFT Block.

3.5.7.8 Stage History Function

Displays present position and registered positions on a specimen picture with trajectory lines showing the order of registration.
Click the **Disp** button in the X/Y/R block on the **Stage** tab. The **Stage History** window will open.

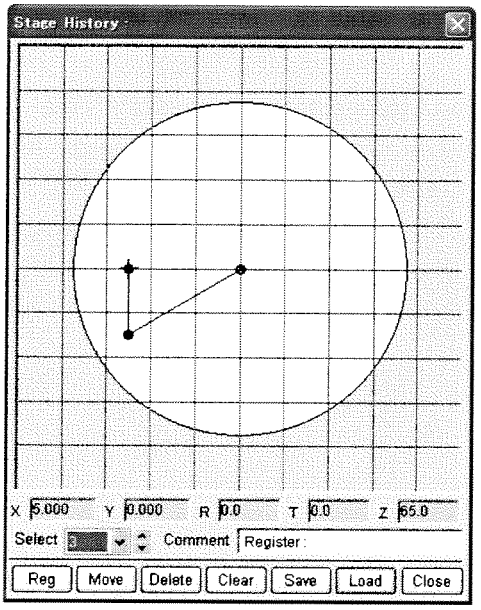


Fig. 3.5-47 Stage History Window

(1) Display
The white circle represents the stub size. The red cross indicates beam irradiation point. The green points are registered points. And the blue point is selected point.
Lines connecting registered points show the stage movement history.
The **Comment** field automatically shows the conditions under which the information was recorded, such as Register (registered using the **Reg** button), Capture, or Photo. Appropriate comments should be entered after these indicators.

(2) Registration
Stage coordinates are registered automatically by capturing, photographing and moving to home or specimen exchange position.
Also clicking the **Reg** button on the window or **Regist** button in the **X/Y/R** block on the **Stage** tab registers present stage position.

(3) Retrieving registered stage coordinates
To retrieve a registered coordinate and go to the position, select a point by clicking the point on the display, or select its number in the **Select** box. The selected point is changed to blue color. Click the **Move** button to go to the position representing the selected point.

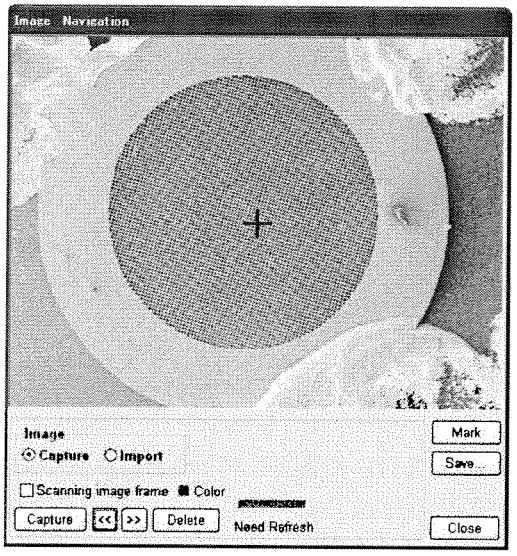
(4) Deleting registered points
To delete points individually, select the point and click the **Delete** button. To delete all points, click the **Clear** button.

(5) Saving and reading history data
To save displayed position data, click the **Save** button. A window for saving will open. Specify folder and file name and then, click the **Save** on it. The extension of history files is .ssh.
To read saved data, click the **Load** button and specify a file name on the opening window. The saved data contains the information on specimen size and data reading is possible when the present specimen size setting is the same as that of the data to be read.
If the read data is just that of the current specimen or of a specimen having the same object layout, the data is effective for retrieving a prior imaged field of view.

3.5.7.9 Image Navigation

The Image Navigation function moves the stage to the position pointed out on the navigation images.
Captured SEM images at low magnification as well as imported externally created images, such as optical microscope images or drawings, are available as navigation images. In this case, alignment operations are needed to ensure that the drawing (photo) to be used and the specimen being observed match in their relative geometry.
SEM images and imported images can be used in 10 images each. Navigation images to be used can be switched at any time.

SEM image



Imported image

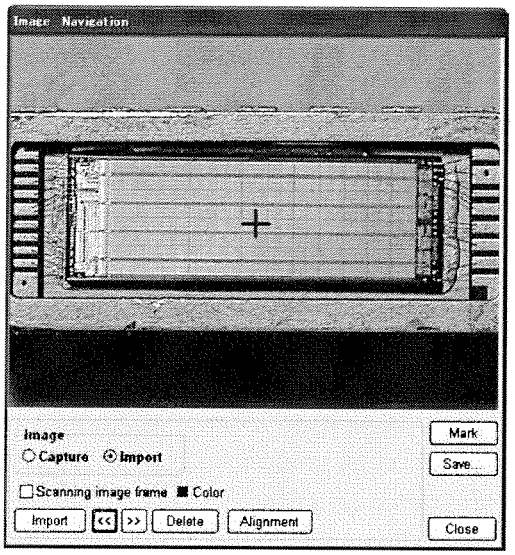


Fig. 3.5-48 Image Navigation Window

(1) Starting image navigation
The **Navigate** button on the **Stage** tab opens **Image Navigation** window.

(2) Using Captured SEM images
Select **Capture** at **Capture/Import** selection.
Click the **Capture** button. The present displayed scanning image will be captured and shown on the **Image Navigation** window.
Up to 10 images, with different stage position or magnification, can be captured and you can use any one by selecting with [<<] [>>] buttons.

NOTICE:
- Use the navigation image function at magnification lower than 5000×. Capturing of higher magnification image is not allowed.
- When the following operations are performed, the precious image becomes unregistered, and the **Need Refresh** window will blink in red:
  (a) When the R, T, or Z-axis for the stage is moved (for raster rotation, changing angles does not unregister an image).
  (b) When the accelerating voltage is changed.

(3) Navigation on an SEM image
On the navigation image, the mouse pointer becomes a white cross cursor. Place the cross mark intersection point at the position to be enlarged, and click the left button on the mouse. The stage will move so that the indicated point will come to the center of the screen. Moreover, by dragging with mouse's left button, the image moves to dragged area and magnification changes so that the area may display in full (RISM&ZOOM function).
The red cross mark indicates the current observation point.
If multiple images are registered, use the [<<] [>>] button to select images in sequence.

(4) Using imported images
Select **Import** at **Capture/Import** selection.
Picture files of windows bitmap (.bmp), Tiff (.tif) or JPEG (.jpg) format can be loaded as imported images. Up to 10 images can be imported.
The pictures shall have correct aspect ratio and not be mirror inverted or flipped. Also it is recommended that the picture direction coincide with the specimen direction (looking from the display unit side to the main unit).
To import an image, click the **Import** button. Select a file in the **Load Image File** window.

(5) Alignment operation
To use imported images for navigation, alignment operation is necessary.
Select two alignment points on a navigation image. These two points shall be separated left - right or upper - lower side of the image center.

(a) Select the object, which corresponds to the first alignment position on scanning image.

(b) Click the **Alignment** button on the **Image Navigation** window.

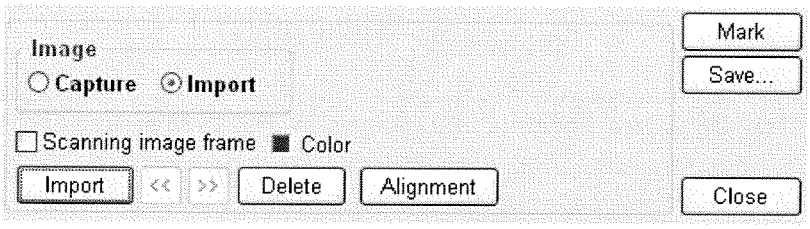


Fig. 3.5-49 Alignment Box

A message [Move a remarkable object to the center of image and click the **1st.** button, click the position in the navigation image corresponding to the selected object by mouse.] will be shown. Close the message by **OK** button. Adjust the stage so the selected object goes to the center of image and then click the **1st.** button.

Fig. 3.5-50A 1st Setting

(c) Find the first alignment point in the navigation image and click it.
The next message [Move a selected object to the center of image and click the **2nd.** button, click the position in the navigation image corresponding to the remarkable object by mouse.] will appear. Close the message by **OK** button.
Search the object, which corresponds to the second alignment position on scanning image, and move it to the center of image.

(d) Click the **2nd.** button on the **Image Navigation** window. And then find the second alignment point in the navigation image and click it.

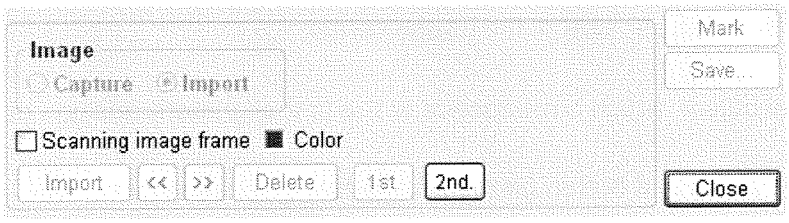


Fig. 3.5-50B 2nd Setting

NOTICE:
- The two alignment points on the navigation image shall be separated left - right of the image center. The navigation image is divided into four areas with cross mark in the alignment operation. Alignment points shall be selected on two different areas.
- When you have moved R, T or Z-axis of stage or have changed accelerating voltage, perform alignment again.

(6) Navigation operation
After finishing alignment, the picture can be used in just the same manner as a captured SEM image.
Clicking a point or drugged on the navigation image moves the stage to bring the point to the center of field of view.

(7) History Function
Clicking the **Mark** button puts the red cross mark position on the navigation image. Cross mark is displayed by green cross mark, and the number is displayed in the lower right.

NOTICE:
- The number to be able to mark is up to 50 places per one image.
- Marked cross mark and number cannot be deleted and be moved.

(8) Saving image
Clicking the **Save** button saves the navigation image. The green cross mark and the number are embedded into the image data when the image is saved.

(9) Display of scanning image frame
Scanning image frame is displayed on the navigation image.
Scanning image frame check box : Shows (checked) or hides (unchecked) the scanning image frame.
Color check box : Switch the color of the scanning image frame. Change the color displayed by clicking the color check box.

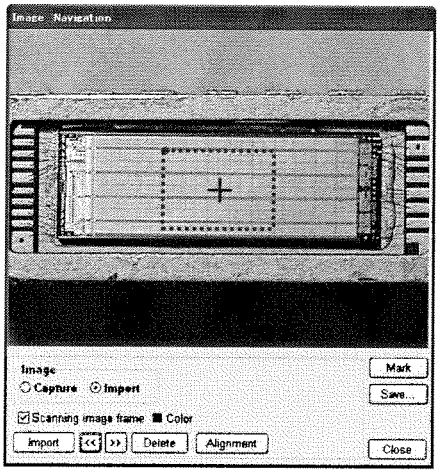


Fig. 3.5-51 Scanning image frame

NOTICE:
- In the following cases, scanning image frame is hidden:
  (a) When there is no image on the navigation image.
  (b) SEM image: When the precious image becomes unregistered.
  (c) Imported image: When alignment operation has not ended.
  (d) When the R, or T-axis for the stage is moved (for raster rotation, changing angles does not hide a scanning image frame).
  (e) When scanning image is not displayed on the navigation image.
  (f) When scanning image is larger than the navigation image.

(10) Using both imported and SEM images
Valid (with a green **Need Refresh** window) SEM images and properly aligned imported images can be switched at any time for navigation purposes.

(11) Deleting a navigation image
Clicking the **Delete** button deletes the image that is currently displayed as a navigation image.

3.5.7.10 Rotation/Tilt Eucentric Function and Calibration

The rotation eucentric function serves to keep the present field of view after specimen rotation. It calculates XY position that will recover the present viewing position after rotation axis is driven using the present XY position and the angle to be rotated. X and Y axes are moved to the calculated point together with rotation axis.
In addition, the tilt eucentric function moves the X and Y axes together with Tilt-axis so that the previous viewing point will be kept after the tilting operation.
To improve accuracy of the functions, calibration of the error factors is necessary.

(1) Specifying eucentric or non-eucentric rotation or tilt
Check the Eucentric check box in the X/Y/R block to enable the eucentric rotation.
It is effective when rotating R-axis by specifying the angle value. It is not effective when rotating R-axis using continuous rotation.
Check the Eucentric Tilt check box in the Z/TILT block to enable the eucentric tilt.
It is effective when tilting specimen by specifying the angle value. It is not effective when using continuous tilting.

(2) Calibration
The following calibration commands are provided:

(a) Measure and correct the deviation between rotation center axis and beam irradiation position.

(b) Measure and correct the deviation between tilt center axis and beam irradiation position.

(c) Measure and correct the deviation between rotation center axis and beam irradiation position caused by changing Z-axis position.

(d) Measure the specimen height error and compensate the rotation center and the tilt center axes.

The beam irradiation position may shift when adjusting the electron beam axis, this measurement tool is provided to enable measurement and correction at any time. For execution methods, see 3.5.7.10 (4) Calibration is necessary when accuracy is degraded.
On the other hand, the specimen height error (the above (d)) will change whenever specimens are exchanged. It should be compensated at each specimen exchange to get the best accuracy. For execution methods, see 3.5.7.10 (3) Stage tilt calibration - Calibration necessary for each specimen exchange.
It is not necessary when you use the eucentric rotation function with no tilting condition.

NOTICE: For this auxiliary operation, a flat specimen should be used and the specimen height should be measured as accurately as possible using the height gauge. This series of operations will automatically move the R, Z, and T axes of the stage.

(3) Stage tilt calibration - Calibration necessary for each specimen exchange
When specimen height differs from the standard value and the specimen is tilted, the rotation and tilt center axes will shift. For accurate operation of the eucentric function, the specimen height must be measured and corrected at each specimen exchange.
Since the previous correction factor is retained, calibration is not necessary if the specimen height does not vary at each specimen exchange.
Carry out the calibration as follows.

(a) Insert a specimen. On the **Z/TILT** block, verify that the movable range of the Tilt-axis is 20° or greater.
Then search for a structure of interest near the specimen center.

(b) Click the **Calibration** button in the **Z/Tilt** area on **Z/TILT** block, then the **Stage Tilt Calibration** window will appear.

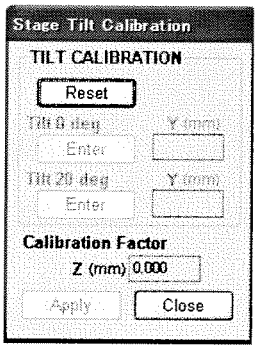


Fig. 3.5-52 Stage Tilt Calibration Window

(c) Click the **Reset** button. The following message will appear.

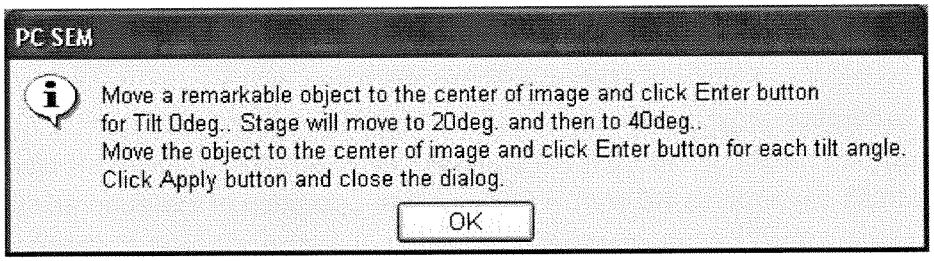


Fig. 3.5-53 Confirming the Operation Method

As described in the message, bring the structure of interest to the image center at a magnification of about 500×, then click the **Enter** button of Tilt 0 deg.

(d) Stage is moved to tilt angle of 20°. Again bring the structure of interest to the image center, and click the **Enter** button of Tilt 20 deg. A Calibration Factor is calculated and indicated. This value represents the deviation of specimen height from the reference position. Now click the **Apply** button.
Click the **Close** button to close the window.

(4) Calibration is necessary when accuracy is degraded.
Carry out the following three calibrations when accuracy of eucentricity is degraded.

(a) Rotation center
It measures the deviation of the rotation center from the beam irradiation point.
For this auxiliary operation, use a specimen base (height: 6 mm) on which no specimen is loaded. Use the **Stage** tab to set the specimen **Height** in the **SPECIMEN** block to Standard.

1) Insert a specimen, set WD at 10 mm, tilt at 0° and R at 0°, then search for a structure of interest near the specimen center.

2) Select **Stage Calibration - Rotation Center** command in the **Option** menu.
The **Rotation Center** window will open.

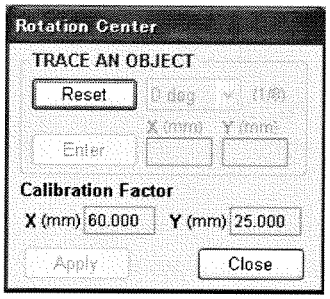


Fig. 3.5-54 Rotation Center Window

3) Click **Reset** button. The following message indicating steps of operation will be shown.

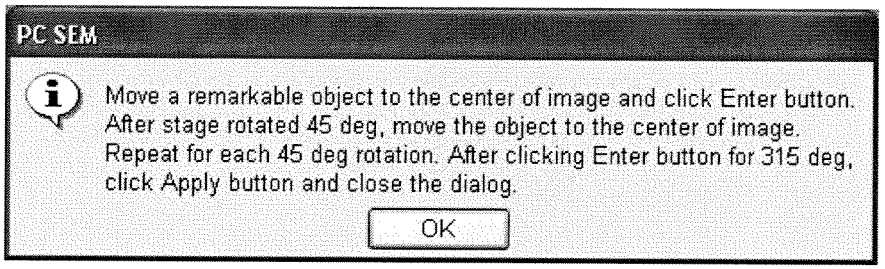


Fig. 3.5-55 Verifying the Operating Method

4) Bring the structure of interest to the image center, and click the **Enter** button.
The specimen rotates 45°. After it stops, search for the aforementioned structure of interest (although it shifts from the image center, it will be located within a range of about 300 µm). Bring this point to the image center and click the **Enter** button.

5) The specimen rotates to an angle of 90°. Again bring the point of interest to the center and click **Enter** button.

6) In the same way, each click of **Enter** button rotates the specimen 45° at a time. Bring the point of interest to the center each time and then click **Enter**.
Upon clicking **Enter** at a rotation angle of 315°, a **Calibration Factor** is calculated and indicated. This value is the stage coordinate at the rotation center, and is normally within 60±1 mm, 25±1 mm. After clicking the **Apply** button, click the **Close** button to close the box.

(b) Stage tilt calibration
It measures the deviation of the tilting center from the beam irradiation point.
For this auxiliary operation, use a flat specimen, and measure the specimen height as accurately as possible with the height gauge and setting it. The specimen size should be ϕ32 mm or less.
Refer to 3.2.4.3 Setting the Specimen Size and Height.

1) Insert a specimen, set WD at 30 mm, tilt at 0° and R at 0°, then search for a structure of interest near the specimen center.

2) Select the **Stage Calibration** - **Tilt center** in the **Option** menu.
The **Stage Tilt Calibration** window will open.

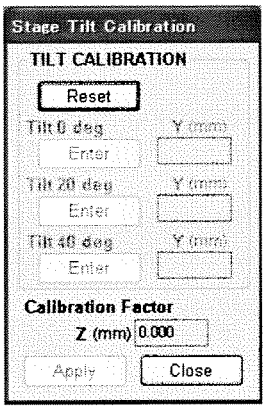


Fig. 3.5-56 Stage Tilt Calibration Window

3) Click the **Reset** button. The following message indicating steps of operation will be shown.

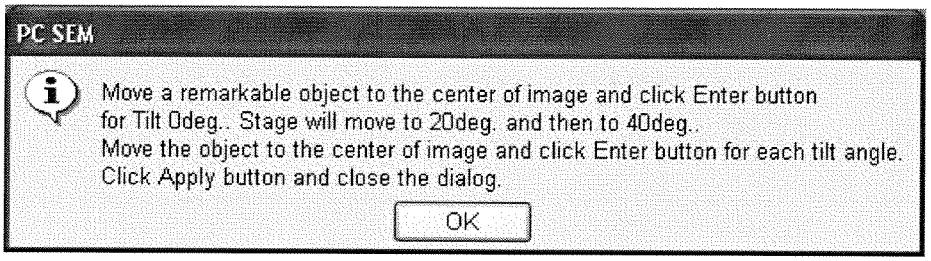


Fig. 3.5-57 Verifying the Operating Method

As described in the message, bring the point of interest to the image center at a magnification of about 500×, then click **Enter** button of Tilt 0°.

4) The stage will be moved to a tilt angle of 20°. Bring the point of interest to the image center and click **Enter** button of Tilt 20°.

5) The stage will be driven to a tilt angle of 40°. Again bring the point of interest to the image center and click **Enter** button of Tilt 40°.
A **Calibration Factor** is now calibrated and indicated. This value represents the deviation of specimen height from the reference position. Click **Apply** button, then click **Close** button to close the window.

(c) Z-axis compensation
It measures the shift of the stage caused by changing Z-axis position.
For this auxiliary operation, use a flat specimen, and measure the specimen height as accurately as possible with the height gauge and setting it.
Refer to 3.2.4.3 Setting the Specimen Size and Height.

1) Insert a specimen, set WD at 30 mm, tilt at 0° and R at 0°, then search for a structure of interest near the specimen center.

2) Select **Stage Calibration - Z Axis Comp** in the **Option** menu.
The following window appears:

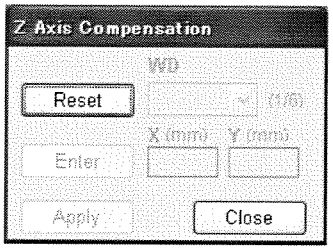


Fig. 3.5-58 Z Axis Compensation Window

3) Click the **Reset** button. The following message indicating steps of operation will be shown.

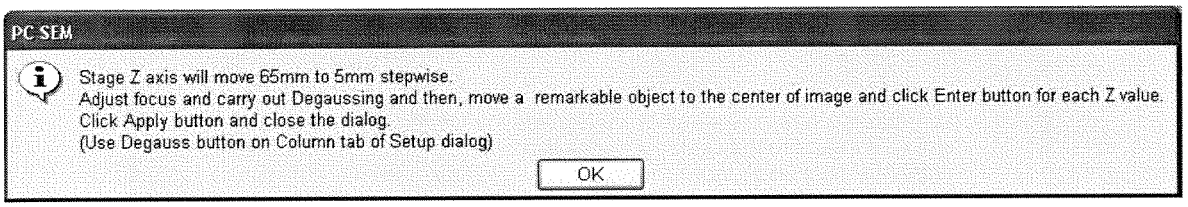


Fig. 3.5-59 Verifying the Operating Method

Upon closing the message, the Z-axis will be driven to 30 mm. Carry out focusing and set magnification to about 500×, then bring the point of interest to the image center and click the **Enter** button.

4) The Z-axis of stage will be driven to 50 mm. Carry out focusing again, bring the point of interest to the image center and click the **Enter** button.

5) At each click of the **Enter** button, the Z-axis will be driven to 35 mm, 20 mm, 10 mm and then 5 mm. Bring the point of interest to the image center each time and then click the **Enter** button.
After clicking the **Enter** button at 5 mm, click the **Apply** button and then click the **Close** button to close the window.

3.5.7.11 Stopping Stage and Returning to Previous Stage Position

If an incorrect position specification must be canceled when the stage is moving to a coordinate specification or the stage keeps moving and does not stop for some reason, click the **STOP** button.

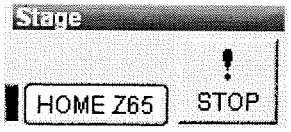


Fig. 3.5-60 STOP Button

To return to a previous position after moving stage using coordinate specifying operation, use **Undo - Stage Drive** menu. It is effective for only one previous position.
(The stage cannot be reset to two or more previous positions. The **Undo-Stage** is valid only on coordinate specification or stage memory motion.)

IMPORTANT:	Do not repeat clicking the **STOP** button. Clicking the button repeatedly can cause malfunction and damage the specimen or components inside the specimen chamber.

3.5.7.12 Movable Range and Limitation by Optional Detectors

(1) Movable range of the specimen stage for various specimen sizes
The movable range is limited when observing large size specimens.
Stage motion is limited to the movable range automatically designated by the computer.
The limit value is calculated using the size information set on the **Specimen/Detector Setting** window.
The following operating ranges apply:
- For small size specimen, X and Y limitation is specified so the movable range covers just the size of the specimen.
- For large size specimen, the movable range is limited to safety area. When optional detectors are inserted to their operating position, the safety area will be limited to narrower range.

IMPORTANT:	Always measure the height of a specimen using the supplied height gauge. In the **SPECIMEN** input field in the Operation Panel **Stage** tab, set the specimen size and height. Incorrect specimen size, height, or detector settings can damage the objective lens, the BSE detector located on the underside of the objective lens, or the specimen itself.

(2) Observable range

The following page shows the X and Y observable ranges by specimen size, and mutual restrictions on the Z and Tilt axes at the Standard height, and the movable range for the Tilt-axis as a function of specimen height by specimen size. With regard to Z and Tilt restrictions, for an actual movable range, if either the Z or T scrollbar is set to the coordinates to which the axis is moved by using the **Z/TILT** box of the **Stage** tab on the Operation Panel, the movable range for the other axis is automatically calculated and displayed on the scrollbar. Therefore, Z and Tilt axes should be set within that range. See 3.5.7.5 Z and Tilt Axes Operation.

The Z-axis coordinate value indicated in the Z scrollbar and the Z coordinate box on the **Z/TILT Window** of the **Stage** tab changes according to setting of the specimen height. Refer to 3.2.4.3 Setting the Specimen Size and Height.

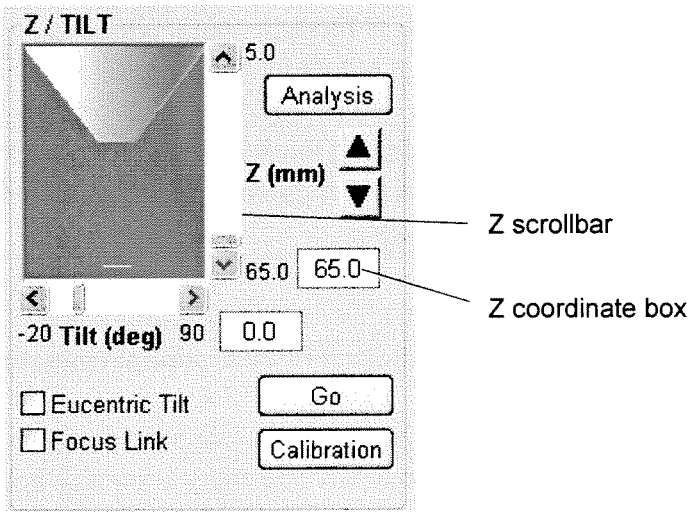


Fig. 3.5-61 Z/TILT Window

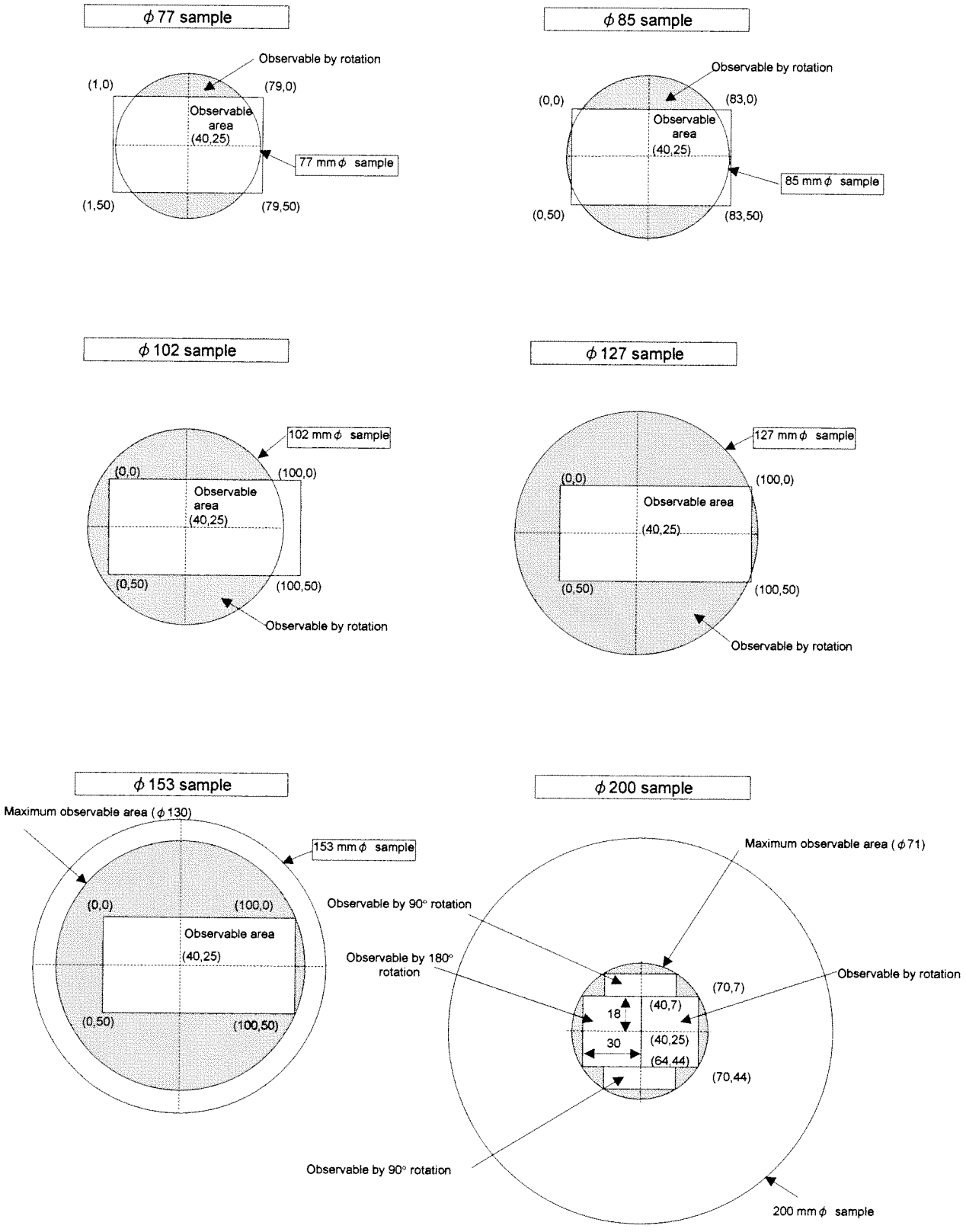


Fig. 3.5-62 X and Y Movable Ranges for the Type Ⅱ Stage by Specimen Size (when an optional detector is not used)

Type Ⅱ stage

Movable range of the Tilt-axis with respect to Z values at Standard specimen height by specimen size (when an optional detector is not used)

- Restrictions on positive angles of tilt

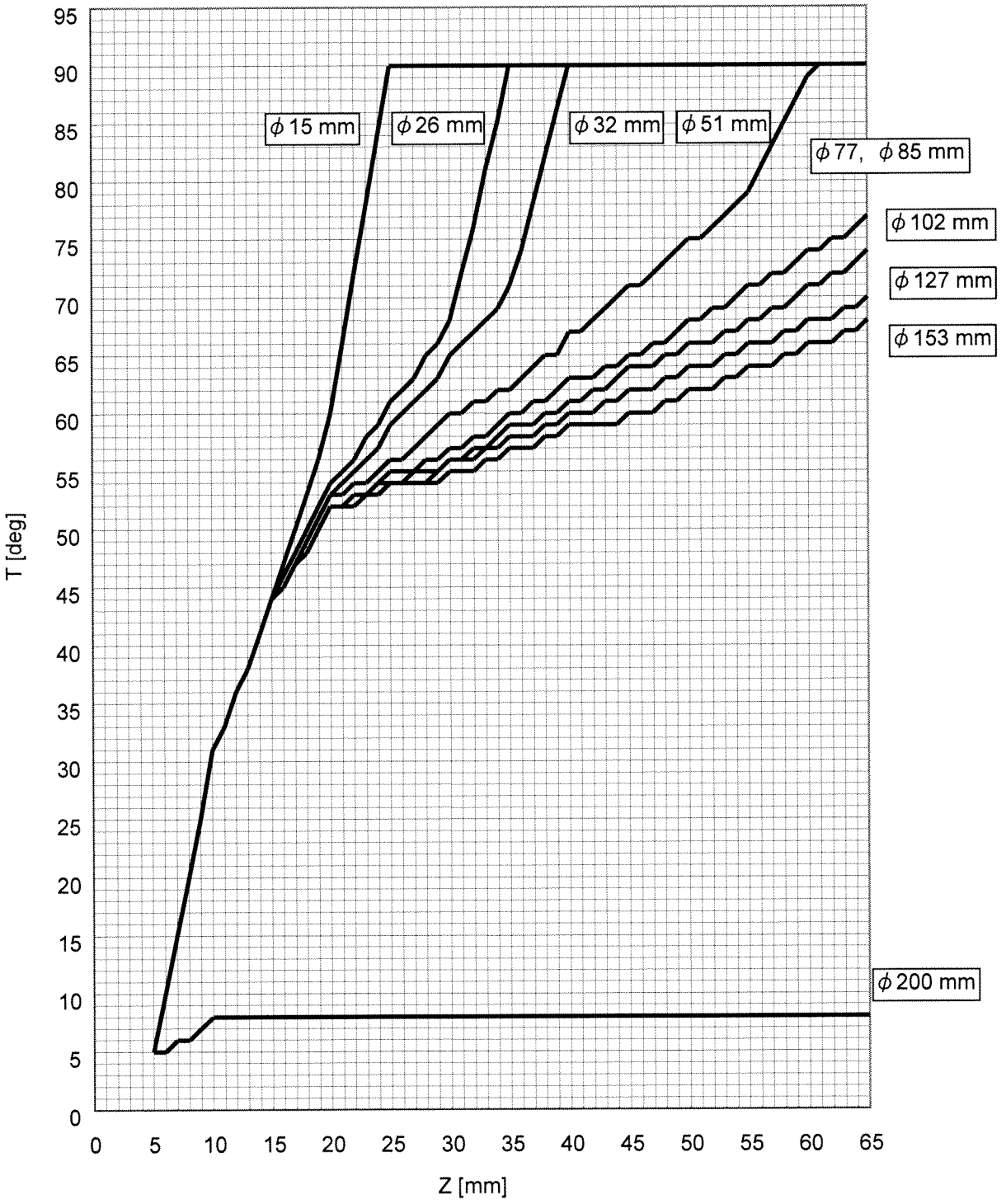


Fig. 3.5-63 Tiltable Angles with respect to Z-axis Positions (Type Ⅱ) (positive angles of tilt)

- Restrictions on positive angles of tilt (when an optional detector is not used)

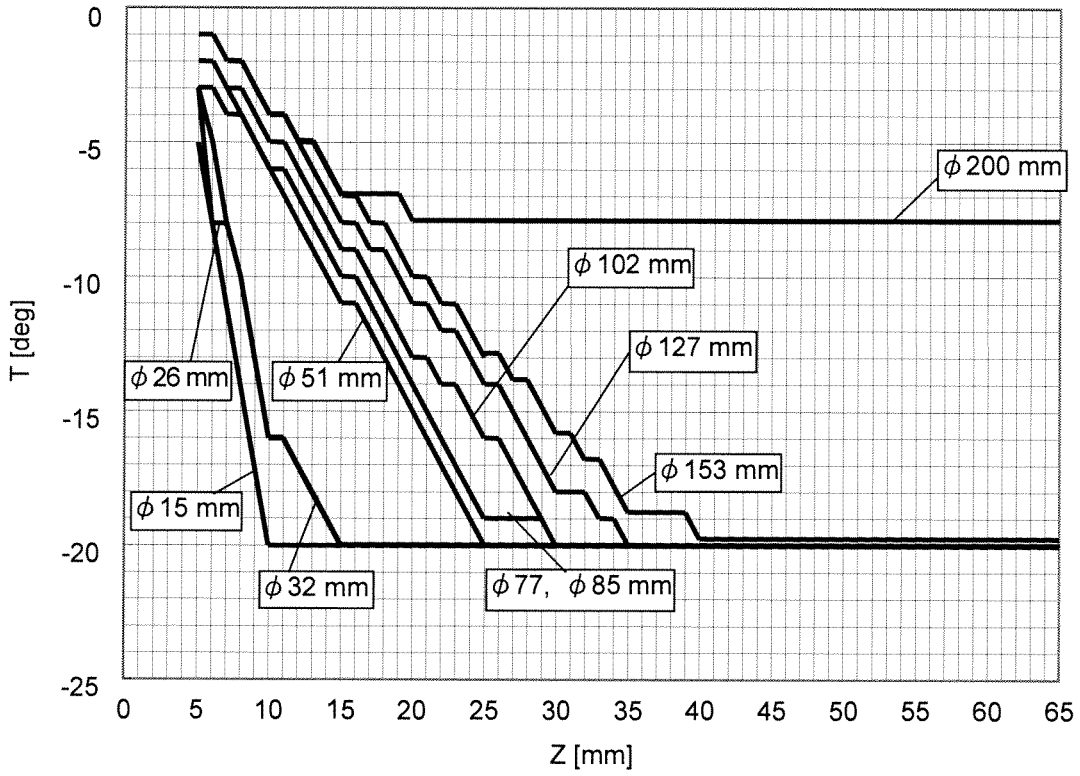


Fig. 3.5-64 Tiltable Angles with respect to Z-axis Positions (Type I Stage) (negative angles of tilt)

(3) Limitation and evacuation when an optional detector is inserted
Some optional detectors have sensor switches and are automatically sensed when they are inserted. For detectors not having such sensor switches, it is necessary to set detector in use correctly in the **Specimen/Detector Setting** window. If a detector having sensor switch is inserted when present stage position is out of allowable area, the stage will evacuate to the safe position as follows.

(a) EDX detector
No limitation required.

(b) WDX detector (made by Oxford Corporation) used:
φ5-inch (127 mm) specimens are restricted to X: 0.0 to 85.0 mm in mechanical coordinates.
φ6-inch (153 mm) specimens are restricted to X: 0.0 to 72.0 mm in mechanical coordinates.
φ8-inch (200 mm) specimens cannot be loaded.

NOTICE: If the stage positions (X, Y, Z, and T) are outside the movable range when a detector is inserted, and if a detector equipped with a detection sensor is inserted, the stage will be forced to undergo retraction motions.

3.6 Saving and Recording Images

3.6.1 Saving and Recording Images

It is possible to record images using conventional photo films and printers, and/or as image data files (to disk drive). There are four methods of image recording:

(1) Taking photographs (optional photo-recording unit is necessary)
For photographic image recording, you can use Direct Photo or Memory Photo recording. Memory Photo can produce multiple photographs from a given image.
See <3.6.7 Taking Photographs (Option)>.

(2) Saving images
Direct Saving, which saves an image on the scanning image display, and Captured Image Saving, which saves captured images, are available.
Also available is a Quick Save function, which can automatically save captured images under a specified name. Using these functions, it is possible to save images that are processed on **SEM Data Manager**.

(3) Printing images
Printing of images using Windows-supported printers is available.
Refer to <3.9.10 Printing Images Using Report Generation Function>.

(4) Copying images to other application software
Scanning Image can be copied to Windows-clipboard. You can use the image on application software by simply pasting it.
When the optional PCI image database software is installed, images are transferred directly to it without saving images.
Refer to <3.9.11 Copy Image>.

(5) Related information
Auto data display, and text and graphics written on the image using data entry functions are recorded with the image. A text file including image information such as operating condition, date and others is created when the image is saved. It is saved in the same directory as the image. The measurement function option allows you to save and output images by writing any text to them as well as incorporating the results of measurements (measured values and cursors).

NOTICE: For storing images, we suggest the use of external storage devices, as the storage capacity of PC hard drives is limited. Also, external storage devices are recommended for data backup.

3.6.2 Preparing Images for Recording

The source of images to be recorded is frozen images in the image memory except for direct photographing.

(1) Freezing an image

(a) Using **Run/Freeze** button
Scanning image will be frozen. When scanning speed is slow, scanning continues to the end of the frame and then, the image is frozen. Image size is 1280 × 960 pixels in full screen. It is 640 × 480 pixels in small and dual screen mode.

(b) Capturing an image
During the image capture process, depending on the particular scanning speed employed, the image is frozen either after integration or after one frame is scanned slowly. Image size depends on the selected capture resolution (640 × 480, 1280 × 960, 2560 × 1920 or 5120 × 3840 pixels).

(c) Direct photographing
After photographing, the image is frozen in the image memory. Image size depends on the capture resolution selectable with **Capture resolution select** button (640 × 480, 1280 × 960 or 2560 × 1920 pixels).

(2) The source of image to be recorded
Several commands or buttons are placed on multiple areas. The image sources for the commands are as follows.

(a) When you use menu commands, or buttons on the control panel, the scanning image will be used as the image source. Image size depends on the way of freezing, as mentioned above.

(b) When you use buttons on the **Captured Image** window, the selected image on the window is used as the image source. Image size depends on the capture resolution setting.

(3) Embedding texts and graphics written on the image

(a) **Auto Data Display**
When the **Embed into Image** check box in the **AUTO DATA DISPLAY** area on the **Setup** window - **Record** tab has been checked, the auto data display is embedded into the image data when the image is saved. If it is not checked, only the image data is saved. This setting is also applied for **Print**, **Copy** and **PCI** Transfer commands. If the **For Photograph** box is checked, the position of the auto data display in the saved image is shifted slightly upward to ensure that it is properly framed in photographs. It is recommended not to check the box if the saved image data will be used on the computer only.

(b) **Data Entry**
When recording scanning images, graphics and texts written using **Data Entry** function are recorded as they are shown on the scanning image.
When recording captured images using command buttons placed on the **Captured Image** window, graphics and texts written before starting capture are embedded into captured images and recorded.
Note that they may be different from present displayed data.
If data embedding is not necessary, uncheck the **Embed into Image** on the **Captured Image** window.
For details, refer to <3.6.8 Recording Data Display with Images>.

(c) **CD Measurement** data (option)
The measured data and cursors together with **Data Entry** data are saved, recorded, printed or copied with images.

3.6.3 Image Capture

Image Capture stores images using specified scanning mode and specified resolution.
Two methods, multi-frame integration and single frame slow scanning are available.
Max 16 images can be recorded temporarily (Up to 100 images can be shown by setting change).
Multi frame integration is effective for specimens susceptible to charge-up. Slow scan is advantageous in order to obtain high-resolution images.
To select conditions for image capture, use the following steps.

(1) Capture Resolution
Click either the » button in the upper right section of the Capture button on the Control panel or right-click the Capture button. Then, a pull-down menu for selecting capture resolution will appear. Select the desired resolution on this menu. The selected resolution is displayed on the Capture button as follows:

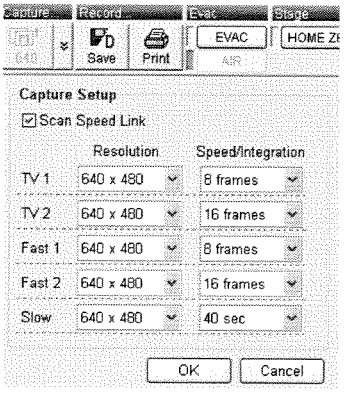


Fig. 3.6-1 List of Capture Settings

- 640 × 480: Low resolution
  Advantageous for small image sizes and faster acquisition times.

- 1280 × 960: Medium resolution
  Adequate image quality with reasonable acquisition times. Recommended for usual operation.

- 2560 × 1920: High resolution
  Fine quality image. The large image size results in a long acquisition, storage and processing time.

- 5120 × 3840: Highest resolution
  Effective for relatively low magnification and samples containing very fine structure.
  Note that the large image size requires long processing time for creation, saving, loading and image processing.

NOTICE: For large size captured images, the following limitations apply.
(1) CD Measurement function works on 2560 × 1920 pixel or smaller images.
(2) Color mixing on SEM Data Manager works on 2560 × 1920 pixel or smaller images.
(3) Pseudo Coloring on SEM Data Manager works for 2560 × 1920 pixel or smaller images.

In the above cases, a message will be shown and the specified commands will be canceled.

(2) Selecting the number of integration frames and the speed of slow scanning capture
Either click the » button in the upper right section of the Capture button on the Control Panel or right-click the Capture button to bring up a list of capture settings.

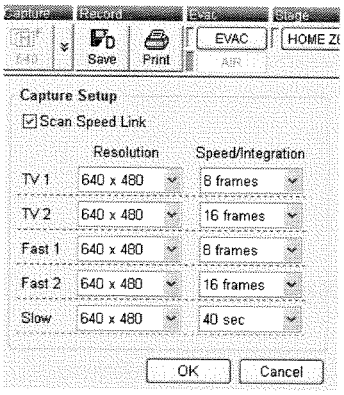


Fig. 3.6-2 Link to Scanning Speeds Selected

- **The Scanning Speed Link is check-marked:**
  Capturing is executed according to the current scanning speed settings.

- **TV 1/TV 2/Fast 1/Fast 2:**
  Select the desired number of integration frames (16 to 1024 frames) for the TV/Fast scanning capture process.
  The larger this number, the higher is image quality at the expense of an increased processing time. Under conditions of a high magnification rate and specimens that are susceptible to charging up, a high integration frame number can cause a reduction in the sharpness of the image due to image drifting during the integration.

- **Slow:**
  Select the desired scanning speed (10 to 320 s) for the slow scanning capture mode. (If the image cannot be captured within a specified time depending on the particular display mode in effect, the nearest possible condition will be employed for the execution of the scanning process. No matter what scanning speed is selected, the actual capturing speed in this mode will be in the Slow 1 to 6 range.

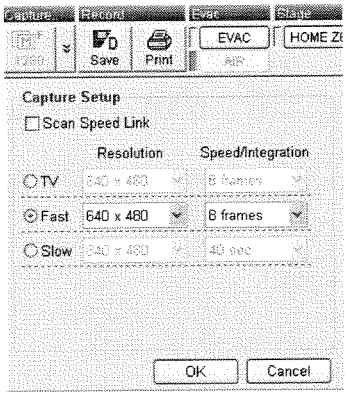


Fig. 3.6-3 No Link to a Scanning Capture Link

- **The Scanning Speed Link is not check-marked:**
  Irrespective of the current scanning speed, the capturing process is executed at the scanning rate selected on the **TV/Fast/Slow** radio button.

- **TV/Fast:**
  Select the desired number of integration frames (16 to 1024 frames) for the TV/Fast scanning capture process.
  The larger this number, the higher is image quality at the expense of an increased processing time. Under conditions of a high magnification rate and specimens that are susceptible to charging up, a high integration frame number can cause a reduction in the sharpness of the image due to image drifting during the integration.

- **Slow:**
  Select the desired scanning speed (10 to 320 s) for the slow scanning capture mode. (If the image cannot be captured within a specified time depending on the particular display mode in effect, the nearest possible condition will be employed for the execution of the scanning process.

(3) Image Capture

To start Image Capture, click the **Capture** button on the **Control panel**. Image capture can be started either in RUN or FREEZE status.

(4) Displaying a captured image
After the scanning is finished, the **Captured Image** window opens and the captured image is added in the list as a thumbnail.

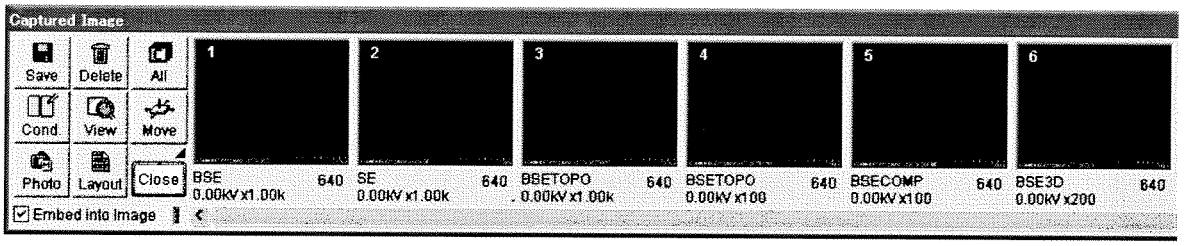


Fig. 3.6-4 Captured Image Window

The **Captured Image** window opens by using the Img.List buttons in the lower part of the Operation panel, **Captured Image** command in the **Window** menu and the shortcut **Ctrl - L** at any time.
Refer to <2.3.10 Captured Image Window>.

(5) Setting change for the max number of image capturing
The max number of image capturing can be changed from 16 images to 100 images. (The max number of image capturing is set to 16 images when being shipped from the factory.)
The setting for the max number of image capturing can change at **Option** menu - **Optional Setup** - **General** tab - **IMAGE CAPTURE** block.

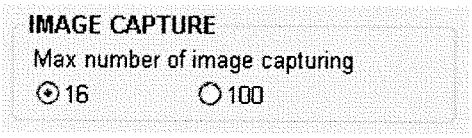


Fig. 3.6-5 IMAGE CAPTURE Block

NOTICE:	The setting cannot change when **Captured Image** window has any image. The setting for the max number of image capturing can change without image in **Captured Image** window.

3.6.4 Interval Capture

Interval capture refers to a function that captures multiple images at fixed intervals.
The function captures images at a set interval, resolution, and Speed/Integration, and saves them at a specified destination.
Selecting **Interval Capture** from **Scan** on the menu bar brings up the **Interval Capture** window.

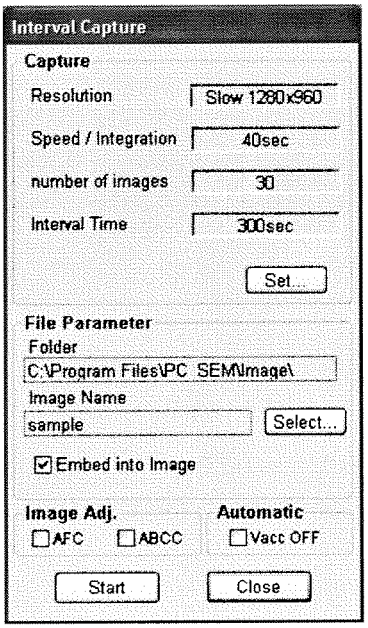


Fig. 3.6-6 Interval Capture Window

(1) Capturing conditions
Displays the resolution of the image to be captured, the scanning speed, the number of images to be captured, and the interval at which captures are to be performed.
To change any of the settings, click the **Set** button and display the **Interval Capture Setting** window.

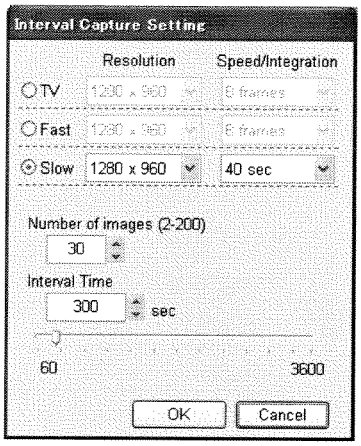


Fig. 3.6-7 Interval Capture Setting Window

(a) Setting the **Resolution**, **Speed/Integration**
The **Interval Capture Setting** window specifies the resolution for the image to be saved, and the Speed/Integration to be in effect during the capturing operation.
Table 3.6-1, 3.6-2, and 3.6-3 shows allowable resolution and speed/integration.

Table 3.6-1 Setting the Resolution and Speed/Integration of TV Mode

Mode	Resolution	Speed/Integration	Minimum Interval Time [sec.]
TV	640 × 480	Integration ×8	30
		Integration ×16	30
		Integration ×32	30
		Integration ×64	30
		Integration ×128	30
		Integration ×256	30
		Integration ×512	40
		Integration ×1024	60
	1280 × 960	Integration ×8	30
		Integration ×16	30
		Integration ×32	30
		Integration ×64	30
		Integration ×128	40
		Integration ×256	60
		Integration ×512	100
		Integration ×1024	180
	2560 × 1920	Integration ×8	30
		Integration ×16	30
		Integration ×32	40
		Integration ×64	60
		Integration ×128	100
		Integration ×256	180
		Integration ×512	350
		Integration ×1024	680

IMPORTANT: Interval capture at 5120 × 3840 resolution cannot be executed.

Table 3.6-2 Setting the Resolution and Speed/Integration of Fast Mode

Mode	Resolution	Speed/Integration	Minimum Interval Time [sec.]
Fast	640 × 480	Integration ×8	30
		Integration ×16	30
		Integration ×32	30
		Integration ×64	30
		Integration ×128	30
		Integration ×256	40
		Integration ×512	60
		Integration ×1024	100
	1280 × 960	Integration ×8	30
		Integration ×16	30
		Integration ×32	30
		Integration ×64	30
		Integration ×128	40
		Integration ×256	60
		Integration ×512	100
		Integration ×1024	180
	2560 × 1920	Integration ×8	30
		Integration ×16	30
		Integration ×32	40
		Integration ×64	60
		Integration ×128	100
		Integration ×256	180
		Integration ×512	350
		Integration ×1024	680

IMPORTANT: Interval capture at 5120 × 3840 resolution cannot be executed.

Table 3.6-3 Setting the Resolution and Speed/Integration of Slow Mode

Mode	Resolution	Speed/Integration	Minimum Interval Time [sec.]
Slow	640 × 480	Integration ×16	30
		Integration ×32	40
		Integration ×64	50
		Integration ×128	90
		10 secs.	30
		20 secs.	40
		40 secs.	60
		80 secs.	100
	1280 × 960	Integration ×16	40
		Integration ×32	50
		Integration ×64	90
		Integration ×128	160
		20 secs.	40
		40 secs.	60
		80 secs.	100
		160 secs.	180
	2560 × 1920	Integration ×16	50
		Integration ×32	90
		Integration ×64	160
		Integration ×128	290
		40 secs.	60
		80 secs.	100
		160 secs.	180
		320 secs.	340

IMPORTANT: Interval capture at 5120 × 3840 resolution cannot be executed.

(b) Setting Number of images
Specifies the number of images to be captured. Allowable range: 2 to 200 images.

(c) Setting Interval Time
Interval refers to the length of time from the start of a capture to the start of another capture. Specifies an interval at which capture operations are started. Allowable range: 30 to 3600 seconds. The minimum allowable time varies depending on the smallest interval time associated with Resolution and Speed/Integration settings and the ON/OFF setting of image adjustment function.

(d) Clicking the **OK** button applies the Interval Capture Setting value to the capture condition in the **Interval Capture** window.

(2) Saving an image

(a) **Select** button
Clicking the **Select** button displays the folder in which the image is to be saved and a file name-setting window. In each file name for an image, a four-digit number representing the sequence number for the image is appended to a user-specified file name. The number 0001 is appended to the first image, and subsequent images are numbered in ascending order.

IMPORTANT: When an image is captured, in addition to a BMP file containing the image, a file with a TXT extension with the same file name is created. The TXT files contain the conditions under which a given image was captured.

(b) Embed into Image
Even if input data and an auto data display are displayed at the time of an image capture, by unchecking the **Embed into Image** check box, it is possible to save the image only. If the displayed data is to be saved together with the image, the check box should be left ON (checked).

(3) Image adjustment

(a) AFC
When checked, this function executes auto-focusing (fine) during the capture of an image.

(b) ABCC
When checked, this function executes auto-brightness and contrast adjustments during the capture of an image.

IMPORTANT: If either an AFC or ABCC error occurs during the execution of AFC or ABCC, the interval capture is canceled.
Checking AFC increases minimum interval time by 30 seconds.
Checking ABCC increases minimum interval time by 20 seconds.
By checking both AFC and ABCC, image adjustments are performed in ABCC/AFC/ABCC order, and minimum interval time is increased by 70 seconds.

(4) Auxiliary function
Vacc OFF
Checking this function turns off Vacc upon completion of a specified number of interval captures.
Vacc is also turned off if an error occurs during interval capture.

(5) **Start** button
Starts an interval capture.
Interval capture can be cancelled by clicking the **Cancel** button in the **message** window that is displayed during the execution of the capture process.

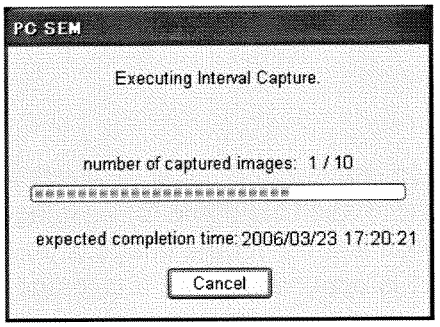


Fig. 3.6-8 Interval Capture in Progress Window

IMPORTANT: During the execution of an interval capture, the trackball, the operation panel, or other SEM-operating windows should not be touched. Also, non-SEM PC operations should not be performed, including Windows file operations, external communications, connecting to a network, or writing to a CD-R.

IMPORTANT: Interval capture cannot be performed when the S-3400N is in any of the following conditions.

- In analytical mode
- In any of the alignment modes
- In any of the monitor modes
- CD measurement in progress
- Image display size [SCREEN MODE] in double-screen display
- Image display size [SCREEN MODE] in all-screen display
- In split screen/dual mag mode
- Accelerating voltage off

(6) **Close** button
Closes the **Interval Capture** window.

3.6.5 Saving a Scanning Image (Direct Save)

The scanning image, simply frozen or captured, can be saved. Resolution of saved image is 1280 × 960 or 640 × 480 depending on present screen mode when saved just after freezing the image. When saved after capturing, resolution follows capture resolution.
Graphics and texts written using **Data Entry** function and **CD measurement** function are put on saved images when saved while they are shown on the image.

Click the **Direct Save** button on the control panel or select the **Direct Save** command from the **File** menu. The **Image Save [Direct Save]** window will open.

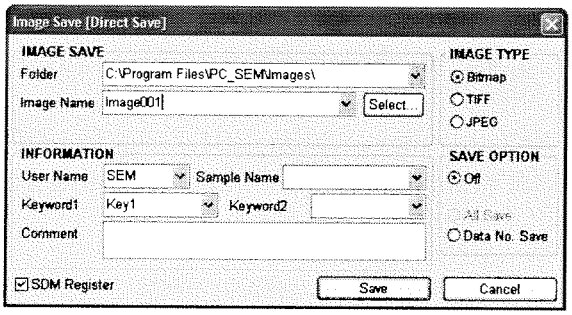


Fig. 3.6-9 Image Save [Direct Save] Window

(1) Select an image format on **IMAGE TYPE** area.
Bitmap: Windows bitmap
TIFF: TIFF (Tagged Image File Format)
JPEG: JPEG

(2) Set **SAVE OPTION** if necessary.
Off: Save one image only.
All Save: Effective when opened from **Captured Image** window. Saves all images selected in **Captured Image** window at a time.
File names [{Input File name} + _m {capture number}] are automatically generated.
Data No. Save: Puts a data number, which is specified in **Auto Data Display** setting to the end of file name when saving images.
This function is effective when saving plural captured images with one saving operation.
The **Auto Increment** shall be set for **Data Number** on **Setup** window - **Record** tab.
To enable auto Increment, set **Data Number** to ON, **Auto Increment** to ON and put "-" plus **number** to the end of the data number as shown on the following picture.

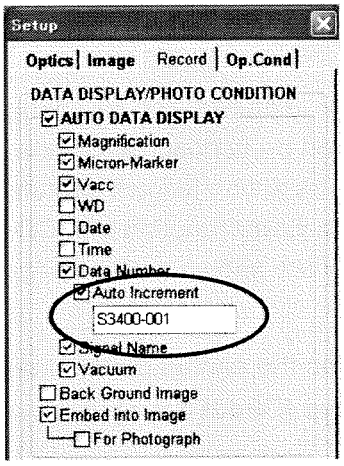


Fig. 3.6-10 Setup Window Record Tab

In the above case, resulting file names are [S3400_i001.TIFF], [S3400_i002.TIFF] and so on. If the **Auto Increment** is not set when the **Data Number Save** is selected, Following message will be shown.

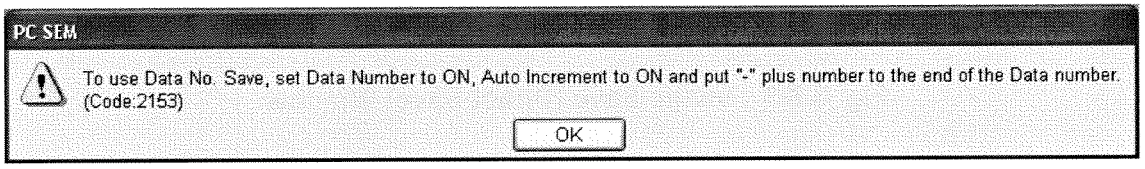


Fig. 3.6-11 Data No. Save Window

If the function is reset so that the above auto incrementing is not performed after the "Save Data No." option was enabled, the image will be saved with no Data No. (using a specified file name only). If an attempt is made to save multiple images in a single operation, the second and subsequent images will be saved under the same name, in which case a confirmation message will appear, asking the user whether files can be overwritten. In this case, temporarily cancel the image save, cancel the "Save Data No." option, and save the images one by one. The captured image is assigned a data number that was in effect when the capturing process was executed. Therefore, before performing a capturing process, the auto incrementing option should be enabled.

(3) Input INFORMATION.
User Name, **Sample Name**, **Keywords** can be selected from already used names or created newly. Entry of these items is not necessary but useful for selection of files in the **SEM Data Manager**.

(4) Set options.
The saved data is automatically registered to **SEM Data Manager** database when the **SDM Register** is checked.

(5) Specify folder and file name.
The button beside the Folder and Image Name input box opens a list of recently used names. You can select one of them and modify it. The **Select** button opens **Save Image** window. You can select or create folder and file name on it.
Click **Save** button to execute saving.
Note that for file names on Quick Save and All Save, only up to 251 characters is allowed.
Another function available to save the image under observation is Quick Save.
After an image is captured as described in <3.6.3>, Quick Save allows you to save images under a previously specified file name.
To set Quick Save, select **Quick Save** on the **File** menu. This will open the **Image Save [Quick Save]** window shown below:

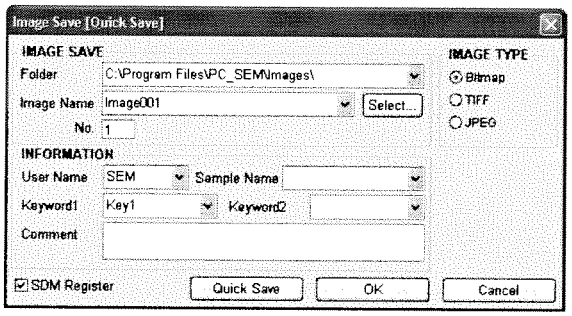


Fig. 3.6-12 Image Save [Quick Save] Window

On this window, enter **IMAGE TYPE**, **INFORMATION**, **SDM Register**, the destination folder, and a Image name. Quick Save indicates a file number below the file name. **Quick Save** saves files under a file name with a "qXXX" extension, where the letters XXX corresponds to the file number. File numbers are half-size numeric characters ranging from 1 to 999. Once **Quick Save** is executed, the file number is incremented by 1. When the file number reaches, 999, a message appears, prompting you to change file names.
After setting, the image can be saved without setting the file name etc. by the **Quick Save** Save button on the control panel.

3.6.6 Saving Captured Images

(1) Select the image to be saved in the **Captured Image** window.
Clicking a thumbnail image causes it to be enclosed in yellow frames, which indicates that the image has been selected.
To save multiple images in a single operation, click images by holding the Ctrl key down; the clicked images are selected.

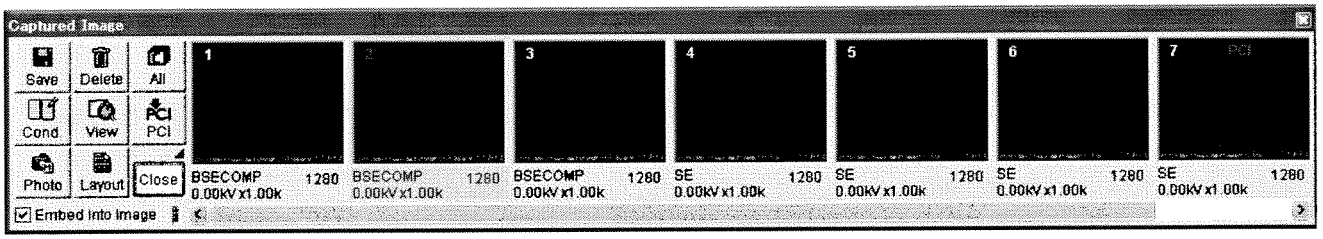


Fig. 3.6-13 Captured Image Window

(2) Clicking the **Save**  button in the **Captured Image** window opens the **Image Save** window.
See the section above, 3.6.4, for a description of how to perform operations in this window.
A saved image thumbnail is indicated by the characters **Saved**.

3.6.7 Taking Photographs (Option)

To take a photograph of an image, use one of two modes: **Direct Photo** mode and **Memory Photo** mode.

Direct Photo:
Direct Photo mode takes a photograph while directly scanning the electron beam.

Memory Photo:
Memory photo mode can produce photographs of simply frozen or captured, or stored images. It is also possible to take a photograph of an image formed by using a Fast scan integration method, which is useful for observation of charge-sensitive samples. The Fast scan integration method can also embed auto data displays, characters that are input using the data entry function, and graphics.

3.6.7.1 Setting Photo Condition

To select the conditions for photo recording, open the **Setup** window - **Record** tab by clicking the **Setup** 

button on the tool button area of the **Operation panel**, or by selecting the **Photo Condition** command in the **Setup** menu.

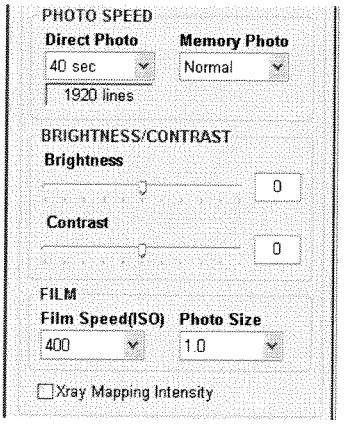


Fig. 3.6-14 Settings Window Record Tab

(1) **PHOTO SPEED**

- **Direct Photo**

  Recommended selection is 80 seconds.
  Use a 40-second scan for beam-sensitive specimens, or to shorten recording time.
  A selection of 160 or 320 seconds is recommended for recording X-ray mapping images.
  Number of scanning lines is shown below the selection box.

- **Memory Photo**

  The number of scanning lines is selectable.

  Normal : 640 × 480 pixel image →960 lines (16/19 s)
  1280 × 960 pixel image →960 lines (16/19 s)
  2560 × 1920 pixel image →1920 lines (16/19 s)

  Enhance : 640 × 480 pixel image →960 lines (16/19 s)
  1280 × 960 pixel image →1920 lines (16/19 s)
  2560 × 1920 pixel image →1920 lines (16/19 s)

(2) **BRIGHTNESS/CONTRAST**

Use slider controls to adjust brightness and contrast of recorded images. Set the controls in plus areas to brighten or enhance contrast. Set them in minus areas to darken or reduce contrast. These values indicate compensation factors for brightness and contrast on the scanning image.

(3) **FILM**

Film Speed (ISO)

Select the speed (sensitivity) of the film. This parameter is necessary in order to obtain an adequate brightness of recorded images for various types of film.

Photo Size

Select a size of film. The magnification value is adjusted internally according to the selected size.

× 0.6: For Type 120 negative film
× 0.8: For small size Polaroid film (type 107, 105 or equivalents)
× 1.0: For 4 × 5 Polaroid film

(4) **X-ray Mapping Intensity**

Check this to brighten a low density X-ray mapping image.

3.6.7.2 Direct Photo Recording

Direct Photo mode takes a photograph while directly scanning the electron beam.
It generally shows better image quality compared to the Memory Photo mode.

To start recording, click the **Photo** 

button on the **Control panel** or select the **Direct Photo** command from the **File** menu.
The scanning speed and other conditions can be selected in the **Setup** window - **Record** tab.

3.6.7.3 Memory Photo Recording

Memory Photo mode can reproduce photographs of memorized or filed images. It is also possible to take a photograph of an image formed using Fast scan integration method, which is useful for observation of charge sensitive samples.

(1) Photographing frozen scanning image

To take a photograph of a frozen scanning image, click the **Memory Photo** 

button on the **Control panel**, or select the **Memory Photo** command from the **File** menu.
In the case of recording a frozen image, the image resolution depends on screen size, 1280 × 960 pixels for full screen and 640 × 480 pixels for small and dual screen mode.

(2) Photographing images from the **Captured Image** window

It is also possible to take a photograph of a captured image by clicking the **Photo** 

button in the **Captured Image** window.
On the window;

(a) Select an image by clicking a thumbnail. The selected image is shown with yellow bordering.

(b) Click the **Photo** 

button in the **Captured Image** window.
When the Embed into Image has been checked, auto data display and texts and graphics written using Data Entry function are overlaid on image. (Note that the data is at the time capture was executed.)

(3) Photographing saved images

To take a photograph of a saved image from disk, use **SEM Data Manager**.

3.6.8 Recording Data Display with Images

Text and graphics drawn using Auto Data Display and Data Entry function are embedded into image data as follows.

3.6.8.1 Image Recording Using Menu Commands or Buttons on the Control Panel

When images displayed on the scanning image screen are saved, photographed, printed or transferred to PCI using menu commands or using command buttons on the **Control panel**, text and/or graphics will be embedded and recorded as they are shown on the image.

(1) Text and graphics written using Data Entry function will be recorded just as they are shown on the image.

(2) Auto Data Display on the bottom of the image will be recorded when the **Embed into Image** check box on **Record** tab of **Setup** window is checked. If the check box is not checked, Auto Data Display text is not recorded even if it is shown on the image.
The control is provided because the Auto Data Display may be used simply for indication purposes.

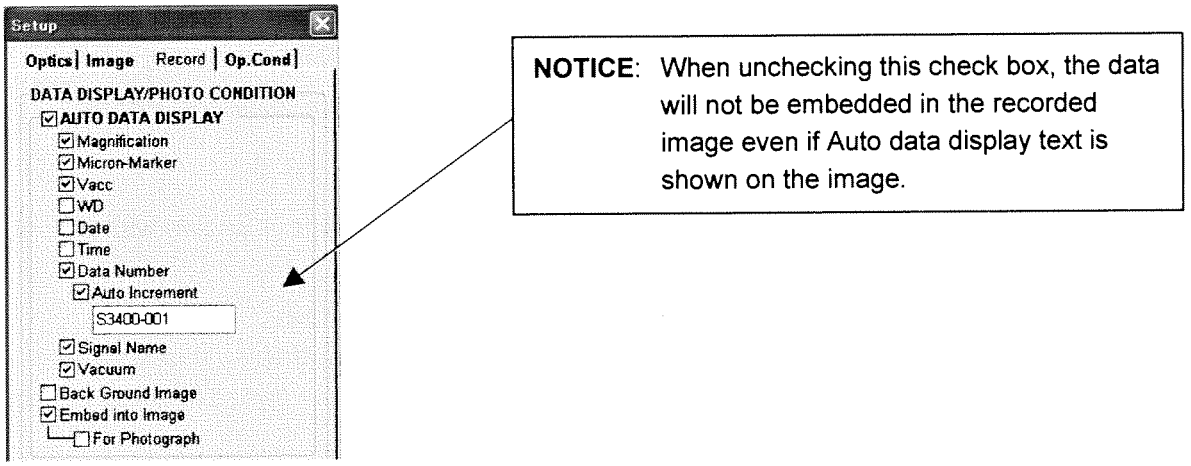


Fig. 3.6-15 Settings Window Recording Tab

3.6.8.2 Captured Image Recording Using Buttons on the Captured Image Window

When images are captured, text and graphics shown on the image at the moment of starting capture are memorized as the data for the captured image. The memorized data will be recorded when the image is recorded using command buttons on the **Captured Image** window.

(1) To change entry data of the latest captured image, edit or add data and then click the **Update** button on the **DATA ENTRY** block. The memorized data for the captured image is then replaced with the new data.
It is not possible if the image has been refreshed by RUN operation.

(2) During a capture process, if data input is performed either to add or change data while the image is being displayed (with a CAP number displayed in yellow on the upper left edge of the image), and then if the image is saved (Direct Save) from either the menu or the Control Panel, photographed, printed, or sent to a PC, the data that is added will be added as data on the captured image.

(3) When the **Embed into Image** check box on **Record** tab of **Setup** window is checked, Auto Data Display on the bottom of the image is memorized for the captured image at the moment of starting capture. The memorized data will be recorded when the image is recorded using command buttons on the **Captured Image** window. If the check box is not checked, Auto Data Display text is not memorized even if it is shown on the image.

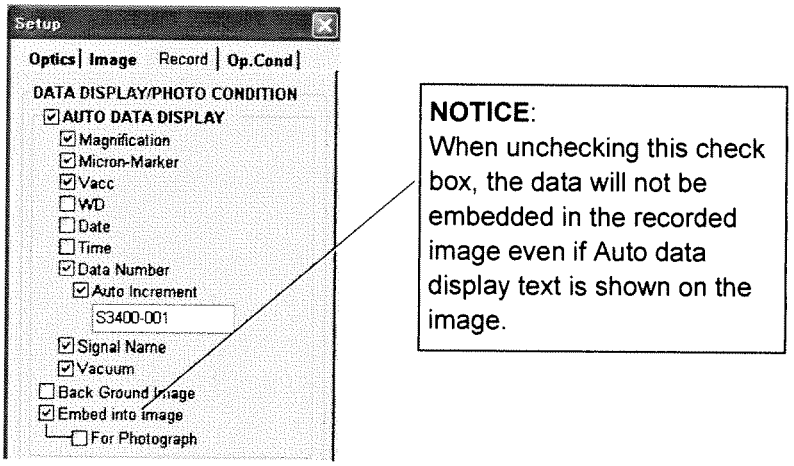


Fig. 3.6-16 Setup Window Record Tab

3.6.8.3 Record Captured Images without Embedding Text or Graphic Data

When the **Embed into Image** check box on the **Captured Image** window is not checked, captured images are recorded without embedding text or graphic data even if the data has been memorized at the moment of capture. This selection can be set at just before carrying out recording.

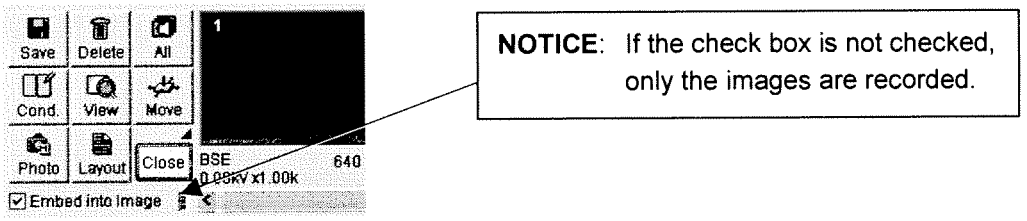


Fig. 3.6-17 Captured Image Window

3.7 Using SEM Data Manager

SEM Data Manager is an image-filing program with an easy-to-operate database function. A database table is established for each user, and acquired SEM images are registered to this table automatically when saving. The **SEM Data Manager** lists image files, finds images following a Select query, displays images, displays and enables image information editing, and allows image processing.
Refer to <3.11 Managing Image Data (SEM Data Manager)>.

3.8 Shutting Down

3.8.1 Turning High Voltage Off

Perform the following procedures when shutting the system down.

(1) Close opening windows. Save data if necessary.

(2) Click the Acceleration Voltage **OFF** [OFF] button on the Control Panel to turn off the acceleration voltage.

3.8.2 Setting the Stage at the Specimen Exchange Position

(1) Type I (manual stage)
Align the axial scale with the specimen change position.

Specimen exchange position	X: 30 mm	Y: 20 mm	Z: 35 mm	
	R: 0°	T: 0°		

(2) Type II (motor drive stage)
On the right edge of the Control Panel, click either the **HOME Z65** button. Wait until the display window to the left of the button lights up in blue.

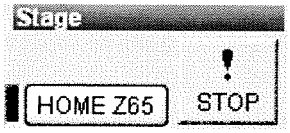


Fig. 3.8-1 Moving to the Specimen Exchange Position

Specimen exchange position	X: 60 mm	Y: 25 mm	R: 0°	T: 0°
	Z: Arbitrary (HOME Z65)			

NOTICE: The specimen stage can temporarily be stopped while moving the specimen stage to the exchange position by clicking the **STOP** button. At this time, should click the **Home Z65** button and move the stage to the specimen exchange position. Then, confirm that the display window of left of the button lights up in blue.

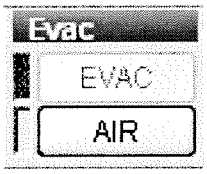
3.8.3 Withdrawing the Specimen and terminating the operation

According to the following procedures, withdraw a specimen from the specimen chamber and perform the exit operation.

(1) If the vacuum mode is set to Low Vacuum (**VP-SEM**) on the Operation Panel, change it to High Vacuum (**SEM**).

(2) On the EVAC panel located on the front side of the main unit, press the **AIR** button. Alternatively, click the **AIR** button located in the upper right section of the Control Panel. This introduces air into the specimen chamber. Wait approximately 100 seconds until the specimen chamber is completely at the atmospheric pressure. (Wait until the electronic sound of the AIR leak rings three times.) At this time, if the stage is not at the specimen exchange position, the stage moves to the specimen exchange position.

EVAC Panel



Control Panel

Fig. 3.8-2 AIR Button (letting air into the specimen chamber)

(3) Grasp the handle on the front side of the specimen stage. Pull the specimen stage forward, and take out the specimen holder.

NOTICE:	When removing the specimen, be sure to put on clean gloves; do not use a bare hand.

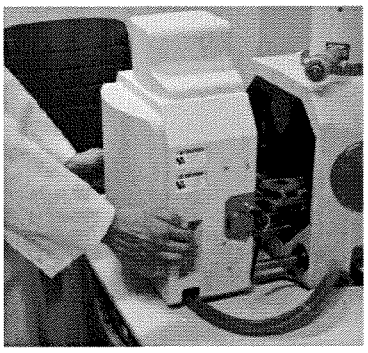


Fig. 3.8-3 Pulling Out the Stage

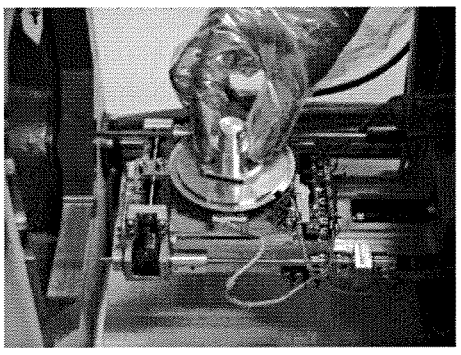


Fig. 3.8-4 Removing the Specimen

IMPORTANT: Do not touch the operation parts such as gears and driving screws and note that clothes are never placed when you bring the hand close to the movement mechanism in the specimen stage by the specimen exchange etc.

(4) Grasp the handle. Insert the specimen stage into the specimen chamber.

⚠ **CAUTION:** When inserting the specimen stage into the specimen chamber, be careful that your fingers are not caught between the stage and the specimen chamber.

(5) The **Specimen Setting** window appears. After confirming the content of the window, click the **Specimen Setting** button.

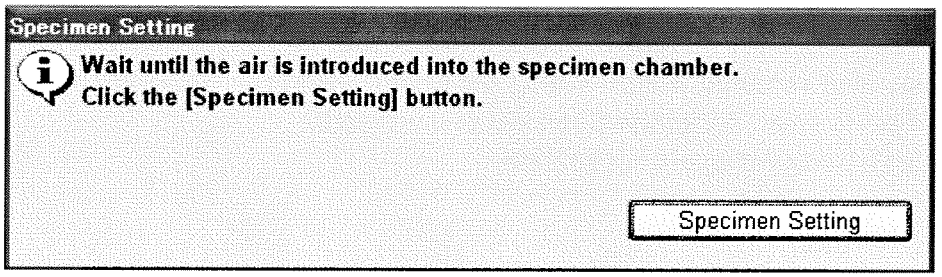


Fig. 3.8-5 Specimen Setting Window

(6) **Specimen/Detector Setting** window appears. Click the **Exit SEM Manager** button to terminate the program.

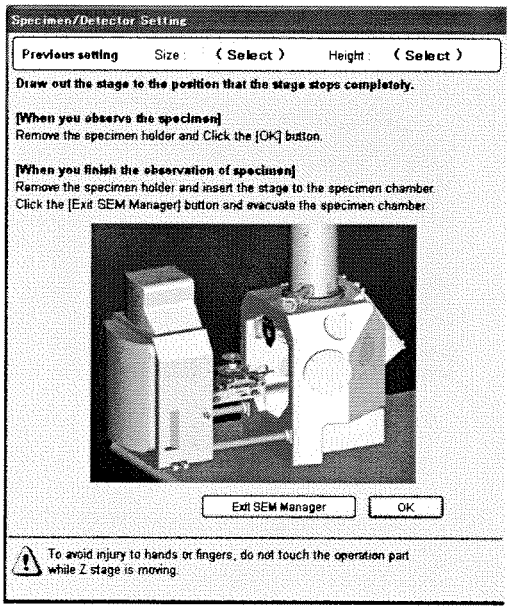


Fig. 3.8-6 Specimen/Detector Setting Window

(7) Confirmation message appears. Click the **OK** button to close the operation screen of S-3400N.

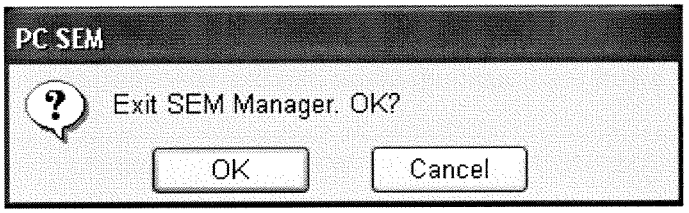


Fig. 3.8-7 Confirmation message

If the processing is not completely finished, the following message appears. If this happens, take appropriate action:

- Some of the captured images still need to be saved:
  [Images in the captured images dialog not saved. Save?]
  Click "Yes" to save. An **Image Save** window appears.
- The acceleration voltage is not shut off:
  [HV will be turned off. OK?]
  Click OK to exit.

(8) On the EVAC panel on the front side of the main unit, press the **EVAC** button. The evacuation of the specimen chamber commences.
If the specimen chamber had already been in a fairly good vacuum condition, a high vacuum state can be attained in approximately 2 minutes. (EVAC button lamp blinks while evacuating and lights when evacuation is completed. The electronic sound rings once when the evacuation system is terminated.)

EVAC Panel

Fig. 3.8-8 Evacuating the Specimen Chamber

(9) On the Windows task bar, click the **Start** button and select **Shut Down**.

(10) In the **Shut Down** window, select **Shut down the computer** and click **Yes**.

(11) Wait until the message "It's now safe to turn off your computer" is displayed, or the power of PC is shut down automatically.

(12) Turn off the key switch located on the front side of the main unit to turn off the power.

> ⚠ **CAUTION:** Wait until the power of PC is shut down automatically, or the message "It's now safe to turn off your computer" is displayed. If the key switch is turned off before the above condition, the power of PC will be shut off while the PC is running and it may cause damage to its data or hard disk.

3.8.4 Termination Confirmation Items

When the key switch is turned off, the **EVAC/AIR** buttons on the EVAC Panel will blink alternately. The power is shut off after the termination procedure for the evacuation system is completed. Normally it takes approximately 10 seconds after the key switch is turned off and before the power is shut off. If a problem occurs during the termination procedure for the evacuation system, the power may fail to shut off after 10 seconds, in which case the main breaker in the back of the main unit should be turned off. Also, the breaker in the back of the main unit should be turned off if the system is to be brought down completely.
To restart the system, turn on the main breaker, and turn the key switch to the **START** position. See <4.5 What to Do in the Event of a Power Outage or the System must be Shutdown Completely for a Long Time>.

3.9 Other Functions

In addition to the basic operations described above, the system provides various functions, which should be employed depending on the particular application to be accomplished.

3.9.1 Screen Mode

Screen modes, **Full**, **Dual** or **Small** are selectable with **SCREEN MODE** block of the operation panel.

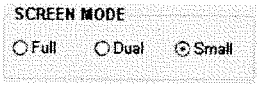


Fig. 3.9-1 SCREEN MODE Block

(1) **Full screen** mode
A scanning image is displayed with full desktop size. Image resolution is 1280 × 960 pixels. It is recommended to use this mode for normal operation.

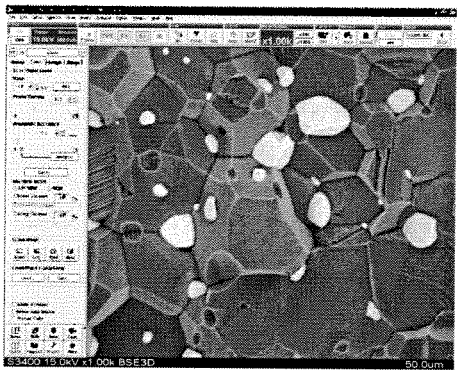


Fig. 3.9-2 Full Screen Mode

Large image provides easy to operate condition. Magnification of displayed image is about 3 times the indication that is calculated for 4 × 5-inch photograph size.
Scan speed is somewhat slower compared with **Small screen** mode. If scanning image is noisy or you need faster refreshing rate, try using **Small screen** mode.
When **TV** scan is selected or in alignment mode, image size is reduced to half to obtain true **TV** rate scanning speed.

(2) **Small screen** mode
Scanning image size is reduced to half. Image resolution is 640 × 480 pixels.
Faster scanning rate compared with **Full screen** mode may result in better image quality in some cases. Magnification of displayed image is about 1.5 times the indication.

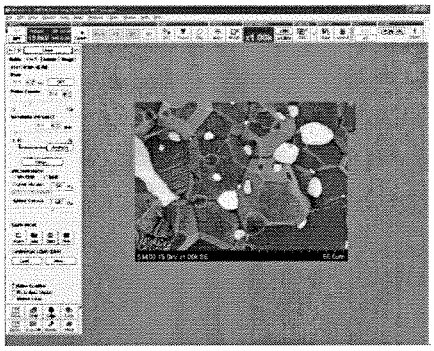


Fig. 3.9-3 Small Screen Mode

(3) **Dual screen** mode
Two 640 × 480 pixel images are shown simultaneously. These two images can be live or frozen independently, and can display different signals or the same signal. In this mode, color mixing is available, while analysis modes (line, spot and area analysis) and split screen modes are disengaged.

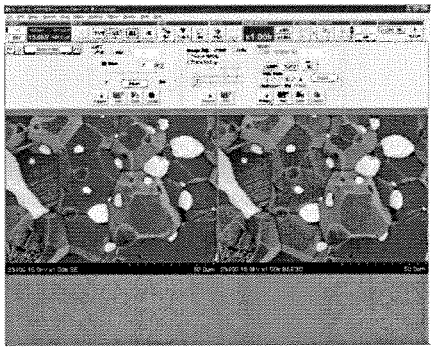


Fig. 3.9-4 Dual Screen Mode

The **Dual** mode in some cases behaves differently from the **Small** mode:

- Signal selection
  You can observe two images with different signals on two image screens simultaneously. Use the **Signal Select** block of the operation panel.

Fig. 3.9-5 Signal Select Block

Left side selection box is for left side (A screen) image, and right side box for right side (B screen) image.

- **Run/Freeze** operation

  Using the  buttons located in the right and left frames at the top of the screen, Panels A and B can independently be switched Run/Freeze. To switch Run/Freeze both for Panels A and B at the same time, use the  button at the center.

- Capturing images

  To capture an image on one of the two screens, click the  button located at the top of the screen to be captured. To capture the images on both Panels A and B, click the  button located in the center.

- Saving and recording an image

  For operations such as direct photo, memory photo, direct save, quick save, direct print, layout print, and PCI transfer can be selected by using the buttons located at the top of the screen. The buttons that are displayed are identical to those displayed in the image recording section of the Control Panel.

- Capture resolution

  Capture resolutions 2560 × 1920 and 5120 × 3840 are not available.

- The brightness and contrast knob assignments on the ABCC and Operation Panel operate on the image signal that is specified by the right or left selection button for image adjustment.

Fig. 3.9-6 Image Adj. Button

- If the scanning speed is RED (1/2/3), the focusing monitor, the BC monitor mode, the alignment mode, or the filament image mode is on, an image is displayed only on the right or left screen. On which screen the image will be displayed depends on the settings that are in effect on the **Image Adj. Left/Right** radio button shown above.

3.9.2 Split Screen and Dual Mag Mode

In the split screen/dual mag mode, the screen can be split two ways to display dissimilar signal images, such as a secondary electron image and a backscattered electron image on the right and left screens (split screen). It is also possible to enlarge a part of the left screen to display it on the right screen (dual mag). This feature can be used in both **Full** and **Small** modes.
Selecting **Split DM Mode** from **Scan** menu brings up the **Split/Dual Mag** controller. Selecting the specific magnification rate under which the image is to be observed split the screen into right and left sections, and displays images enlarged 1×, 4×, and 8× on the right side.

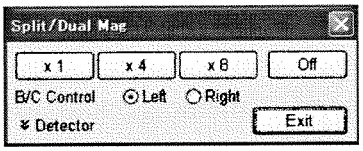


Fig. 3.9-7 Split/Dual Mag Controller

(1) Split screen mode
Clicking the ×**1** button displays dissimilar-signal images at the same magnification on the right and left split screens. By selecting input signals under this condition, it is possible to display images based on different signals on the right and left.
Input signals can be selected and set by bringing up a Setup field using the **Detector** button.

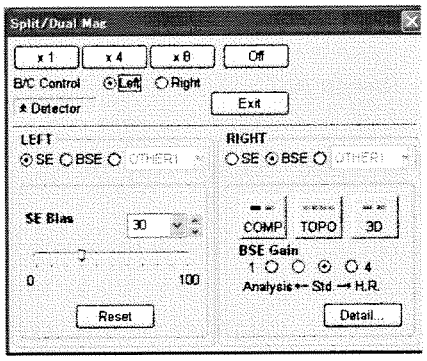


Fig. 3.9-8 Enlarged Display of Detector Settings

(2) Dual mag mode
Clicking either the ×**4** or ×**8** button causes a part of the left screen to be enlarged 4× or 8× and displayed on the right screen. The area to be enlarged is displayed in a box in the left image. By dragging the box, it is possible to specify the specific area to be enlarged.

3.9.3 Signal Selection and Color Mixing

The S-3400N has three external signal channels for optional signal detectors and one X-ray signal input, in addition to the standard secondary electron detector. When these detectors are installed, you can select a signal from among these detectors. Using **Dual screen** mode or **Split screen** mode, you can display two images with two different signals simultaneously. Also color mixing, which combines two signals with different colors, is available.

To select a signal;

(1) Signal selection in **Full** and **Small** screen modes
In the **DETECTOR** block of the Operation Panel, select the signal to be observed.

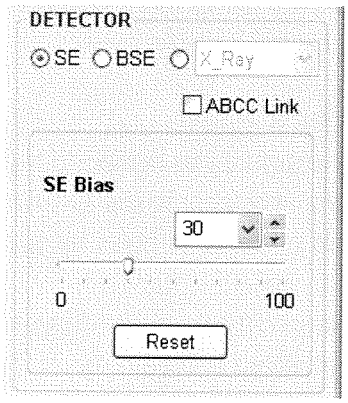


Fig. 3.9-9 DETECTOR Block

The signal for line profile in the Line Analysis mode is selected independently of the signal for image. Use the **LINE PROFILE SIGNAL** block in the **Setup** window - **Image** tab.

(2) Signal selection in **Dual** mode

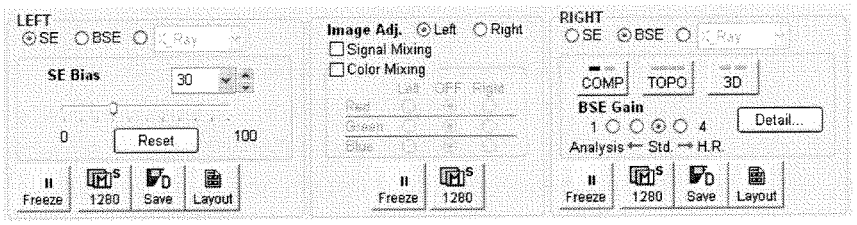


Fig. 3.9-10 Enhanced Control Panel for Dual Mode

In the **Dual** mode, use the left box to select Panel A (left image), and the right box to select Panel B (right image) signals.
Brightness and contrast adjustments using the mouse on the screen work on the image signals that are selected on the signal selection fields in Panels A and B.

(3) **Signal Mixing** (available in the **Dual** mode)
This feature allows you to mix the signals assigned to right and left before displaying them.
The **Signal Mixing** feature is available only in the **Dual** mode.
First, turn on the **Dual** mode, and observe images by assigning different signals to the right and left panels.
In the **Image Adj.** box, place a check mark on the **Signal Mixing** feature, which displays an image produced by mixing the selected two signals on Panel B (the right image).
The example below displays an SE (secondary electrons) image on Panel A (left), and a mixed image of SE (secondary electrons) and BSE (backscattered electrons) on Panel B (right).

Fig. 3.9-11 Signal Mixing Control

- Contrast and Brightness adjustment by mouse operation on scanning image is applied to original signals, not to mixed signal.
- To turn off the **Signal Mixing** mode, simply remove the check mark.

(4) **Color Mixing** (available in **Dual** mode)
When different signals are assigned to the right and left screens, this feature assigns different colors (R/G/B) to the two signals to display a mixed color image. The image on the right will be in color.
First, turn on the **Dual** mode, and then assign different signals to the right and left before observing images.
In the **Color Mixing** block located at the top of the image, place a check mark on the **Color Mixing** check box. Click the color to be assigned to Panel A or B, and assign colors to the various signals. If a given color is not to be assigned, click the **OFF** radio button on it. In the example below, colors are mixed between red signal assigned to Panel A and yellow signal (resulting from a mix of red and green) assigned to Panel B, and the results are displayed on Panel B.

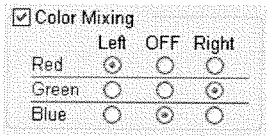


Fig. 3.9-12 Color Mixing Control

Removing the check mark from the **Color Mixing** check box resets the display to ordinary monochrome display. To save a color image, capture it, and then either use the Save option on the **Capture Image** window, or click the **Direct Save** button on the Control Panel.

NOTICE:	Both A and B screen images are refreshed by capturing even when one of the screens was frozen before starting capture.

3.9.4 X-ray Analysis Mode

This is an analysis operation mode, such as line or spot analysis. This mode is specified on the **SCAN MODE** block in the **Cond.** tab of the Operation panel. It is disabled during the **Dual screen** mode.

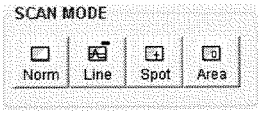


Fig. 3.9-13 SCAN MODE Block

NOTICE:	Move the mouse cursor to analyses Markers, and the markers change to an intersecting arrow mark ✣. Then the mouse wheel button is clicked, color of markers will change to 7 kinds (White, red, green, yellow, purple, and light blue). Default is white. You can use by favor color.

(1) **Normal** mode 

Normal image observation mode. Click this to return from analysis modes.

(2) **Line Analysis** mode 

Displays a line profile of the signal intensity as a horizontal line in the observed image.
The **Line Analysis** button is used for two scanning modes as follows.

(a) **Position Set** mode for **Line Analysis** 

Upon the first click of the button in other scanning modes or in **Line Analysis** mode, a horizontal dotted line cursor is shown on the image. This line cursor corresponds to a position of the scanned line in **Line Analysis** mode. To position the line cursor, locate the mouse icon near to the line. When the mouse cursor is changed to an intersecting arrow mark  , drag the line cursor with the mouse while holding down the left button.

(b) **Line Analysis** mode 

When the **Line Analysis** button is clicked in **Position Set** mode, the scanning image is frozen and a waveform, which is a profile of the signal intensity of the line, is shown on the image. You can move the line cursor in this mode with the same operation as above, and you can change scanning speeds.
Use **Scanning Speed** buttons to select line scan speed. **TV** or **Fast** scans with fast speed, useful for SE or BSE signal profiling. **Slow1** to **Slow6** scans with slow speed, used for X-ray intensity profiling.
When the **Background** in the **LINE PROFILE SIGNAL** block on the **Setup** window - **Image** tab is checked, the line profile is overlaid on the image. When it is not checked, only the line profile is shown on the screen.

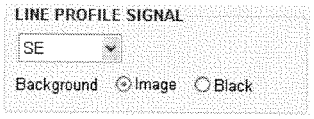


Fig. 3.9-14 LINE PROFILE SIGNAL Block

The **Run/Freeze** button changes run and stop alternately.
In the Freeze state, the line profile of an image is displayed clearly.
Recommended procedure for taking a photograph is:

1) Observe an image in **Position Set** mode at **Slow2** or slower scanning speeds. Click the **Line Analysis** button when the scanning raster reaches the bottom of the screen.

2) Set the line cursor at an analyzing position. Adjust the baseline (in case of SE or BSE, adjust brightness) and the height (in case of SE or BSE, adjust contrast and in case of X-ray, adjust the count-rate meter range) of the profile. Then stop the scanning.

The signal for line profile can be selected independent of the signal for image.
For example, you can observe or take a image of an X-ray intensity line profile on the secondary electron image. To select a signal for the line profile, use the **LINE PROFILE SIGNAL** block on the **Setup** window - **Image** tab.
Saving an image under a Line Profile condition (Freeze state) causes an image containing a profile to be saved. Line profiles cannot be photographed.

(3) **Spot Analysis** mode 

Stops the scanning and places the electron beam at a specified point on the image.
This is used for X-ray analysis of a point on the specimen.
The **Spot Analysis** button is used for two scanning modes as follows.

(a) **Position Set** mode for **Spot Analysis** 

Upon the first click of the button in other scanning modes or in **Spot Analysis** mode, a cross-hair cursor is overlaid on the image. The cross point of the cursor corresponds to a position where the electron beam is positioned in **Spot Analysis** mode.
To select a position of the cursor, locate the mouse icon near the cross point.
When the mouse cursor is changed to an intersecting arrow mark  , drag the cursor with the mouse while holding down the left button.

(b) **Spot Analysis** mode 

Clicking the **Spot** button again freezes the image, and the electron beam is spot-irradiated onto the position of the cross cursor. The analysis position can also be changed in this state.
The **Run/Freeze** button and **Scanning Speed** buttons are disabled in this mode.

(4) **Area Analysis** mode 

Scans the electron beam in a selected frame in the image. This is used for X-ray analysis of a specified area on the specimen.
The **Area Analysis** button is used for two scanning modes as follows.

(a) **Position Set** mode for **Area Analysis** 

Upon the first click of the button in other scanning modes or in **Area Analysis** mode, a box cursor with dotted line is overlaid on the image. The box cursor corresponds to an area where the electron beam is scanned in **Area Analysis** mode.
To set a position and size of the cursor, locate the mouse icon near the line, corner or inside of the box. When the mouse cursor is changed to  or (change the size in horizontal direction),  or (change the size in vertical direction),  (change the size in both directions), or  (move the position), drag the cursor with the mouse while holding down the left button.

(b) **Area Analysis** mode 

When the **Area** button is clicked again, the scanning image is frozen and the electron beam is scanned in the box area. The box cursor changes to a solid line. In that condition, the analysis position can also be changed.
The **Run/Freeze** button and **Scanning Speed** buttons are disabled in this mode.

3.9.5 Signal Processing

Processing of the image signal is available on a live image.
For SE signal, digital processing, spatial filtering, gamma control and inversion can be applied.
In addition, analog signal processing is available for an optional detector signal.

(1) Digital signal processing
From the **Image** menu, select **Signal Processing**.

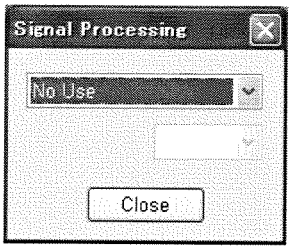


Fig. 3.9-15 Signal Processing Window

Click button and select a processing on the pull-down list that appears.

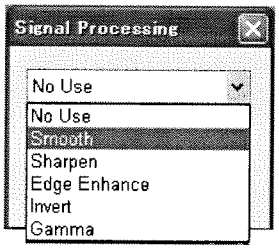


Fig. 3.9-16 Signal Processing List

Some of the processing includes depth of processing. Select with the selection box.

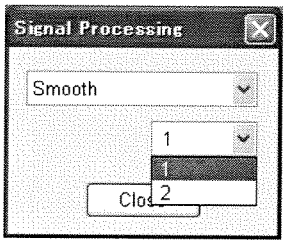


Fig. 3.9-17 Signal Processing Depth List

The following processing is available.

(a) **Smooth** (1/2)
Reduces snow noise. It is effective especially at high magnification, where originally image itself has defocusing limited by spatial resolution. In this case, noise can be reduced without image defocusing.
For lower magnification images, the processing may cause loss of sharpness.

(b) **Sharpen** (1/2)
Increases image sharpness.
Snow noise may be intensified if the image includes noise.

(c) **Edge Enhance** (1/2)
Similar but stronger effect than the above **Sharpen**.

(d) **Invert**
Inverse contrast.

(e) **Gamma** (-5 to +5)
Plus value of Gamma suppresses white contrast and enhances dark part.
Minus value increases contrast.

NOTICE: 1. The digital processing is applied to saved images and pictures taken using Memory photographing. It is not applied to pictures taken with Direct photographing.
2. When you set or change the processing, scanning will be reset to the top of the frame.

(2) Analog signal processing for optional detector signal
To use analog signal processing, click the **Option Signal** button in the **SIGNAL PROCESSING** block on the **Operation panel**. The **Opt. Signal Processing** window will open.

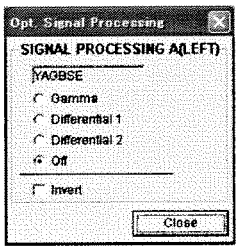


Fig. 3.9-18 Opt. Signal Processing Menu

(a) **Gamma**:
Gamma correction suppresses excessive contrast, maintaining the contrast of the average brightness of the image.

(b) **Differential**:
Differential 1 and 2 are high-pass filters for the image signal. When applied, the image is differentiated in a horizontal direction and details of the image are emphasized, while broad shades are suppressed. Results vary with scanning speeds because it applies time domain differentiation.

(c) **Invert**:
Inverse contrast.

NOTICE: 1. Signal processing mode of the Gamma and the Differential is not applied to TV and FAST scanning.
2. Please observe the differentiated image by a scanning that is slower than SLOW3, because results vary with scanning speeds.

3.9.6 Operating Condition Memory

The **Operating Condition Memory** is provided for saving and loading conditions of the electron optical column. If the column is aligned and a specimen is observed at a particular accelerating voltage, the same condition can be reproduced by saving and loading the condition memory.

(1) Saving Present Operating Conditions
Use the following steps to save the present operating conditions.

(a) Open the **Setup** window
Either select **Condition Save** from the **Setup** menu or click the **Save** button on the **CONDITION LOAD/SAVE** block of the Operation panel. Then select the **Save Present Condition** radio button.

(b) Refresh present condition data
Condition items are memorized when the tab is brought up. If column condition is changed while the tab is opened, the **Update** button memorizes the present condition.

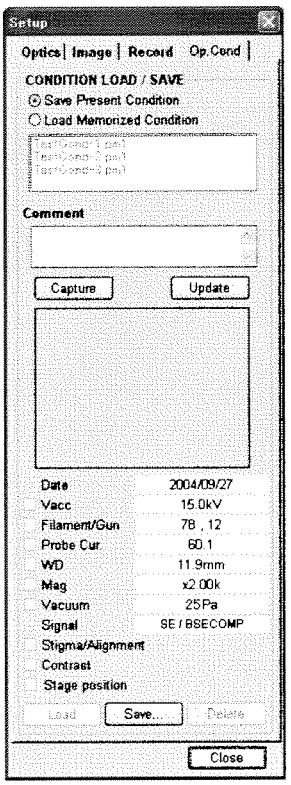


Fig. 3.9-19 Op.Cond Tab (Save)

NOTICE: The memorized condition data remains until the **Update** button is clicked, even when loading previously stored condition. Update the present condition by the **Update** button before saving.

(c) Capture an image as a sample picture
The **Capture** button captures the present scanning image. It can be memorized together with condition data.

(d) Saving condition data
Click the **Save** button. The **Condition Save** window will open.

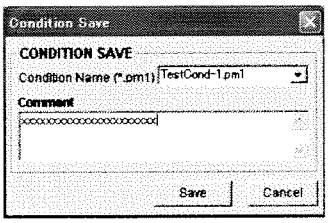


Fig. 3.9-20 Condition Save Window

Input a comment; specify a **Condition Name** and then click the **Save** button.

(2) Loading a Set of Operating Conditions
Perform the following steps to load electron optics system observation conditions and reset the electron optics system to those conditions:

(a) Open the **Setup** window
Either select **Condition Load** from the **Setup** menu or click the **Load** button on the **CONDITION LOAD/SAVE** block of the Operation panel. Then, select the **Load Memorized Condition** radio button.

(b) Select a condition name
Memorized condition names are listed. Select a name by clicking it. If a sample image was previously saved, the image is displayed.
Use sample picture and comment for reference of selection.

(c) Select items to be loaded
The items following **Vacc** represent the recorded observation conditions. Check the items to be reset on the system, and uncheck those items that are not needed. **Stage position** is effective only for Type 2 instrument.

(d) Reproduce column condition
Click the **Load** button. Memorized data are retrieved and the electron optical column is set.

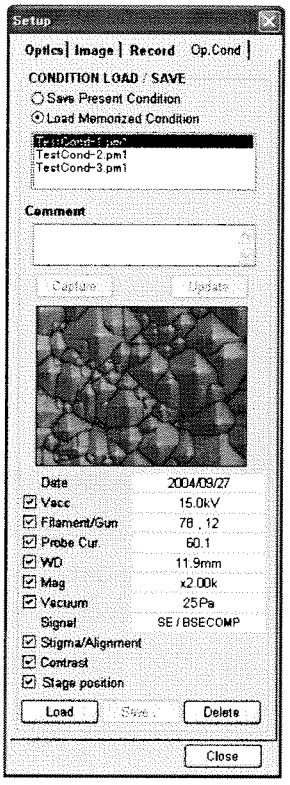


Fig. 3.9-21 Op.Cond Tab (Load)

If the **Stigma/Alignment** is checked, a message will appear for confirmation. These are possibly changed if the loaded condition was saved long before.
In such cases, it may be better not to reproduce Stigma and Alignment data. The recent data is memorized automatically by another condition memory function (the most recent condition for each of Vacc - Condenser lens setting is memorized and reproduced automatically).

(3) Deleting an operating condition
Select a condition name in the same manner as above, and click the **Delete** button.

3.9.7 Pseudo Color Display

Image pseudo colors can be displayed on SEM Data Manager.
See 3.11.3.7 Contrast Conversion.

3.9.8 Data Entry Function

Use the **DATA ENTRY** block on the Operation panel for drawing graphics and texts on the scanning image display. For saved image, use the same function provided in the **SEM Data Manager**.

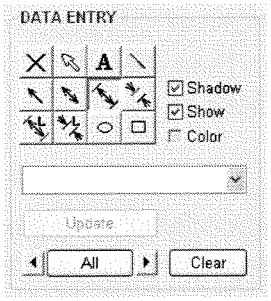


Fig. 3.9-22 DATA ENTRY Block

(1) Function of tool buttons

(a) **Stop data entry**

Stops data entry. Tool buttons are disabled.
Drawn data remains on the image.

(b) **Edit text**

Edits already written texts.
Selecting the **Edit** button changes mouse pointer to mark. Click the text to be edited. The text is changed to black background form. You can edit the text.
The Enter key terminates editing. The text is shown in red color and you can move its position by dragging it with mouse.

(c) **Text input**

Writes texts on the image.
After selecting the button, click on the image. The text input area of black stripe is shown on the image. Input text using keyboard and terminate with Enter key.
The text is shown in red color and you can move its position by dragging it with mouse.
If you enter a text in the text box and then click on the image, the text is placed automatically. 10 recently used texts are memorized and can be selected with the button. Use the function when you repeat writing the same or similar texts.
To set the font and size, use **DATA ENTRY/MEASUREMENT** window in the **Optional Setup** window - **General** tab.

(d) **Line**

Draws lines on the image. Click this button, and press the left button of the mouse to create the starting point of the line on the image. Move the mouse to an end position and then release the button of the mouse. While this button is depressed, you can repeat a line drawing.

(e)  **Arrow**

Draws single-head arrow marks on the image.

(f)  **Double head arrow**

Draws double-head arrow marks on the image.

(g)  **Inner dimension mark**

Draws inner dimension arrow marks on the image.

(h)  **Outer dimension mark**

Draws outer dimension marks on the image.

(i)  **Inner dimension mark with measurement**

Draws inner dimension marks with measurement on the image.

(j)  **Outer dimension mark with measurement**

Draws outer dimension marks with measurement on the image.

(k)  **Circle**

Draws circles or oval shapes on the image. Click this button and press the left button of the mouse to create a starting point on the image. Draw a shape by moving the mouse and then releasing the mouse button. While this button is depressed, you can repeat drawing of a shape.

(l)  **Rectangle**

Draws rectangles on the image. Click this button and press the left button of the mouse to create a starting point on the image. Draw a shape by moving the mouse and then releasing the mouse button. While this button is depressed, you can repeat drawing of a shape.

(m) **Shadow** check box

When the **Shadow** box is checked, texts and graphics are drawn with shadow.

(n)

Text box

If you enter a text in the text box and then click on the image for text, the text in the text box is placed automatically. 10 recently used texts are memorized and can be selected with the  button. Use the function when you repeat writing the same or similar texts.

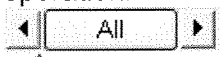
(o) **Show** check box

Shows (checked) or hides (unchecked) text and graphics.

(p) **Color** check box

Switch the color of the text, the graphics, and the mouse cursor.
Change the color displayed by clicking the color check box.

(q) **Update** button
The entry data is memorized at the moment of image capture for the image. However, it is possible to edit or add entry data while the captured image remains on the image screen. To exchange the previously memorized data with new edited data, click the **Update** button. It is possible only before the image is refreshed by RUN operation.

(r) 

Select buttons
or button selects graphics or text on the image in order. A selected graphics is indicated with gray color and a surrounding dotted line box. A selected text is indicated with gray color and black background. They can be moved and re-positioned by mouse dragging. A selected text can be edited by double-clicking on it. The text line is prolonged and editing becomes possible.
All button selects all graphics and text.

(s) **Clear** button
Clears selected graphics or text.

(2) Entry data and show/hide drawn data
When tool buttons except for **Stop data entry** are pressed, a green dotted rectangle will be shown on the image. It shows area for data entry. The selected shape or text can be drawn.
The **Stop data entry** button disables data entry and the area rectangle is cleared.
To hide drawn data, uncheck **Show** check box.

(3) Editing texts
To edit already written texts, select the **Edit text** tool.
Selecting the button changes mouse pointer to mark. Click the text to be edited. The text is changed to black background form. You can edit the text. The Enter key terminates editing. The text is shown in red color and you can move its position by dragging it with mouse.

(4) Moving position or deleting drawn data
or button selects graphics or text on the image in order. A selected graphics is indicated with gray color and a surrounding dotted line box. A selected text is indicated with gray color and black background. They can be moved and re-positioned by mouse dragging. A selected text can be edited by double-clicking on it. The text line is prolonged and editing becomes possible.
The **Clear** button erases the selected data. To erase all, select all data by clicking **All** button and then click the **Clear** button.

(5) Embedding into image data

(a) Save (direct save or quick save), print, or PCI transfer from the menu or control panel
Any of these actins records the currently displayed image, and the input data, in the form that is displayed, is also embedded into the image.

NOTE: (See 3.6.8 Recording Data Display with Images.)
Any graphics and character written using the data entry function, in the form that is displayed, is recorded together with the image.
The Auto Data Display mode saves the data displayed on the screen together with the image itself if the **Embed into Image** check box is turned ON in the **Record** tab of the **Setup** window. If the check box is turned OFF, the displayed data, even when appearing on the screen, will not be saved as embedded data. Since auto data display, even when not recorded, can be used for monitoring purposes during operation, can be specified in terms of embedding/not embedding into the recorded image in this manner.

(b) Using a command button on the **Captured Image** window
When an image is captured, the contents of the displayed input data and auto data display are stored separately by captured image.
Use the command button on the **Captured Image** window to save the image. When printing or PCI-transferring the image, the "contents drawn at the time of image capture," that were stored at the time of the execution of capture are embedded.
If data is entered, data can be added or modified after the execution of capture. To do it, when the captured image is still remaining as a displayed image (before RUN or before the execution of the capture of another image), add or change data entry, and then click the **Update** button of the **DATA ENTRY** window. Additions or modifications cannot be made after the displayed image has changed from the captured image due to the execution of RUN or a capture.

NOTICE: The **Auto Data Display** mode saves the data displayed on the screen together with the image itself if the [Embed into Image] check box is turned ON in the **Record** tab of the **Setup** window. If the check box is turned OFF, the displayed data, even when appearing on the screen, will not be saved as embedded data.
If the Input Data and Auto Data options are on at the time an image is captured, only the image can be saved by unchecking the **Embed into Image** check box on the **Captured Image** window.
If the data being displayed is to be saved together with the image, turn ON the check box.

NOTICE: If an image is displayed with dimensions, and if the magnification factor is changed after the image is input, the dimensions are recalculated and re-displayed at the following timing:

- When the image is frozen
- When the image being scanned is fixed, such as executing the Capture function

NOTICE:

1. Dimension marks with measurement calculate dimension using present magnification value. The dimension value will be re-calculated when image magnification is changed. In Dual Screen mode, it is possible to display two different magnification images.
2. On rare occasion, the results of character input appear as double-stacked characters. If this problem occurs, it can be repaired by editing (character editing) the affected character or by drawing the graphic. The user is requested to perform this operation.
3. Any entered data is canceled if the screen mode (full/dual/reduced) is changed.

3.9.9 Raster Rotation, Dynamic Focus and Tilt Compensation

(1) Raster Rotation
Scanning of electron beam can be rotated within a range of -200° to +200°, using the slider. This allows observation of an image at the best orientation. Use the **R. ROTATION** block on the **Operation panel**.

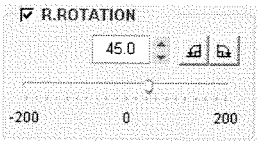


Fig. 3.9-23 R.ROTATION Block

To operate the Raster Rotation, check the **R. ROTATION** check box.
To select a rotation angle, move the slider, click the arrow buttons, or input an angle into the angle indication box.

Also mouse operation on image can be used.
For operating procedures, see 3.5.7.6 Mouse Operation of Stage on the Scanning Image (12) Rotation adjust tool.

NOTICE: Image rotation caused by the objective lens magnetic field is compensated automatically even when the above rotation angle is set at **0** or the **R. ROTATION** check box is not checked. The scanning direction is kept to coincide with the direction of stage movement by this function. If it is necessary to disable the automatic compensation, set the **WD-Rotation Link** to off in the **Optional Setup** window - **General** tab.
For normal operation, it is strongly recommended to enable the automatic compensation function.

(2) Tilt compensation (Dynamic focus and Tilt magnification compensation)
When a specimen is tilted at a large angle, the field of view that can be focused is small (particularly at low magnifications and at a short WD). Dynamic Focus function allows you to focus the beam for the entire field of view. Dynamic Focus scans the focal length linked with the scanning positions.
Also magnification along the tilting direction is lower than that in a non-tilting direction. As a result, the image appears to be contracted in the tilting direction. The image can be corrected so the magnification is accurate in all directions by using Tilt (magnification) compensation.
To operate this function, click **Image Adjustment** on the **Operate** menu, and select the **Tilt Comp.** tab of the **Image Adjustment** window that appears.

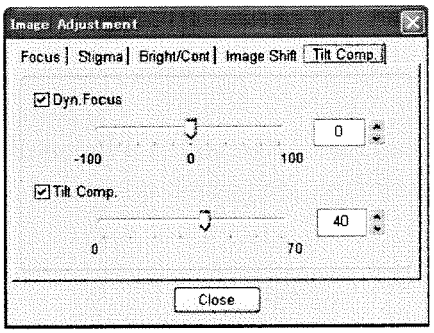


Fig. 3.9-24 Tilt Comp. Tab

Use the following steps to focus the entire field.

(a) Set the Raster Rotation angle at **0**. In this condition, direction of the scanning beam coincides with the specimen tilting direction.

(b) Check the **Dyn.Focus** check box and focus the image so that the center of the image is focused. Adjust the **Dynamic Focus** slider so the whole image is in focus.

(c) Alternately, use the Reduce 2 scanning speed. After focusing the center part of the image, set the scanning speed at Reduce 2 and move the scanning area to the top of the screen. Adjust **Dynamic Focus** slider for the best focus.

Take the following steps to use Tilt (magnification) compensation.

(d) Check the **Tilt Comp.** check box, and set the angle to the specimen tilting angle (move the slider or input an angle into the angle indication box).

NOTICE: If magnification, WD, or accelerating voltage is changed, the Dynamic Focus slider needs to be re-adjusted.
Tilting the specimen extensively can cause distortion in the observed image at a low magnification or low accelerating voltage as the electron beam undergoes a rotation in the objective lens magnetic field.
At SLOW1 or faster scanning speed, unexpected defocusing may appear in the image. It is caused by a slow response of the magnetic field of the objective lens.
Tilt Compensation may result in an unnatural image when a specimen has three-dimensional structures.

3.9.10 Printing Images Using Report Generation Function

The scanning image or saved image can be printed using a Windows-supported printer.
This function allows you to lay out and print one or more images on paper with a specified size.

(1) Startup

The **Report Generation** window opens when **Layout Print** is executed from the **File** menu, or the Layout button is clicked from the Control Panel or the **Captured Image** window.
In this case, the following image is displayed in the window:

- Activated from the menu or the Control Panel
  The observed image is displayed on the layout. (In the **Dual** screen mode, when clicking the right or left layout button of the control panel, the image on the clicked side is displayed.)
- Re-activated when the **Report Generation** window is already open
  Adds the image that is being observed to the layout.
- Activated from the **Captured Image** window
  The selected (yellow-rimmed) thumbnail image is displayed on the layout.
  Plural selected images are displayed on the layout when activating this function after plural images are selected (Hold the Ctrl key down and click plural thumbnails).

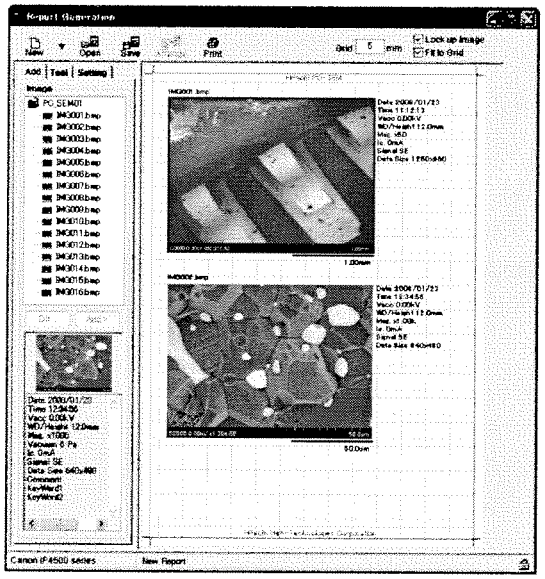


Fig. 3.9-25 Report Generation Window

(2) Selection of printer and setting sheet size
Use the **Printer** area on the **Setting** tab to select a printer to be used and to select sheet direction.
Use Windows function for printer property setting and sheet size selection.

(3) Setting image size on the sheet
Click the **Image Setting** button in the **Setting** tab. The **Image Setting** window will open.

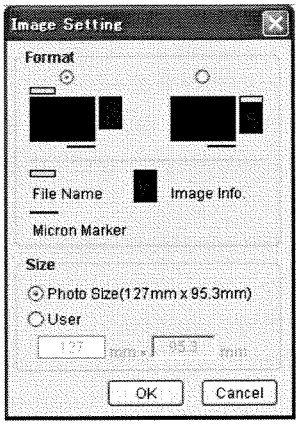


Fig. 3.9-26 Image Setting Window

- **Format**
  This allows you to specify whether the file name of the image to be printed should be printed independently in the upper left portion of the image or it should be printed as part of the image attribute section.
- **Size - Photo Size** (127 mm x 95.3 mm)
  When an image is added, the same image size as the Polaroid film is used (at this size, the magnification rate for the printed image will be equal to the magnification rate of the displayed image).
- **Size - User**
  By selecting this option and entering a numerical value (in mm) in the box on the left side, you can specify an image size for the printed results. (This setting applies to the image size to be registered in the layout.)

NOTICE: The size setting is not effective for already brought up images. To change the size of these, right-click the mouse on the image and select **Set default size** in the opening pop-up menu.

Images can be added from the **Add** tab.

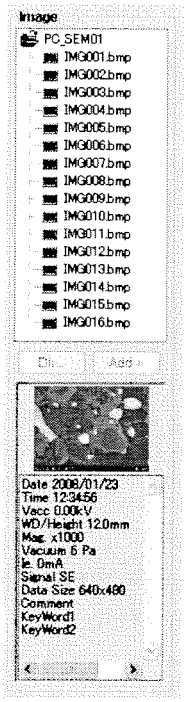


Fig. 3.9-27 Add Tab

(4) Adjusting layout and image size

To adjust image size on the sheet, select an image by clicking it and drag the lower-right corner.

To move an image, drag it using the mouse.

The  button on the toolbar arranges images automatically.

When adjusting the layout manually, use either the **Grid** or **Fit to Grid** function to bring up grid lines so that the images being adjusted can be aligned to the grid lines and made to line up along them.

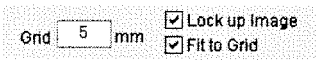


Fig. 3.9-28 Grid Control

When the "Lock up Image" check box is checked, the image position adjustment with mouse, deletion, size change of images are inhibited. And the Edit Lock  mark is located in the lower right part of the menu.

(5) Text information

- Header and Footer
  On the **Setting** tab, enter the header and footer texts. Both are printed on the sheet when **Header** and **Footer** boxes are checked.

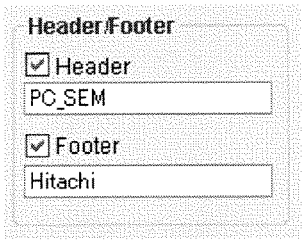


Fig. 3.9-29 Header/Footer Block

- File name and image information
  File Name, **Micron Marker** and **Image Info.** are printed around the image when check boxes for each on the Display tab are checked.
  To change these fonts, click the **Set** button for **Font** located under the Control to bring up a Font setup window.

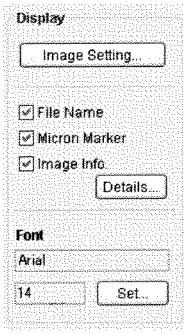


Fig. 3.9-30 Display Block

- Comment
  Press the **A** button on the toolbar and click on the sheet.
  The window for comment will open. Input a comment.
  To change comment fonts or size, click the **Font** button in the **Comment** block to bring up a Font setup window.

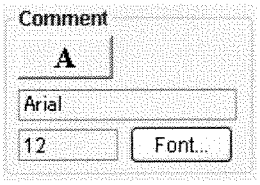


Fig. 3.9-31 Comment Block

The comment placed on the sheet can be moved by mouse dragging. To edit a comment, double-click it. The **Font** window will open and you can edit the comment on it.
To delete a comment, highlight the comment with the mouse, and then press the **Delete** button on the keyboard.

(6) Contrast adjustment
When you click an image on the sheet, the image will be brought to preview area of the **B/C Adjustment** block of the **Tool** tab.
Adjust brightness and contrast using scrollbars. The **Auto** button will make auto adjustment.

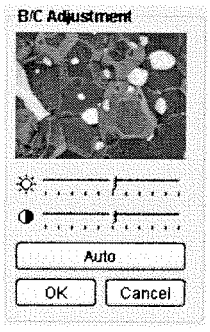


Fig. 3.9-32 B/C Adjustment Block

The result of adjustment is applied to the image on the sheet by clicking the **OK** button.

(7) Print
Set number of print on the **Setting** tab and then click the **Print** button.
The layout sheet will be printed.

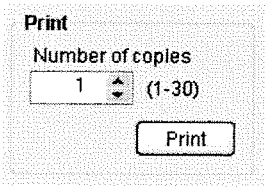


Fig. 3.9-33 Print Block

(8) Additional functions
These functions allow you to perform image contrast compensation on the layout, fetching images that are registered in **SEM Data Manager**, and saving and reading paper formats.

- **Batch Print**

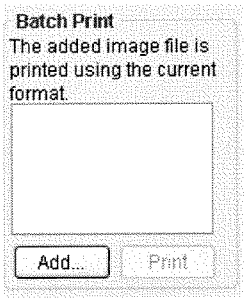


Fig. 3.9-34 Batch Print Block

By clicking the **Add** button, you can specify an image file and add it to the list.
By clicking **Print**, you can print the image that was added to the list in the layout.
These functions can be used to print different images in the same layout.

- **Index Print**
This function allows you to print a list of images managed by user name selected under **User** (a user name created for image management under SEM Data Manager), in a reduced format.

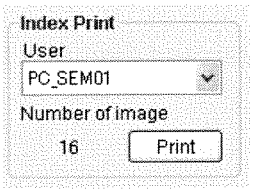


Fig. 3.9-35 Index Print Block

- **Layout Template**

  The Layout Print application provides predefined report templates. Clicking the ▼ button to the right of the **New** button brings up the window shown above, from which a desired layout can be selected:

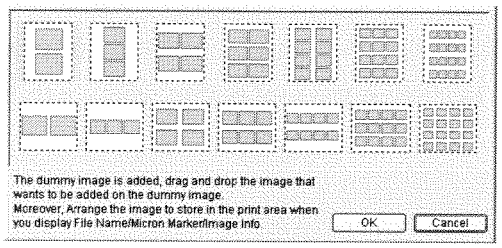


Fig. 3.9-36 Layout Template Menu

Select a template by clicking it and click the **OK** button. Existing images on the sheet is cleared by this operation. To avoid a careless operation, the confirmation message is displayed.

Lock up Image ☑ Lock up Image  is set when the new template is selected. Uncheck the box to change the image and arrangement.

- **Open/Save**

  A layout that has been created can be opened and saved by using the button shown in the above figure on the Toolbar.

  The Save process can also output to HTML format documents in addition to report files.

  Lock up Image ☑ Lock up Image  is set when the report is opened. Uncheck the box to change the image and arrangement.

Fig. 3.9-37 Open/Save Button

- **Document**

  Create a page as Microsoft Word document.

  This button will be shown only when Microsoft Word is installed in the PC.

  This function is effective with Word 2003.

Fig. 3.9-38 Document Button

3.9.11 Copy Image

The Copy Image command copies the scanning image to the Windows clipboard in a size of 1280 × 960 pixels (**Full** screen) or 640 × 480 pixels (**Small** or **Dual** screen). The copied image can be used in any application software such as a word processor or image processor by pasting it from Windows clipboard.
To copy an image to the Windows clipboard, select the **Copy Image** command from the **Edit** menu or click the **Copy** 

button on the tool button area on the Operation panel.

3.9.12 Copy Attribute

The Copy Attribute command copies information in the auto data display to the Windows clipboard as a text file. The copied text can be used in any application software such as a word processor or image processor by pasting it from Windows clipboard.
To copy image attributes to the Windows clipboard, select the **Copy Attribute** command from the **Edit** menu or click the **Copy** 

button on the tool button area on the Operation panel.

3.9.13 Oblique Image

An oblique (or bird's-eye-view) image is formed from a scanning image.
To open the **Oblique Image** window, select the **Oblique** command from the **Analysis**.

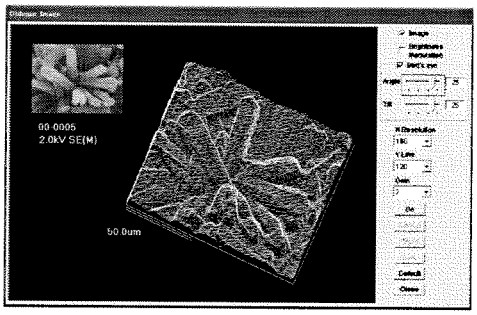


Fig. 3.9-39 Oblique Image Window

(1) Setting properties
Check the **Image** check box to show reference image together with oblique image.
Bird's eye area specifies viewing angle and tilting angle. If it is not checked, just a flat image is formed.
X Resolution and **Y Line** specify number of horizontal pixels and vertical lines. Too much **Y Line** may cause overlapping of lines and result in a complicated image. Select a proper number.
Gain sets height of modification.
Brightness Modulation modulates brightness of each line with signal intensity. If not checked, lines are drawn with a fixed brightness.

(2) Drawing and recording oblique image
Go button starts drawing image. **Photo** button is for photographing (needs photo monitor option). Click the **Save** button to save the oblique image.

3.9.14 Optional Setting

Operation environments are set on the **Optional Setup** window. To open the **Optional Setup** window, select the **Optional Setup** command from the **Option** menu or click the **Option** 

button on the tool button area of the Operation panel.
The window has 6 tabs. Each has functions as follows.

NOTICE:	Setting on each tab is applied when the **OK** button is clicked.

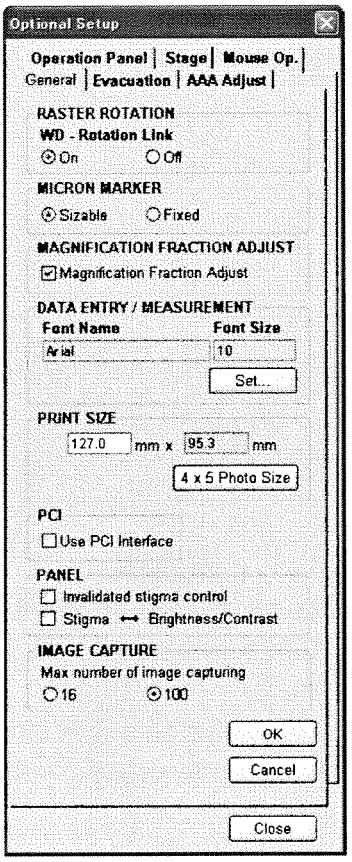


Fig. 3.9-40 General Tab

(1) **General** tab: general setting

(a) **RASTER ROTATION**
WD-Rotation Link selection specifies if the image rotation caused by the objective lens magnetic field will be compensated automatically or not.
For normal operation, it is strongly recommended to enable the automatic compensation function.

(b) **MICRON MARKER**
When Sizable is selected, the length of the micron marker will be adjusted so the length indication does not have a fraction.
If Fixed is selected, the length is fixed at 30 mm on 4 × 5-inch photograph. In this case, the length value indication some times has a fraction, especially by coarse focusing.

(c) **MAGNIFICATION FRACTION ADJUST**
Put check mark to this check box to enable the auto magnification fraction adjustment. Magnification value will have fraction by focusing operation.
The auto fraction adjustment calculates and set nearest even magnification value when starting image capturing or direct photographing.

(d) **DATA ENTRY/MEASUREMENT**
This box allows you to specify the character font to be used in the **Data Entry** and **Measurement** functions.
Specify the font in **Font Name**, and the character size in **Font Size**.

(e) **PRINT SIZE**

This box allows you to specify an image size on the application if an image saved in either TIFF or BMP format is assigned in an application that supports X Resolution/Y Resolution that are stored in a file in the S-3400N. Entering an X value in the left box automatically sets a Y value (0.75 times the value of X). In applications such as Adobe PageMaker, Adobe Photoshop, and Microsoft Word that support this feature, a font size can be assigned in a specified value irrespective of the number of pixels in the image. Many of the commonly used word processing programs may not support this feature, in which case a value specified in the **PRINT SIZE** box will have no effect.
By clicking the **4×5 Photo size** button, it is possible to specify a font size equal to the magnification rate for the image that was photographed using 4 × 5-inch Polaroid film.

(f) **PCI**

If PCI (a database program made by Quartz Imaging Corporation) is installed in the system, this box should be checked on.

(g) **PANEL**

This box allows you to specify Operation Panel settings.
Turning on the check mark on **Invalidated stigma control** disables the Stigma knob on the Operation Panel.
Turning on **Stigma⇔Brightness/Contrast** switches between the Stigma X/Y knob and the Brightness/Contrast knob on the Operation Panel.

(h) **IMAGE CAPTURE**

The max number of image capturing can be changed from 16 images to 100 images (The max number of image capturing is set to 16 images when being shipped from the factory).

NOTICE:	The setting cannot change when **Captured Image** window has any image. The setting for the max number of image capturing can change without image in **Captured Image** window.

(2) **Operation Panel** tab

The arrangement of control blocks to be placed on the operation panel can be customized.
See 2.3.2 S-3400N SEM Main Window.

(3) **Stage** tab

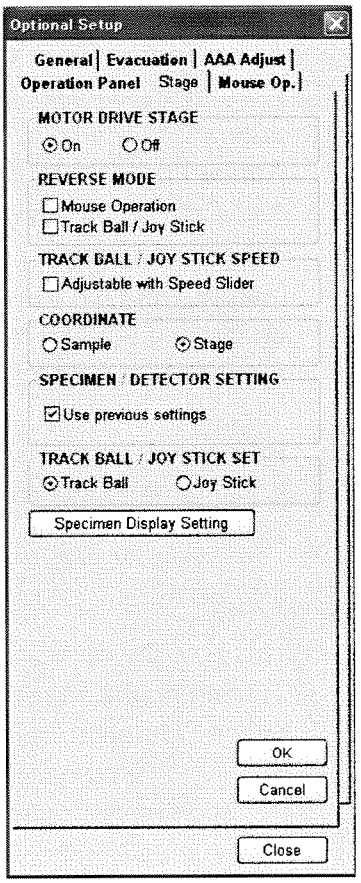


Fig. 3.9-41 Stage Tab

(a) **MOTOR DRIVE STAGE**
Selects enable (**On**) or disable (**Off**) for motor driven stage (5-axis motorized stage of type Ⅱ). Set it at **Off** when the motorized stage is removed or not used, for example when using the cryo-stage. It is necessary when control program accesses motor drive part and may be locked up if there is no response from the motorized stage.

(b) **REVERSE MODE**
Changes direction of image motion by mouse operation on the scanning image and by the trackball and the joystick. When it is not checked, image moves in the direction of mouse movement or trackball rotation. When it is checked, image moves in the reverse direction.

(c) **TRACK BALL/JOY STICK SPEED**
When this box is checked, stage driving speed by the trackball or the joystick option can be adjusted with the **Speed** slider on the **Stage** tab on the **Operation panel**.

(d) **COORDINATE**
Selects coordinate notation.
Refer to 3.5.7.1 Coordinate Notation.

(e) **SPECIMEN/DETECTOR SETTING**
Use previous setting Check box
When it is checked, the previous setting value is set and displayed in the **Set Sample Size / Detector** window. When it is not checked, the character of [(Select)] is displayed in the window. It is not checked in default.

(f) **TRACK BALL/JOY STICK SET**

Only when both the track ball and joystick are attached, this set item is displayed.
The stage controller can be selected. The track ball has been selected in default.

(g) **Specimen Display Setting**

The display of the specimen size can be customized.
When checking the check box in the **Specimen Display Setting** window, the specimen size that is selected is added to the size list of the **Specimen/Detector Setting** window.
The specimen size that is not checked is not displayed on the size list.
All the sizes are checked in default.
The specimen size of 15 mm, 26 mm, and 51 mm that are standard accessory are always shown in the size list.
Refer to 3.2.4.3 Setting the Specimen Size and Height.

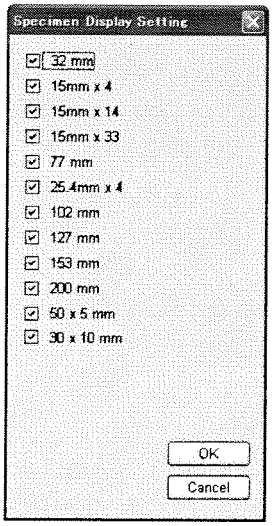


Fig. 3.9-42 Specimen Display Setting Window

(4) **Mouse Op.** tab

Set the sensitivity of mouse operation (focus, stigma, brightness and contrast adjustment) on the scanning image.

Set a slider control at the **Slow** side for lower sensitivity or at the **Fast** side for higher sensitivity. Adjustable range is from a half to 1.5 times the default sensitivity.

On each of the **Stigma, Brightness/Contrast**, and **Focus**, specify whether mouse operations are to be performed on the image. By checking the appropriate check box for these functions, you can perform mouse operations. Because stigma adjustments require experience, if the **Stigma** box should not be touched by mistake, the check box for it should be turned off.

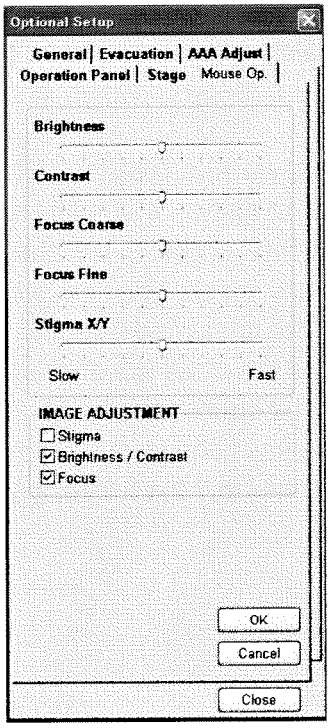


Fig. 3.9-43 Mouse Op. Tab

(5) Selecting a vacuum mode when the application is started: **Evacuation** tab/**Evacuation** menu

- Selecting a startup vacuum mode
  This box allows you to specify the particular vacuum mode to be in effect when an application is started. The **Previous Mode** recalls the vacuum mode that was used previously. The **SEM** option starts the High Vacuum mode. The **VP-SEM** option starts the Low Vacuum mode. For low vacuum, the desired vacuum level can also be specified at the same time.

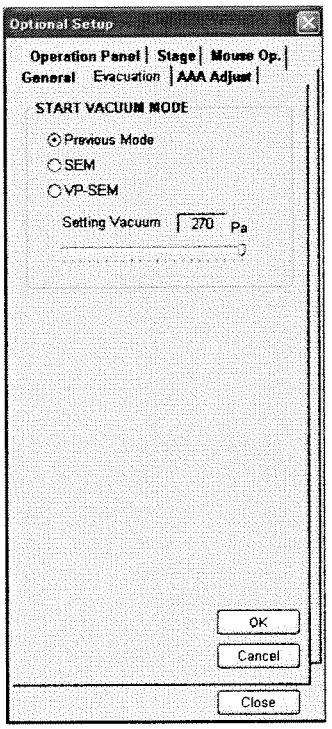


Fig. 3.9-44 Evacuation Tab

(6) Setting the Auto Axial Adjustment function: **AAA Adjust** tab/**AAA Adjust** menu

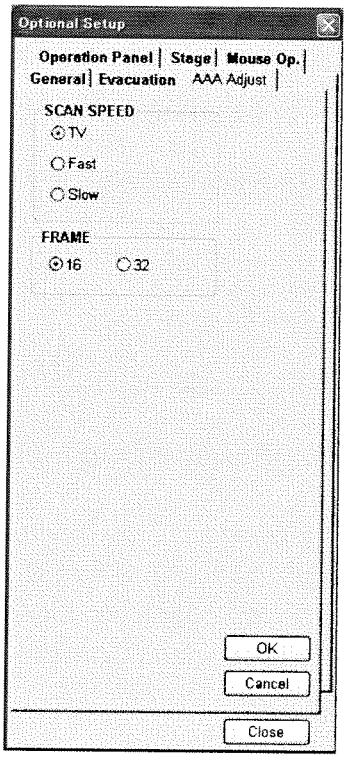


Fig. 3.9-45 AAA Adjust Tab

- Setting the Auto Axial Adjustment function
  This box allows you to the particular mode in which the Auto Axial Adjustment function is to run. In **SCAN SPEED** you can specify the speed at which auto axial adjustments are to be run. **FRAME** is enabled when either **TV** or **Fast** is selected in **SCAN SPEED**, and it allows you to specify the number of frames to be captured on an integration basis.

3.9.15 Password Setting

Use the **Password Setting** window for setting or changing the password of the login name for current user.
To open this window, select the **Password Setting** command from the **Option** menu.

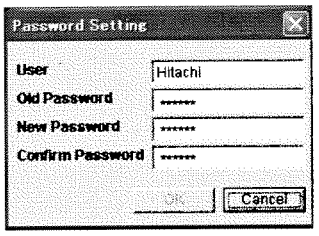


Fig. 3.9-46 Password Setting Window

The present login name is shown in the **User** box. Input present password to **Old Password** box and then input **New Password** and **Confirm Password**. Click the **OK** button. Up to eight characters are accepted as password. Uppercase and lowercase letters are distinguished.
If you click the **OK** button without entering **New** and **Confirm Password**, password will be deleted.

Setting login name is possible using the **Login Setting** window. It is only accessible when logged in with the superintendent login name "S-3400".

3.9.16 Setting Login Name

By setting login names and passwords, the instrument will be protected from unauthorized users' operation.
When the instrument is shipped, the login name "S-3400" is set up with no password. Use this name for the user who is responsible for the instrument.
Use **Login Setting** command in the **Option** menu for setting a password for the login name "S-3400" and also for setting other login names and passwords. This command is available only when logged in with "S-3400".

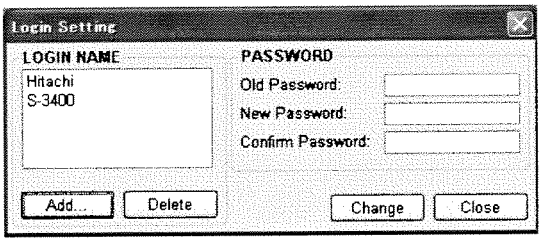


Fig. 3.9-47 Login Setting Window

Use the following steps for setting password protection.

(1) Login with the name "S-3400".

(2) Open the **Login Setting** window by selecting the **Login Setting** command from the **Option** menu.

(3) Select the "S-3400" in the **LOGIN NAME** list. Set a password for the name. Input **Old Password**, if already set, and input new password to **New** and **Confirm Password** boxes and then click the **Change** button.
If you do not open the password to other users, they cannot use the login name "S-3400" for next login. Because the **Login Setting** command will not open when logged in with other than "S-3400", it cannot register a new login name nor change the password for "S-3400".

(4) Register login names for general users. Click the **Add** button and input a login name on the opening input window.

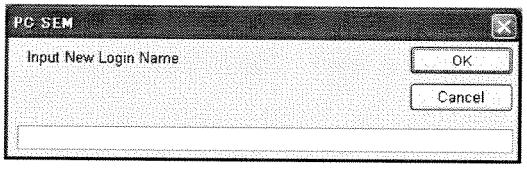


Fig. 3.9-48 Add User Menu

(5) Select a name on the **LOGIN NAME** list by clicking it and set a password for the name. You will notice the names and passwords to general users. Then, they can login using them.
Up to eight characters are accepted as login names and passwords. Uppercase and lowercase letters are distinguished.
The password of each general user can be changed using the **Password Setting** command by the user.

(6) To delete a login name, select the name in the **LOGIN NAME** list by clicking it and click the **Delete** button. Note that the name "S-3400" cannot be deleted.

NOTICE: If you forget the password for "S-3400", the above operation is not possible. You must call the service engineer to recover the password for the name.

3.9.17 Restoring DB

S-3400N control program utilizes database files for storing conditions or data.
If an error occurs in a database file, it cannot be accessed normally and a message "Database not found" will be shown. A database error may occur, for example, when PC is stopped while the database file is open for accessing.
In such a case, open the **Maintenance** window by **Mainte.** button on the tool button area of the Operation panel or by **Maintenance** command in the **Help** menu, and select the **DB Repair** tab.

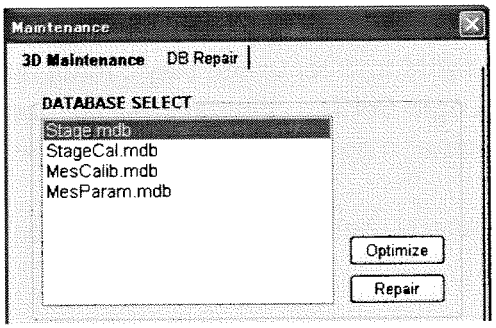


Fig. 3.9-49 DB Repair Tab

Database files are shown in the list box. Select a database, which is considered to be the source of error, by mouse clicking and click the **Repair** button.

When repairing is finished successfully, the message **End of this procedure will** be shown.
If it failed, the message **Repair unsuccessful** will be shown. After that, if the same error occurs by a certain operation, contact the service engineer.

The **Optimize** button is provided for optimizing database files. It is usually not necessary to operate this.

3.9.18 User Dependent Operation Condition Memory

The operating conditions just before shutting down S-3400N operation program are memorized and reproduced at the next starting up.
Most of operating conditions are memorized individually to each login user name.
The following list shows items memorized individually for login user name.

Table 3.9-1 User Dependent Operation Conditions

Condition Item	Contents
Operation panel display	The foreground tab, show or hide, left side or right side
Operation panel arrangement	Arrangement of **control** windows on the operation panel (Setting the **Options setup** window - **Operation Panel** tab)
Accelerating voltage setting	Previously used acc. voltage, emission current setting, list of recently used voltage
Electron Optics System setting	**Setup** window - Probe Current and AFS level in the Electron **Optics System** tab working distance value
Signal selection	Operation Panel - Detector settings
Image Saving	Setting on **Save Image** window Image format, Save option, destination folder, file name etc.
Image display parameters	Setting on **Setup** window - **Image** tab
Screen mode	Full, Dual or Small screen
Scanning speed assignment	Scanning speed assignment to **Scan Speed** buttons (At startup, the scanning speed is equal to the speed represented by the leftmost button)
Image recording button selection	Assignment function to **Record** buttons
Raster Rotation setting	Rotation angle and Tilting angle (Raster rotation is set to OFF at starting up)
Optional setting for specimen stage	Stage coordinate system selection, etc. (Settings on **Options Setup** window - **Stage** tab)
Data Display setting	**Setup** window - **recording** tab - Auto data display settings
Optional setting for mouse operation	Setting on **Optional Setup** window - **Mouse Op.** tab
Other optional setting	Display languages, μ marker mode, character fonts, etc. (Settings on **Options Setup** window - **General** tab)
Data Entry setting	Recent entered strings, drawing option etc (The input mode is off at startup)
Color mixing setting	Combination of color-mixing colors (color mixing is off at startup)
Window opening position	Last opened position
Specimen stage operation	Setting of **Eucentric rotation and tilting**
Max number of image capturing	16 images or 100 images

3.9.19 Password Locking of Windows

Password locking of Windows is possible using screen saver function. However, it can not be used when operating S-3400N program because the screen saver locking forces termination of Direct Draw function which is used by S-3400N program for image display and results missing of image display when unlocked again.

Instead of using Windows function, password locking can be started on S-3400N GUI.

Please notice that after unlocking, scanning mode and speed will be set to normal, slow1 condition regardless of previous scanning mode.

To lock Windows, select **Password Lock** from **File** menu.

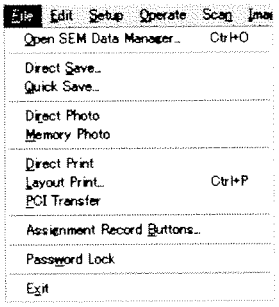


Fig. 3.9-50 File Menu

The following warning message will be shown.

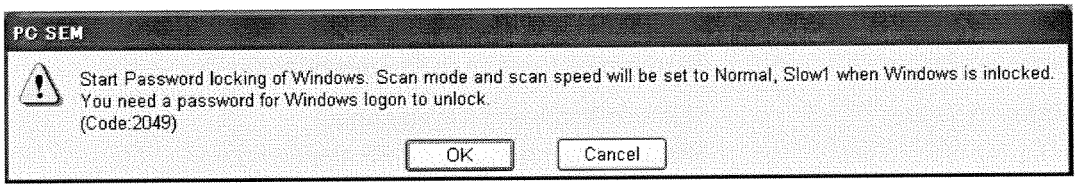


Fig. 3.9-51 Password Lock Confirmation Message

OK button locks Windows.

To unlock Windows, press **Ctrl + Alt + Delete** keys simultaneously.
Enter user name and password following to Windows message.

NOTICE:	Use user name and password for logging on to Windows, not for S-3400N logon. User names shall be Power User level. By using with Users level, S-3400N program will not work correctly.

3.9.20 Downloading Stage Control Program

As versions are upgraded, the update of the control program of the stage might be required. The customer can do the update work, but there is a possibility not to be able to recover when the update work is not normally completed. Execute the update work of the program only when the manufacturer of the control program or a service engineer informs. To start stage program download, select **Stage Program Download** from **Option** menu. The following message will appear.

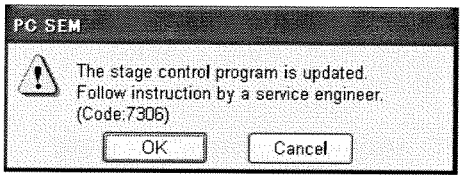


Fig. 3.9-52 Stage Program Download Confirmation Message

Click the **OK** button to continue.
At first stage status is checked. If stage is not working correctly, the following message will be shown and program downloading will be canceled by clicking the **OK** button.

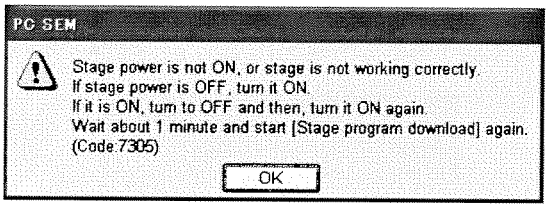


Fig. 3.9-53 Connection Lost Error Message

When stage is working correctly, the **Stage program download** window will appear.

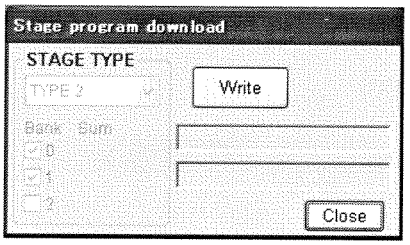


Fig. 3.9-54 Stage program download Window

Click the **Write** button. The following message will appear.

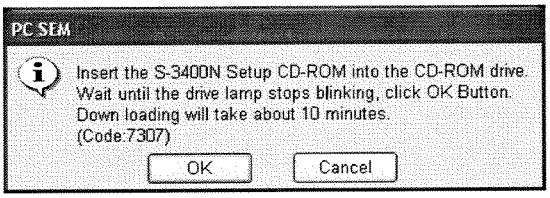


Fig. 3.9-55 Write Confirmation Message

Set the CD-ROM and click the **OK** button . Program downloading will start. Following messages are shown on the message area of the above window.

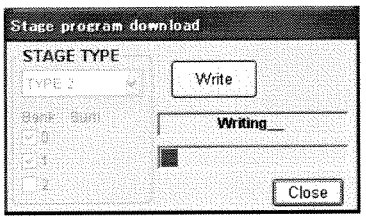


Fig. 3.9-56 Writing

The above message comes on while a write operation is in progress.

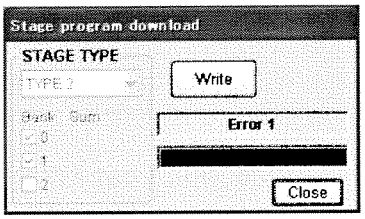


Fig. 3.9-57 Write Error

This message comes up when an error occurs. If this happens, please note the error number and notify the Hitachi Service Department.

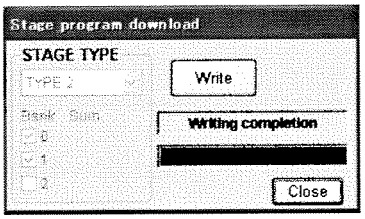


Fig. 3.9-58 Write Completed

The program has terminated normally.
Upon normal program termination, remove the CD-ROM, and click the **Close** button to close the **stage program download** window.

3.10 Image Quality

The following are references for getting better image quality.

3.10.1 Accelerating Voltage and Image Quality

There is a multitude of accelerating voltages to choose. Resolution, image quality, charging and other effects are greatly determined by the selected accelerating voltage. Below is a guideline for selecting an accelerating voltage with which to image various specimens.

Table 3.10-1 Accelerating Voltage and Image Quality

Acc. volt. (kV)	1 2 3 5	10 15 20 25	30
Resolution	Low ←	→	High
Secondary electron signal	High →	→	Low
Surface information	Topmost surface info. →	→	Surface info. (incl. internal info.)
Influence of contamination ※1	High →	→	Low
Charge-up ※2	Low ←	→	High
Non-deposition observation ※2	Easy →		
Specimen damage ※2	Low ←	→	High
Influence of floating magnetic filed	High →	→	Low
X-ray analysis		X-RAY	

※1: Under a low accelerating voltage, information is at the topmost surface. When there is contamination, that surface is observed, exerting significant impact on the image.

※2: The extent of this factor is subject to change depending on the type of specimen involved and the type of specimen pretreatment conducted.

3.10.2 Probe Current Setting and Image Quality

On the **ELECTORION BEAM** block, image quality can be adjusted by specifying an appropriate probe current level. An appropriate setting should be selected in reference to the table below. The default probe current is set to 50. The lower the probe current, the higher the resolution at the expense of decreased probe current. For low-magnification observation, the probe current should be set high, and for high-magnification observation, it should be set low.

Table 3.10-2 Probe Current and Image Quality

Probe Current Setting	0	50	100
	◄	———	►
Irradiation current (A)	Low	⟺	High
Resolution	High	⟺	Low
Secondary electron signal	Low	⟺	High
Image roughness	High	⟺	Low
Charge-up ※1	Low	⟺	High

※1: For non-conducting specimens

See 3.4.1 Setting Parameters for the Electron Optical System.

3.10.3 Objective Lens Movable Aperture and Image Quality

The diameter of the objective lens movable aperture can be selected from four options. The table below shows the relationship between aperture diameters on one hand and the specimen current, the focal depth, and applications, on the other hand. Resolution is set so that it is the highest when the hole diameter is 30 μm. The probe current can be adjusted by using the Probe Current menu on the **ELECTRON BEAM** block.
The surface condition of the objective lens movable aperture can have a significant impact on image quality, especially at low accelerating voltage levels. Maintenance services on the objective lens movable aperture should be performed periodically. Also critical is axial alignment for the electron optical system.

Table 3.10-3 Objective Lens Movable Aperture and Image Quality

Stop No.	1	2	3	4
Aperture diameter (μm)	150	80	50	30
Focal depth	Shallow ⟵			⟶ Deep
Probe current	High ⟵			⟶ Low
Resolution	Low ⟵			⟶ High
Application	X-ray analysis on low accelerating voltage	Observation and normal X-ray analysis		Observations requiring a great focal depth

See 3.4.2 Axial Alignment.

3.10.4 Influence of WD in Low-vacuum Mode

When observation is conducted in the low-vacuum mode, in which the specimen chamber is maintained at a low vacuum level, some of the primary electrons and the backscattered electrons that provide signals are subject to scattering by residual gas molecules, and this may result in a less than clear image. To ensure a clear image, the following settings may be required.

(1) Accelerating voltage
The accelerating voltage should be set as high as possible (see Table 3.10-1).

(2) Probe current
If image roughness is noticeable, the probe current should be increased (see Table 3.10-2).

(3) Working distance
To increase the sensitivity of the detector, the working distance should be minimized as much as possible (see Table 3.10-4).

Table 3.10-4 Impact of WD in Low-vacuum Mode

Working Distance (mm)	10	50
Scattering of irradiation electrons	Low ⟵	⟶ High
Scattering of backscattered electrons	Low ⟵	⟶ High

3.11 Managing Image Data (SEM Data Manager)

Saved images can be managed using the SEM Data Manager functions.

SEM Data Manager is a filing function designed to perform image save, edit, display, search, and other functions.
Databases are created for each user. When saved, an image is automatically saved in a database on which image retrieval, display, image-processing, and editing can be performed.
To display SEM Data Manager, either select **Open SEM Data Manager** from the **File** menu or click the **SDM**  button in the Operation Panel button area.

3.11.1 Precaution on SEM Data Manager

(1) Available image formats are 8-bit gray scale BMP, TIFF and JPEG. It is possible to register images of other color modes, which are converted into 8 bit gray scale images when image modifications (i.e. Data Entry, Image Processing etc.) have been performed.

(2) Use the Batch Process function to delete or move images to other directories, in order to keep information in the database of SEM Data Manager. Using Windows File Manager or Explorer functions for such operations will cause errors when you try to access these images from SEM Data Manager. When such errors occur, remove these images from the database using the **Batch Process** - **Remove List** function. If necessary, images can be added to the database using the **Add From File** function.

(3) When an image is saved, a file {image filename}.t × t is created automatically in the same directory as the saved image. It includes operating conditions of SEM and other image acquisition information necessary for the database organization. Do not delete, move, or edit these files.

(4) Do not edit Image Database files SDM.sdb as they are compatible with Microsoft Access database files. Unexpected modifications of database files may cause errors in the SEM Data Manager.

(5) Large size images (5120 × 3840, 2560 × 1920 pixels) will need a longer time for loading, displaying or processing.
There are the following limitations.

(a) CD Measurement function works on 2560 × 1920 pixels or smaller images.

(b) Color mixing works for 1280 × 960 and 640 × 480 pixels images.

(c) Pseudo Coloring works for 2560 × 1920 pixels or smaller images.

In above cases, a message will be shown and the specified commands are canceled.

(6) Opening of image files, image processing, and other operation on the SEM Data Manager are CPU-intensive. When SEM operation is executed while processing as mentioned above is running, it might cause some incorrect results. For example, when image capture is executed while slide show is running, a proper image might not be recorded. Opening the image and executing image processing etc. while image capture is running are not recommended for the same reason.

(7) When operating Color Mixing mode on SEM (not on SEM Data Manager), Photo Replay from SEM Data Manager is inhibited. Terminate the Color Mixing mode to carry out photographing.

3.11.2 Functions

3.11.2.1 Image Database

The SEM Data Manager window is shown below.

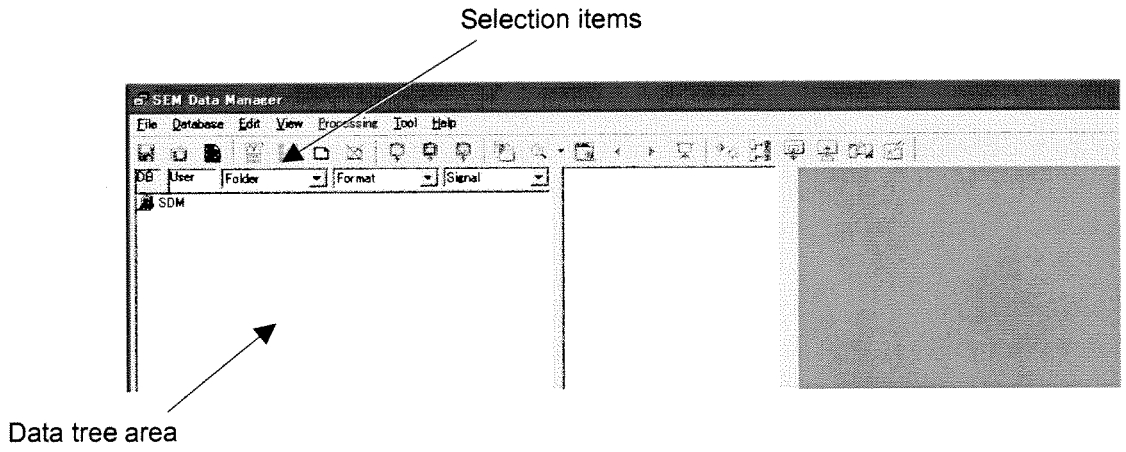


Fig. 3.11-1 SEM Data Manager Window

(1) Opening a database
Database name is shown on the **Data tree** area.
Double click the database to open. User names included in the database will be shown following the database name on the **Data tree** area.
Lower level tree opens following the **Selection** items. In the above example, Data tree is open in the order of Folder - Format - Detector signal.

(2) Database fields
The following fields are created for each registered image data.

- User: Create a user name on the SEM Data Manager. It may also be created when saving images.
- Folder and Media
- Image format: BMP, JPEG or TIFF
- Date: Date of creation or modification
- Sample, Keywords: Applied when saving
- Image size
- Instrument condition: Magnification, signal source, Vacc, column condition etc.

Among the above fields, the following are used for selection items.

- Folder
- Image size
- Image format
- date
- Vacc
- signal
- Sample
- Keyword1/2
- Media

3.11.2.2 Menu and Tool Buttons

The following picture shows an example where image is open.

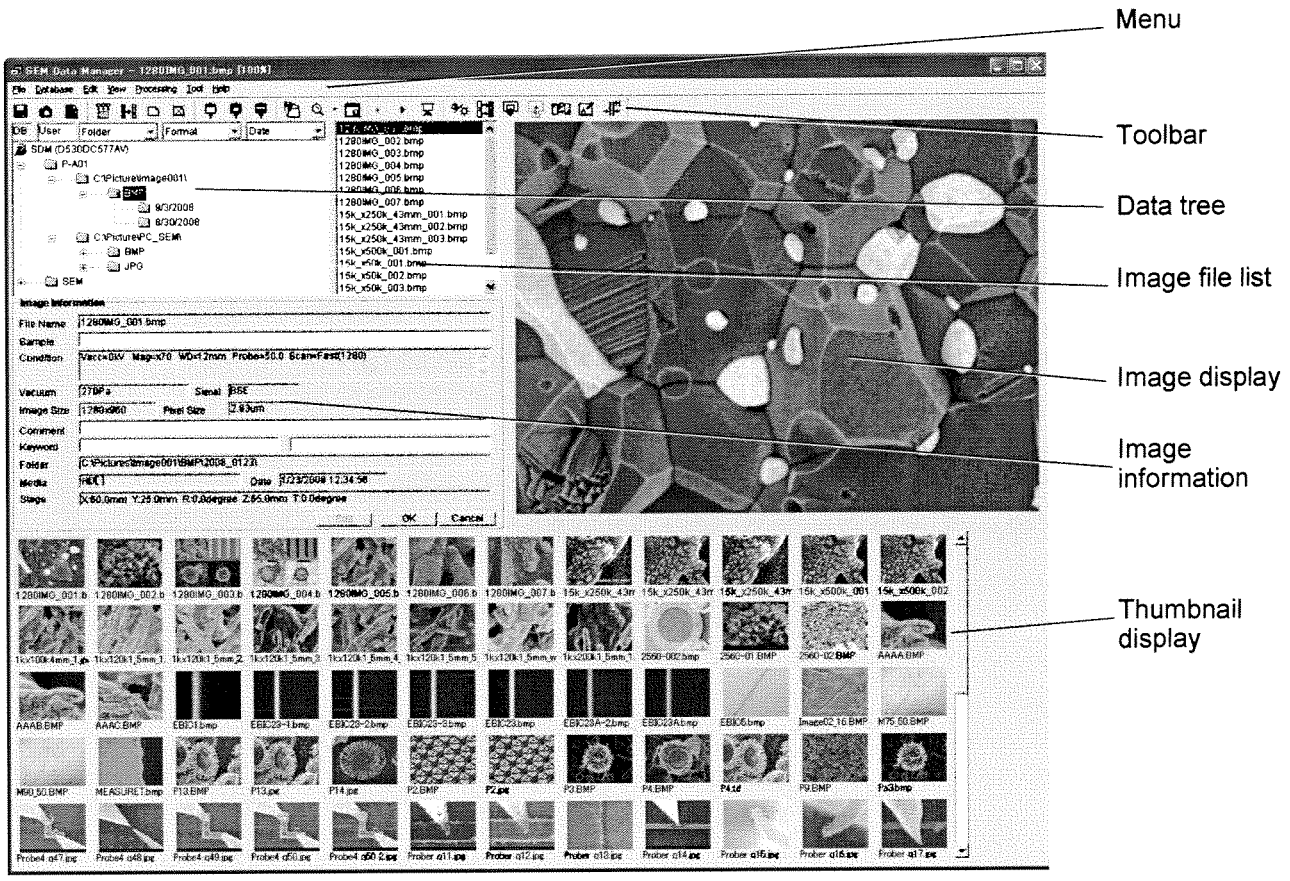


Fig. 3.11-2 SEM Data Manager Window

Functions of Menu commands are as follows. Corresponding tool buttons are shown in parentheses.

(1) **File** menu

- **Save as** ( )
  Saves the image on the display area.
- **Reload**
  Loads and display the original image. Use to recover processing, etc.
- **Photo Replay** ( )
  Takes a picture of the image on the display area. Needs optional photo recording unit.
- **PCI Transfer** ( )
  Transfers the image on the display area to the Quartz PCI together with the information text file. It is available only when Quartz PCI software is built in.

- **Remove List**
  Removes the image from database. Image file is not erased.
- **Delete**
  Deletes the image. Image file is erased.
- **Rename**
  Renames the image file.
- **Layout Print** ()
  Opens the **Report Generation** window for printing images.
- **Exit**
  Closes SEM Data Manager.

(2) **Database** menu

- **Add from File** ()
  Registers image files specifying file name.
- **Batch Process** ()
  Applies file operation (copy, move, delete, etc.) to multiple selected images.
- **Make New User** ()
  Creates new user name.
- **Delete User** ()
  Deletes present selected user name. All images included in the user must be removed before deleting a user.

(3) **Edit** menu

- **Copy** ()
  Copies the image to Windows clipboard.
- **Copy Small Size** ()
  Copies the image to Windows clipboard. The size of image is reduced to 640 × 480 pixels.
- **Copy Info** ()
  Copies the image information text file to Windows clipboard.
- **Image Editor**
  Opens an image editing application program, which has been associated with the image format.

(4) **View** menu

- **Image Maximize** ()
  Displays the image in full desktop. Menu and tool buttons are available on the maximized window.
- **Zoom** ()
  Enables or disable image enlargement by clicking on the image. Mouse pointer is the  mark when it is enabled.
- **Show thumbnail**
  Shows or hide thumbnail display.
- **Viewer Open** ()
  Opens a **Viewer** window and display the image. The window remains even when SEM Data Manager is closed.
- **Next Image** () / **Previous Image** ()
  Opens the image listed at next or previous position in the image file list.
- **Slide Show** ()
  Opens the **Slide Show** window.
- **Refresh** (F5 key)
  Reloads image or refresh thumbnail display.

(5) **Processing** menu

- **Contrast Conversion - Conversion** ()
  Opens **Contrast Conversion** window. Adjusting contrast and pseudo-color conversion are available on it.
- **Contrast Conversion - Auto Adjust**
  Executes automatic contrast enhancement.
- **Contrast Conversion - Gamma - 1.2/1.5/2.0**
  Executes gamma adjustment.
- **Color Mixing** ()
  Opens **Color Mixing** window. Create color composite image using two selected images.
- **Area Copy** ()
  Copies a specified rectangular area of the image on the display area.
- **Area Paste** ()
  Pastes an image copied using above Area Copy command to the image on the display area.

- **Image Processing - Processing** ()
  Opens **Image Processing** window. Several image processings including spatial filtering are available on it.
- **Image Processing - Noise Reduction** to **Flip Vertical**
  Executes each of image processing.
- **Image Processing - Cancel**
  Cancels the results of image processing and load the original image.
- **Data Entry** ()
  Draws shapes and characters on the image.
- **CD Measurement** ()
  Opens **CD Measurement** window (optional function).

(6) **Tool** menu

- **Options**
  Opens **Options** window. Use for setting size of thumbnail, character font and others.
- **Database Utility**
  Repairs or optimize database files.

3.11.3 Operation

3.11.3.1 Registering Images on SEM Data Manager Database

(1) Saving images on SEM
On the **Image Save [Direct Save]** window, put a check mark in **SDM Register** check box to register images when saving.

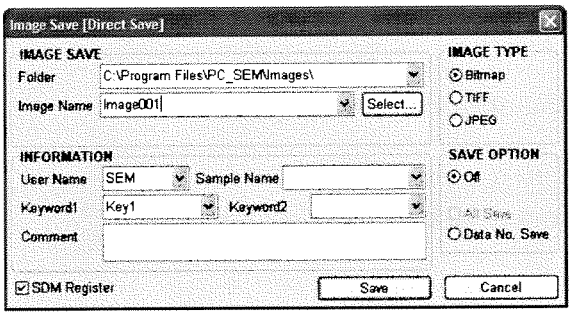


Fig. 3.11-3 Image Save [Direct Save] Window

Parameters for registering image are in the **INFORMATION** area.

(a) User Name
You can select a **User Name** already registered by opening the list with the button, or input a new user name.

(b) Sample Name
Input sample name or other text for classification of samples. You can select from already registered sample names by opening the list with the button, or input a new name.

(c) Keyword1 and 2
Input keywords for selecting images.

(d) Comment
Input a comment if needed. A comment cannot be selected from previously entered comment.

(2) Registering images stored on disks

To register already saved images to the SEM Data Manager database, use **Add from File** command in **Database** menu or the **Add from File** button on the tool bar. The following **Add from File** window will open.

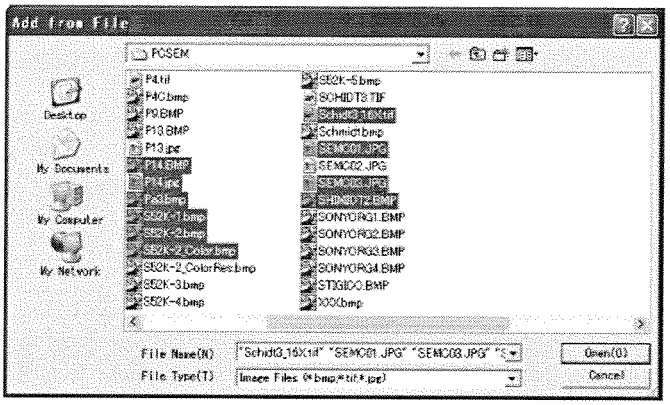


Fig. 3.11-4 Add from File Window

Select a folder and a file name, and click the **Open** button.

The following procedure can be performed to select more than one file:

- Click the first file, and click the last file by holding the Shift key down.
- To select files randomly, click the second and subsequent files by pressing the Ctrl key.

In either method, the selected file is identified with a changed background color.

When copying an image saved on another S-3400N, copy the text file, {Image file name}. txt, stored in the same folder, together with the image file to the same folder as the image. The text file is used to register the image information.

3.11.3.2 Selecting User Name and Opening Data Tree

In the Data tree area, double click the database name (SDM). User names included in the database will open.

Set **Selection items** in the order of opening data tree.

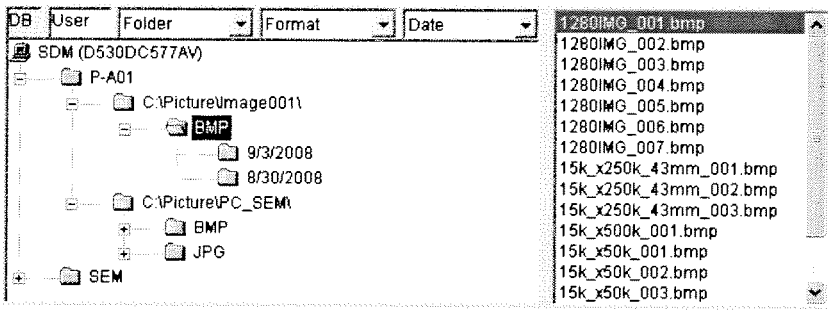


Fig. 3.11-5 Data Tree Window

The above example has two User names (P-A01 and SEM) and data tree is opened in the order of Folder - Image format - stored date.
To open the tree to a lower level, click [+] button and to close the lower tree, click [-] button.
To open image files in the image file list, click a folder mark. The present opening folder is shown with mark.

NOTICE:	When you have changed one of the selection items, the data tree will be closed. Open the tree again.

To make a new user name, use **Make New User** command in **Database** menu or **Make New User** button on the tool bar.
Input a user name and click **OK**.

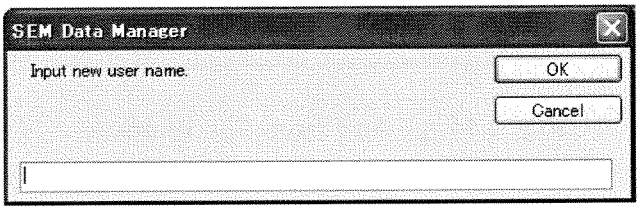


Fig. 3.11-6 New User Window

3.11.3.3 Image Display

Click on a thumbnail or a file name in the image file list to select an image.
The selected image will open on the image display area. The selected image is shown with yellow border on thumbnail area.
To display the image on full desktop, double-click on the image or use **Image Maximize** command in **View** menu or click **Image Maximize** button on the tool bar.
The same operations return the image display to original size.
To zoom up or down image display, use the following operations.

(1) Click the [▼] of **Zoom** button. A magnification list will appear. Select a desired magnification value. (This magnification is the ratio versus the number of pixels of the image data.) Upon selecting **Default**, a reduction ratio is determined so that the entire image will fit into the image display area.

(2) Click the **Zoom** button. The mouse pointer will be changed to magnifier mark. Left click on image magnifies and right click demagnifies the image.
Note that while the mouse pointer is the magnifier mark, other operations on the image are inhibited. Click the **Zoom** button again to return to default pointer.

3.11.3.4 Image Information

Information on the presently selected image is shown on the image information area.

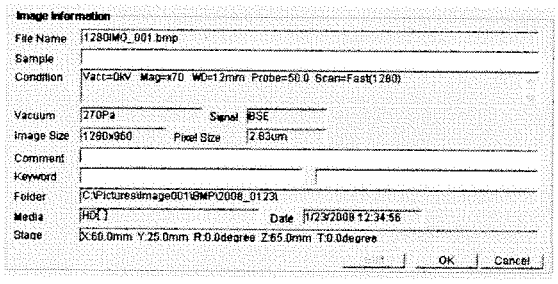


Fig. 3.11-7 Image Information Window

You can edit **Sample**, **Comment**, and **Keywords**.
Click **Edit** button to edit the above items. Input each item and click the **OK** button.

3.11.3.5 Viewer Display

To display the presently selected image on a **Viewer** window, use **Viewer Open** command in **View** menu or **Viewer** button. The **Viewer** is an independent window and remains after terminating SEM Data Manager. It is intended for use as a reference image for observing images with SEM. To close the **Viewer** window, click the [X] button on the title bar.

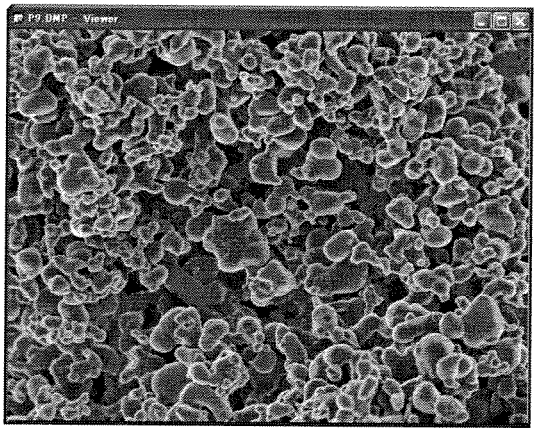


Fig. 3.11-8 Viewer Window

3.11.3.6 Data Entry

Use Data Entry function for drawing shapes and writing texts on the image.
The **Data Entry** toolbox will open by **Data Entry** command in **Processing** menu or **Data Entry** button.

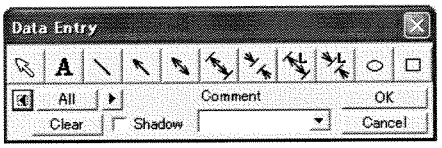


Fig. 3.11-9 Data Entry Window

(1) Function of tool buttons
Function of tool buttons in the **Data Entry** toolbox is similar to the function on the SEM.

(a) Edit text
Edit already written texts .
Selecting the **Edit** button changes mouse pointer to mark. Click the text to be edited. The text is changed to black background form. You can edit the text.
The Enter key terminates editing. The text is shown in red color and you can move its position by dragging it with the mouse.

(b) Text input
Write texts on the image.
After selecting the button, click on the image. The text input area of black stripes is shown on the image. Input text using keyboard and terminate with Enter key.
The text is shown in red color and you can move its position by dragging it with the mouse.
If you enter a text in the text box and then click on the image, the text is placed automatically. 10 recently used texts are memorized and can be selected with the button. Use the function when you repeat writing the same or similar texts.
To set the font and size, use **DATA ENTRY/MEASUREMENT** block in the **Optional Setup** window - **General** tab.

(c) Line
Draw lines on the image. Click this button, and press the left button of the mouse to create the starting point of the line on the image. Move the mouse to an end point and then release the mouse button. While this button is depressed, you can repeat a line drawing.

(d) Arrow
Draw single-head arrow marks on the image.

(e)  Double head arrow
Draw double-head arrow marks on the image.

(f)  Inner dimension mark
Draw inner dimension arrow marks on the image.

(g)  Outer dimension mark
Draw outer dimension marks on the image.

(h)  Inner dimension mark with measurement
Draw inner dimension marks with measurement on the image.

(i)  Outer dimension mark with measurement
Draw outer dimension marks with measurement on the image.

(j)  Circle
Draw circles or oval shapes on the image. Click this button and press the left button of the mouse to create a starting point on the image. Draw a shape by moving the mouse and then releasing the mouse button. While this button is depressed, you can repeat drawing of a shape.

(k)  Rectangle
Draw rectangles on the image. Click this button and press the left button of the mouse to create a starting point on the image. Draw a shape by moving the mouse and then releasing the mouse button. While this button is depressed, you can repeat drawing of a shape.

(l) Shadow check box
When the Shadow box is checked, texts and graphics are drawn with shadow.

(m) Comment box
If you enter a text in the comment box and then click on the image for text, the text in the comment box is placed automatically. 10 recently used texts are memorized and can be selected with the ▼ button. Use the function when you repeat writing the same or similar texts.

(n) ◀ All ▶ Select buttons
◀ or ▶ button selects graphics or text on the image in order. A selected graphics is indicated with gray color and a surrounding dotted line box. A selected text is indicated with gray color and black background. They can be moved and re-positioned by mouse dragging. A selected text can be edited by double-clicking on it. The text line is prolonged and editing becomes possible.
All button selects all graphics and text.

(o) **Clear** button
Clear selected graphics or text.

(2) Writing texts and graphics
Click a tool button and draw graphics or write texts.

(3) Editing texts

To edit already written texts, select the **Edit** text  tool.
Selecting the button changes mouse pointer to  mark. Click the text to be edited. The text is changed to black background form. You can edit the text. The Enter key terminates editing. The text is shown in red color and you can move its position by dragging it with the mouse.

(4) Moving position or deleting drawn data
◀ or ▶ button selects graphics or text on the image in order. A selected graphics is indicated with gray color and a surrounding dotted line box. A selected text is indicated with gray color and black background. They can be moved and re-positioned by mouse dragging. A selected text can be edited by double-clicking on it. The text line is prolonged and editing becomes possible.
The **Clear** button erases the selected data. To erase all, select all data by clicking **All** button and then click the **Clear** button.

(5) Saving image with entry data

Click **OK** to fix entry data. Use **Save as** command in **File** menu or **Save**  button on the tool bar.
The **Image Save** window will open with present image name as a default file name.
Click **Save** button to overwrite to present image. Input new name and folder to save as a new image.

3.11.3.7 Contrast Conversion

Gray scale conversions and pseudo-coloring are available. To apply conversions to the image, open the **Contrast Conversion** window by clicking the button on the tool bar or use **Contrast Conversion - Conversion** command in **Processing** menu.

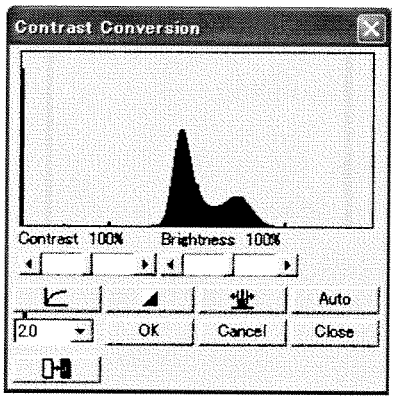


Fig. 3.11-10 Contrast Conversion Window

(1) Manual adjustment of contrast and brightness
Use **Contrast** and **Brightness** scrollbars. The % values show rate of processing.
The histogram display will be changed linked with contrast and brightness change.

(2) Auto adjustment of contrast and brightness
Auto button enhances contrast to full grayscale range.
Note that when auto data display or entry data exists in the image, the true image data cannot be enhanced. Use the next function in such a case.

(3) Contrast and brightness adjustment on the histogram display
Set the left and right yellow cursors to the level to be enhanced to black and white level and then click **Enhance** button. Refer to the following example.

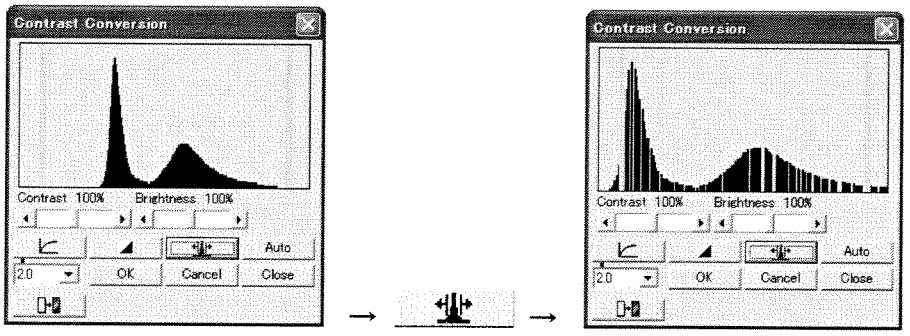
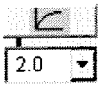


Fig. 3.11-11 Brightness/Contrast Conversion

(4) Contrast inversion
The **Negative** button inverses black and white.

(5) Gamma correction


A Gamma value of larger than 1 enhances dark area and suppresses highlight area.
A value smaller than 1 suppresses dark area and enhances highlight area.
Select a gamma value and click the button.

(6) Apply or cancel conversion result
OK button applies conversion result and rewrites image palette data. **Cancel** button cancels conversion result.
Close button closes the window. If it is clicked before clicking the **OK** button, the conversion result is canceled.

(7) Pseudo color conversion
SE, BSE and other images are black-and-white image because they are formed only by the amount of signals.
Pseudo Color is a function that indicates images in color by replacing light and shade of the images with color.
Clicking the button in the lower part of the **Contrast Conversion** window adds the **Pseudo Color** block.

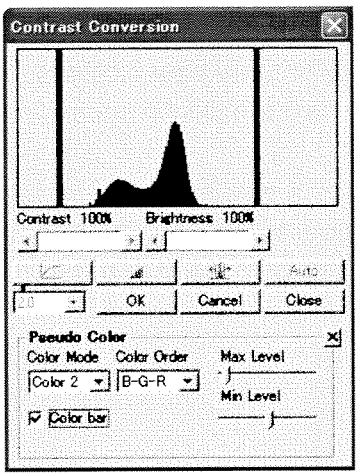


Fig. 3.11-12 Contrast Conversion Window

Set following parameters.

(a) Color Mode and Color Order
- Off : No coloring
- Color 1 or Color 2

Convert gray scale value to RGB color as in the following figures.
The L, M and H represent R, G or B color specified by Color Order setting.

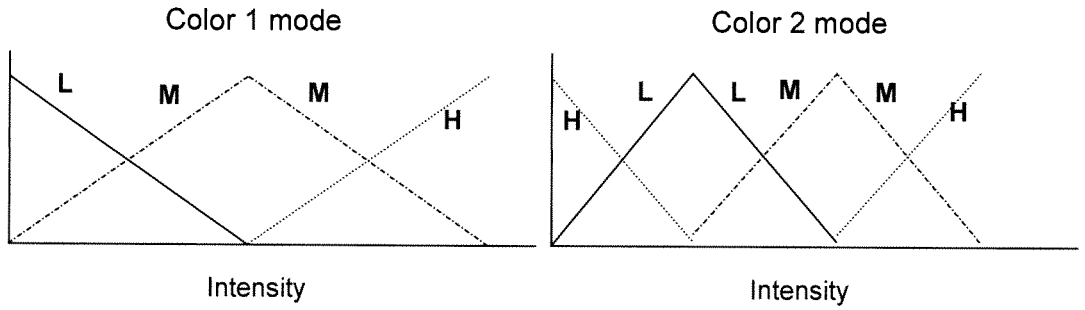


Fig. 3.11-13 Signal/Color Intensity

Example: If the standard pattern **Color Order** settings are B-G-R, B (blue) is assigned to L, G (green) to M, and R (red) to H. In this manner, a pseudo-color image is generated such that in Color1 any dark part of the image is represented in blue, and any bright part in red.

- Slice 4/8/16: Slices signal levels, from the lowest to the highest, into 4/8/16 colors (including black and white).

(b) Standard pattern **Color Order**: Specifies an array of colors, Color 1 and Color 2 that are assigned to L, M, and H.

(c) Maximum and minimum values **Level**: For pseudo-color display, specifies the minimum and maximum levels of signals to which colors are assigned. In situations where signal intensities are locally distributed, colors can be assigned in a manner that matches the range of distribution of signal intensities.
- **Max Level:**
  Specifies the maximum value of the signal level to which a color is assigned.
  Allowable range: 75% to 100% of the maximum level
- **Min Level:**
  Specifies the minimum value of the signal level to which a color is assigned.
  Allowable range: 0% to 25% of the maximum level

(d) **Color Bar**: Checking this option displays a color bar on the right side of the image.

3.11.3.8 Image Processing

Digital image processing for noise reduction, increase of sharpness and detail enhancement is available.
Open the **Image Processing** window by **Image Processing - Processing** command in **Processing** menu or  button on the tool bar.
The following window will open.
OK applies processing result to the image data, Cancel recovers the original image and Close terminates the window.

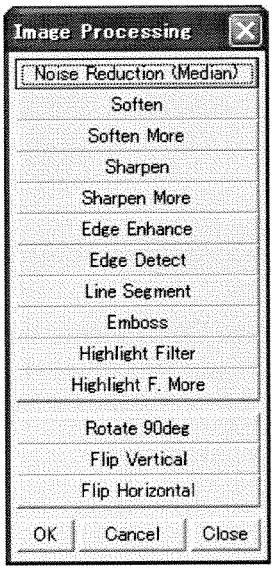


Fig. 3.11-14 Image Processing Window

(1) **Noise Reduction (Median)**
Applies 3 × 3 pixels median filter. It is effective for reducing noise.

(2) **Soften**
Applies 2 × 2 pixels averaging. It is effective for reducing noise.

(3) **Soften More**
Applies 3 × 3 pixels averaging. It is more effective for reducing noise. Fine details may be lost.

(4) **Sharpen**
Increases sharpness. Snow noise may increase when applied to noisy images.

(5) **Sharpen More**
Increases sharpness. Snow noise may increase when applied to noisy images.

(6) **Edge Enhance**
Applies Laplacian filter. It is effective for edge enhancement.

(7) **Edge Detect**
Applies Laplacian filter. It is effective for edge detection.

(8) **Line Segment**
Extracts line segment.

(9) **Emboss**
Emboss effect.

(10) **Highlight Filter**
It emphasizes microstructures and makes the structures of the dark space clear.

(11) **Highlight F. More**
Highlight filter emphasizes detailed construction and reduces shadowing of the image.

(12) **Rotate 90deg**
Rotates the image by 90° clockwise.

(13) **Flip Vertical**
Inverts top and bottom of the image.

(14) **Flip Horizontal**
Reverses the left and right of the image.

3.11.3.9 Color Mixing

Creates color composite image using two original images.
It is applicable for color composition of two different signal images, or stereo imaging using colored glasses. Positional alignment of two original images is possible.

(1) Color mixing operation
Select one of two original images to be mixed and open the **Color Mixing** window by **Color Mixing** command in **Processing** menu or **Color Mixing** button.
The selected image is shown in the source image area A.

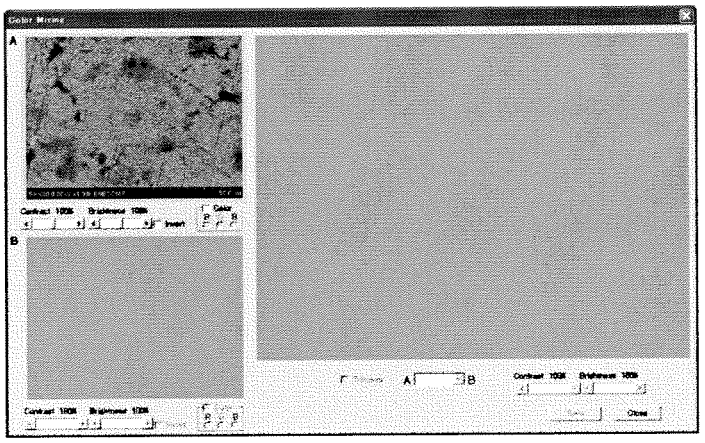


Fig. 3.11-15 Color Mixing Window

To bring another source image, select the source area B by clicking it and then double-click the image thumbnail to be used as the source image.
The source images can be exchanged by the above operation.

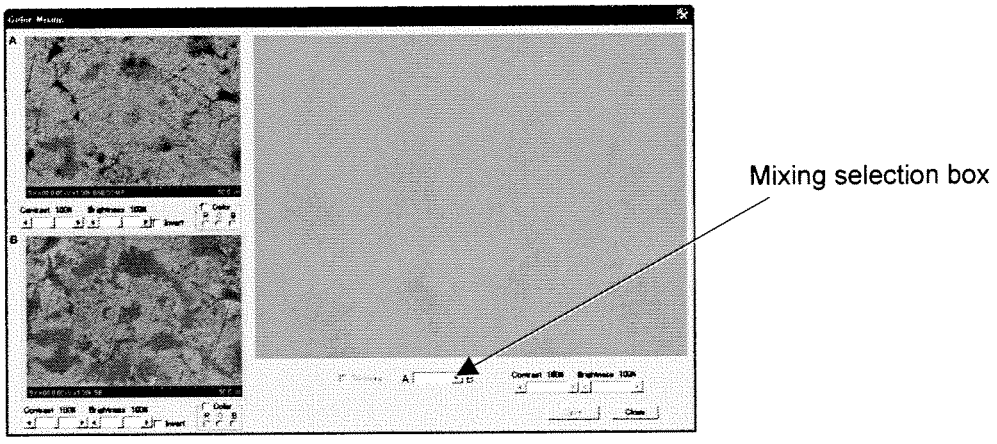


Fig. 3.11-16 Image Selection Status on Color Mixing Window

Select color for source images. Check **Color** and select **R**, **G** or **B** button.
Select a mixing mode in the mixing selection box.

- **ADD**: Add A and B source images. Use this when two images are of different single colors.
- **AVG**: Average of A and B source images is used. Use this when one or both of source images are monochrome.
- **MAX**: Compare intensity of each pixel of source A and B images and use larger data for resulting composite image. When A and B are of different color, it results in the same image as when using ADD. When one or both of source images are monochrome, it will result in a clearer contrast than when using AVG.
  The following picture is an example where source A is SE and B is BSE image and they are mixed with green and red colors.
- **SUBDST**: Subtract B from A
- **DIXDST**: Divide A by B

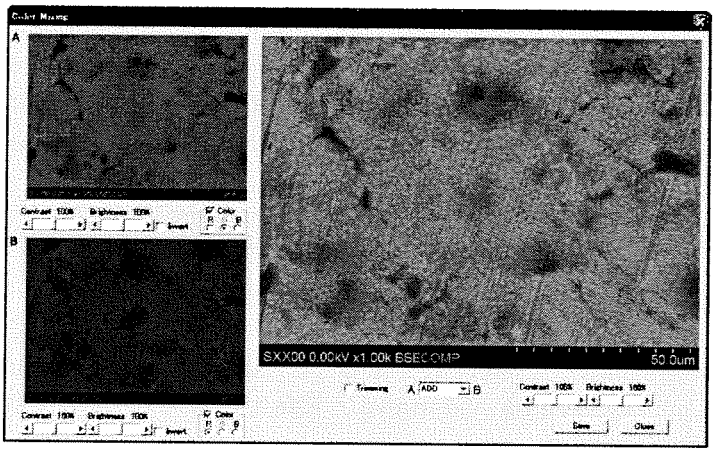


Fig. 3.11-17 Color Mixing Results Display Window

(2) Contrast adjustment
Use scrollbars to adjust contrast and brightness of source images. Also contrast and brightness of the resulting image can be adjusted.

(3) Trimming
Check the **Trimming** box. Yellow box cursors are shown on source images. The cursor on the B image is movable with mouse. Mixing is carried out for the area in the cursors. You can correct a small positional deviation between two source images.

(4) Saving composite image
Click the **Save** button. Specify file name on the opening the **Image Save** window.

NOTICE:
- The composite image is saved with 24 bit RGB format. It has a file size 3 times larger than original monochrome images.
- Original source images for Color Mixing shall be of 2560 × 1920 pixels or smaller size.
- When one or both of source images are monochrome, it will take a longer processing time than where both images have different single colors.

3.11.3.10 Printing Images

Use **Layout Print** command in **File** menu or **Layout Print** button on the tool bar.
The **Report Generation** window will open with the presently selected image on the layout sheet. Double-click a thumbnail image to add it to the layout sheet. Selecting the file name from the file list and dragging it in the layout sheet can also add the image.
Refer to <3.9.10 Printing Images Using Report Generation Function>.

3.11.3.11 Image File Operation

NOTICE: Use functions provided on SEM Data Manager to delete or move images to other directories, in order to keep information in the database of SEM Data Manager. Using Windows File Manager or Explorer functions for such operations will cause errors when you try to access these images from SEM Data Manager. When such errors occur, remove these images from the database using the **Batch Process - Remove List** function. If necessary, images can be added to the database using the **Add From File** function.

(1) Saving processed image

To save the result of image processing and/or contrast conversion, use **Image Save** button on the tool bar or **Save as** command in **File** menu.
Image save window will open with the present image name as the default file name. Just click **Save** button to overwrite, or input a new file name and click **Save** button to save as a new file.

(2) Removing an image from database
Use **Remove List** command in **File** menu. The presently selected image is removed from the database. This command is executed without showing message. Image file itself is not deleted.

(3) Deletion of an image
Use **Delete** command in **File** menu. The presently selected image is deleted and removed from the database. A message for confirmation will be shown. Image file itself is deleted.

(4) Renaming an image file
Use **Rename** command in **File** menu to rename the presently selected image file.

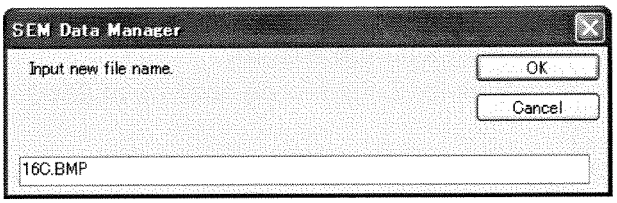


Fig. 3.11-18 Rename File Window

3.11.3.12 Batch Operation of Image Files

Two or more image files can be operated at once.

Use **Batch Process** command in **Database** menu or **Batch Process** button on the tool bar. The **Batch Process** window will open.

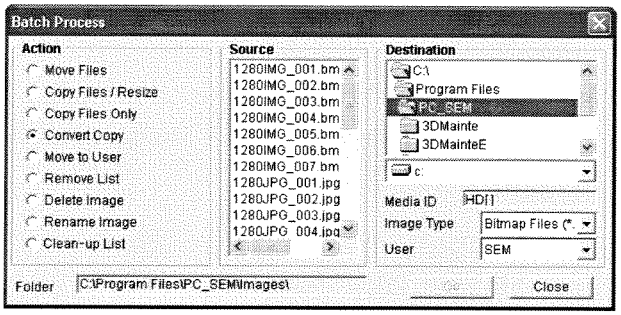


Fig. 3.11-19 Batch Process Window

(1) Action buttons

(a) **Move Files**:
Moves image files selected from the Source list to other folders specified in the Destination area. Image files in the source directory are deleted.

(b) **Copy Files/Resize**:
Copies images files selected from the Source list to other folders specified in the Destination area.

(c) **Copy Files Only**:
Copies images files selected from the Source list to other folders specified in the Destination area. Files in target folders are not registered in the database. Use this command to copy image files to floppy disks for carrying data to other PCs.

(d) **Convert Copy**:
Converts image format of files selected from the Source list and then copies to other folders specified in the Destination area.

(e) **Move to User**:
Moves images selected from the Source list to another User database.
Moved images are removed from the source User database. The image files are not moved.

(f) **Remove List**:
Image files selected from the Source list are removed from the present User database. Image files are not deleted.

(g) **Delete Image**:
Deletes image files selected from the Source list and removes them from the present User database. Image files are deleted.

(h) **Rename Image**:
Renames an image file selected from the Source list.

(i) **Clean-up List**:
When using Windows File Manager or Explorer functions for deleting images, "Image not found" message will be shown at the SEM image display area. The image file remains at the image list.
Select **Clean-up List** and click **Go** button. A message for confirmation will be shown. After clicking **Yes** button, the image file that does not have image will be deleted.

(2) Source list
Image files included in the present opening folder are listed here. Files can be selected from this list for one of the aforementioned actions. Multiple selection using the Shift or Ctrl key is supported.

For multiple file selection,

(a) Press the left button of the mouse on the first selected file, and move the mouse while holding down the button to the last selected file, and then release the button. Selected files are shown by reverse color.

(b) Click the first selected file and then click the last selected file while holding down the Shift key.

(c) Click selected files while holding down the Ctrl key.

(3) Destination
These are enabled when **Move Files**, **Copy Files/Resize**, **Copy Files Only** or **Convert Copy** actions are selected. Select a target folder. The Media ID indicates the volume label of the selected drive.

NOTICE: It is recommended to put independent volume labels on removable disks such as MO and ZIP disks. The volume label is shown in the Media ID area.
To put a volume label onto a disk, right-click the drive name in the Windows Explorer. Select Property (R) on the pull-down menu. You can check or set a volume label in the Information tab.

(4) Image type selection
Select a file format. BMP, JPG and TIF are available.
It is shown when **Convert Copy** action is selected.

(5) Image size selection
Select an image size for resizing image files. It is shown when **Copy Files/Resize** action is selected.

(6) User selection
User selection is enabled when **Move Files**, **Copy Files/Resize**, **Convert Copy** and **Move to User** actions are selected. With the exception of the current User, all other Users are listed. Select a User for selected Action.

3.11.3.13 Slide Show

Use the **Slide Show** window for viewing images in continuous slide motion.

To open the **Slide Show** window, use **Slide Show** command in **View** menu or **Slide Show** button on the tool bar.

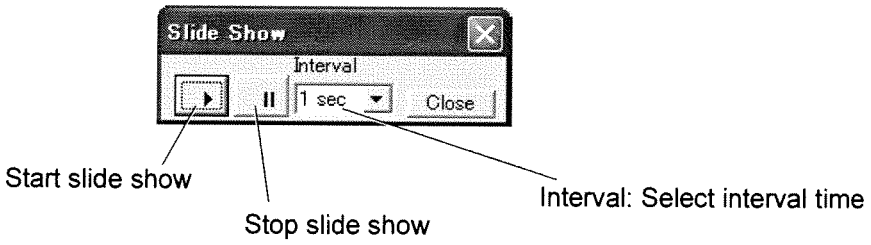


Fig. 3.11-20 Slide Show Window

3.11.3.14 Optional Setting

Tool menu - **Options** command opens the **Options** window.

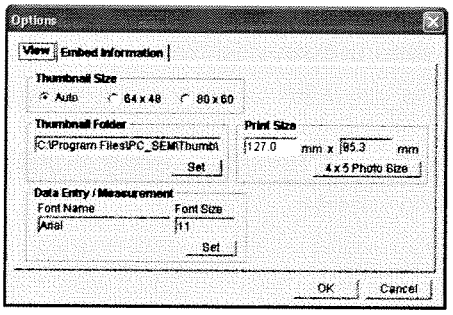


Fig. 3.11-21 Options Window View Tab

(1) Thumbnail Size

- **Auto**:
  When desktop size is 1280 × 1024 pixel, thumbnail size is set to 80 × 60 pixels.
  When desktop size is 1024 × 768, it is set to 64 × 48 pixels.
- **64 × 48** or **80 × 60**:
  Thumbnail size becomes a specified size, and the number of thumbnail that is displayed changes depending on a desktop size.
  Normally, the Auto mode or 80 × 60 are recommended when starting with the S-3400N control program (desktop size 1280 × 1024 pixels).

(2) Thumbnail Folder

The default directory of thumbnail images is "C:\ProgramFiles\PC_SEM". It can be set here at any directory. If the thumbnail directory is changed, all of existing image thumbnails are re-created in the new directory when the images are opened. It is recommended not to change the thumbnail directory frequently.

(3) Data Entry/Measurement

See 3.11.3.6 Data Entry.

(4) Print Size

Set the image size when pasted on some other application software which supports X Resolution/Y Resolution parameter included in the header part of image files.
Input horizontal size in mm into the left size box. The vertical size is automatically set.
For example, Aldus Page Maker and Adobe Photoshop will support it in TIFF format images.
Microsoft Word supports it in Bitmap format images.

(5) Selecting information to be embedded

Open **Options** window - **Embed Information** tab with **Tool** - **Options** menu.
Put check marks to data items you want to embed into images.

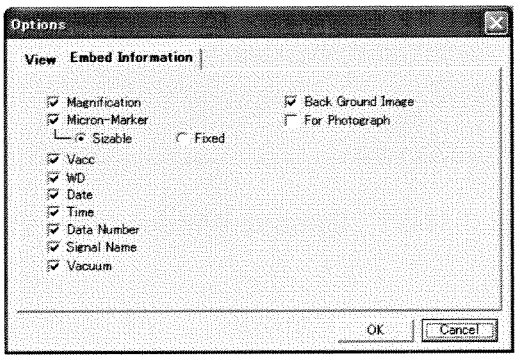


Fig. 3.11-22 Options Window Embed Information Tab

(6) Executing information embedding

Select **Embed information** command from **Processing - Image Processing** menu to embed information data into present observing image. If the present observing image had been saved with auto data display, the command will be disabled when you open the menu. And if the image information file which will be saved simultaneously with image saving, is not exist in the same folder as of the image file, the command will be canceled showing an error message "An information as SEM-image is missing. You cannot process this image".

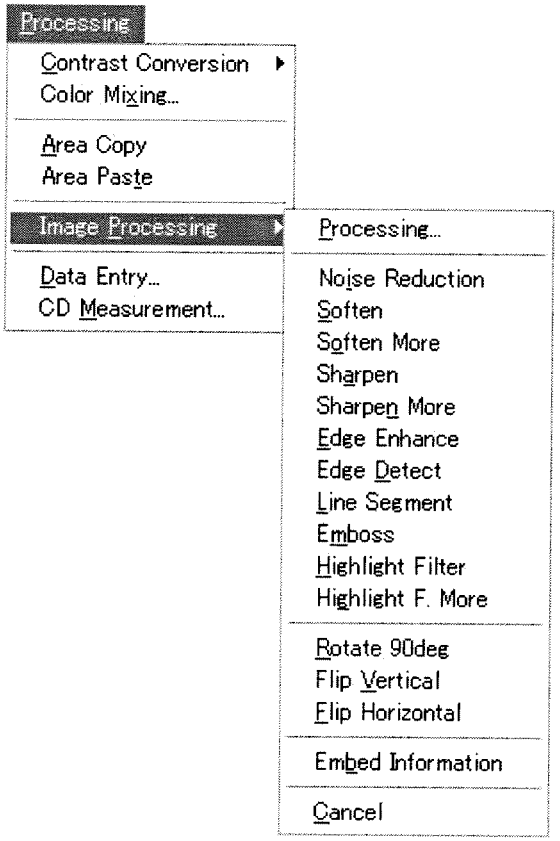


Fig. 3.11-23 Processing Menu

3.11.3.15 Optimizing and Repairing Database File

This function can repair a database rendered inoperative due to a conflict in its internal structure and optimize a given database.
Use **Database Utility** command in **Tool** menu. The following window will open.

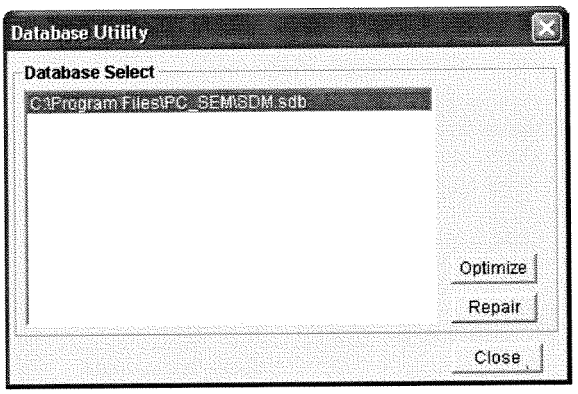


Fig. 3.11-24 Database Utility Window

(1) Optimizing database file
To optimize the database file when the file size becomes unnecessarily large by repeating registration and deletion, select the database file by clicking the name and click **Optimize**. Usually it is not necessary if no problem has been shown.

(2) Repairing database file
When the message "Database not found" is shown while operating SEM Data Manager, try to repair the database. Select the database file by clicking the name and click **Repair** button.

4. MAINTENANCE

When attempting maintenance of this instrument, observe the following cautionary instructions.

(1) Read through the maintenance procedures contained in this manual, and then carry out maintenance as described.

(2) Avoid disassembling/reassembling or repairing any part that is not described in the maintenance procedures.

(3) The vacuum pump (turbo-molecular pump) recommends the maintenance of the oil cartridge and the bearing once/three years. Contact the nearest Hitachi service when the maintenance message is displayed after three years from installed day.

4.1 Maintenance of Electron Optical Column

4.1.1 Filament Exchange

It is thought of as filament cuts when the image or the emission current does not obtain even if the accelerating voltage is impressed. Directions on how to replace a filament, prepared in 3D CG, are also available. For details, see 2.3.4 Menus.

(1) In the **Optics** tab in the **Setup** window, set the **Filament** value to 0.

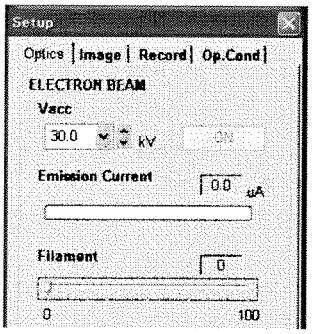


Fig. 4.1-1 Filament Setting

(2) If the accelerating voltage is ON, click the **OFF** button to shut it off.
(Notes on display: When the accelerating voltage is **ON**, the **OFF** button is active. When the accelerating voltage is **OFF**, the **ON** button is active.)

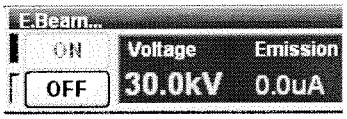
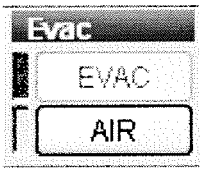


Fig. 4.1-2 Electron Beam Control Block

(3) Either press the **AIR** switch on the Evacuation Control Panel or press the **AIR** button located on the right side of the observation screen Control Panel. Wait until the inside of the column reaches a complete AIR state.

EVAC panel



Control Panel

Fig. 4.1-3 Evacuation Control Panel

(4) Lift the entire electron gun unit toward left, and tilt it.

> ⚠ **WARNING:** When the filament assembly is replaced, it can be as hot at 90°C. Touching it can cause burns. When replacing a filament assembly, turn off the acceleration voltage, and let the assembly stand for 30 minutes or longer after the air is let in before working on it.
> Or, execute the filament exchange by using heatproof gloves of the clean room specification.

Fig. 4.1-4 Removing the Electron Gun Unit

⚠ CAUTION: When lifting the entire electron gun unit, be sure to hold it in two hands and move it until it stops. Releasing the hand in the middle carries the risk of injury such as a finger getting caught.

NOTICE: Take care not to leave fingerprints on the internal vacuum parts for preventing gas degassing. Be sure to wear clean gloves when performing the following procedure.

(5) Turn the holding ring counterclockwise to remove the cartridge filament assembly.

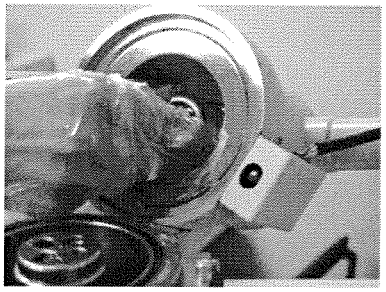


Fig. 4.1-5 Removing the Cartridge Filament Assembly

⚠ WARNING: When the filament assembly is replaced, it can be as hot at 90°C. Touching it can cause burns. When replacing a filament assembly, turn off the acceleration voltage, and let the assembly stand for 30 minutes or longer after the air is let in before working on it.
Or, execute the filament exchange by using heatproof gloves of the clean room specification.

(6) Remove the Wehnelt cylinder. If the Wehnelt cylinder hole is contaminated, clean it with bamboo stick, absorbent cotton, polishing paste, acetone, etc. It is good practice to clean Wehnelt at every filament change.

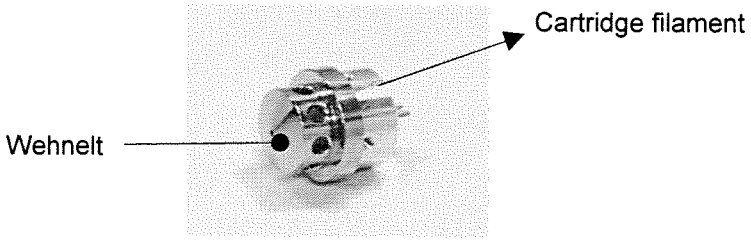


Fig. 4.1-6 Cartridge Filament Assembly

NOTICE: Any polishing paste used in the cleaning operation should be removed completely. If a cartridge filament assembly with some residue still attached is used, the emission current fluctuates and can cause a faulty image, such as changes in brightness. Inspection with an optical microscope is a good way to check. Cleaning parts in an ultrasonic cleaner is good practice.

(7) If the area around the center of the anode hole is dirty, the screwed-in anode should be removed. As described in (6) above, clean the area around the hole on the anode plate, and then install the cleaned anode.

Fig. 4.1-7 Cleaning the Anode

(8) Attach the Wehnelt to the cartridge filament.

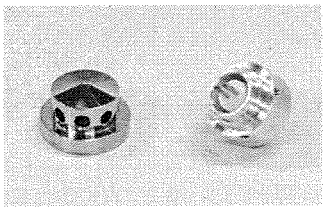


Fig. 4.1-8 Wehnelt (left) and Cartridge Filament (right)

NOTICE: Spacers to adjust the height of each filament are attached to the cartridge filament. Install these spacers when exchanging the cartridge filament.

NOTICE: The emission current value of the cartridge filament might increase and decrease from the value of the adjustment standard by the combination of the filament and wehnelt. In that case, execute quantity adjustment of spacers and adjust the emission current value.

【Standard adjustment of the emission current】

Check the emission current value after executing "ABS" by the following setting condition. (Refer to Table 4.1-1, Fig.4.1-9)

Table 4.1-1 Setting conditions for standard adjustment

HV	AUTO GUN BIAS	AFS	EMISSION CURRENT
30 kV	ON	Mid	40～120 μA

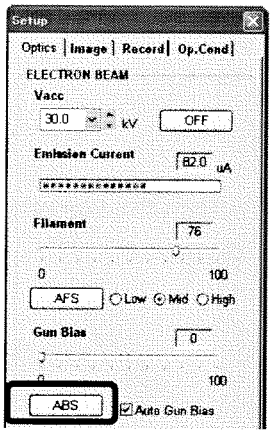


Fig. 4.1-9 Setup Window

【Adjustment of the emission current】

NOTICE: Spacers for the emission current adjustment are attached to the back of the cartridge filament case lid. Use them when decreasing the emission current is required after checking the emission current.

NOTICE: The thickness of a spacer is about 50 μm. The emission current is changed by ±30 μA according to increasing or decreasing one spacer.

In case of decreasing the emission current : Add some spacers
In case of increasing the emission current : Remove some spacers

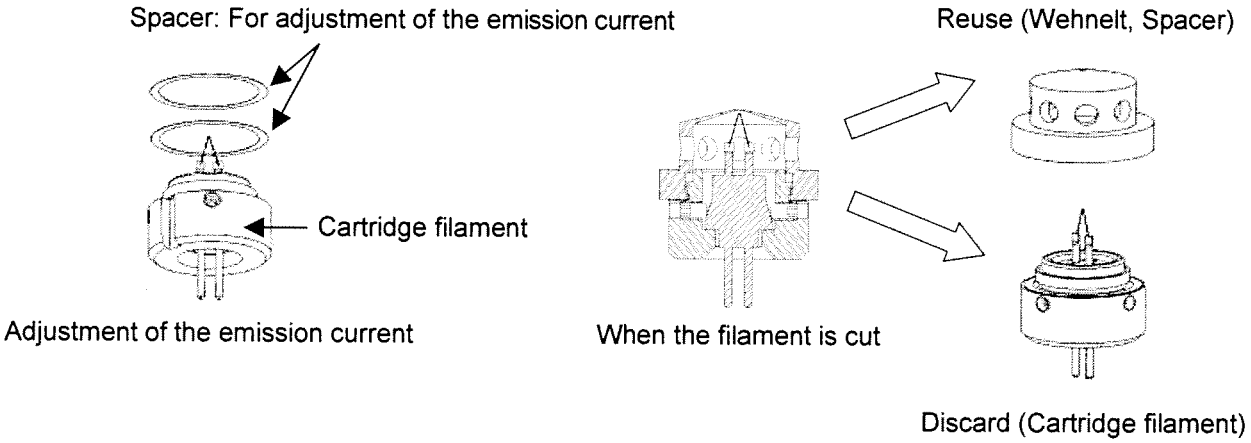


Fig. 4.1-10 Details of Assembling the Cartridge Filament

(9) Check to see that the Wehnelt is securely fitted. After that, use a spray or blower to completely remove any lint and other debris attached to the filament assembly.

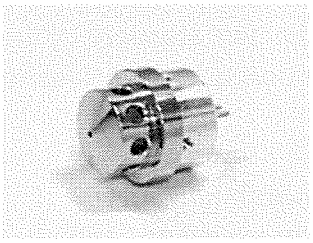


Fig. 4.1-11 Cartridge Filament Assembly

(10) Attach the filament assembly to the electron gun. Fix it by turning the holding ring clockwise.

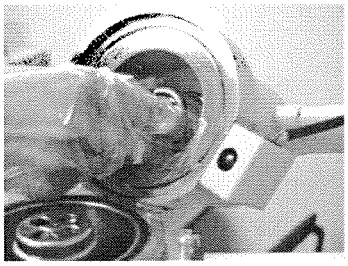


Fig. 4.1-12 Installing the Cartridge Filament Assembly

(11) Set the gun onto the column.

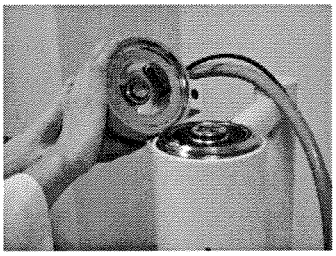


Fig. 4.1-13 Installing the Electron Gun Unit

NOTICE: Unload the electron gun after O-ring returns to the groove when it has come off from the groove.

⚠ **CAUTION:** When lowering the electron gun unit, be sure to hold it in two hands and lower it quietly until it stops. Releasing the hand in the middle carries the risk of injury such as a finger getting caught.

NOTICE: Adequate care should be taken to prevent any dust particles from intruding into the electron gun unit or the inside the column.

(12) Either press the **EVAC** switch on the Evacuation Control Panel or the **EVAC** button located on the right side of the Observation Screen Control Panel. Wait until the evacuation process finishes.

EVAC Panel Control Panel

Fig. 4.1-14 Evacuation Control Panel

(13) When application of accelerating voltage is enabled, apply an accelerating voltage, and perform and electron beam axial alignment according to <3.4.2 Axial Alignment>.

4.1.2 Maintenance for the Objective Lens Movable Aperture

A dirty objective lens movable aperture can cause a stigma aberration with a significant impact on image resolution. Although how often the objective lens movable aperture should be serviced depends on the frequency of use of it, it should be serviced as follows:

- Periodically once every six months under normal usage conditions.
- If resolution declines apparently due to a dirty aperture.
- More frequent routine maintenance may be required if a low accelerating voltage (less than 5 kV) is ordinarily used.

Maintenance procedures are given below. Operating instructions based on 3D CG are also available. For further details, see <2.3.4 Menus>.

(1) On the **Setup** window, set the numerical value in **Filament** in the **Optics** tab to 0.

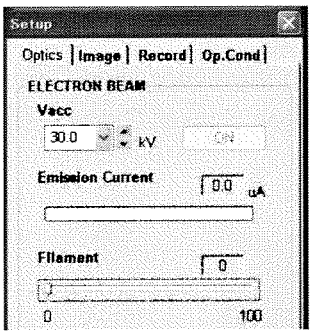
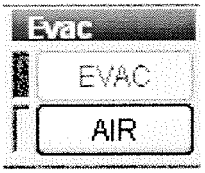


Fig. 4.1-15 Filament Setting

(2) If the accelerating voltage is **ON**, click the **OFF** button to shut it off.

(3) Press either the **AIR** switch on the Evacuation Control Panel or the **AIR** button located on the Observation Screen Control Panel. Wait until the interior of the column completely attains the AIR state.

EVAC Panel



Control Panel

Fig. 4.1-16 EVAC Control Panel

(4) Set the objective lens movable aperture to the "0" position. Using a hexagon wrench, loosen the Align screw that secures the advancing mechanism for the objective lens movable aperture.

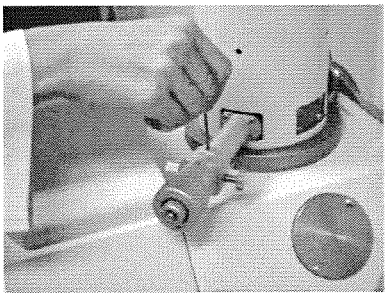


Fig. 4.1-17 Removing the Objective Lens Movable Aperture

(5) Pull out the entire assembly for the objective lens movable aperture.

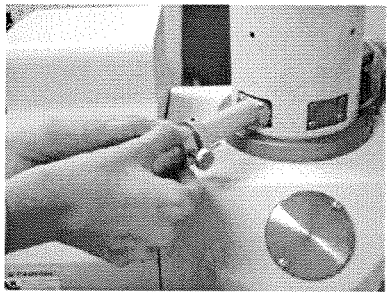


Fig. 4.1-18 Removing the Objective Lens Movable Aperture Assembly

(6) Using a precision screw driver, remove the retaining screw that holds down the objective lens movable aperture plate.

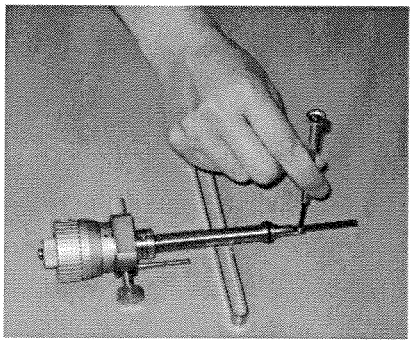


Fig. 4.1-19 Removing the Retaining Screw

(7) Using a pair of tweezers, remove the aperture plate and replace it with a new one (or one that has been baked in vacuum deposition equipment). If the aperture holder or aperture base is dirty, polish it with a cotton swab soaked in polishing paste, and then clean it with acetone.

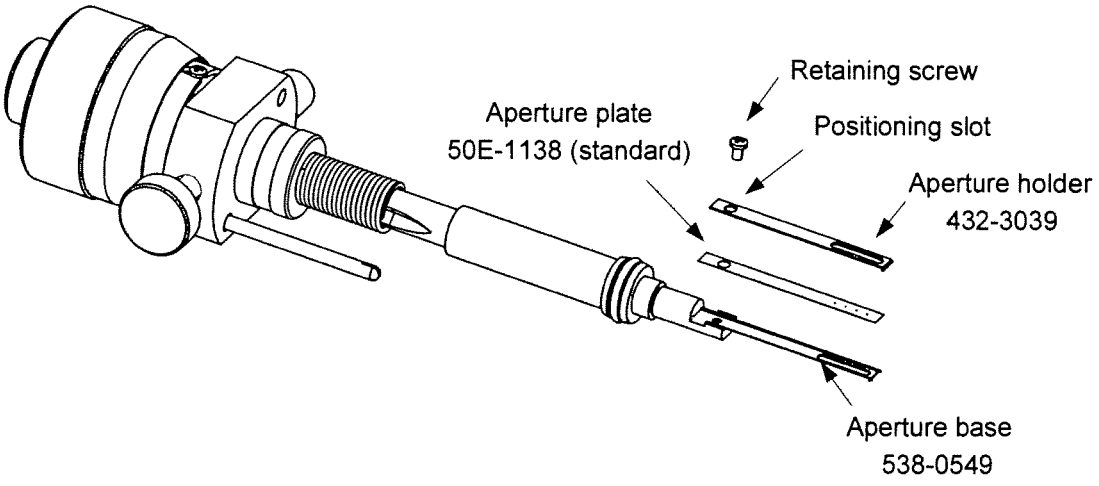


Fig. 4.1-20 Replacing the Aperture Plate

NOTICE: Objective lens movable aperture plates can be used on either side.

(8) Referring to Fig. 4.1-21, align the positioning slot for the objective lens movable aperture plate with the positioning slot for the aperture base. Place the aperture holder over them, and lightly fasten the aperture holder retaining screw.

(9) Verify that that the positioning slot for the aperture plate is properly aligned with the positioning slots for the aperture base and aperture holder, and then tighten the aperture holder retaining screw.

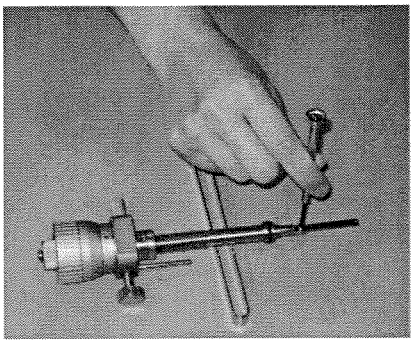


Fig. 4.1-21 Attaching the Retaining Screw

(10) Make sure that the area around the objective lens movable aperture plate is free of dust, and it's the "0" position. Insert the objective lens movable aperture advancing mechanism straight into the guide slot.

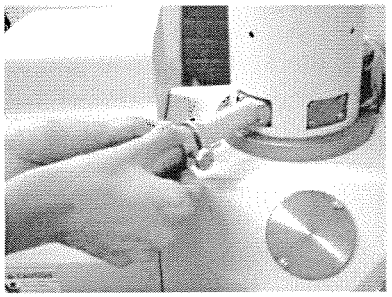


Fig. 4.1-22 Installing the Advancing Mechanism

NOTICE: If there are dust particles in the area around the objective lens movable aperture plate, they should be removed using a spray or blower; care should be taken to avoid contaminating the inside of the column.

(11) Securely insert the advancing mechanism for the objective lens movable aperture. Fasten the W-point screw with a hexagon wrench to secure the advancing mechanism.

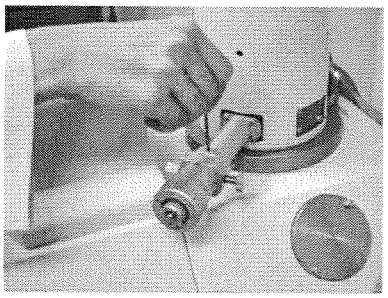
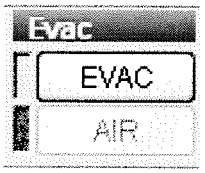


Fig. 4.1-23 Installing the Objective Lens Movable Aperture

(12) Press either the **EVAC** switch on the Evacuation Control Panel or the **EVAC** button on the Observation Screen Control Panel; wait until the evacuation process finishes.

EVAC Panel



Control Panel

Fig. 4.1-24 Evacuation Control Panel

4.1.3 Maintenance for the Orifice Unit

The orifice unit in the S-3400N rarely becomes dirty due to the presence of an objective lens movable aperture in the upper part of the column and because the space between them is evacuated. The orifice unit, however, requires maintenance services in the following cases:

- Image stigma is substantial with a declining resolution. Although the objective lens movable aperture was serviced according to Section 4.1.2, the stigma could not be removed and the problem has not been resolved.
- Stigma was still significant when the objective lens movable aperture position was set to "0" during the observation.
- Some dust fell into the orifice unit.
- It has been more than one year since last servicing under normal usage conditions.

NOTICE:	Procedure for servicing the orifice unit are given below. However, this operation, which involves the handling of tiny components, should be delegated to service personnel.

(1) If the accelerating voltage is ON, click the **OFF** button to shut it off.

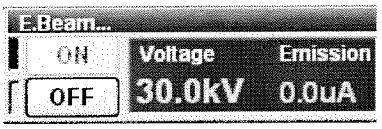
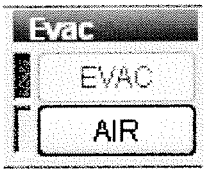


Fig. 4.1-25 Electron Beam Control Block

(2) Press either the **AIR** switch on the Evacuation Control Panel or the **AIR** button located on the Observation Screen Control Panel. Wait until the interior of the specimen chamber completely attains the AIR state.

EVAC Panel



Control Panel

Fig. 4.1-26 Evacuation Control Panel

(3) Pull out the stage.

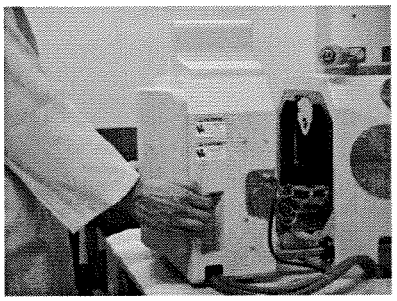
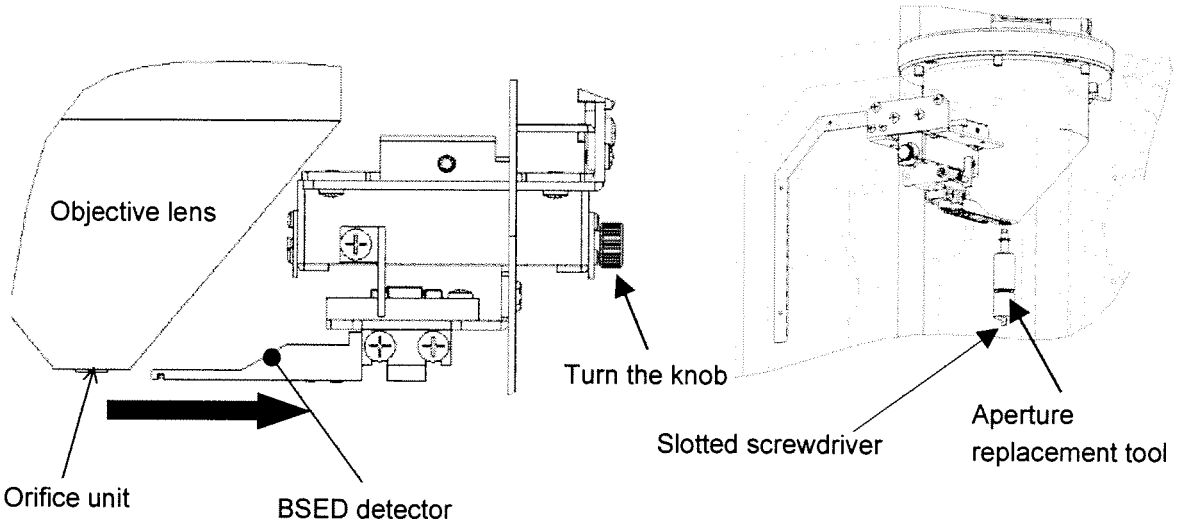


Fig. 4.1-27 Pulling Out the Stage

IMPORTANT:	Before pulling out the Type Ⅰ stage, be sure to move the Z knob for the stage to the sample exchange position. Pulling out the stage with the specimen in a position other than the sample exchange position can potentially damage the specimen or equipment.

IMPORTANT:	Before pulling out the Type Ⅱ stage, be sure to press the **HOME Z65** button in the Stage Operation window to move the specimen to the sample exchange position. Pulling out the stage with the specimen in a position other than the sample exchange position can potentially damage the specimen or equipment.

(4) Turn the knob for the BSED (backscattered electron detector) mechanical unit to pull out the BSED detector, and insert the aperture replacement tool through the stage opening to remove the orifice unit.



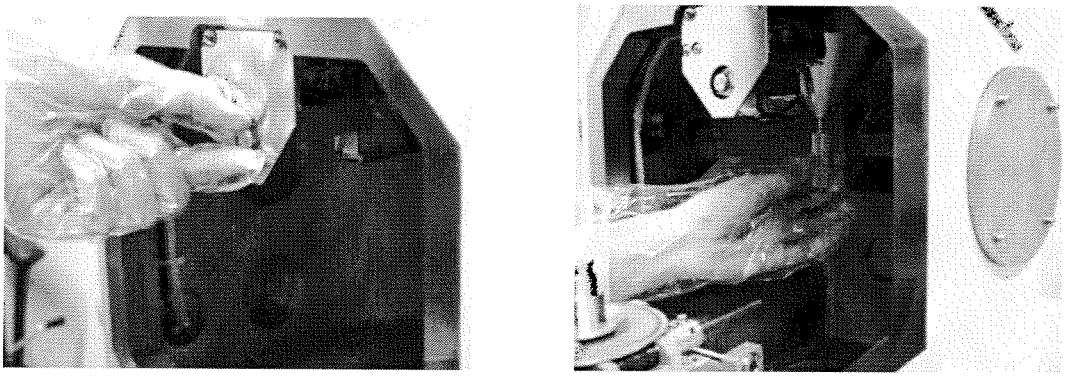
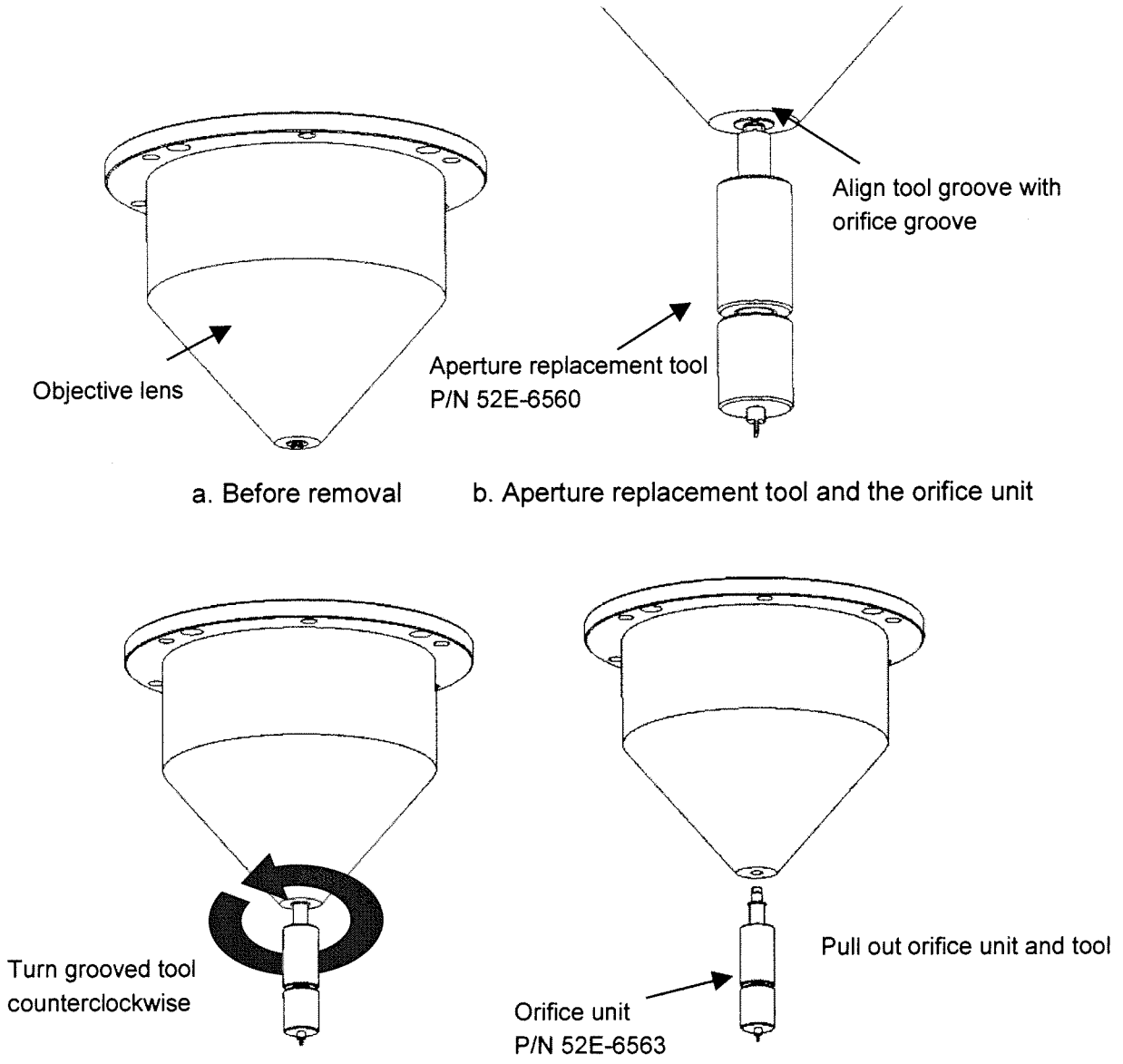


Fig. 4.1-28 Removing the Orifice Unit (1)

IMPORTANT:	Do not touch the operation parts such as gears and driving screws and note that clothes are never placed when you bring the hand close to the movement mechanism in the specimen stage by the orifice maintenance.



a. Before removal b. Aperture replacement tool and the orifice unit

c. Turn the orifice unit and the tool together d. Removal

Fig. 4.1-29 Removing the Orifice Unit (2)

To remove the orifice unit, first insert the tip (the M4 male screw) of the part inside the replacement tool into the hole located on the underside of the objective lens, and screw it into the orifice unit, as illustrated in Fig. 4.1-29 b. In this step, align the outer groove of the aperture replacement tool with the circular groove located in the lower part of the orifice unit. After that, rotate the outer part of the replacement too counterclockwise, as shown in Fig. 4.1-29 c, and then remove the orifice unit, as shown in Fig. 4.1-29 d.

IMPORTANT:	Subjecting the objective lens to shock or scratching it can significantly reduce system performance. The replacement operation should be performed with great care. Also, care should be exercised so that no dirt or dust will get on the objective lens.

IMPORTANT: Be careful to avoid any damage to the surface of the scintillator in the specimen chamber or to the backscattered electron detector.

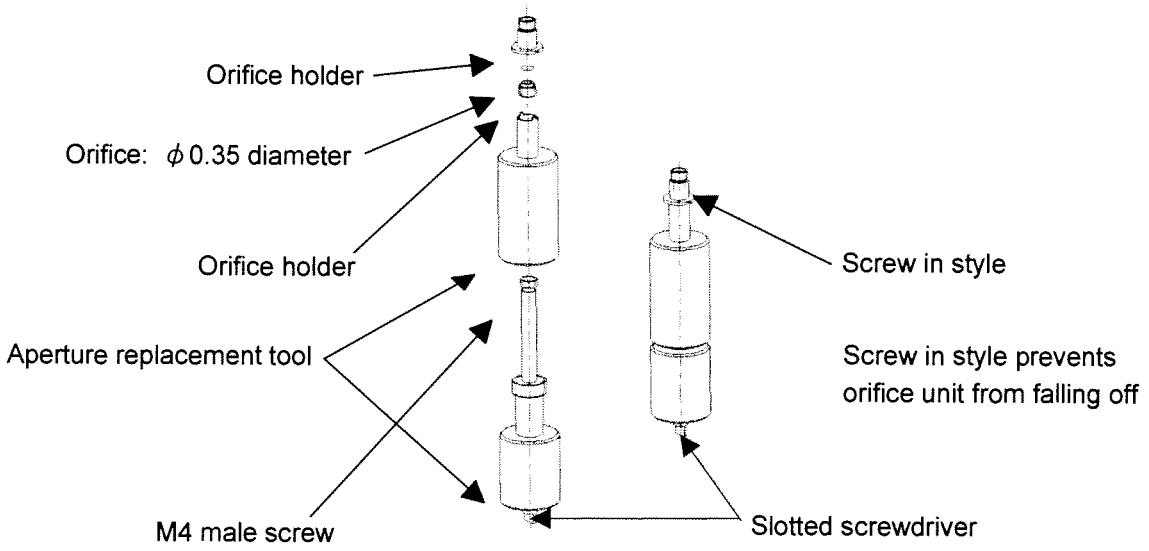


Fig. 4.1-30 Makeup of the Orifice Unit and Aperture Replacement Tool

Ordering a set of orifice unit: Fixed aperture set P/N 52E-6563
Ordering a set of aperture replacement tools: Fixed aperture tools P/N 52E-6560

(5) Set the slotted screw driver attached to the reverse side of the aperture replacement tool on the ring groove of the orifice unit, turn it counterclockwise, remove the ring, and take out the aperture.

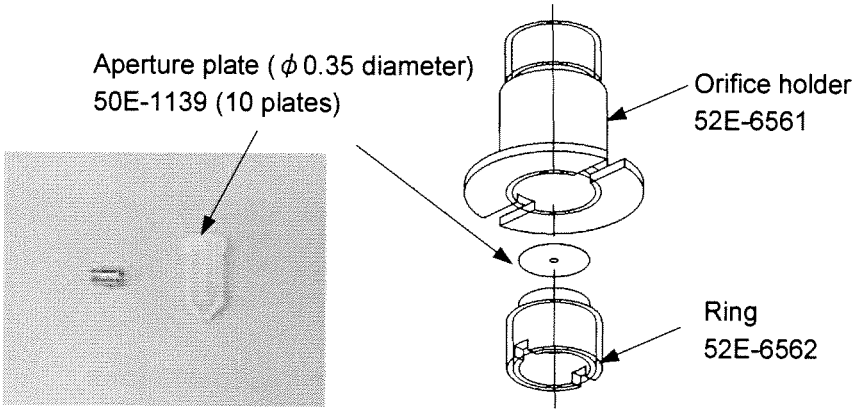


Fig. 4.1-31 Removing the Orifice Ring

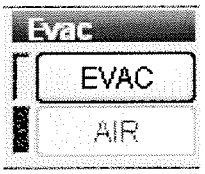
(6) Thoroughly clean the components, with the exception of the aperture, with acetone-dipped cotton swabs. The acetone should be wiped off completely so as to leave no residue. Preferably, an ultrasound cleaner should be used. Inspect all parts with optical microscope to check for residue.

(7) Replace the aperture with a new one.

(8) After the aperture has been countered, perform Steps (4) - (5) in reverse to re-assemble the unit. When turning the knob clockwise and inserting the BSED detector, turn it until the BSED detector catches the orifice unit and stops. Notice that if the knob is turned too hard, the detector will disengage from the orifice unit and overshoot.

(9) Press either the **EVAC** switch on the Evacuation Control Panel or the **EVAC** button located on the right side of the Observation Screen Control Panel, and wait until the evacuation process finishes.

EVAC Panel



Control Panel

Fig. 4.1-32 Evacuation Control Panel

4.1.4 Maintenance for the Condenser Aperture

The condenser aperture should be replaced once a year.
Directions on how to replace a condenser aperture, prepared in 3D CG, are also available.
For details, see 2.3.4 (11) **Help** menu.

(1) If the accelerating voltage is ON, click the **OFF** button to shut it off.

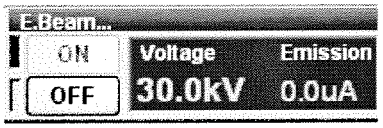
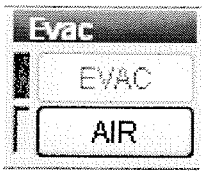


Fig. 4.1-33 Electron Beam Control Block

(2) Either press the **AIR** switch on the Evacuation Control Panel or press the **AIR** button located on the right side of the observation screen Control Panel. Wait until the inside of the column reaches a complete AIR state.

EVAC Panel



Control Panel

Fig. 4.1-34 Evacuation Control Panel

(3) Lift the entire electron gun unit to the left and tilt it.

Fig. 4.1-35 Removing the Electron Gun Unit

> ⚠ **CAUTION:** When lifting the entire electron gun unit, be sure to hold it in two hands and move it until it stops. Releasing the hand in the middle carries the risk of injury such as a finger getting caught.

> **NOTICE:** To avoid any fingerprint, which can release gas, on components inside the vacuum unit, the steps described below should be performed by wearing clean gloves.

(4) Remove the anode which is screwed in.

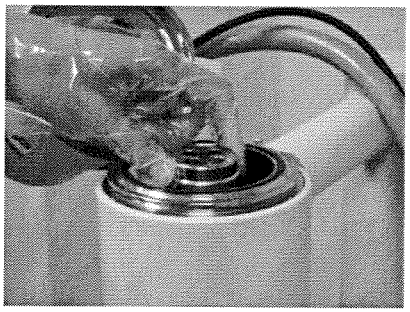


Fig. 4.1-36 Removing the Anode

(5) Using a special pair of tweezers, pull out the condenser aperture.

Fig. 4.1-37 Removing the Condenser Aperture

(6) Referring to Fig. 4.1-38, loosen the pipe and the pipe holder, and remove the single-hole mesh aperture.

(7) Install a new aperture.
When re-using an old aperture, it should be cleaned by baking. The new aperture should be checked under an optical microscope to make sure that it is free of dirt or dust, and that it is clean and its hole is neatly machined.

(8) After assembling the aperture, use a spray or blower to remove any lint or dust.

(9) After the cleaning is completed, follow the procedure from (6) to (2) to complete the assembling process.

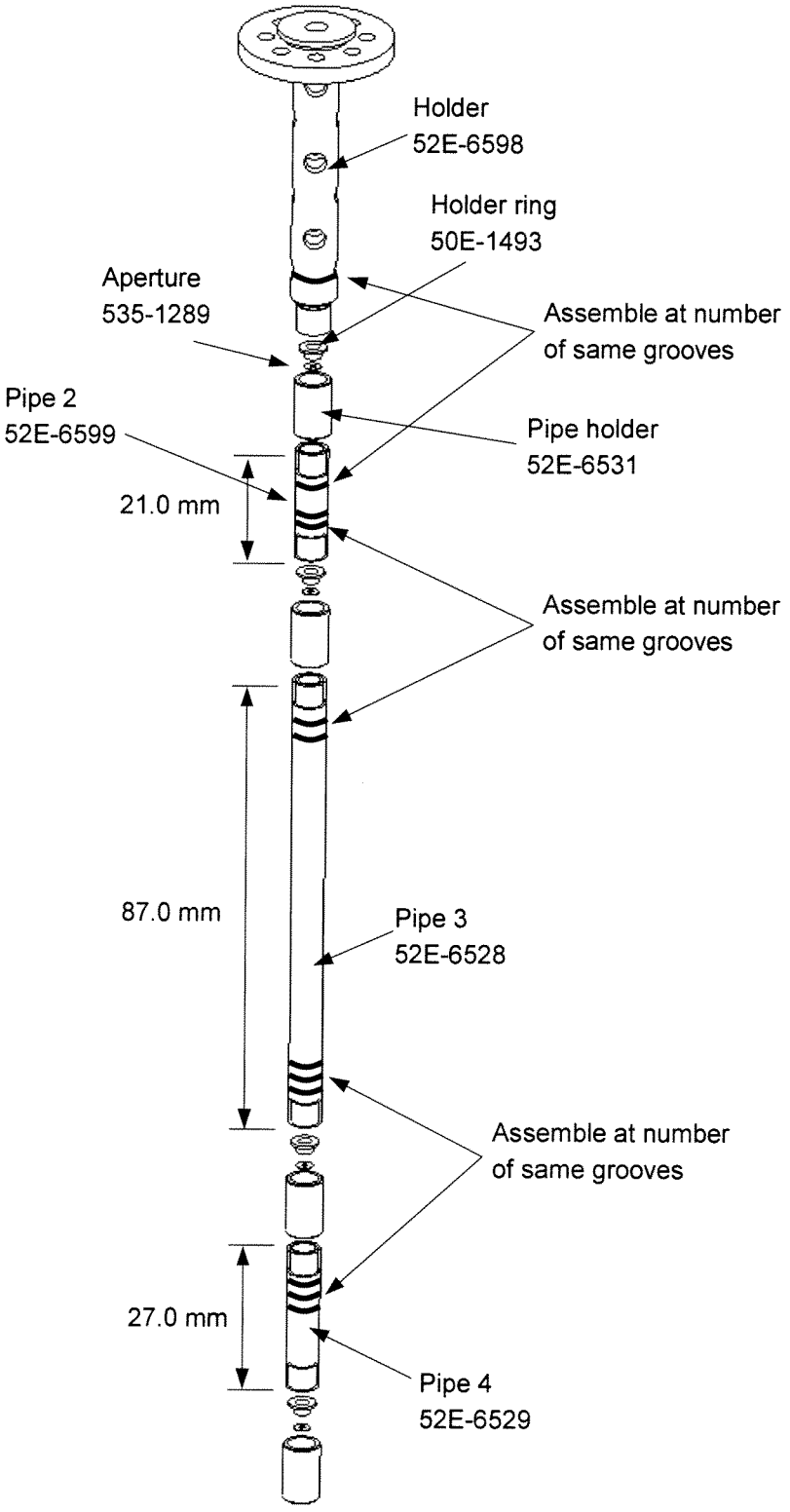


Fig. 4.1-38 Condenser Aperture Assembly

4.1.5 Cleaning of Aperture Plates

(1) Use the vacuum evaporator for heating aperture plates. For handling of the vacuum evaporator, refer to the instruction manual of the evaporator.

(2) Mount the molybdenum board in the vacuum evaporator. (See Fig. 4.1-39.)

(3) Evacuate the vacuum evaporator to better than 5×10^{-3} Pa.
Heat the molybdenum board. Continue applying heater current until the molybdenum board becomes incandescent. Do not apply too much heater current, otherwise the molybdenum board may be melted.

(4) After completion of heating the molybdenum board, wait about 15 minutes for cooling down. And then introduce air into the vacuum evaporator.

(5) Mount an aperture plate at the center of the molybdenum board.

(6) Evacuate the vacuum evaporator to a high vacuum better than 5×10^{-3} Pa.
Apply heater current. Heat the molybdenum board up to the incandescent point and then stop heating. Be careful not to heat for a long time.

(7) After completion of heating, wait for about 15 minutes and introduce air into the vacuum evaporator. Then remove the aperture plate with tweezers.

> ⚠ **CAUTION:** Heated aperture plates after baking are hot. Touching it can cause burns. Do not touch the heated aperture plates with bare hands.

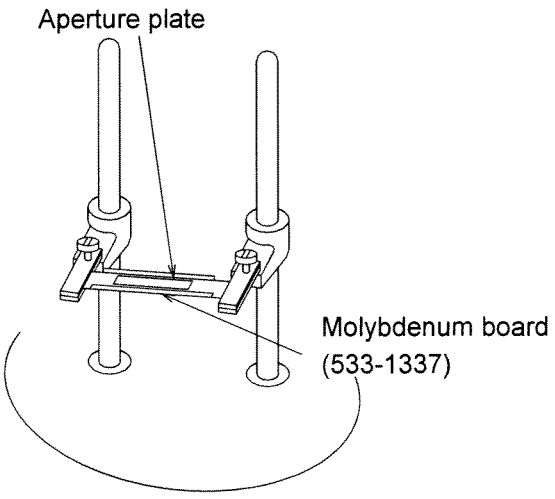


Fig 4.1-39 Baking of Aperture Plate

4.1.6 Ultrasonic Cleaning with Organic Solvent

> ⚠ **CAUTION:** When handling organic solvent (volatile solvent), take the following points into consideration to avoid the danger of injury or explosion caused by ignition.
> (a) Volatile solvent should be handled at a place which is well ventilated and is well away from flame.
> (b) If volatile solvent is excessively inhaled, dyspnea (difficulty in breathing) may be caused. If volatile solvent is swallowed or gets onto the skin or into the eyes, the symptoms of polyneuritis including anesthesia and ataxia (difficulty in walking) may develop. So use a gas mask for organic gas, plus an inhaler, safety goggles, protective gloves, protective boots, etc. as the occasion demands or in consideration of conditions.

For cleaning of the Wehnelt cylinder and anode plate, the polishing paste is used and organic solvent is used to remove polishing paste.
Conduct the work safely with reference to the warnings given at the beginning of this manual.

(1) Supply water into the wash-basin of the ultrasonic cleaner up to 10 to 20% of its capacity.

(2) Fill organic solvent into a beaker to about half of its capacity.

(3) Put parts, which have been cleaned with polishing paste, into the beaker.

(4) Place the beaker in the wash-basin of the ultrasonic cleaner.

(5) Turn on the cleaner and clean the parts for 2 to 3 minutes.

(6) After the cleaning, take the parts out of the beaker and rinse them in distilled water for 2 to 3 minutes to remove organic solvent.

(7) Put the rinsed parts into another beaker filled with clean ethyl alcohol.

(8) After substituting water adhering to parts with alcohol, take the parts out of the beaker with tweezers and place them on a sheet of clean filter paper to evaporate the alcohol heat to dry.

4.1.7 Replacement of Scintillator

When the instrument is used in the low vacuum mode for a long time, the inside of specimen chamber is likely to be contaminated sooner than in the high vacuum mode.
The scintillator receiving secondary electrons is also apt to be contaminated in the low vacuum mode. If the surface of scintillator is contaminated, the efficiency of secondary electron detection may deteriorate to cause an unclear image. So, replace the scintillator before it is contaminated heavily. It is advisable to replace the scintillator in a cycle of about three years, though depending on the instrument operating condition in the low vacuum mode.
The replacement work should be conducted by the service engineer.

4.2 Maintenance of Rotary Pump

NOTICE: Instruments shipped to European area where CE marking conformity is necessary are not provided with the rotary pump. Also according to the configuration of the apparatus, the rotary pump is not provided even when shipped to outside of the European area.

A period of inspection cannot be uniformly determined simply because operating conditions of vacuum pumps differ. To minimize trouble and to maximize service life, conduct periodic inspections (at least once every six months) according to the operation conditions.
For maintenance and inspection of the rotary pump refer to the instrument manual furnished with it.

4.2.1 Oil Change

Condition of the pump oil exerts a strong influence on vacuum pressure produced by the pump as well as on pump service life. To maintain the pump under ideal operating conditions, always pay attention to the oil volume and cleanliness by observing through the **oil level gauge** window. Replace the oil with a new supply as soon as it appears to be contaminated.

(1) Under normal operating conditions, replace old oil with new oil semiannually, although the recommended period for oil change greatly differs according to actual operating conditions. When employing the pump with air containing steam or other materials noxious to the oil, the oil rapidly becomes degraded. In this instance, replace it sooner than usual.

(2) When changing oil, refer to the instruction manual furnished with the pump.

(3) We recommend employing **SMR-100 (ULVAC, Inc.)** for this Vacuum Pump.

4.2.2 Replacement of Oil Mist Trap Element

The oil mist trap element is of a disposable type. When oil vapor or soot is found, replace this assembly with a new one. (P/N 51E-1545)

IMPORTANT: The rotary pump has a finite life. Any rotary pump that has been in service for five years should be replaced with a new one. An expired motor can cause abnormal heating and emit fumes.

⚠ **CAUTION:** The rotary pump is a heavy object weighing approximately 30 kg. When moving the rotary pump, it should be lifted by at least two persons to prevent your hands or feet from getting caught.

⚠ **WARNING:** If it stops abnormally the rotary pump remains hot. Touching it can cause burns. Do not touch the rotary pump in the event of an abnormal stoppage.

4.3 Maintenance of Air Compressor

NOTICE: Instruments shipped to European area where CE marking conformity is necessary are not provided with the air compressor. Also according to the configuration of the apparatus, the air compressor is not provided even when shipped to outside of the European area.

Execute check and maintenance regularly in order to use the air compressor with good condition. The maintenance list of the air compressor is shown in Table 4.3-1. Refer to the manual of the air compressor for a detailed method of handling.

Table 4.3-1 The maintenance list of the air compressor

Check Item	Procedure	Service Cycle			
		Every day	Every 250 h (1 month)	Every 3,000 h (12 months)	Every 8,000 h (30 months)
Draining the condensate	Turn the drain valve's handle to remove the condensate.	○			
Operation of control devices (pressure gauge, pressure switch and safety valve)	Check for working pressure and function. Contact your distributor or dealer.	○		○	●
Abnormal vibration and noise		○			
Loosened bolts, nuts and joints	Retighten as required.		○		
Clogging of suction filter	Air-blast the dusts off.		○	●	●
Leaking of air valve	Contact your distributor or dealer.			○	●
Lip ring and Cylinder				○	●
Packing		Replace Packing after disassembling without failure			
Push Solenoids and Delay circuit				○	●
Connecting rod assy				○	●

NOTICE: The mark "○" indicates the time period after the start of operation or replacement of the part. The mark "●" shows the time point for part replacement.

4.3.1 Daily Inspection

4.3.1.1 Operating Time Confirmation of Air Compressor

The operation time of compressor is about 30 to 90 seconds. It is different depending on the pressure when starting operation. Confirm whether the drain valve is closed if the compressor continuously drives 180 seconds or more (for three minutes). If the compressor continuously drives 180 seconds or more (for three minutes) with the drain valve closed, it might be abnormal continuous driving. Ask the service engineer to check.

> ⚠ **CAUTION:** When the compressor is running continuously and abnormally, the discharge pipe becomes high temperature. Do not touch the discharge pipe.

4.3.1.2 Removing the Condensate

After the operation, discharge the compressed air in the air-tank completely after the main switch off.

> ⚠ **WARNING:** The inside of the compressor tank is pressurized. When draining off the compressor, jerky motion can cause the liquid to splash, causing eye injuries. When draining off the compressor, do not stand directly in front of the drain. Turn the drain cock slowly.

> **IMPORTANT:** Be sure to drain compressor everyday. Corroding might cause damage of device.

> **IMPORTANT:** If you do not use the air compressor for more than one month, take a rust-preventive measure with the condensate drain valve fully opened. The longevity of grease might decrease by moisture when not using it for a long time. When abnormal operation is confirmed, ask the service engineer to check.

4.3.1.3 Checking the Pressure Gauge

Depressurize the tank completely, and make sure that the pressure gauge pointer shows 0 MPa. When abnormal operation is confirmed, ask the service engineer to check.

4.3.1.4 Checking the Pressure Switch

Start the compressor. Raise the pressure, and make sure that the compressor can automatically stop at the pressure setting below. Open the drain valve to lower the pressure, and make sure that the air compressor can automatically restart at the pressure setting below.

Automatic STOP Pressure	Automatic START Pressure
0.49 MPa	0.34 MPa

4.3.1.5 Checking the Safety Valve

If the pressure switch has failed, the air tank internal pressure raises abnormally, and as a result the safety valve (release valve) may operate at the pressure setting bellow.
This is to lower the pressure for preventing the compressor and motor from overloading. If the safety valve operates frequently or the compressed air leaks, contact your Hitachi distributor or dealer.

Safety Valve Working Pressure
0.59 MPa

4.3.1.6 Confirmations of Abnormal Vibration and Sound

If abnormal vibration or sound is confirmed, ask the service engineer to check.

4.3.2 Maintenance at 250,3000, and 8000 Operation Hours Intervals

The check and the maintenance every 250, 3000, and 8,000 hours might be required depending on the use conditions or use period. Ask the service engineer to check if necessary.

4.3.3 Troubleshooting of Air Compressor

When trouble with the compressor is caused, refer to the following table.

Table 4.3-2 Troubleshooting list

Symptoms	Probable Cause	Actions
Air compressor can start, but;		
Cannot build up the pressure, or take a longer time to build up.	Air leak from drain valve or stop valve	Re-tighten, or replace if needed.
	Sealing failure on O-ring or threaded parts	Replace O-ring or Re-tighten.
	Air leak from pipe joints	Re-tighten.
	Air leak from safety valve (release valve)	Replace with new one.
	Failure of air valve	Clean or replace.
	Clogging of suction filter	Clean or replace.
	Wearing of pressure switch	Replace with new one.
	Failure of pressure switch	Replace with new one.
	Failure of pressure gauge pointer	Replace with new one.
The pressure rises to abnormally high level.	Failure of pressure switch	Adjust or replace.
	Failure of pressure gauge pointer	Replace with new one.
Abnormal sound is heard.	Contact of retainer and valve seat	Order to distributor or dealer.
	Failure of bearings	Order to distributor or dealer.
	Improper installation	Re-install on the leveled floor.
Electric motor is overheated.	Failure of pressure switch	Replace with new one.
	Reverse direction (Three Phase)	Change two of three wires of power cord.
	Damage of Cooling Fan	Replace with new one.
Air compressor can't start, and;		
Electric motor does not rotate.	Seizure of metal contacting.	Order to distributor or dealer.
	Failure of motor.	Order to distributor or dealer.
Electric motor hums.	Voltage drop.	Replace wires with larger-size wires.
	Air leak from air valve.	Replace with new one.
	Failure of pressure switch.	Replace with new one.
	Failure of push solenoids & delay circuit	Replace with new one.

NOTICE: In the following cases, they are not breakdown.
After executing actions described below, confirm the electric motor rotates.

1. Main power is off	—	Just turn on the main power.
2. You have switched on the main power when the pressure is within the control range of pressure switch.	—	Release the internal pressure. Make sure that the motor can start when the pressure drop to 0.34 MPa.

- When asking the service engineer for repair, please notify them of the following.
  1. Model code (Check it on an identification label on the motor)
  2. Symptom of trouble (Include the conditions before and after the trouble has occurred)

4.3.4 Location and Functions of Major Components

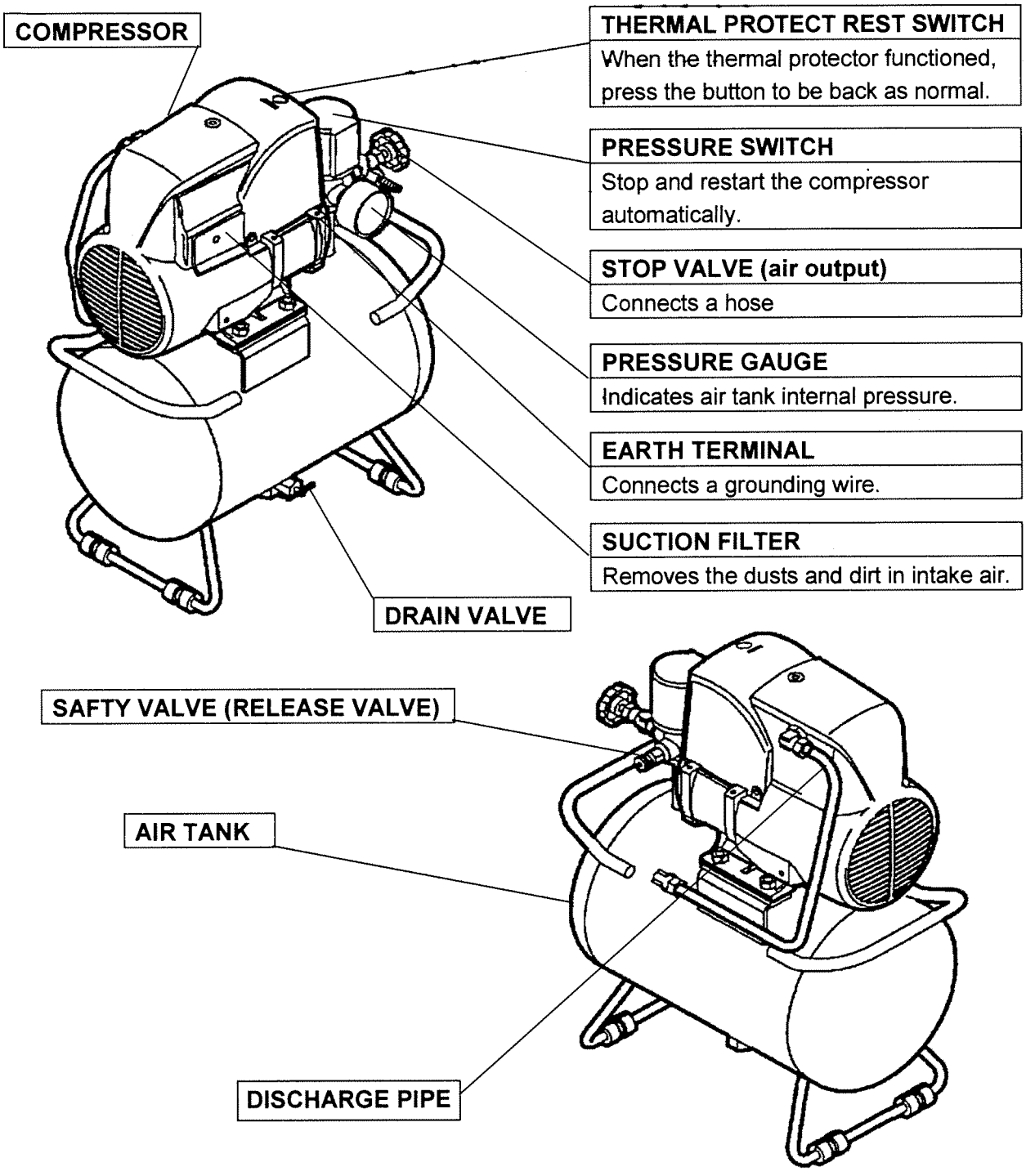


Fig. 4.3-1 Part Names and Functions of Air Compressor

4.4 Troubleshooting

4.4.1 The Evacuation System does not Run

If the evacuation system fails to run or the evacuation system does not proceed, the following items should be checked:

(1) Is there an error?
If both the **EVAC/AIR** switches on the EVAC Panel are blinking and the buzzer is sounding, it is an indication that an error has occurred. If this happens, check the error message on the PC operation screen. If an error message is displayed, the corrective action described in the list of error messages in the Appendix should be taken.

(2) Is the **PUMP** light on the EVAC Panel either lit or blinking?
In the steady-state operation condition, the pump is running normally if the **PUMP** light is on. During system startup, the **PUMP** light begins to blink after the compressor air pressure has reached a prescribed level and values are set, and the pace of blinking picks up as the rpm for the turbo molecular pump increases. When the rpm for the turbo molecular pump has reached a prescribed level and the pump goes into the normal running condition, the **PUMP** light becomes solidly lit.
Normally, the turbo molecular pump reaches a set rpm level and the **PUMP** light becomes solidly lit within 10 minutes after the power is turned on. If the **PUMP** light fails to blink or the blinking condition lasts more than 10 minutes, and if an error message is displayed on the PC operation screen, the corrective action described in the list of error messages in the Appendix should be taken. If an error message does not come up, call the service engineer.

4.4.2 The Vacuum Level in the Specimen Chamber does not Rise

If the evacuation process does not end in 5 minutes after the evacuation process for the specimen chamber was started by flipping the **EVAC** button on the EVAC Panel keeps blinking, it is an indication of an error, and an error message appears on the PC operation screen. If this happens, perform the tips provided in the error message, and check the following items:

(1) Is the specimen stage securely inserted into the specimen chamber? The vacuum level will not rise if the specimen stage is pulled out or there is something caught between the specimen stage and the contact unit for the specimen chamber. Verify that the **Current Vacuum** level displayed in **VACUUM MODE** on the operation panel declines gradually. The pump is running normally if the vacuum levels falls to near the set vacuum level in low-vacuum mode, or to 1 Pa or less in high-vacuum mode.

(2) If the pump is set to the low-vacuum mode, reset it to the high-vacuum mode, and then press the **EVAC** button to run the evacuation process.
If you have attached some unit, e.g. objective lens aperture unit, prior to starting evacuation, then introduce air into the specimen chamber and detach the unit. Clean and grease up the O-ring of the unit and attach it again. Then restart evacuation.
Check if your specimen has dried. If the specimen is not dry, outgas from the specimen may cause a longer evacuation time.

(3) If you do not find any failure mentioned above, contact the service engineer.

4.4.3 The Emission Current Fails to Flow Normally

Execute the following checks when the accelerating voltage is applied and the emission current does not flow normally.

(1) Confirm whether the filament is not severing or is installed correctly when the emission current does not flow.
See <3.4.1 (2) (c) Auto Beam Setting (ABS) >.
See <4.1.1 Filament Exchange>.

(2) When the accelerating voltage is less than 2 kV, the emission current is decreased.
See <3.3.2 Setting the Accelerating Voltage and Filament Current>.
See <4.1.1 Filament Exchange>.

4.4.4 When Image is not Shown on Screen

If an image does not appear on the screen or if it is difficult to focus the image, check the following.

(1) Is a specimen loaded? Is the specimen at the exchange position? Are the accelerating voltage and emission current normal? Is either SE (secondary electron) or BSE (backscattered electron) selected as a detector? Is the probe current set too low?
See <3.3.2 Setting the Accelerating Voltage and Filament Current>.
See <3.5.1 Selecting a Detector>.
See <3.10.2 Probe Current Settings and Image Quality>.

(2) Set contrast at maximum.

(3) Open the objective lens movable aperture (set it to the 0 position). If an image appears, perform mechanical axial alignment and aperture alignment adjustments on the objective lens movable aperture.
See <3.4.2.2 Axial Alignment Items in Detail>.

(4) If an image fails to appear in Step (3) above, perform a beam alignment.
See <3.4.2.2 Axial Alignment Items in Detail>.

(5) On **Operate** menu, set the **Filament Image** mode. If a round image appears off center on the screen or the circle is chipped, re-adjustments should be performed.

(6) If the BSE option is selected, is the detector properly inserted? Pull out the specimen stage and verify that the BSE is inserted on the underside of the lens.

If image signals are not displayed at all and the screen fails to become bright even when the Brightness knob is turned to a maximum position, the problem may be that the PC screen is not set properly. It should be noted that the screen on the personal computer has the following default settings:

(Specified using **Screen Properties** and **Setting**)
Color palette: Full color (approximately 16,000,000 colors)
Desktop: 1280 × 1024 pixels
Refresh rate: 60 Hz or 75 Hz (monitor-dependent)

If the problem still cannot be resolved, call the service engineer.

4.4.5 When Image is Very Noisy

There may be three types of noise on scanning images.
The first is a snow noise that appears uniformly on the image. It is mainly due to statistical fluctuation of number of primary or secondary electrons. It appears when probe current is too small, secondary electron emission efficiency of the specimen is too low, or efficiency of signal detection is too low.
If images show such a noise, check the following.

(1) Is the emission current too low?
Reset the accelerating voltage, the filament, and the gun bias.
See <3.3.2 Setting the Accelerating Voltage and Filament Current>.

(2) Is the probe current setting too low?
If the probe current level is less than 30, it should be set to a level greater than or equal to 30.
See <3.10.2 Probe Current Setting and Image Quality>.

(3) If you are using TV or FAST scanning speed, open the Image tab of the **Setup** window and check if the **Frame Averaging** for TV1, TV2, Fast1 and Fast2 is set at 1 or 2. If so, try setting at 4 and 8.

(4) Decrease contrast and increase brightness.

(5) If the BSE is selected, re-check the BSE settings in the **DETECTOR** tab on the Operation Panel. If contrast is too high, reduce the **BSE Gain**; if contrast is too low, increase the **BSE Gain**. The detector should normally set to the **COMP** mode.
In the case of a BSE detector, a long WD reduces the detection efficiency. If that is the case, set a WD less than 15 mm. If the BSE is selected in the high-vacuum mode, try to select the SE detector.
See <3.5.1.2 Backscattered Electron Detector (BSE)>.

(6) On **Operate** menu, set the **Filament Image** mode. If a round image appears off center on the screen or the circle is chipped, re-adjustments should be performed.

The second is random noise caused by unstable probe current or unstable detector.
For example, bright spots or bright or dark lines appear when emission current is unstable or the scintillator of the secondary electron detector has been damaged.
If images show such a noise, check the following.

(1) Is the emission current too low?
Reset the accelerating voltage, the filament, and the gun bias.
See <3.3.2 Setting the Accelerating Voltage and Filament Current>.

(2) If the filament setting off?
If the filament setting is off the saturation point, the emission current may fluctuate, in which case the filament should be reset.
See <3.3.2 Setting the Accelerating Voltage and Filament Current>.

(3) Select the BSE detector to check the noise level. If there is no noise, the problem may lie with the SE detector itself, such as a specimen charge-up problem.

The third is random noise caused by partial charging of a specimen.
Observe another area of specimen or surface of a specimen stub. If noise does not appear, your specimen may be charged. Select operating conditions for such charged samples or apply a suitable preparation to your specimen to eliminate charging.

4.4.6 When You cannot Correct Astigmatism

If astigmatism still remains at the maximum correction level (One (and/or both) of Stigma sliders is set at the maximum or the minimum, or one (and/or both) of Stigma knobs on the operation panel is full), check the following.

(1) Open the **Alignment** window and start Aperture Alignment mode. If image is wobbling, carry out aperture alignment.

(2) Use another opening of the objective lens aperture. If you can correct astigmatism, use the opening or conduct cleaning of the aperture plate referring to the instruction manual.

(3) If astigmatism correction is difficult due to shift of image during correction, open the **Alignment** window and carry out Aperture alignment and Stigma alignment.

If you still have troubles, contact a service engineer.

4.4.7 When Auto Focus or Auto Stigma does not Work Satisfactorily

When auto focus or auto stigma does not produce sharp images, check the following.

(1) Open the **Alignment** window and start Aperture Alignment mode. If image is wobbling, carry out aperture alignment.

(2) Open the **Alignment** window and start Stigma Alignment mode. If image is wobbling, carry out stigma alignment.

(3) Check if the observed specimen has a fine surface structure. If it does not, please use manual focus and manual astigmatism correction.

(4) If an abnormal contrast appears due to a charge-up problem, appropriate results may fail to be produced.

4.4.8 When S-3400N Control Program does not Start Up

When the progress bar on the **login** window does not progress to the end, or the **login** window disappears before completing start up, check the following.

Confirm that the evacuation system is up. Is either the **AIR** or **EVAC** switch on the EVAC Panel blinking or solidly lit? If both switches are off, or both switches are lit or blinking, it is possible that the evacuation system is in error.
If the stage is a motor-drive stage, is it running normally? After the stage is powered up, operate the motor again to move the stage to its home position for initialization. If it appears that the motor is not running properly, turn off the Stage breaker located in the back of the main unit and restart the stage. If the S-3400N control program comes up normally even when the stage cannot be operated, it is possible that the motor drive stage is in error, in which case the service engineer should be called.

4.4.9 When PC has Hung Up

If the PC locks up during system operation, close Windows, shut down the system, and restart it. Although the program can be ended and the system restarted, that approach may result in unstable system behavior. The recommended procedure is to shut down the entire system. Before the system is shut down, if there any programs other than the SEM control program that are running, save the data if it is at all possible, and close the programs.

(1) On the Windows Taskbar, click **Start** and select **Shut down Windows**. On the Windows closing screen, select **Computer may be turned off**, and click the **Y** button.
If this cannot be performed, on the keyboard press the **Alt, Ctrl, and Delete** keys simultaneously. Windows Security will appear, on the menu, select **Shutdown**.

(2) Wait until a "Turn off computer" message appears (depending on settings, in some PCs the power is shut off automatically).
If the PC fails to turn itself off, hold down on the power button on the PC to shut it off.
On rare occasion if the power for the PC fails to shut off when the power button on the PC is pressed for 20 seconds or more, confirm that the hard disk access light is off, and then turn off the **DISPLAY breaker**, to be described in the next paragraph. (If the hard disk access light is on, wait until it goes off.)

(3) Allow about 1 minute, and then turn on the DISPLAY breaker. (If the PC is not set to start up automatically when the power is turned on, manually turn on the PC power.)
If Windows was not shut down properly during the preceding session, a "Checking file system on C: ... To skip disk checking, press any key with 10 second." message may come on. If no action is taken at this point, the Scan Disk program starts automatically.
Upon completion of Scan Disk, on rare occasion the system may come up in Safe mode. If this happens, click **Start - Turn off computer** to restart the system.

(4) Log in to Windows. Launch the S-3400N program.
See <3.1.2 Start-up Operation>.

(5) If the program locked up and the S-3400N control program was not shut down normally, in some cases the condition that existed before the shutdown may not be reproduced (the condition that existed two sessions ago comes up).

4.4.10 When Error Messages are Shown

Messages shown on the S-3400N GUI include operation assist messages, warning for operation and messages showing instrumental error.
Messages are shown with a number. Refer to the list of messages in the appendix.

4.5 What to Do in the Event of a Power Outage or the System must be Shut Down Completely for a Long Time

(1) Perform routine shutdown operations (remove the specimen, shut down Windows, and turn off the power).
See <3.8 Shutting Down>.

(2) Turn off the MAIN breaker located in the back of the main unit.

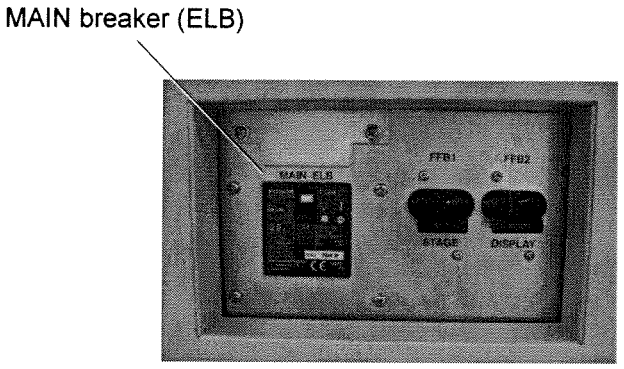


Fig. 4.5-1 MAIN Breaker

(3) Turn off the power breaker on the distribution board at the installation site.

4.6 What to Do when the Power Failure and the System is to be Started Up

When the power failure returns, the device is started according to the following procedure.

(1) Do the operation similar to section 4.5.
(Confirm that Main breaker on back of the main unit and the power breaker on the distribution board at the installation site are OFF.)

(2) Turn on the power breaker on the distribution board at the installation site.

(3) Turn on the MAIN breaker located in the back of the main unit. For the Type Ⅰ stage, make sure that the DISPLAY breaker is on. If it is off, turn it on. For the Type Ⅱ stage, confirm that the DISPLAY and STAGE breakers are on. If they are off, turn them on.

(4) On the front side of the system unit, rotate the key switch to the START position, release it, and perform the normal startup operations.
See <3.1.2 Start-up Operation>.

4.7 Caution on Maintenance

On maintenance of the instrument, the following cautions must be observed.

(1) Follow the maintenance procedures described in this manual after a full understanding of it. (In particular, carefully read "PRECAUTIONS ON HANDLING" at the beginning of the manual.)

(2) Maintenance work (disassembly-reassembly or repair) of the components other than described in this manual must not be carried out by the customer.

4.8 Electron Gun Beam Axis Maintenance

Because the maintenance and adjustment of the electron gun and the condenser lenses (C lens) are important work related to the device performance, only the service engineer is carrying out the maintenance and the adjustment.
It is recommended to carrying out the maintenance and the adjustment of the electron gun beam axis by the service engineer, when the equipment becomes the following condition.

- After the filament exchanged, the image disappears completely when the accelerating voltage is changed with the objective lens movable aperture is "0".
- The glare on the image stands out even if **Probe Current** is enlarged with the objective lens movable aperture is "0".
- The most lightened spot exceeded the adjustable range in the Beam Alignment.

4.8.1 Adjusting the Electron Gun Mounting Position (for service engineers)

Subtle mechanical variability in the cartridge filament can sometimes create a misalignment state, exhibiting the types of symptoms described in Section 4.8 above. When **Beam Alignment** operations are performed in such a condition, symptoms such as "out of tuning range" tend to occur.
To prevent this problem, verification/adjustments should be performed according to the steps given below:

(1) Start the **Alignment** window. Press the **Reset All** button.

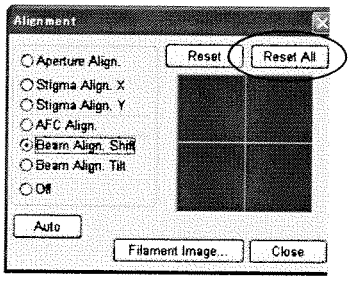


Fig. 4.8-1 Selecting Reset All

(2) Set the acceleration voltage to 5 kV. With the **Filament Image** mode on (with an elliptic image displayed), set the **Probe Current** to 100.
Make sure that the objective lens movable aperture is "0".

(3) Set the **Filament** to approximately 90 (saturation condition).
Turn off **Auto Gun Bias**.

(4) In **Filament Image**, select the **Beam Align Shift**. If the image is too bright or dark, adjust the contrast by using the M4 screw (using an M4 hex wrench) of the electron gun so that the bright spot is brought to the center of the screen. See Fig. 4.8-2 on the right. Be careful that the M4 screw is not confused with a transport screw or the C-lens adjustment screw.
If the C lens adjustment screw is moved by mistake, the C-lens current center can shift, causing a significant change in system performance. The operation should be performed with great care to avoid this type of problem.

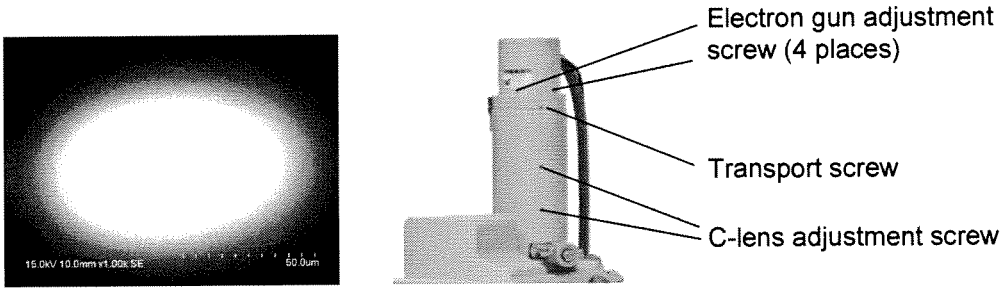


Fig. 4.8-2 Adjusting the Electron Gun Mounting Position

(5) Fix the electron gun mounting position screws when the image in the **Filament Image** assumes the condition shown in Fig. 4.8-2 on the left.
To avoid over-tightening, secure the screws diagonally a little at a time.

(6) Turn off the **Filament Image**

This concludes the electron gun mounting position adjustment process. Confirm that the image is displayed normally when the acceleration voltage is modified or the **Probe Current** is changed.

5. REPLACEMENT PARTS

5.1 Consumables

The items shown in Table 5.1-1 should always be on hand for normal operation.
For Customer-supplied Items, refer to <1.3 Customer-supplied Items>.

Table 5.1-1 Consumables

Part No.	Part Name	Use	Remarks
50E-6159	Carbon seal	For fixing specimen	Set of 20
G743002	Stick bamboo	For cleaning parts	10 pcs
S370057	Cotton cloth	For cleaning parts	
S269003	Aluminum foil	For cleaning parts	
585-4267	Vacuum grease (in tube)	For vacuum seal (stationary part)	
50E-1138	Objective lens aperture plate	(0.03, 0.05, 0.08, 0.15 mm dia.)	
50E-1139	Objective fixed aperture 0.35 (made of Mo)	For orifice unit	Set of 20
535-1289	Condenser aperture (made of Mo)	For condenser lens aperture	Set of 20
51E-0240	Cartridge Filament	Needs for cartridge wehnelt	Set of 10
50E-0524	Cartridge Wehnelt	Wehnelt for Cartridge Filament	
51E-1526	Oil mist trap OMT-200A	For oil rotary pump	
	Acetone	For cleaning	
533-1337	Molybdenum board	For baking aperture plate	
S263001	Polyethylene gloves	For handling parts	

5.2 Replacement Parts

Replace the replacement parts listed in this manual at their expiration time. The parts passing their expiration time might cause the failure of the instrument or serious injury.
When replacement operations are needed except the operation that is performed by the customer, contact the nearest Hitachi Service Department (Refer to Table 5.2-1).

Table 5.2-1 Replacement Parts

Part No.	Part Name	Use	Expiration
J386042	Photomultiplier R6249	Secondary electron detector	5 years
52E-1629	TMP oil fluid reservoir	Turbo molecular pump	4 years
—	TMP exchange service	Turbo molecular pump	4 years
50E-1205	Scintillator	SE detector	3 years
K433004	Pirani gauge bulb	Evacuation system	3 years
52E-4501	Rubber tube for evacuation	Evacuation system	5 years
F229251	Vinyl tube	Evacuation system	3 years
51E-1528	Rotary pump	Evacuation system	5 years
52E-3410	Element	Evacuation system	3 years
—	PC monitor	PC	5 years
—	Hard disk	PC	3 years
—	Keyboard	PC	3 years
—	Mouse	PC	2 years
—	Battery for PC	PC	2 years
K429012	Rotary encoder	Manual operation panel (Mag.)	3 years
K429013	Rotary encoder	Manual operation panel (others)	5 years
52E-2384	Pulse motor X	Type II stage	4 years
52E-2385	Pulse motor Y	Type II stage	4 years
52E-2386	Pulse motor Z	Type II stage	4 years
52E-2387	Pulse motor R	Type II stage	4 years
52E-2388	Pulse motor T	Type II stage	4 years
52E-4013	Specimen stub spring	Stage	3 years
K111250	Relay device	Control system	5 years

NOTICE: The replacement term indicates the approximate lifetime of the part, and not the guaranteed period.

NOTICE: Lifetime of replacement parts may change by the usage condition. However, replace them at their replacement term for planning maintenance.

NOTICE: Do not carry out the replacement of the parts. Consult the nearest Hitachi service or service representative.

5.3 Spare Parts

The items shown in Table 5.3-1 must be prepared for long-term operation.
Select a proper quantity in consideration of the application of each part.

Table 5.3-1 Spare Parts

Part No.	Part Name	Location	Q'ty Used
52E-2012	Accessory FUSE (W) set		1set
433-3702	Specimen stub	15 mm dia	-
52E-4020	Specimen stub	26 mm dia	-
52E-4021	Specimen stub	32 mm dia	-
52E-4022	Specimen stub	51 mm dia	-
52E-4023	Specimen stub	77 mm dia	-
52E-4024	Specimen stub	102 mm dia	-
52E-4025	Specimen stub	127 mm dia	-
52E-4026	Specimen stub	153 mm dia	-
52E-4027	Specimen stub	200 mm dia	-
L456825	O-ring AS568-235 FPM	For electron gun	1
L456711	O-ring AS568-012 FPM	For objective lens aperture	1
L456815	O-ring AS568-225 FPM	For specimen chamber port	6
L456810	O-ring AS568-220 FPM	For specimen chamber	1
L456818	O-ring AS568-228 FPM	For specimen chamber	1
L456865	O-ring AS568-275 FPM	For specimen stage	1

5.4 Daily Operational Maintenance

Periodic maintenance check items for proper operation are shown in Table 5.4-1.

NOTICE: When maintenance check is needed except the maintenance that is performed by the customer, contact the nearest Hitachi Service Department.

Table 5.4-1 Periodic Maintenance Check Items

Sign of person in charge: U・・・Customer, S・・・Hitachi Service Department

No.	Frequency	Items	Person in charge		Remarks
			U	S	
1	1/day	a. Checking the amount of oil of rotary pump	○	—	
		b. Pulling out the drain of the compressor	○	—	
2	1/week	a. Cleaning of device externals	○	—	
		pintle mount, control console, monitor, keyboard			
		mouse			
3	1/6 months	a. Changing oil of rotary pump	○	○	
		b. Changing oil mist trap of rotary pump	○	○	
4	1/year	a. Replacing the objective lens aperture plate	○	○	
		b. Objective fixed aperture 0.35 (For orifice unit)	○	○	
		c. Condenser aperture (For condenser lens aperture)	○	○	
		d. Changing the element	×	○	
5	1/2 years	a. Changing mouse	×	○	
		b. Changing battery for PC	×	○	
		c. Changing DC motor R	×	○	

No.	Frequency	Items	Person in charge		Remarks
			U	S	
6	1/3 years	a. Changing scintillator	×	○	
		b. Changing pirani gauge bulb	×	○	
		c. Changing vinyl tube	×	○	
		d. Changing hard disk	×	○	
		e. Changing keyboard	×	○	
		f. Changing rotary encoder (Mag.)	×	○	
		g. Changing encoder R	×	○	
		h. Changing specimen stub spring	×	○	
7	1/4 years	a. Changing the kit of TMP spare parts	×	○	
		b. Changing TMP oil reserver	×	○	
		c. Changing pulse motor X	×	○	
		d. Changing pulse motor Y	×	○	
		e. Changing pulse motor Z	×	○	
		f. Changing pulse motor T	×	○	
		g. Changing joint X	×	○	
		h. Changing joint Y	×	○	
		i. Changing universal joint	×	○	
8	1/5 years	a. Changing photomultiplier R6249	×	○	
		b. Changing rubber tube for evacuation	×	○	
		c. Changing PC monitor	×	○	
		d. Changing rotary encoder (others)	×	○	
		e. Changing rotary pump	×	○	
		f. Changing relay device	×	○	
		g. Changing V6 leak valve filter	×	○	
		h. Changing needle valve filter	×	○	
		i. Pulse motor (For needle valve)	×	○	

6. ACCESSORY OPERATION

6.1 Faraday Cup Device (Option)

This device is used for measuring the probe current.

NOTICE: The method of handling changes depending on the kind of the stage.

6.1.1 Faraday Cup Device for Type I Stage

<Movable range of Type I Stage>
Limit the movable range of Z and T axes of the specimen stage (Type I) as follows, when the Faraday cup is used.

- Z-axis: 10 mm-35 mm
- T-axis: 0°

6.1.2 Usage Method

(1) Connect an ammeter (μμA meter) to the connector (the ammeter is to be prepared by the customer).

(2) Move Z and T axes of the specimen stage to the following range.

- Z-axis: 10 mm-35 mm
- T-axis: 0°

NOTICE: The sample and the specimen stage touch the Faraday cup and it causes damage to them if Z-axis (WD) of the specimen stage is 9.9mm or less and T-axis is not 0°.

(3) The stopper screw is loosened while gripping the knob, and the Faraday cup is inserted in the specimen chamber slowly. After insert, confirm the hole in Faraday cup is almost at the center on the screen.

(4) Set the magnification more than 10,000×, and measure the probe current.

(5) After the measurement ends, draw out the Faraday cup to the end, and tight the stopper screw and fix it.

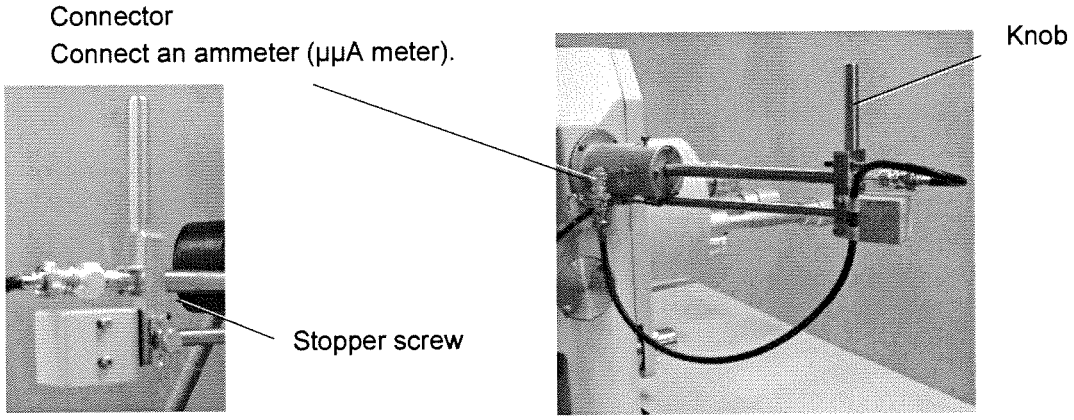


Fig. 6.1-1 Faraday Cup Device (For Type Ⅰ Stage)

6.1.3 Faraday Cup Device for Type Ⅱ Stage

<Movable range of Type Ⅱ Stage>
When the Faraday cup device is used, the movable range of Z and T axes of the specimen stage (Type Ⅱ) is limited as follows.

- Z-axis: 10 mm-65 mm
- T-axis: 0° fixation

6.1.4 Usage Method

(1) Connect an ammeter (μμA meter) to the connector (the ammeter is to be prepared by the customer).

(2) Use **HOME Z65** button on the control panel to bring stage to specimen exchange position. The **HOME Z65** button moves the Z-axis to the 65 mm mark.

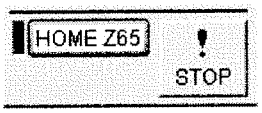


Fig. 6.1-2 The Specimen Exchange Position Button

(3) Confirm the specimen stage moved to the specimen exchange position.

(4) The stopper screw is loosened while gripping the knob, and the Faraday cup is inserted in the specimen chamber slowly. Following alert message is displayed on screen. After insert, confirm the hole in Faraday cup is almost at the center on the screen.

《Alert message》

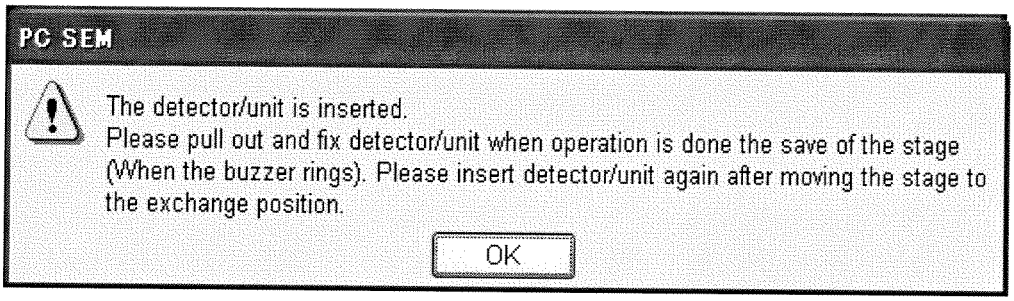


Fig. 6.1-3 Alert Message

(5) Set the magnification more than 10,000×, and measure the probe current.

(6) After the measurement ends, draw out the Faraday cup to the end, and tight the stopper screw and fix it.

NOTICE: When you insert the Faraday cup, confirm the stage has moved to the specimen exchange position. Otherwise the Faraday cup device and the specimen or the stage is damaged by contact with them.
And if you insert the Faraday cup device, the stage moves to safety position with the warning buzzer when the stage position is outside of the range written in 6.1.1. In this case, draw out the Faraday cup device immediately. After the movement of stage is finished, insert the Faraday cup device again.

NOTICE: Do not insert Faraday cup when introducing air into the specimen chamber, or setting the specimen. The specimen and the specimen stage might touch Faraday cup and get damage. Pull out the Faraday cup promptly when it was inserted by mistake. In this case, it becomes the following.

- The setting window of the specimen closes.
- Stage operation stops with the stage moved to the upper limit position when setting the specimen.

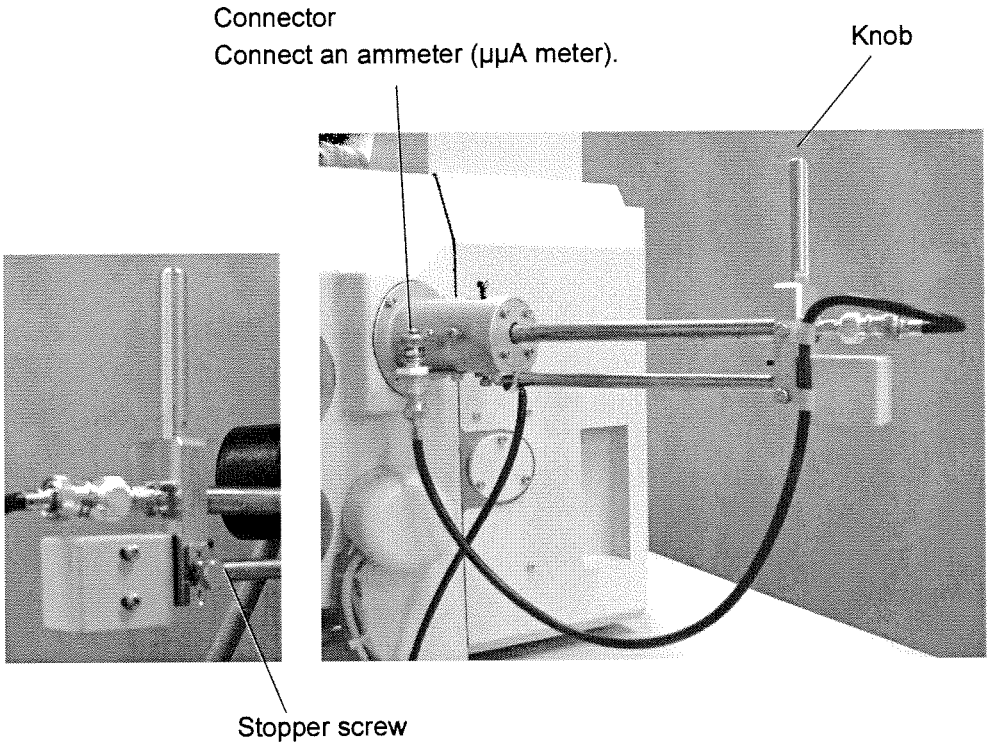


Fig. 6.1-4 Faraday Cup Device (For Type II Stage)

6.2 CD Measurement Function (Option)

6.2.1 Outline

6.2.1.1 CD Measurement Function

The CD Measurement function is designed for carrying out measurement of a critical-dimension or angle at a specified position on a SEM image, and then displaying and recording the result. The Measurement function comes in various modes - manual, automatic, successive measurement, simultaneous width and pitch measurement, and so on. This allows selecting and applying a measurement method from among these that is suitable for your purpose.
Fig. 6.2-1 shows an example of the **operating** window for the CD Measurement function.

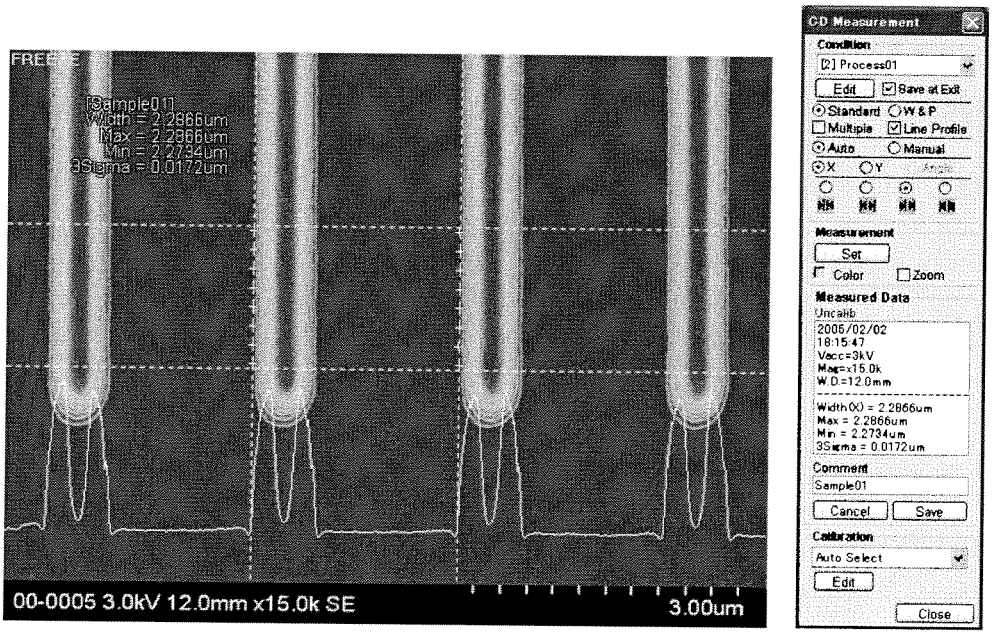


Fig. 6.2-1 Example of Operating Window for CD Measurement

6.2.1.2 CD Measurement Function Options

The following two CD measurement function options are available.

(1) CD Measurement Function Option for SEM Main Unit
Permits measurement of images displayed on the **Scanning Image** window of the SEM main unit.

(2) CD Measurement Function Option for SEM Data Manager
Allows measurement of the images saved on the SEM data manager that is operated on a different PC from the SEM data manager of the SEM main unit.

6.2.2 Specifications

6.2.2.1 Modes of CD Measurement

(1) Manual Measurement
Distance (X, Y, D, width and pitch) between cursors placed by manual operation is measured. An angle (T) between two cursor lines placed by manual operation is also measured.

(2) Automatic Measurement
The edges of specimens within a specified range are automatically detected and the distance (X, Y, width and pitch) is measured. Either linear approximation method or threshold level method is selectable for the edge detection.

6.2.2.2 Display of Measured Result

(1) Measured result is superposed on an image in 5 digits (in μm unit).

(2) A maximum of eight distances and/or angles can be displayed in succession.

(3) A line profile can be displayed simultaneously with the measured result.

6.2.2.3 Recording/Saving of Measured Result

(1) The measured result and line profile can be photographed on the displayed image (function available only with SEM main unit).

(2) The measured result and line profile can be saved in a file with the displayed image.

(3) The measured result can be saved in a file of text format.

6.2.2.4 CD Measurement Accuracy (Reproducibility)

Within ±5% in automatic CD measurement after calibration with the following conditions fixed; accelerating voltage, scan speed, magnification, Working distance, raster rotation angle, measurement parameter, etc.
Within ±10% without calibration.

6.2.3 Principle of CD Measurement

6.2.3.1 Edge Detection Algorithm in Auto Measurement

Fig. 6.2-2 shows the cross section and secondary electron signal of the typical specimen. As demonstrated in the figure, the intensity of secondary electron signal is higher at the edges of the pattern. In auto CD measurement, edge positions are detected using this characteristic of secondary electron signal.

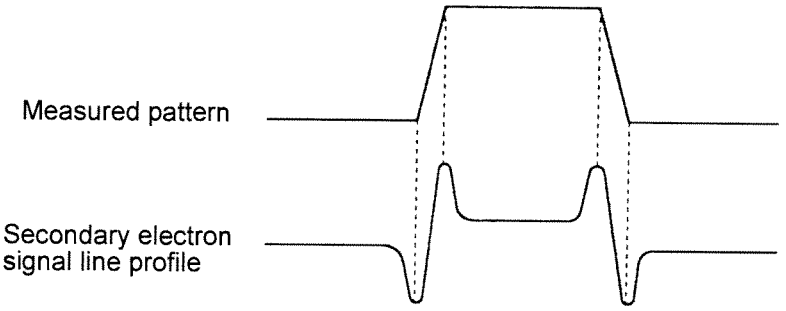


Fig. 6.2-2 Secondary Electron Signal Waveform

There are two kinds of edge detection algorithms available; linear approximation method and threshold level method. Determine which method to use with reference to the description below.

(1) Linear Approximation Method
In this method calculation is made upon determining the intersecting point of baseline and edges, and it is suitable when a standing wave is relatively sharp at the pattern edges. In this case, it is required to specify a constant threshold level parameter for the same kind of specimens.

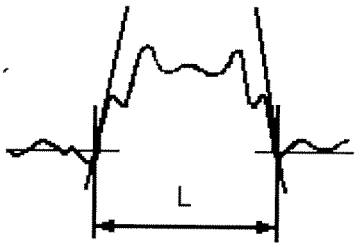


Fig. 6.2-3 Linear Approximation Method

(2) Threshold Level Method
In this method the variation of image signal at the edges is detected upon cutting off at a desired threshold, and it is suitable when the sides of pattern edges are relatively linear.

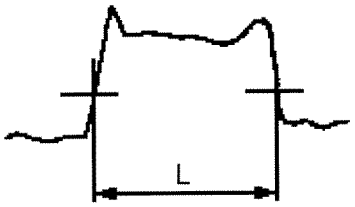


Fig. 6.2-4 Threshold Level Method

6.2.3.2 Linear Approximation Method

Explained below is the linear approximation algorithm.

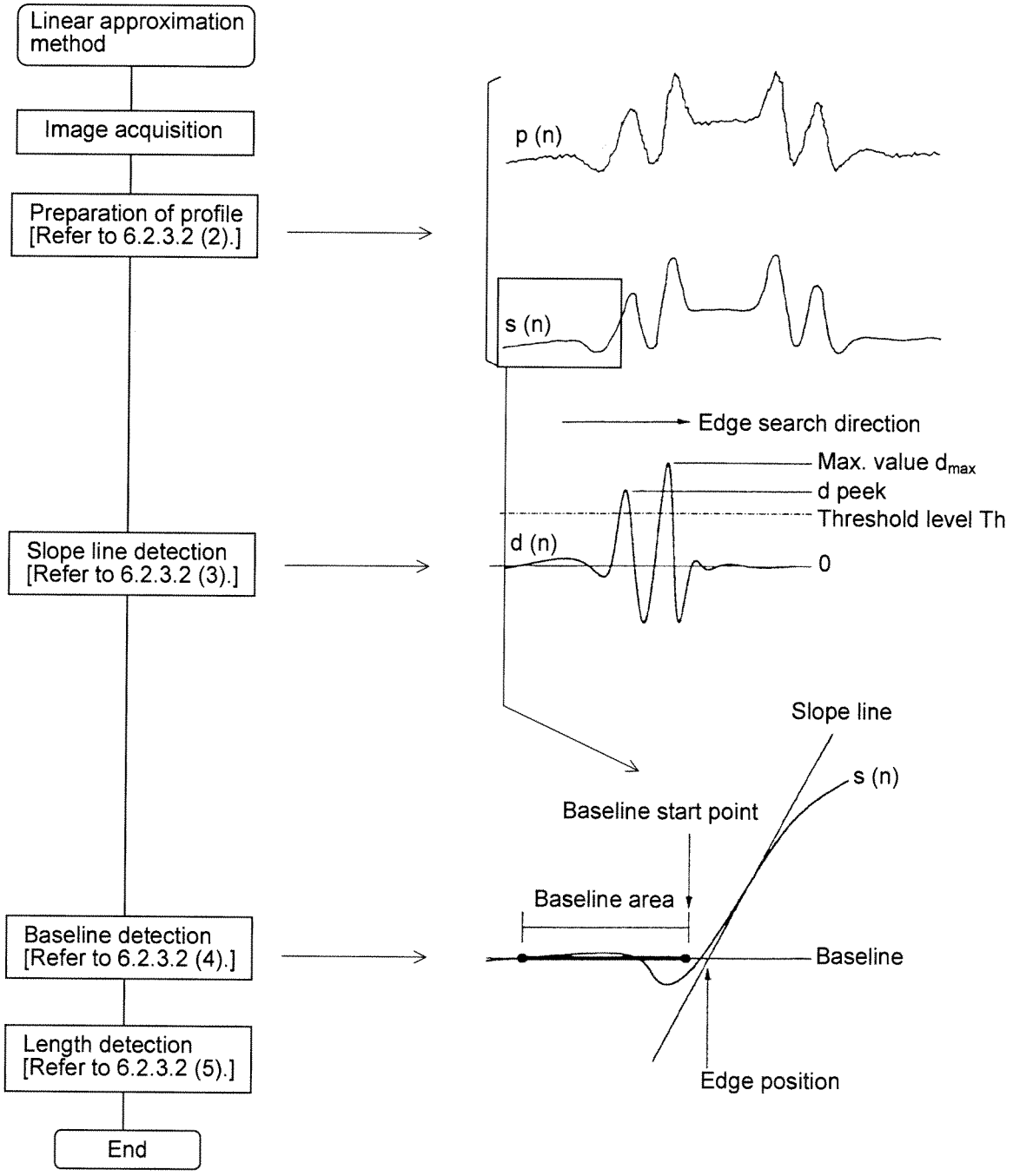
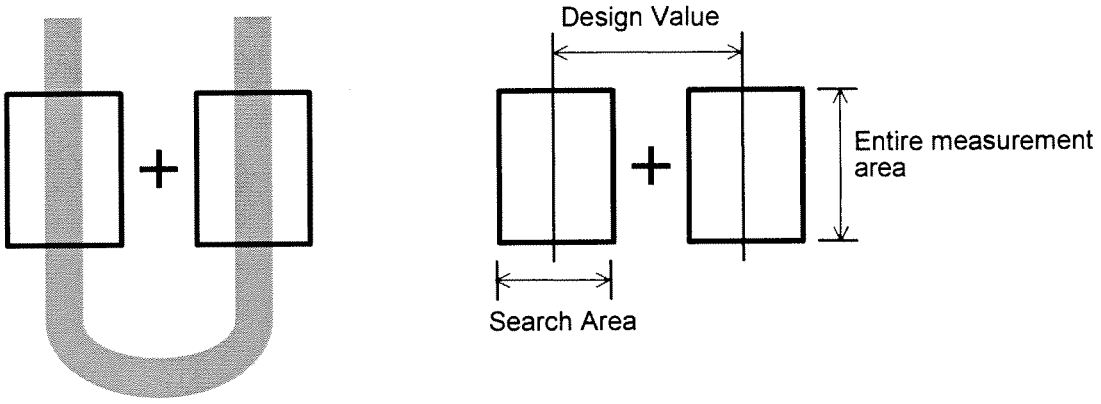


Fig. 6.2-5 Linear Approximation Algorithm

(1) Area Used for CD Measurement

The area in each on-screen box cursor is used for CD measurement. Fig. 6.2-6 shows the relationship between box cursor and measurement parameters. For "Design Value", specify a distance (μm) between box cursors. The "entire measurement area" is determined by a combination of parameters. For "Search Area", specify a number of pixels. When the distance between box cursors is changed using the mouse, it is automatically reflected at "Design Value".



(a) Cursor placement for CD measurement parameters

(b) Relationship between cursor and

Fig. 6.2-6 CD Measurement Area

(2) S/N Ratio Improvement and Preparation of Profile

Fig. 6.2-7 shows the relationship between a pattern under measurement and its secondary electron signal. For improving the S/N ratio, take the following procedure:

First, as shown in Fig. 6.2-7 (a), detect secondary electron signals of "N" lines on the pattern and then overlay these signals. After overlaying, a signal having little variation is attained as indicated in Fig. 6.2-7 (b). If the number of overlaid lines is insufficient, a signal having greater variation is provided as shown in Fig. 6.2-7 (c). For "Summing Line", specify the number of lines to be overlaid as required.

Also, the S/N ratio can be improved by carrying out smoothing based on moving average operation of secondary electron signals. For "Smoothing", specify a width of moving average operation. Denoting the "Smoothing" value as N, the relationship between signal overlaying "p(n)" and signal smoothing "s(n)" is defined by the following expression (6.2.1).

$$s(n) = \frac{1}{N} \sum_{i=-L}^{L} p(n+i) \quad \text{..... (6.2.1)}$$

$$L = (N - 1)/2$$

In this manner, a signal profile can be prepared.

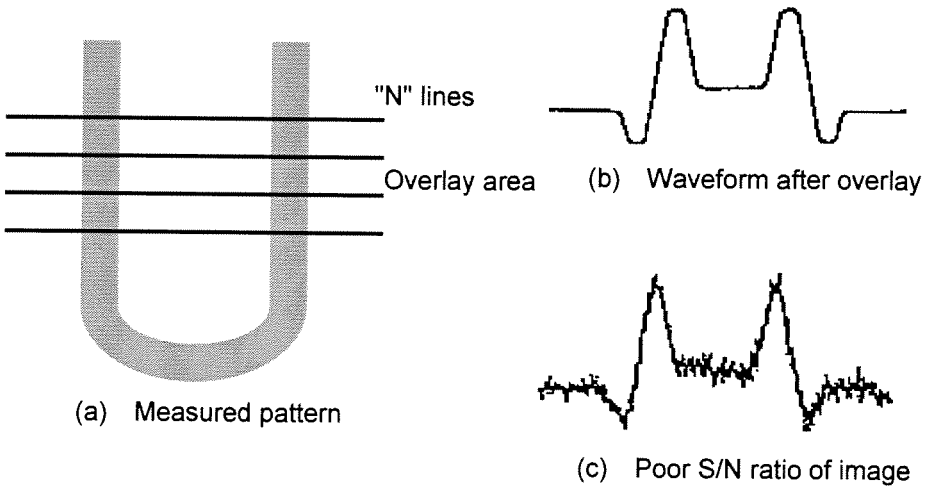


Fig. 6.2-7 Measured Pattern and Secondary Electron Signals

(3) Slope Line Detection

To detect a slope line using a profile, the following differentiation is performed on profile "s (n)" as expressed below.

$$d(n) = s(n + M) - s(n - M) \quad \text{..... (6.2.2)}$$

$M = (N - 1)/2$

N: Differential size

Then, a peak position having a higher value than "Th" given by the following equation is determined.

$$Th = \frac{d_{max} \times T}{100} \quad \text{.....(6.2.3)}$$

d_{max} : Max. value of differentiated profile

T : Threshold (%)

If multiple peaks d (n) appear as shown in Fig. 6.2-5, the first peak position higher than "Th" in searching in the specified direction is defined as the target peak position.

To reverse the search direction, then reverse the "edge search direction" indicated in the figure.

A slope line is tangent to the peak position determined above on the profile "s (n)".

(4) Baseline Detection

The baseline is a straight line having no slope, which is determined by the peak position attained before, the "baseline start point" and "baseline area".

The start point of the baseline is located outside or inside the peak position, and it corresponds to a position of data having differential coefficient "dbase" in the following expression of profile differentiation.

$$d_{base} = \frac{d_{peak}}{|B|} \quad \text{.....(6.2.4)}$$

d_{peak} : Differentiation coefficient of peak position

B : Baseline start point (1, 2, 4, 8)

To determine the baseline, averaging is performed on a profile area included in a range specified with "baseline area". For the "baseline start point", it is allowed to enter any one of 1, 2, 4 and 8.

(5) Length Detection

For length detection, an intersecting point of slope line and baseline is determined. Then an actual pattern dimension is calculated using the intersecting point data, magnification and correction coefficient.

6.2.3.3 Threshold Level Method

Described next is the threshold level algorithm. In the same manner as for the linear approximation method, a smoothed profile "s (n)" is obtained. Maximum and minimum values of the profile are determined in the edge detection area. Then an intersecting point with "Th" given by the following expression is defined as the edge position.

$$Th = \frac{s_{max} - s_{min}}{100} \times T + s_{min} \quad \text{.....(6.2.5)}$$

s_{max} : Max. value of profile in the vicinity of edge

s_{min} : Min. value of profile in the vicinity of edge

T : Threshold (%)

6.2.3.4 Measurement Accuracy and Error Factors

Following is a description on measurement accuracy and error factors.

(1) Measurement Reproducibility and Absolute Dimensional Accuracy

In CD (critical dimension) measurement, the reliability of measured results can be evaluated in terms of variation of measured values and accuracy of mean value obtained by measuring the same dimension repeatedly. The variation of measured values is represented by measurement reproducibility defined by 3 σ (dispersion). On the other hand, absolute dimensional accuracy can be evaluated in terms of difference in measurements between mean values (statistical mean values) and true values.
CD measurement function of the S-3400N provides a calibration function and the measured result can be calibrated so that measured values (mean values) of a standard sample such as a microscale agree with known dimensions.
The dimensional accuracy of measured values after calibration is determined by the dimensional accuracy of the standard sample itself. Therefore, as long as calibration is made using a standard sample of sufficiently high reliability, the reliability of measurement data finally depends on measurement reproducibility.
Although the measurement reproducibility depends on a number of factors described in the next section, even if all the factors are temporarily ideal, one must be careful about measurement errors caused by pixel size or resolution when the measured object is extremely small (a thin film of a few 10 nm thickness, for instance).

(2) Factors Determining Measurement Reproducibility, and Methods of Improvement

(a) Factors Determining Measurement Reproducibility
Measurement reproducibility is affected by magnetic hysteresis of the objective lens, reproducibility of focus, stability of image contrast (for instance, a stable contrast is difficult to obtain when there is charge-up or specimen damage), floor vibration or external magnetic field variation at the installation site, and other factors. One must also be careful about dimensional change of samples due to contamination or sample damage in measurement of very fine pattern widths. Also, upon changing the instrument operating parameters (viewing parameters) such as accelerating voltage or working distance during a measurement, the magnification accuracy may vary and measurement reproducibility may decrease.

(b) Methods for Improving Measurement Reproducibility

It is recommended to use the SEM under fixed operating conditions (magnification, accelerating voltage, probe current, raster rotation angle, working distance, etc.) in CD measurement. If measurement under varied conditions is unavoidable, then calibration should be made under each of the conditions. A number of calibration conditions are registered in the CD measurement function, and these can be selected either automatically or by specifying a registration No.

It is also recommended to measure dimensions in the X (horizontal) direction for images acquired by slow scan. Although measurement is also possible in the Y (vertical) direction, accuracy is lower than that in the X direction for the reasons given below.

Since image acquisition time is longer in Y direction measurement, external magnetic field may fluctuate during the acquisition and cause specimen drift, resulting in measurement error. This error is more conspicuous as the measured dimension becomes smaller.

To measure dimensions in the Y direction accurately, it is recommended to rotate the image 90° by means of raster rotation and measure the dimensions as X-direction ones. Note that since the magnification accuracy of the instrument is also dependent on the raster rotation angle, it is important to calibrate the magnification at each raster rotation angle to permit high-accuracy measurement.

In order to minimize the effect of magnetic hysteresis of the objective lens and improve the focus reproducibility (working distance), it is essential to set the sample Z position and focus in the following procedure.

- Set the working distance to be used for measurement on the Operation panel - **Cond.** tab.
- Adjust Z-axis control of the stage to obtain an approximate focus (so that the image profile can be identified at a few thousand times magnification).
- After focus adjustment, click the **DeGauss** button on **Setup** window - **Optics** tab and focus again.
  It is recommended to set magnification once after making final focus adjustment. It is because focusing operation will cause small fraction to magnification value even when indication do not have fraction. It may cause discrepancy with calibration condition.

The abovementioned procedure allows measurement reproducibility (3σ) of 2% or on the order of 10 nm or less when the effects of sample damage, charge-up and installation conditions are not serious. Note that the 3σ value depends on measurement dimensions and image magnification.

(3) Measurement Error Caused by Pixel Size or Image Resolution

Described in this section are the measurement errors caused by pixel size or SEM image resolution. These errors are more conspicuous as the measured dimension becomes smaller.

(a) Measurement Error Caused by Pixel Size

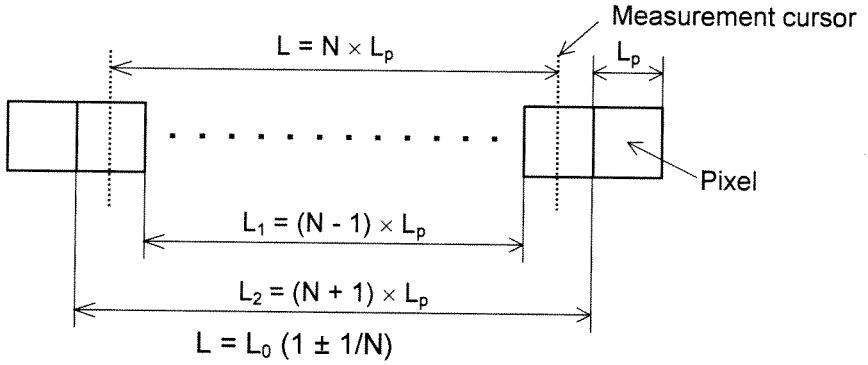
In the CD measurement function, dimensions are measured by counting a number of pixels included within measurement cursors in the acquired SEM image of 640 × 480 pixels. The minimum dimension for measurement (measurement resolution) therefore coincides with pixel size in the image.

As shown in Fig. 6.2-8, if the number of pixels included within cursors is N and the measured dimension is L, the true dimension L0 will be in the following range:

$$\left(1-\frac{1}{N}\right)\cdot L < L_0 < \left(1+\frac{1}{N}\right)\cdot L \quad \text{..... (6.2.6)}$$

In other words the measured dimension includes error of ±L/N relative to true value L0. When the number of pixels within cursors is 10 and measured dimension is 1 μm, for example, the true value of dimension will be in the range of 0.9 to 1.1 μm. Therefore the measured dimension includes error of ±10% in this case. However, if measurement is made by 100 pixels at ten times higher magnification on the same dimension (1 μm), the true dimensions will be in the range of 0.99 to 1.01 μm and the error will decrease down to ±1%.

The number of pixels within cursors is dependent on dimensions and image magnification. Higher magnifications allow more pixels for measuring dimensions, and therefore the measurement error caused by pixel size decreases at higher magnifications. But the effect of resolution in SEM image upon measurement error becomes more important at higher magnifications. The effect of installation conditions (floor vibration and stray magnetic field), sample damage and contamination will also be important at higher magnifications. The highest magnification which is suitable for measuring dimensions is limited for these reasons.



$L = L_0 (1 \pm 1/N)$

L : Measured value

L_P : Pixel size

L_0 : True dimension ($L_1 < L_0 < L_2$)

Fig. 6.2-8 Measurement Error Caused by Pixel Size

(b) Measurement error Caused by SEM Image Resolution
Image resolution can be regarded as the minimum dimension where sample information can be reproduced in a form of brightness (contrast) change. Thus there is no meaningful contrast when a dimension is smaller than the image resolution. Such an area of no contrast is equivalent to a pixel because there is also no contrast in a pixel area. Therefore the effect of resolution upon measurement error is similar to that of pixel size described above, and image resolution finally determines the measurement error at higher magnifications.

(c) Measurement Error in Consideration of Both Pixel Size and Image Resolution
Measurement errors caused by both pixel size and image resolution are determined by the effective pixel size.
L_{Px}^{eff} is approximated by the following equation:

$$L_{Px}^{eff} = \sqrt{L_P^2 + L_R^2} \quad \text{..... (6.2.7)}$$

Here L_P and L_R represent pixel size and image resolution, respectively. If image resolution is 1.5 nm and measured dimension is L at a magnification of 150 k×, for example, measured dimension L includes error of ±1.95 nm since the effective pixel size (L_{Px}^{eff}) is given as 1.95 nm by resolution (1.5 nm) and pixel size (1.25 nm at 150 k×). Fig. 6.2-9 shows the relation between measured dimensions and measurement error (theoretical value) at various magnifications. Measurement error in the figure is caused only by pixel size and image resolution (assumed to be 1.5 nm). Other measurement reproducibility factors are not included. Assuming the upper limit of measurement magnification is 150 k× and measurement error is suppressed to within ±2%, the minimum theoretical dimension measurable is about 0.1 μm.

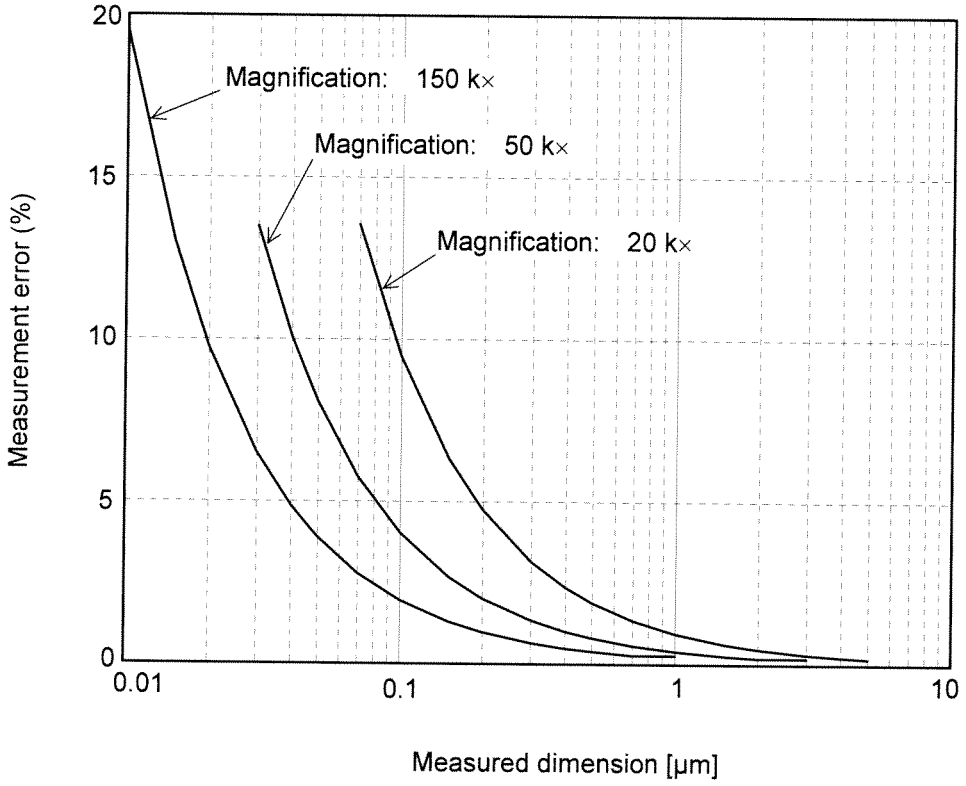
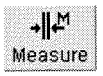


Fig. 6.2-9 Measured Dimension vs Measurement Error (theoretical) at Various Magnifications

6.2.4 Description of Windows Used in Measuring Operation

Following is a description of the windows used in CD measurement.

6.2.4.1 Starting CD Measurement Function

For starting CD measurement on S-3400N GUI, click the **Measure** 

button on the tool button area of the Operation panel or select CD Measurement command in Analysis menu.

To start on SEM Data Manager, click **Measure**  button or select CD Measurement command in Processing menu.

6.2.4.2 Images for Measurement

On the S-3400N GUI, use observing image for CD measurement.
Measurement is carried out in the frozen image. When you start measurement while image is scanning, scan will stop at the end of the frame and then, measurement cursor will be shown. Use Full or Small screen mode. Full screen mode results more accurate measurement in such a condition where error caused by pixel size limitation is dominant.

On the SEM Data Manager, measurement is carried out on an image on the display area.

NOTICE: (1) Use image size of 2560 × 1920 pixels or smaller. Measurement is disabled for 5120 × 3840 pixels images.

(2) In automatic measurement mode, processing time for finding edges depends on the image size. Larger images need longer processing time.It is recommended to use 1280 × 960 image size for measurement.

(3) Showing line profiles also needs processing time. For higher throughput, it is recommended not to show line profiles (uncheck **Profile** check box).

6.2.4.3 CD Measurement Window

Use this window to set measurement and calibration conditions and to execute measurement.

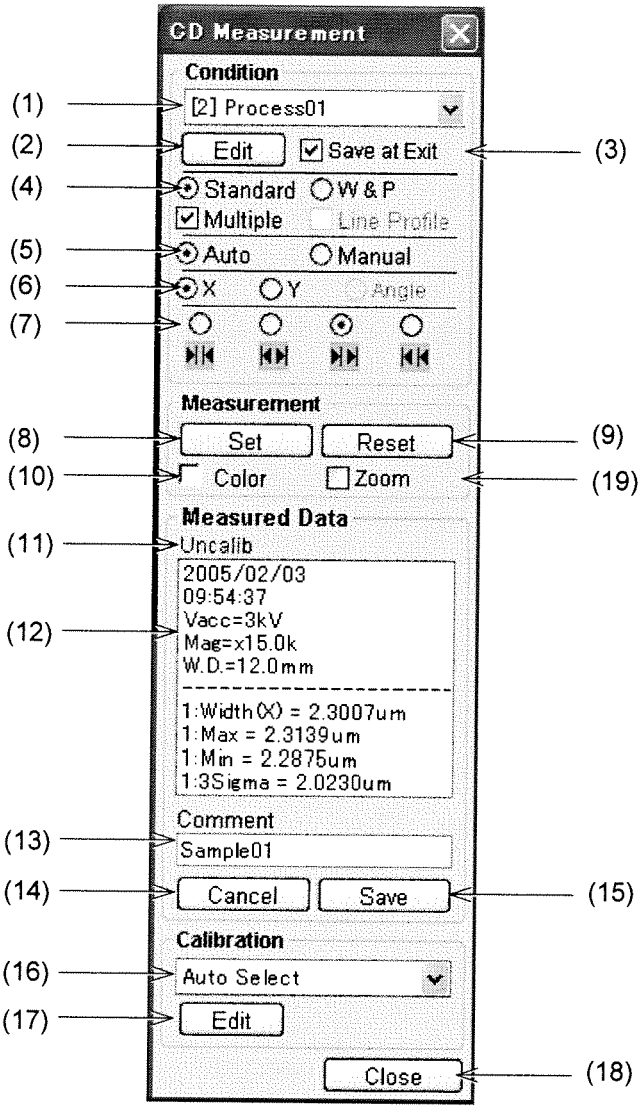


Fig. 6.2-10 CD Measurement Window

(1) **Condition** Combo Box
Select one of the registered measurement conditions. Clicking the button displays a registered measurement condition No. and a caption.

(2) **Edit** Button
Opens the **Condition** window for editing and registering the measurement conditions.

(3) **Save at Exit** Check Box
Registers the measuring conditions set at the end of the measurement function. Setting cannot be made when condition registration is locked.

(4) Type of Measurement
Specify a type of measurement.

(a) **Standard** radio button
Select **Standard** for a single dimension measurement in X or Y direction or angle.

(b) **W&P** radio button
Select this button for simultaneous width and pitch measurement.

(c) **Multiple** check box
Click this for setting successive measurements. This is usable when **Standard** has been selected.

(d) **Line Profile** check box
Click this for displaying a line profile. This is settable when measurement mode is **Auto**.

(5) Mode Selection
Select the measurement mode.

(a) **Auto** radio button
Selects auto measurement.

(b) **Manual** radio button
Selects manual measurement.

(6) Measurement Direction
Select a measurement direction.

(a) **X** radio button
Selects measurement in X (horizontal) direction.

(b) **Y** radio button
Selects measurement in Y (vertical) direction.

(c) **Angle** radio button
Selects an angle measurement. This is selectable when measurement mode is **Manual**.

(7) Edge Detect Direction
Select an edge detect direction of the cursor box that specifies the position including edge to be detected, when X or Y has been selected as the measuring direction. This is selectable when measurement mode is **Auto**. The icon changes with the type of measurement and measurement mode. When Angle measurement has been selected, then select the circle cursor for the side to be measured.

(8) **Set/Cancel** Button
Displays the measurement cursor. The shape of measurement cursor varies with the type of measurement and measurement mode.

(9) **Measure/Enter** Button, **Reset** Button
Executes the CD measurement. When clicking Set button and displaying measurement cursor, Measure or Enter Button will be displayed. Measure or Enter Button will be changed to Reset Button after executing the measurement. When clicking Reset Button, measurement data will be deleted.

(10) **Cursor Color** Indication
Specify a color for the measurement cursor. Color changes in the order of white, red, green, yellow, blue, violet and light blue at each click of the button.

(11) **Done/Uncalib** Indication
When the present operating condition of SEM matches the selected calibration condition, **Done** is indicated together with a calibration No. If the conditions do not match, **Uncalib** will be indicated.

(12) **Measured Data** Box
Displays the SEM conditions at measurement and the measured results.

(13) **Comment** Box
Enter a comment here. The entered comment is displayed and saved together with the measured result.

(14) **Cancel** Button
Deletes the measured result display. In the case of successive measurements, the final result will be deleted.

(15) **Save** Button
Saves the measured result in a text file. Clicking the button displays the **File Save** window.

(16) **Calibration** Combo Box
Selects a calibration condition. When **Auto Select** is selected, a calibration condition which matches the present operating condition will be selected automatically.

(17) **Edit** Button
Opens the **Calibration** window for registering a calibration.

(18) **Close** Button
Terminates the measurement. The **File Save** window won't appear unless measured results are saved.

(19) **Zoom** Check Box
When it is checked, a magnified image is shown in an independent window. It is useful for fitting cursor to measured edge in manual measurement mode.

6.2.4.4 Measurement Condition Window

This is used to edit the measurement conditions.

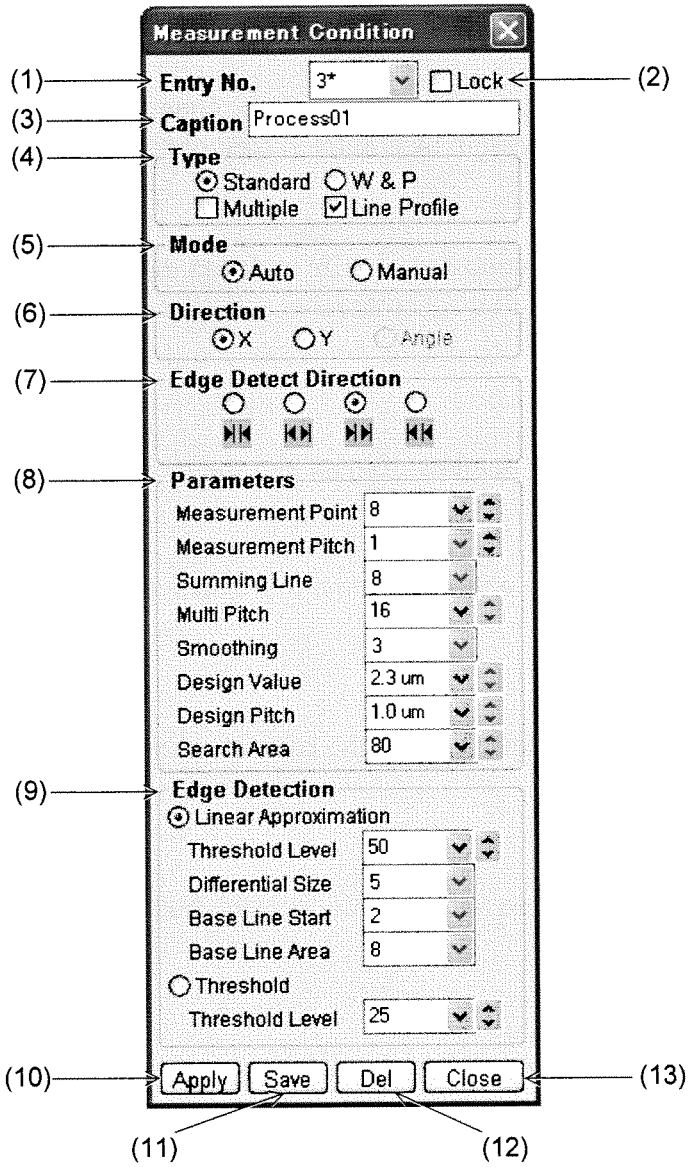


Fig. 6.2-11 Measurement Condition Window

(1) **Entry No.** combo Box
Select a registration No. for measurement conditions. A maximum of 16 measurement conditions can be registered. An asterisk (*) appears at the right of an already registered No.

(2) **Lock** Check Box
Put a check here to inhibit change of the conditions.

(3) **Caption** Box
Enter a caption for the registered No. Entry can be made in a maximum of 16 half-size characters.

(4) **Type**
Select a measurement type.

(a) **Standard** radio button
Select **Standard** for a single dimension measurement in X or Y direction or angle.

(b) **W&P** radio button
Select this button for simultaneous width and pitch measurement.

(c) **Multiple** check box
Click this for setting successive measurements. This is usable when **Standard** has been selected.

(d) **Line Profile** check box
Click this for displaying a line profile. This is settable when measurement mode is **Auto**.

(5) **Mode**
Select the measurement mode.

(a) **Auto** radio button
Selects auto measurement.

(b) **Manual** radio button
Selects manual measurement.

(6) **Direction**
Select a measurement direction.

(a) **X** radio button
Selects measurement in X (horizontal) direction.

(b) **Y** radio button
Selects measurement in Y (vertical) direction.

(c) **Angle** radio button
Selects an angle measurement. This is selectable when measurement mode is **Manual**.

(7) **Edge Detect Direction**
Select an edge detect direction of the cursor box that specifies the position including edge to be detected, when X or Y has been selected as the measuring direction. This is selectable when measurement mode is **Auto**. The icon changes with the type of measurement and measurement mode. When Angle measurement has been selected, then select the circle cursor for the side to be measured.

(8) **Parameters**
Select parameters for the auto measurement.

(a) **Measurement Point** combo box
Enter a numeric value for number of measurement points. When "2" or higher is specified, measurement is performed according to the specified number of measurement points while shifting the scan line at Multi Pitch (described below). Then the average value (Width), maximum value (Max), minimum value (Min) and standard deviation (3 Sigma) are indicated.

(b) **Measurement Pitch** combo box
Specify a scan-line pitch to be used for averaging signal profiles (line profiles) corresponding to scan lines. If "2" is specified, for instance, line profiles are taken every other scan line according to the number of summing lines (described below) to provide one profile for edge detection. This parameter is specifiable in a range of 1 to 64.

(c) **Summing Line** combo box
According to the specified number of scan lines, line profiles are averaged for edge detection. If "8" is specified, for example, line profiles corresponding to eight scan lines are averaged. As the number of summing lines increases, an adverse effect of noise is reduced. This parameter is specifiable in a range of 1 to 64.

(d) **Multi Pitch** combo box
Specify an interval of **Measurement Point** when two or more measurement points are used. This parameter is specifiable in a range of 2 to 64 represented in unit of number of scan lines.

(e) **Smoothing** combo box
This parameter indicates a factor of line profile smoothing on a scan line. It is allowed to select 1, 3, 5 or 7 represented in unit of number of pixels in smoothing. The smoothing can reduce noise contained in the SEM image signal (line profile). Using signal profile data obtained through the Summing Line function (described above) and the Smoothing function, edge detection is carried out in the specified method (linear approximation or threshold level method).

(f) **Design Value** combo box
Specify an interval between cursors (two boxes) for CD measurement. This parameter is specifiable in a range of 0.1 to 200 µm.

(g) **Design Pitch** combo box
Specify a pitch in the case of simultaneous width and pitch measurement. This parameter is specifiable in a range of 0.1 to 200 µm.

(h) **Search Area** combo box
Specify a width of cursor box (edge detection area). This parameter is specifiable in a range of 16 to 160 represented in unit of number of pixels.

NOTICE: In auto CD measurement, the vertical dimension (length) of cursor box indicates a range of measurement, which varies according to the parameter settings mentioned above and also according to the size of images under measurement. The vertical length of box cursor is defined by the following expression; (Measurement Point - 1) × (Multi Pitch) + [(Summing Line) × (Measurement Pitch)] (unit: number of scan lines). It is not allowed to exceed 480 scan lines in parameter input. Even if each parameter is specified within its allowable range, therefore, parameter setting may not be permitted in some combinations.

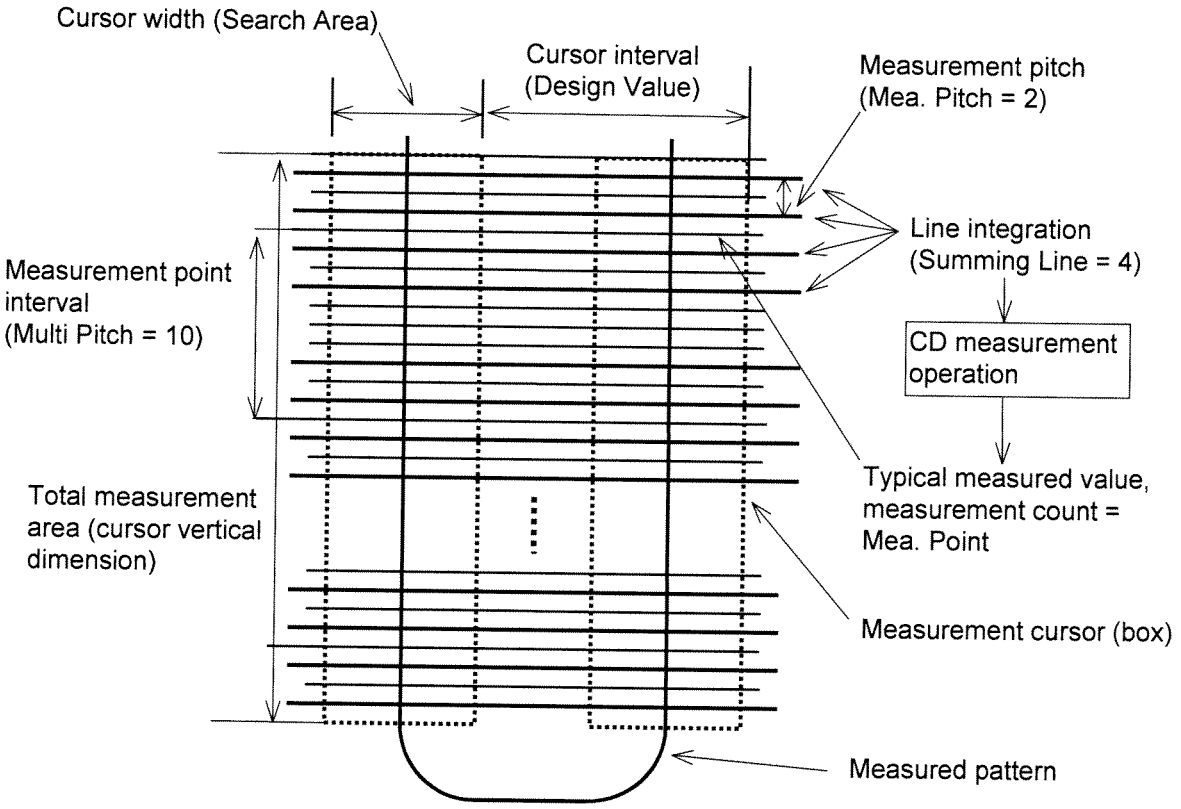


Fig. 6.2-12 Parameters and Measurement Lines (parameters are examples)

NOTICE: Relation between the size of image and the size of cursor box

In case using the CD measurement function on live or frozen SEM images, the size of image is 1280 × 960 pixels in Full Screen mode and 640 × 480 pixels in Small Screen mode. The size of pixel itself is the same for both screen modes. The same parameter set results the same cursor box size for both screen modes.
Measurement is applied to the image displayed on the image screen, even when it is an image captured with larger image resolution, i.e. 2560 × 1920 pixels.

In the other hand in case using the CD measurement function on the SEM Data Manager, measurement is applied to the original image, not to the present displayed image. Using the larger size, i.e. 2560 × 1920 pixels image will results smaller measurement error caused by pixel size limitation (refer to 6.2.3.4) even the display size is small, i.e. 640 × 480 pixels.
And it results different size of cursor box on different size of image for the same parameter set. For example the cursor box size on 2560 × 1920 pixels images is 4 times smaller than that on 640 × 480 pixels images if the same parameter set is used. It may be reasonable because if the same measurement error caused by pixel size limitation is expected, the larger image size allows to include wider specimen area using lower magnification.
But if you prefer to use similar cursor box size for images with different size, it is recommended to set and register parameter set for each of image size, and select a parameter set to fit to the present image size under measurement.

The vertical length of box cursor is limited to 480 lines even when using 1280 × 960 or 2560 × 1920 images. It is because too eliminate to result too long processing time which may caused by too much lines to be calculated.

(9) **Edge Detection**
Set parameters specific for each edge detection method.

(a) **Linear Approximation** radio button
Specifies the Linear Approximation method for auto edge detection. The following four parameters are effective for this method.

(b) **Threshold Level** combo box
Specify a threshold value to be used for linear approximation. This parameter is selectable in a range of 5 to 95. For example, if there are standing waves in the pattern under measurement, multiple steps may be produced at the edge part, resulting in improper edge detection. To prevent this, adjust the threshold value properly for normal edge detection.
In the linear approximation method, a slope line is determined by identifying a local peak (maximum value) on the signal gradient in the edge detecting direction. In this step of operation, if there are multiple gradient peaks (local gradient peaks), a slope line is determined using the first local gradient peak that is larger than an input threshold value, with respect to the maximum value "100" of the signal gradient in the edge part. Therefore, in the case of a signal waveform (line profile) having just one peak in the signal gradient, edge detection is performed independent of the specified threshold value.

(c) **Differential Size** combo box
This parameter is used for signal gradient calculation (coefficient of signal differentiation) in linear approximation. Specify "5" in common practice. If variation in measured value data is appreciable due to noise contained in the image, it is advisable to specify "7". One of numeric values 3, 5 and 7 is selectable.

(d) **Base Line Start** combo box
This parameter is used to determine the start point of signal baseline readout in linear approximation. Using a position specified for Base Line Start, a baseline is determined according to an average value in a signal level range specified for Base Line Area (described below). For Base Line Start, one of the following four values is selectable; 1, 2, 4 and 8. The smaller this value, the nearer the start point of baseline reading is brought to the maximum gradient position of the signal, thereby shifting the baseline upward.

(e) **Base Line Area** combo box
This parameter indicates a range of baseline reading in linear approximation. One of the following four values is selectable; 4, 8, 16 and 32 (represented in unit of number of pixels).

(f) **Threshold** radio button
Specifies the threshold level method for auto edge detection.

(g) **Threshold Level** combo box
Specifies a threshold value to be taken in the threshold level method. A numeric value may be input with respect to a difference of "100" between minimum and maximum in signal variation on the edge part. If "50" is specified, for instance, the intermediate threshold level is used. This parameter is selectable in a range of 5 to 95.

(10) **Apply** Button
Applies the form of cursor under display according to the set value. Also saves the registration No. of the measurement conditions.

(11) **Save** Button
Saves the present settings under a different registration No. A window for specifying the registration No. of the save destination appears.

(12) **Del** Button
Deletes the registration.

(13) **Close** Button
Closes the **Measurement Mode** window. When measurement parameters have been edited, a message asking whether you will save the contents appears.

6.2.4.5 Calibration Window

This is used to carry out calibration.

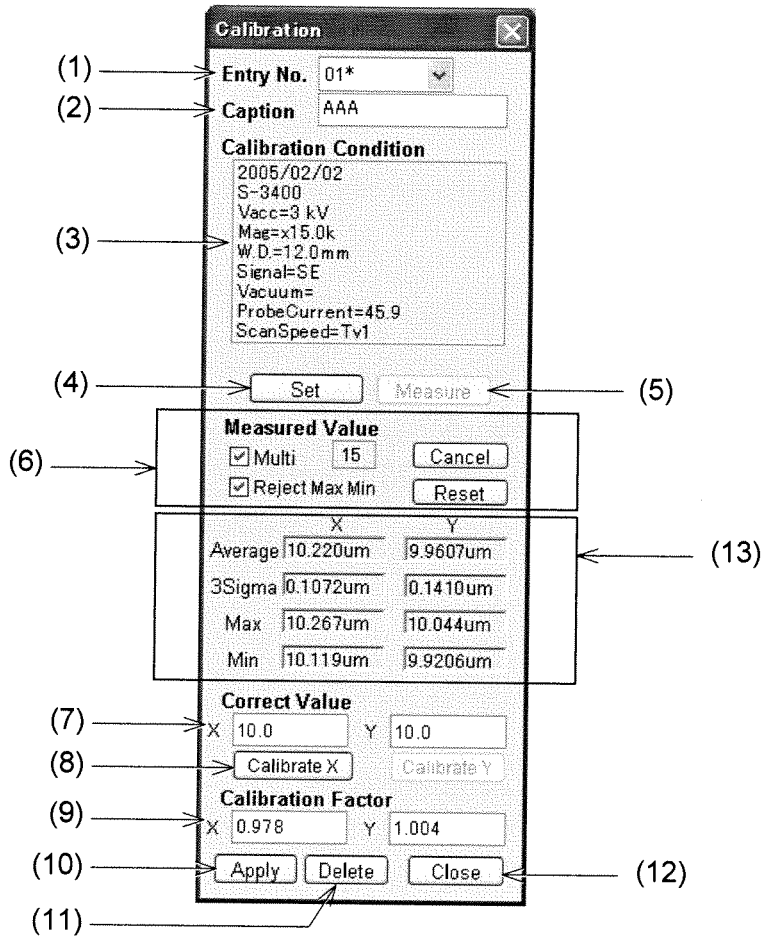


Fig. 6.2-13 Calibration Window

(1) **Entry No.** Combo Box
Specify a No. for registering the calibration. An asterisk (*) appears at the right of an already registered No.

(2) **Caption** box
Enter a caption for identifying the calibration with up to 16 characters.

(3) **Calibration Condition** Box
Indicates the SEM conditions at calibration.

(4) **Set** Button
Displays a measurement cursor for calibration in accordance with the measurement parameters.
For calibration using manual mode, align the measurement cursor in both X, Y directions with a position of known dimensions on the screen. For calibration in auto mode, adjust so that the cursor box encloses the edges of the pattern under measurement.

(5) **Measure** Button
Measures the distance specified by the measurement cursors.

(6) Multiple measurement setting
Use for measuring and averaging multiple points for the measured data.

(a) **Multi** check box
When the box has been checked, multiple measured data are averaged and indicated in the Average box by each measurement. The number of measurement is shown in the right side box.
If it is not checked, only the latest measured data is used.

(b) **Cancel** and **Reset** buttons
Cancel deletes the latest measured data, and Clear deletes all measured data.

(c) **Reject Max Min** check box
When the box has been checked, maximum and minimum data are rejected for averaging calculation. Maximum and minimum data are rejected when number of measurement is 5 times or more.

(7) **Correct Value** Box
Enter a calibration value.

(8) **Calibrate X/Y** Button
Calculates a calibration coefficient.

(9) **Calibration Factor** Box
Displays the calculated calibration factor.
The calibration factor "C" is calculated by the following equation:
C = Correct Value / Measured Value (6.2.8)

(10) **Apply** Button
Registers the calibration result.

(11) **Delete** Button
Deletes the registration of calibration result.

(12) **Close** Button
Closes the **Calibration** window.

(13) Measured Value indication
Displays the measured result.
When the **Multi** check box is not checked, the latest measurement result is indicated in the Average box.
When the **Multi** check box is checked, Average, 3 Sigma, Max and Min value is calculated and indicated by each measurement operation.

6.2.5 Operation

6.2.5.1 Flow of Measuring Operation

Following is the general flow of measuring operation.

- Display of SEM image
- Start of CD measurement function
- Setting of measurement parameters
- Setting of calibration
- Execution of measurement
- Saving of measured results

Details of each operation are described in the following.

6.2.5.2 Display of SEM Image

(1) In the case of the SEM main unit, display a SEM image on the **Scanning Image** window by the usual SEM operation. Do this either by setting the **Run/Freeze** button to freeze or by capturing an image with the **Capture** button.

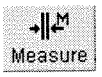
(2) In the case of the SEM data manager, start up the SEM data manager and specify the image to be subjected to measurement from the file list or thumbnail.

NOTICE: (1) Use image size of 2560 × 1920 pixels or smaller. Measurement is disabled for 5120 × 3840 pixels images.

(2) In automatic measurement mode, processing time for finding edges depends on the image size. Larger images need longer processing time.
It is recommended to use 1280 × 960 image size for measurement.

(3) Showing line profiles also needs processing time. For higher throughput, it is recommended not to show line profiles (uncheck **Profile** check box).

6.2.5.3 Start of CD Measurement Function

(1) In the case of the SEM main unit, click the **Measure** 

button on the tool button area of the Operation panel or select Measurement in the Analysis menu.

To start on the SEM Data Manager, use **Measure**  button on the tool bar or Analysis - CD Measurement menu command.
The **CD Measurement** window will open.

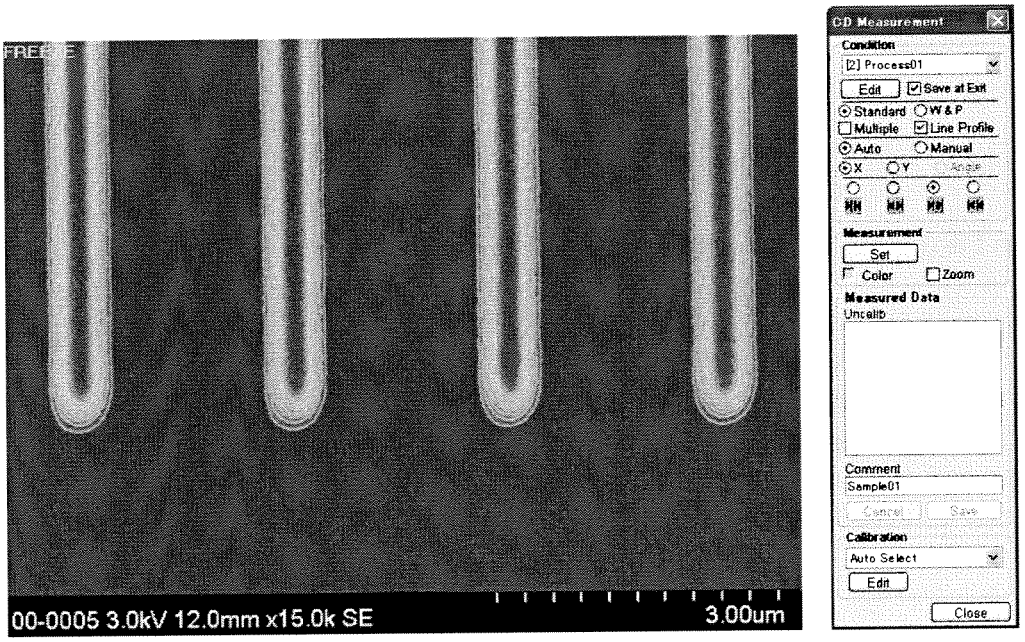


Fig. 6.2-14 CD Measurement Window

6.2.5.4 Setting Measurement Parameters

(1) Selecting Registered Measurement Parameters

(a) Measurement parameters can be saved and then called out later to allow efficient measurement of a number of samples under predetermined parameters.

(b) To call out registered parameters, select the desired parameters from those displayed in the Entry No. box.

Note that the cursor box size for automatic measurement is different for different image size even when using the same parameter set. Refer to notice in < 6.2.4.4 Measurement Condition Window>.

(2) Editing/Saving Measurement Parameters

To edit and save measurement parameters, click the **Condition Edit** button to open the **Measurement Condition** window.

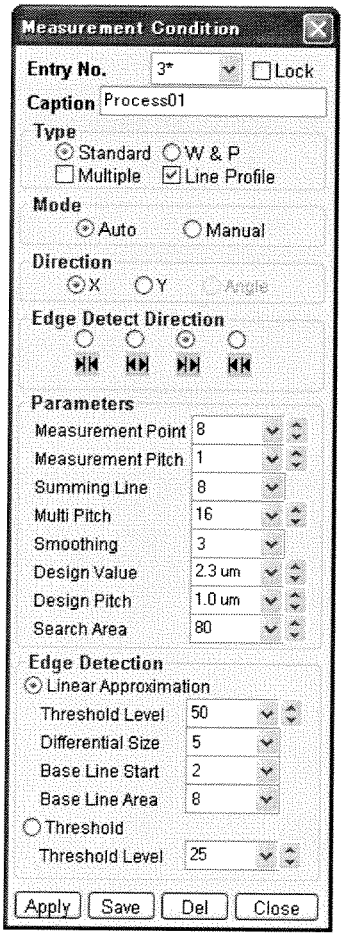


Fig. 6.2-15 Measurement Condition Window

(a) Specify a registration No. according to the setting of the **Entry No.** combo box.

(b) Enter a caption in the **Caption** box that will facilitate calling out measurement parameters.

(c) Set the type of measurement and measurement mode corresponding to the measurement to be executed.

(d) For auto measurement, set the measurement parameters or edge detection parameters.

(e) Click the **Apply** button to apply the set measurement parameters to the process. At the same time the parameters are saved under the set registration No.

(f) By putting a check at the **Lock** button, editing of the measurement parameters can be inhibited.

(g) The **Save** button is used for calling out and editing the saved measurement parameters and then saving them under a new registration No. Clicking this button opens a window for specifying a registration No.

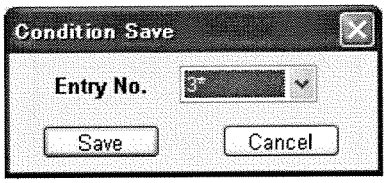


Fig. 6.2-16 Measurement Condition Save Window

Select a save destination No. and then click the **Save** button.

(h) For deleting the saved measurement parameters, click the **Delete** button.

(i) When parameter editing and saving are finished, click the **Close** button to close the **Measurement Condition** window.

6.2.5.5 Calibration

The accuracy of measured values depends on the accuracy of image magnification unless calibration has been made. Factors that affect the accuracy include accelerating voltage, scan speed, magnification setting, working distance, raster rotation angle and others. By fixing these parameters and conducting calibration with a sample of known dimensions, measurement can be made with an even higher accuracy.

(1) Using Registered Calibration factor

Calibration is specified by means of the **Calibration** selector box on **CD Measurement** window. The modes of calibration are selectable from the following.

(a) **Auto** Select
Automatically selects calibration that matches the measurement parameters. When a number of calibrations have been registered under the same parameters, the calibration registered at the maximum **Entry No.** among the relevant parameters will be selected.

(b) **Entry No.**
Calibration is applied only when the SEM parameters of the specified calibration match the SEM parameters of the object image. Specifying an **Entry No.** displays the corresponding SEM parameters. An **Entry No.** for which calibration is not registered cannot be specified.

(c) **Not Apply**
Calibration is not applied.

(2) Applied Parameters for Calibration

Calibration is made when the present SEM parameters are within the following ranges as compared with the calibrated condition.

- Accelerating voltage : Same as calibrated condition
- Viewing magnification : ±1% of calibrated mag.
- Working distance : ±0.5mm of calibration working distance
- Detector : Same as calibrated condition
- Probe Current : ±1.0 of calibrated condition
- Vacuum : Same as calibrated condition
- Scan speed : Same as calibrated condition

(3) Carrying out Calibration

(a) With the CD measurement function of the SEM main unit, set a sample for calibration into the SEM and set the instrument conditions to those actually used for measurement. Since the value of working distance is calculated from the focused objective lens current, adjusting the focus causes a variation in the working distance value. Select a working distance value in the WORKING DISTANCE block of the Operation panel - Cond tab and then, adjust the Z-axis of the specimen stage to obtain a focus. After obtaining a coarse focus with the stage Z control, carry out fine focusing in the usual procedure. Finally set magnification again, because focusing operation will cause a small fraction to magnification value eve if it is not shown in the magnification indication. It may cause discrepancy with measurement condition.

NOTICE: If the focus varies significantly, the objective lens yoke is affected by magnetic hysteresis and causes a reduction in measurement reproducibility.
After a large change in the focus, click the **DeGauss** button on the **Setup** window - Optics tab to eliminate the effect of hysteresis, then adjust the focus and astigmatism correction again.
You can use F2 key as the hot-key for degaussing.

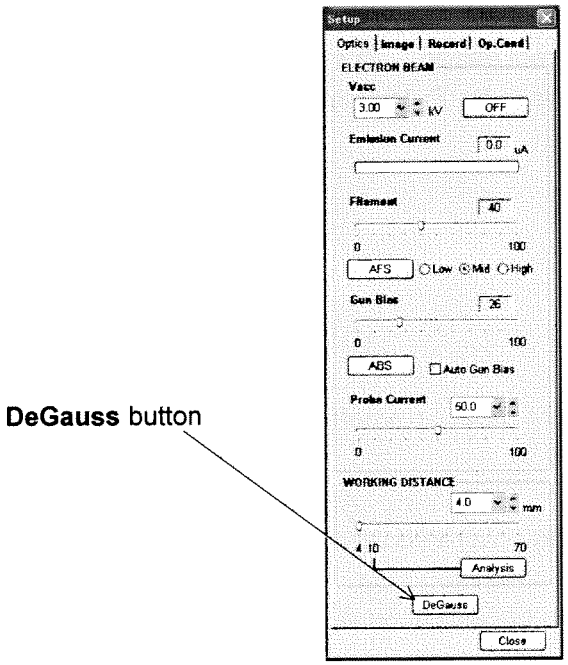


Fig. 6.2-17 DeGauss Button

(b) Observe the image, and set the specific visual field and magnification. Then, click the **Run** button or use the **Capture** button to freeze the image.

(c) In measurement with the SEM data manager, use an image under the same SEM parameters as the image to be measured.

(d) Set measurement parameters such as measurement mode and type of measurement on the **CD Measurement** or **Measurement Condition** window. When Manual measurement mode is selected, calibration can be performed in both X and Y axes directions.
For calibration in the Auto measurement mode, parameters should be set beforehand on the **auto measurement parameter setting** window.

(e) Click the Calibration **Edit** button on the **CD Measurement** window to open the **Calibration** window.

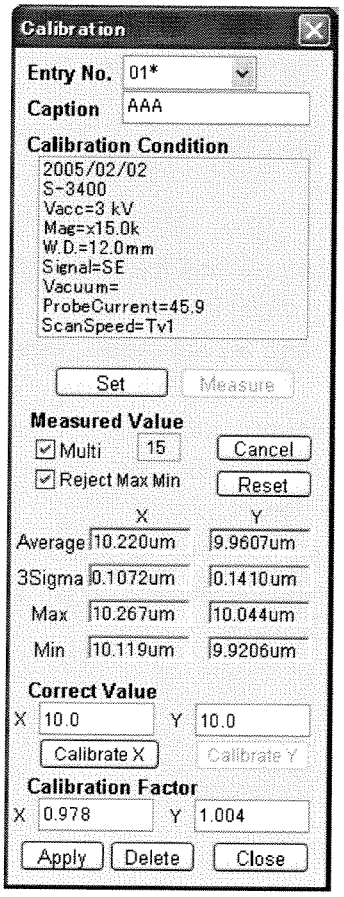


Fig. 6.2-18 Calibration Window

(f) Specify a No. to be registered in the **Entry No.** combo box.

(g) Enter into the **Caption** box a caption that will facilitate call-out.

(h) Click the **Set** button to display the measurement cursor for calibration according to the measurement parameters. For calibration in Manual mode, align the measurement cursors (both X and Y directions) with a position of known dimensions on the screen. For calibration in Auto mode, make sure the cursor box encloses the edges of the measurement pattern.

(i) Click the **Measure** button. The measured result prior to calibration appears in the **Measured Value** box.

(j) Enter a calibration value into the **Correct Value** box.

(k) Click the **Calibrate X/Y** button. The calculated calibration factor appears in the **Calibration Factor** box.

(l) Click the **Apply** button and the data is saved.

(m) Click the **Close** button and the **Calibration** window closes.

(n) Using multi point calibration
In cases where calibration sample has fraction of dimension, it is desirable to use average value by measuring multiple points.
Check the **Multi** check box, and repeat measurement at points having theoretically same dimension.
By each measurement, measured value is averaged with previous measure data and indicated in Average, 3 sigma, Max and Min boxes. Use Cancel to delete the latest data. To delete all data, use Reset.
When the Reject Max Min box has been checked, the maximum and minimum value within measured data are rejected for averaging calculation. It is effective when number of measurement is 5 times or more.

Use the same steps of above (j) to (m) after measurement is finished.

New image acquisition and continued measurement during multi point calibration is possible.
When once scanning is set to RUN state during multi point calibration operation, following image condition will be compared with previous measured image when next measurement is started.
If observation condition of old and new images do not match, a warning message will be shown.
You can continue measurement including data of old image, or start measurement newly clearing old data. Checked condition is

[must be equal] : Accelerating voltage / Magnification / Probe current / Vacuum / scanning speed / detector

[must be nearly equal] : Working distance (within ±5%)

In case of measurement on the SEM Data Manager, a new image can be displayed by clicking a thumbnail.
When new image file is opened during multi point calibration, recording condition will be compared with that of previous measured image.
If recording condition of old and new images do not match, a warning message will be shown.
You can continue measurement including data of old image, or start measurement newly clearing old data. Checked condition is

[must be equal] : Accelerating voltage/Magnification/Probe current/Vacuum/ scanning speed/detector

[must be nearly equal] : Working distance (within ±5%)

Calibration factor and used measured data can be saved.
When **Apply** button is clicked, a message **Save calibration data ?** will be shown.
You can save calibration factor, used measured data and statistical data as text or csv file format.

NOTICE: In the CD measurement function on the SEM data manager, calibration using images obtained with other models (S-3000N, S-4800 or others) is not effective.

6.2.5.6 Measurement Operation

The following six kinds of measurement are mainly available.

- Manual measurement
- Successive manual measurement
- Auto measurement
- Successive auto measurement
- Width & pitch manual measurement
- Width & pitch auto measurement

(1) Manual Measurement

(a) With the measurement type at **Standard**, measurement mode at **Manual** and measuring direction at **X** or **Y**, click the **Set** button on **CD Measurement** window, and measurement cursors as shown in Fig. 6.2-19 will appear.

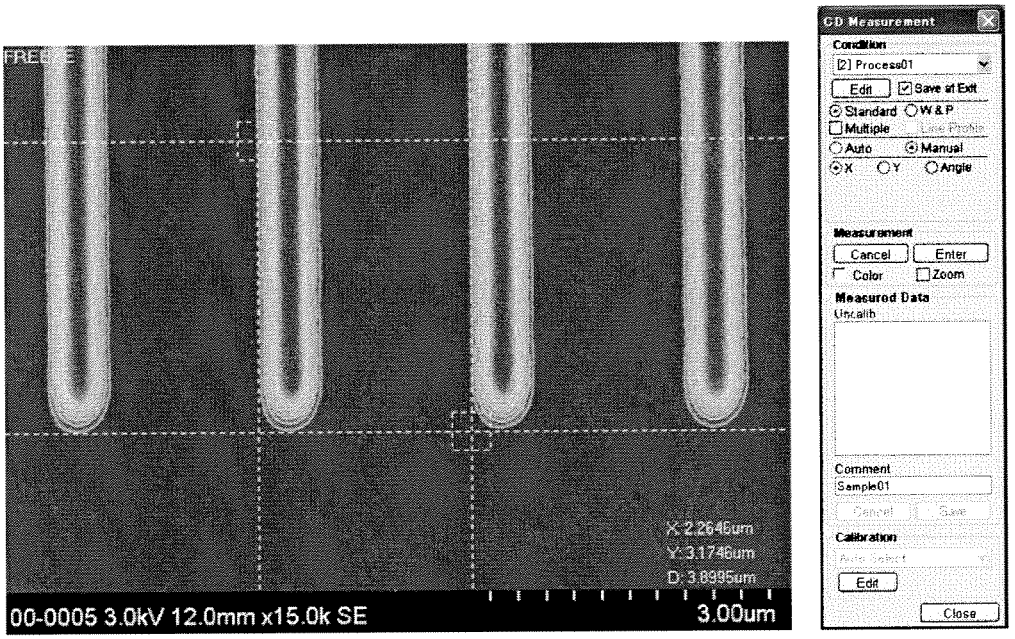


Fig. 6.2-19 Manual Measurement Cursor Display

(b) Drag with the mouse the box located on the cursor intersecting point, and align the cursor with the part to be measured. Even in this status, the measured values (horizontal, vertical, slope directions) can be read out.

(c) Click the **Enter** button, and the measured result can be saved as indicated in Fig. 6.2-20. And if the present SEM parameters match the calibration parameters, the calibrated measurement result will be displayed.

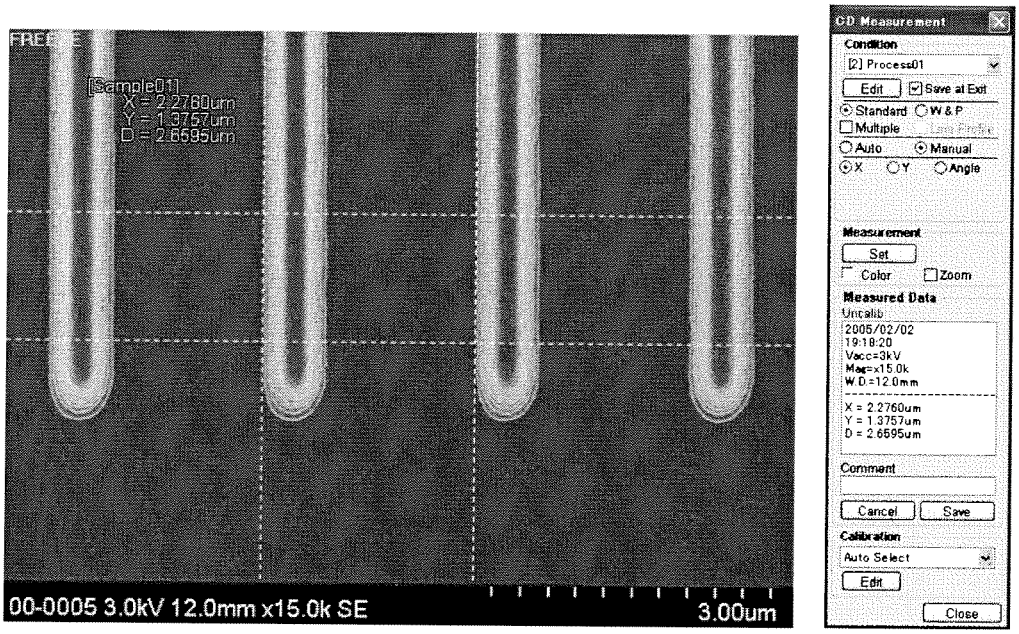


Fig. 6.2-20 Manual Measurement Result

(d) In the CD measurement function of the SEM main unit, click the **Run** button again and the system will return to image observation.

(e) By setting the measuring direction to **Angle** and clicking the **Set** button of **CD Measurement** window, a measurement cursor that permits specifying the angle will appear as in Fig. 6.2-21.

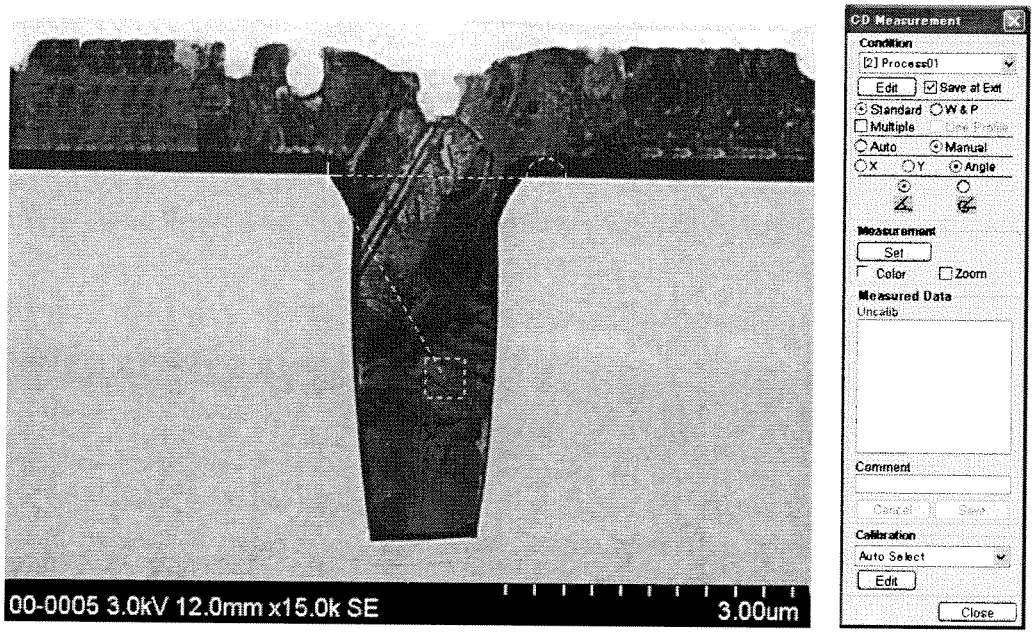


Fig. 6.2-21 Angle Measurement Cursor

(f) Drag the cursor with the mouse and align it with the part to be measured, then click **Enter** button. Angle measurement can thus be done as in Fig. 6.2-22. Calibration is not performed in the case of angle measurement.

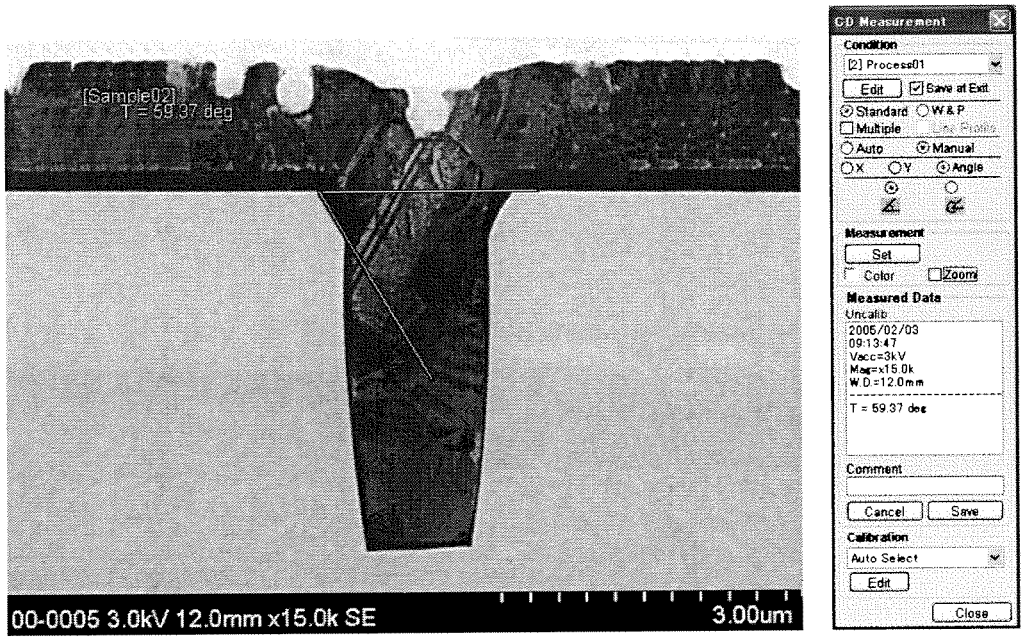


Fig. 6.2-22 Angle Measurement Result

(2) Successive Manual Measurement

(a) By selecting Multiple under manual measurement mode and under the same measurement parameters, successive manual measurement can be carried out. Click **Set** button on the **CD Measurement** window and the measurement cursors appear. In successive measurement, X and Y directions cannot be measured simultaneously, so you must specify a measuring direction.

(b) Drag the measurement cursor box with the mouse as in the manual measurement, and align the cursor with the part to be measured. Click **Enter** button and the measured result appears.

(c) Click **Set** button in this status to display the measurement cursors, then align the cursor with the next part to be measured. Click **Enter** button and the 2nd measured result will appear after the 1st measured result.

(d) In the same manner, click **Set** button, align the measurement cursors, and click **Enter** button to achieve successive measurement. In manual mode, a maximum of 8 successive measurements can be achieved.

(e) Successive measurement is also possible in the angle measurement mode. Successive measurement by changing **X**, **Y** or **Angle** midway as in Fig. 6.2-23 is also feasible. In the case of **Angle**, numerics will be displayed in the part where the circular cursor appears.

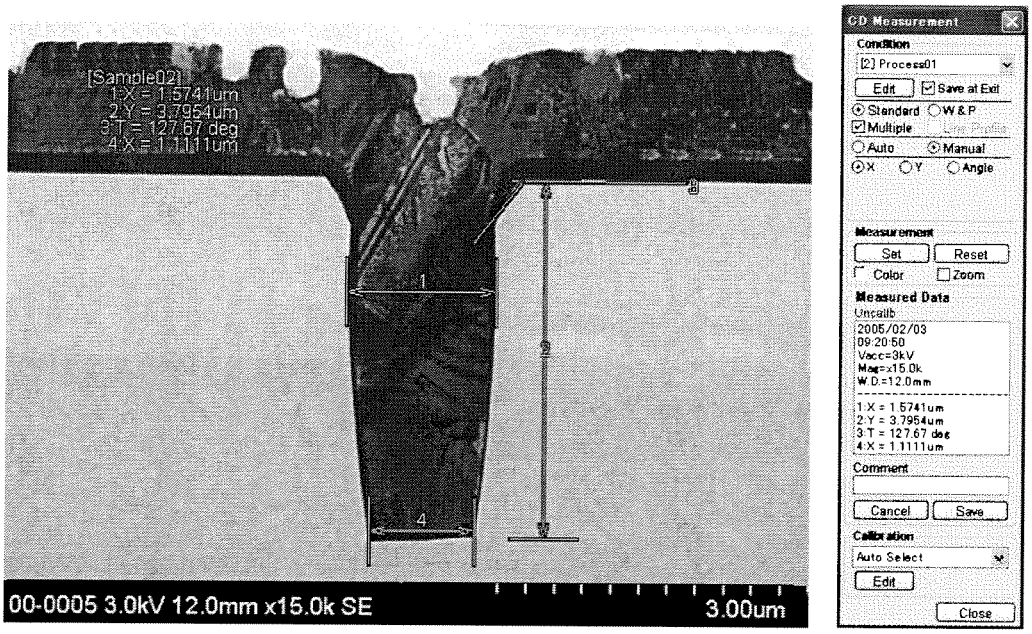


Fig. 6.2-23 Successive Manual Measurement Results

(3) Auto Measurement

(a) With the measurement type at **Standard**, measurement mode at **Auto** and measuring direction at **X** or **Y**, click the **Set** button on **CD Measurement** window, and the auto measurement cursors will appear as shown in the figure. The measurement cursor box will be of the size set previously in the measurement parameters.

(b) Drag the box with the mouse so that the edge part to be measured is enclosed in the box.

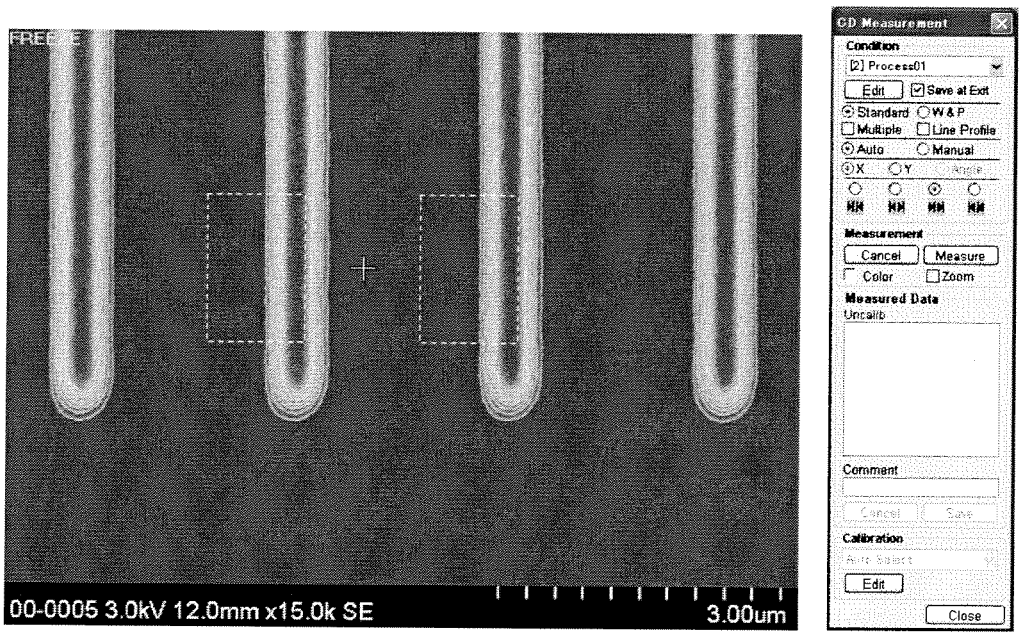


Fig. 6.2-24 Auto Measurement Cursors

(c) Set the cursors and click the **Measure** button to start measurement. When there are two or more measurement points, a "+" sign appears at the location where an edge was detected for each measurement point, and when the measurement of all the points is finished, the cursor moves to the part representing the average value of the points.

(d) When **Line Profile** has been set, a signal waveform (line profile) will appear.

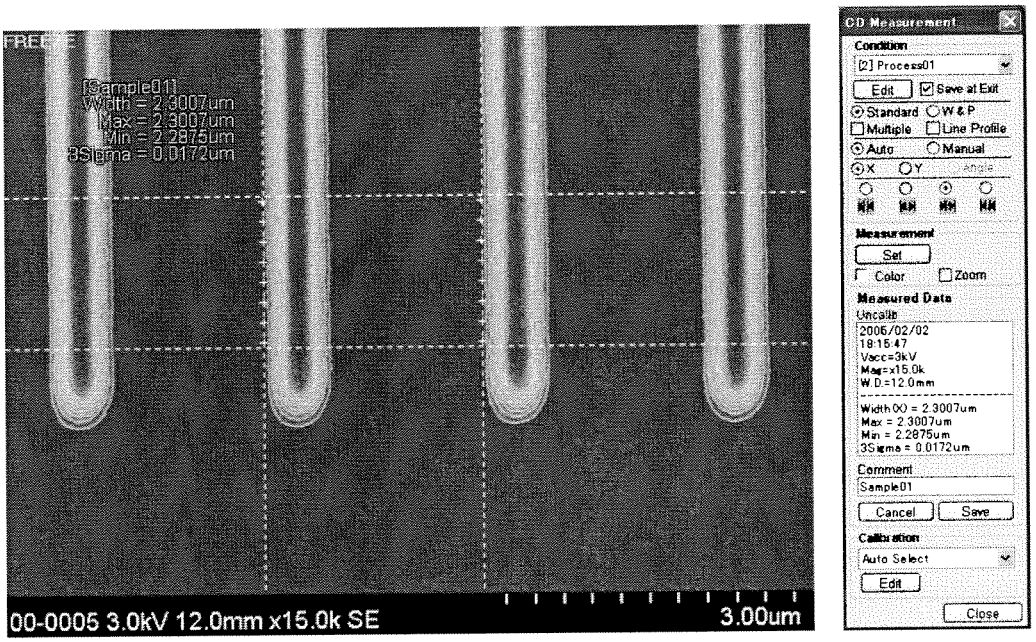


Fig. 6.2-25 Auto Measurement Result Display

(e) The measurement results are indicated as follows.

Width : Measured value of one point, or average of measured values of multiple points
Max : Maximum of measured values
Min : Minimum of measured values
3 Sigma: Standard deviation of measured value

NOTICE:
1. When "1" is set for Measurement Point in the measurement parameters, the maximum, minimum and standard deviation values are not indicated.
2. Standard deviation is calculated using numeric values having more digits than the measured value indication. Therefore the standard deviation may not be "0" even if the maximum and minimum values indicated in the measured results are equal to each other.
3. The standard deviation represents a degree of edge roughness of the pattern under measurement. Use the standard deviation function as required.
4. A comment entered in the comment entry box on **CD Measurement** window appears on the measured results.

(4) Successive Auto Measurement

(a) Set **Multiple** in the measurement parameters the same as for auto measurement, then successive auto measurement can be achieved. Click **Set** button on the **CD Measurement** window and measurement cursors as for auto measurement will appear.

(b) Drag the measurement cursor box with the mouse as in auto measurement, align the cursors with the part to be measured, then click **Measure** button and the measured result will appear.

(c) In this status, click the **Set** button to display the measurement cursors, align the cursors with the next part to be measured, then click **Measure** button and the 2nd measured result will be displayed following the 1st measured result.

(d) In the same way, click **Set** button and set the cursors, then click **Measure** button and successive measurement can be achieved as shown in Fig. 6.2-26. In the case of auto measurement, a maximum of four successive measurements is possible.

(e) Successive auto measurements upon changing **X** and/or **Y** midway is also possible.

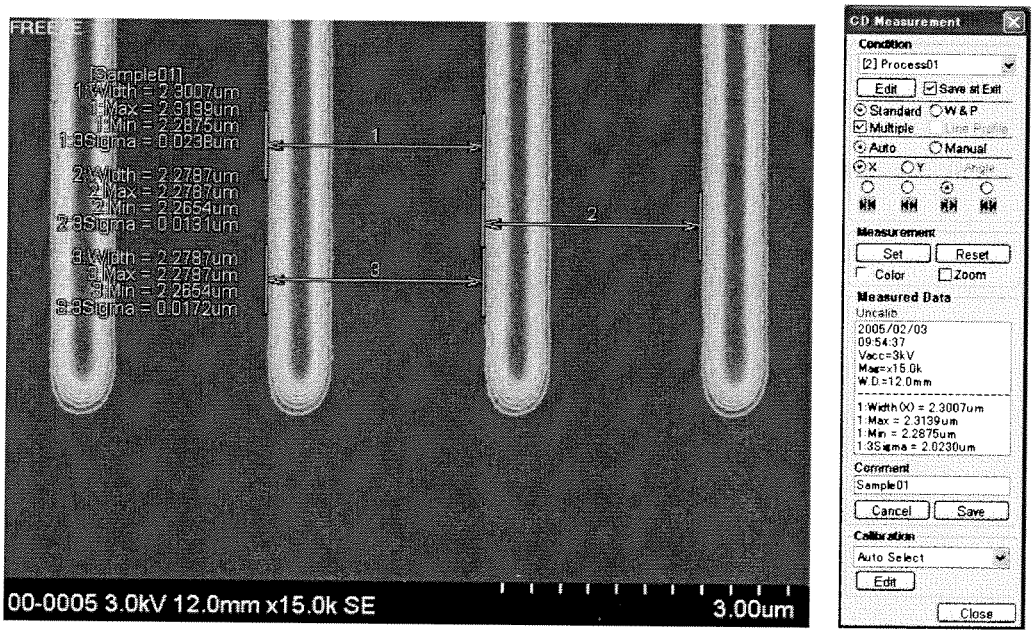


Fig. 6.2-26 Successive Auto Measurement Results

(5) Width & Pitch Manual Measurement

(a) Set the measurement type to **W&P**, measurement mode to **Manual** and measuring direction to **X** or **Y**, then width and pitch can be simultaneously measured manually.

(b) Click **Set** button on **CD Measurement** window. The measurement cursors will appear.

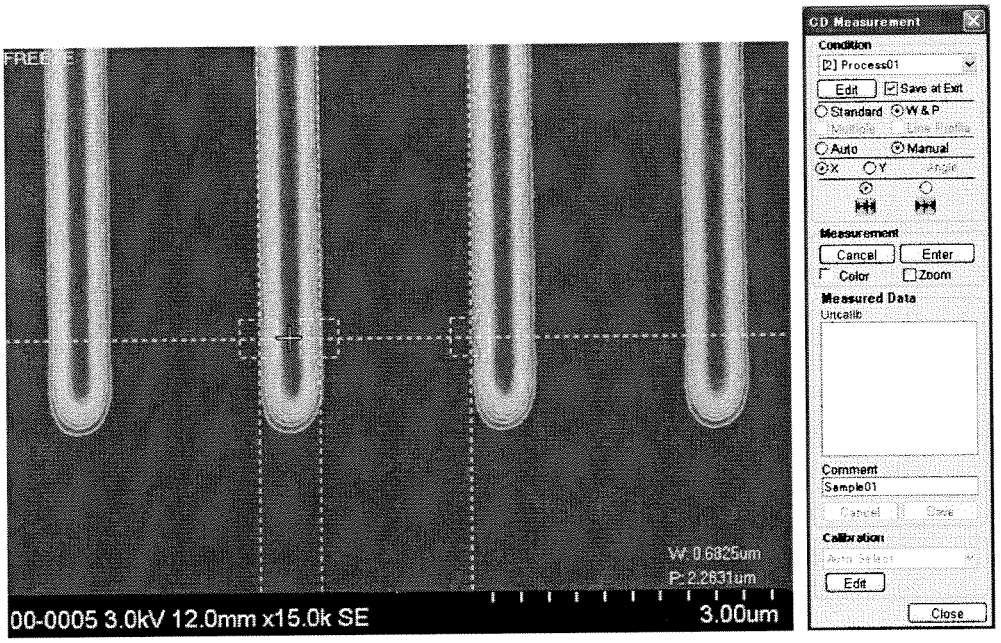


Fig. 6.2-27 Width & Pitch Manual Measurement Cursors

(c) Drag the cursor via the mouse to the edge to be measured, and set the position. The side where the "+" sign is located represents the width.

(d) Align the cursor with the part to be measured as in manual measurement, click the **Enter** button and then the measured results will appear as in Fig. 6.2-28.

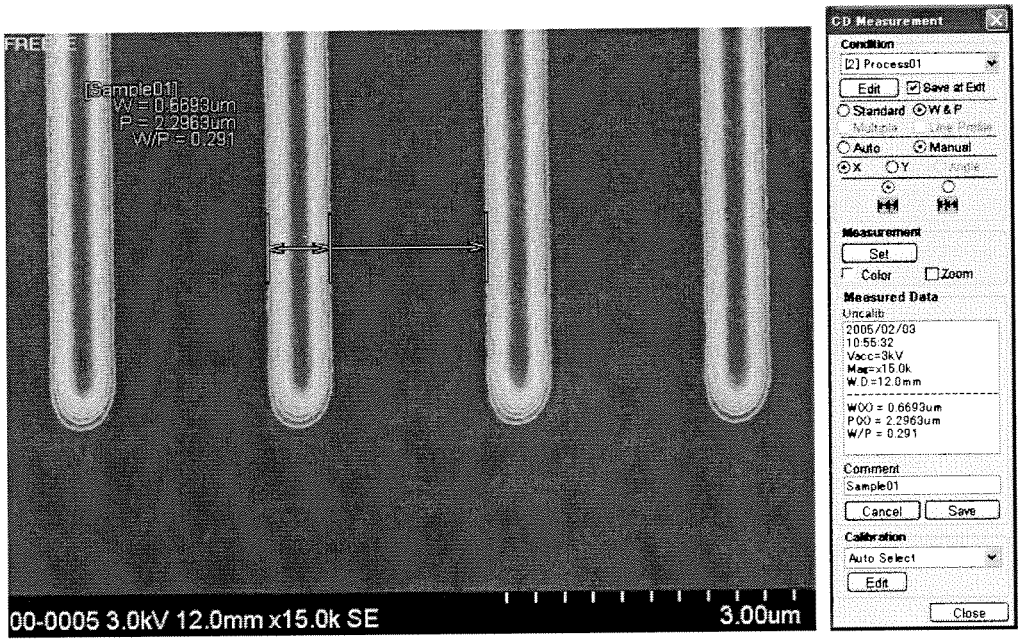


Fig. 6.2-28 Width & Pitch Manual Measurement Results Display

(6) Width & Pitch Auto Measurement

(a) Set the measurement type to **W&P**, measurement mode to **Auto** and measuring direction to **X** or **Y**, then width and pitch can be simultaneously measured automatically.

(b) Click **Set** button on **CD Measurement** window. The auto measurement cursors will appear. The measurement cursor box will be of a size set before in the measurement parameters.

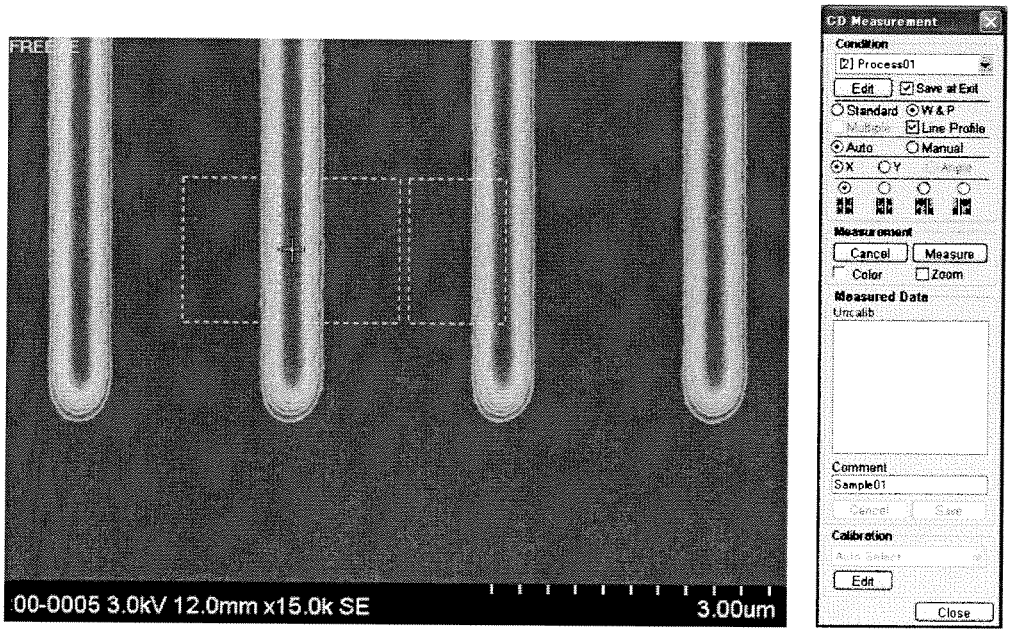


Fig. 6.2-29 Width & Pitch Auto Measurement Cursors

(c) Drag the box using mouse so the edge to be measured will be enclosed in the box, and set the position. The side where the "+" sign is located represents the width.

(d) Align the cursor with the part to be measured as in auto measurement, click the **Measure** button and then the measured results will appear as in Fig. 6.2-30.

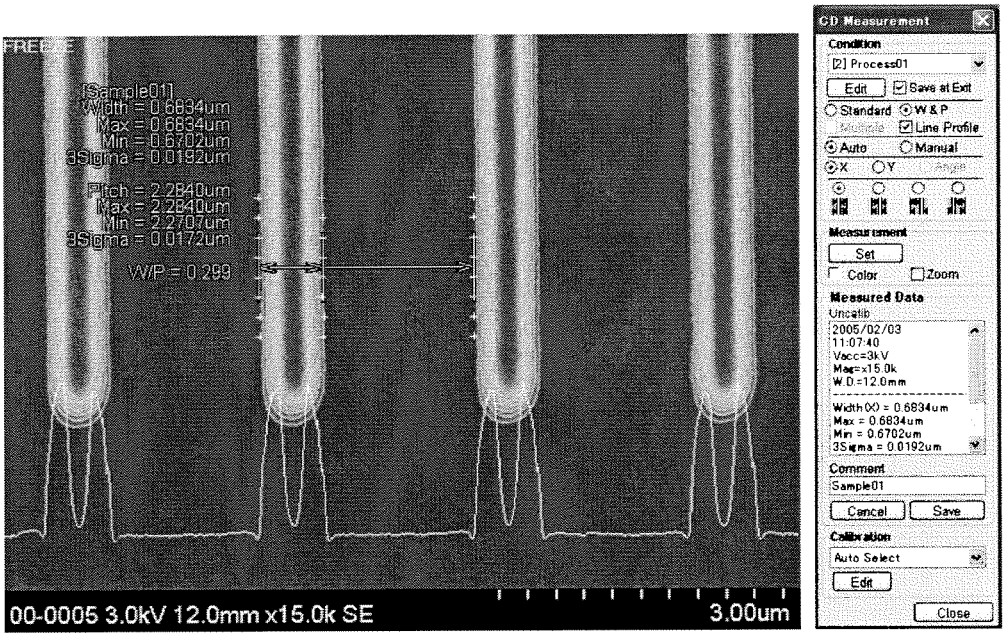


Fig. 6.2-30 Width & Pitch Auto Measurement Results Display

(7) Zoom function

A partial image besides the cursor is magnified and shown on the **Zoom** window. Check the Zoom box to use the zoom function.
The crosshair cursor corresponds to the cursor position. It will be useful for accurate fitting of cursor to the point to be measured in manual measurement mode.

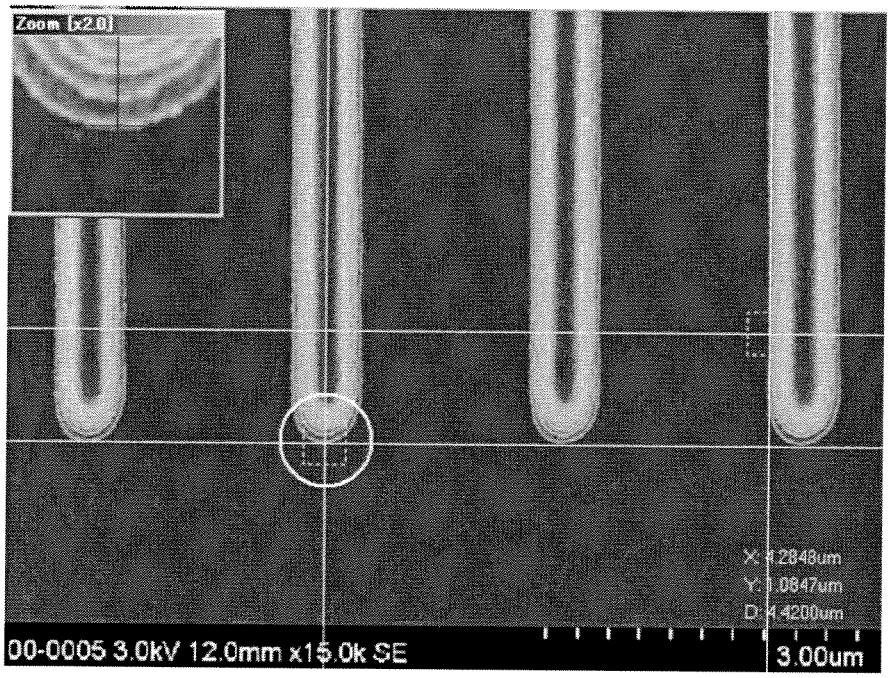


Fig. 6.2-31 Image Exchange during CD Measurement (SEM Data Manager)

The target image can be changed without closing **CD Measurement** window.

In case of measurement on the SEM Data Manager, image file name is put at the top of measured data when saved as text or csv format file to identify measured image.

6.2.5.7 Recording Measured Data

The image can be saved with measured data

(1) The font of the measured result display

(a) For the S-3400N control program
Open the **Option** menu, select the **Optional Setup**, and then the **General** menu. Open the **Optional Setup** window, and choose the font that displays measured data in the image from the **DATA ENTRY/MEASUREMENT** block.

(b) For the SEM data manager
Open the **Options** window from **Options** on the **Tool** menu and choose the font from the **Data Entry/Measurement** block.

NOTICE: When executing the auto measurement repeatedly with the **Multiple** Mode, all the measured data might not be displayed on the image depending on the font size. In this case, change the font size to smaller.

(2) Photographing an image with measured data

When operating on S-3400N, click **Memory Photo** button, or select Memory Photo command in the File menu.
The Memory Photo is started and the image and the measured data are recorded photographically.

(3) Saving an image with measured data

When operating on S-3400N, click the **Save** button on the Control panel, or select the **Direct Save** command in the File menu.
When operating on SEM Data Manager, click the **Save as** button on the tool bar.

Image save window will open. Select or input the User name, folder and file name and then, click the **Save** button.

NOTICE: Measured data is not saved by using the **Save** button on **Captured Image** window.

NOTICE: In case of the SEM Data Manager, the user name cannot be newly input.

(4) Saving measured data

Measured can be saved as text format or csv format. The latter is Microsoft Excel compatible.
Measured data is accumulated by succeeding measurement and saved as a file.

(a) Click the **Save** button on the **CD Measurement** window.

(b) Select a data format (*.mev for text format, or *.csv for Excel format) and specify folder and filename on the **Measured Data Save** window.

NOTICE: 1. To open the saved data file, use text application program for text file (mev files) or Microsoft Excel (csv files).
2. When image data with measured value is necessary, record the image before saving measured data. The data on the image is cleared when the data is saved.

The following table is an example of measured data saved in csv format and opened with Microsoft Excel. (Measurement on SEM Data Manager) Where 3 times of width-pitch (left side width), width-pitch (right side width), 5 times of horizontal and vertical width and 5 times of angle are measured and then, saved.

Table 6.2-1 The Example of Measured Data

File	Comment	Mode	Multiple	Auto/Manua	Date	Vacc	Vdec	Deceleratio	Mag	W.D.	Calibration	Width(Left Pattern)(u	Max(um)	Min(um)	3Sigma(um)	Pitch(Left Line)(um	Max(um)	Min(um)	3Sigma(um	W/P
測長hhh.jpg	2	W&P	Off	Auto	2004/7/9 14:04	1kV	0kV	Off	x100.0k	2.6mm	Calibrated	0.0839	0.0872	0.0796	0.0052	0.2427	0.248	0.2382	0.0077	0.3
測長hhh.jpg	2	W&P	Off	Auto	2004/7/9 14:04	1kV	0kV	Off	x100.0k	2.6mm	Calibrated	0.0837	0.087	0.0794	0.0052	0.2426	0.2479	0.2381	0.0077	0.3
測長hhh.jpg	2	W&P	Off	Auto	2004/7/9 14:04	1kV	0kV	Off	x100.0k	2.6mm	Calibrated	0.0816	0.0852	0.0788	0.0046	0.2411	0.244	0.238	0.006	0.3
File	Comment	Mode	Multiple	Auto/Manua	Date	Vacc	Vdec	Deceleratio	Mag	W.D.	Calibration	Width(Right Pattern)(u	Max(um)	Min(um)	3Sigma(um)	Pitch(Right Line)(u	Max(um)	Min(um)	3Sigma(um	W/P
測長hhh.jpg	2	W&P	Off	Auto	2004/7/9 14:05	1kV	0kV	Off	x100.0k	2.6mm	Calibrated	0.0818	0.0869	0.0792	0.0051	0.2411	0.2444	0.238	0.0046	0.3
測長hhh.jpg	2	W&P	Off	Auto	2004/7/9 14:05	1kV	0kV	Off	x100.0k	2.6mm	Calibrated	0.0776	0.0811	0.0754	0.004	0.2385	0.2424	0.2364	0.0046	0.3
測長hhh.jpg	2	W&P	Off	Auto	2004/7/9 14:05	1kV	0kV	Off	x100.0k	2.6mm	Calibrated	0.0795	0.082	0.0762	0.0042	0.2368	0.2407	0.2334	0.0045	0.3
File	Comment	Mode	Multiple	Auto/Manua	Date	Vacc	Vdec	Deceleratio	Mag	W.D.	Calibration	Width(X)(Line)(um)	Max(um)	Min(um)	3Sigma(um)					
TV35.tif	2	Standard	Off	Auto	2004/7/9 14:07	2kV	0kV	Off	x35.0k	3.0mm	Calibrated	0.7958	0.7962	0.7951	0.0024					
TV35.tif	2	Standard	Off	Auto	2004/7/9 14:07	2kV	0kV	Off	x35.0k	3.0mm	Calibrated	0.7924	0.7932	0.7924	0.0016					
TV35.tif	2	Standard	Off	Auto	2004/7/9 14:07	2kV	0kV	Off	x35.0k	3.0mm	Calibrated	0.7879	0.7887	0.7876	0.0024					
TV35.tif	2	Standard	Off	Auto	2004/7/9 14:07	2kV	0kV	Off	x35.0k	3.0mm	Calibrated	0.7827	0.7838	0.7819	0.004					
TV35.tif	2	Standard	Off	Auto	2004/7/9 14:07	2kV	0kV	Off	x35.0k	3.0mm	Calibrated	0.7872	0.7876	0.7864	0.0024					
File	Comment	Mode	Multiple	Auto/Manua	Date	Vacc	Vdec	Deceleratio	Mag	W.D.	Calibration	Width(Y)(Line)(um)	Max(um)	Min(um)	3Sigma(um)					
TV35R.bmp	2	Standard	Off	Auto	2004/7/9 14:07	2kV	0kV	Off	x35.0k	3.0mm	Calibrated	0.5749	0.5749	0.5749	0					
TV35R.bmp	2	Standard	Off	Auto	2004/7/9 14:07	2kV	0kV	Off	x35.0k	3.0mm	Calibrated	0.5749	0.5757	0.5746	0.0023					
TV35R.bmp	2	Standard	Off	Auto	2004/7/9 14:07	2kV	0kV	Off	x35.0k	3.0mm	Calibrated	0.5678	0.5685	0.5668	0.0035					
TV35R.bmp	2	Standard	Off	Auto	2004/7/9 14:07	2kV	0kV	Off	x35.0k	3.0mm	Calibrated	0.5806	0.5808	0.5806	0.0004					
TV35R.bmp	2	Standard	Off	Auto	2004/7/9 14:08	2kV	0kV	Off	x35.0k	3.0mm	Calibrated	0.581	0.5812	0.581	0.0004					
File	Comment	Mode	Multiple	Auto/Manua	Date	Vacc	Vdec	Deceleratio	Mag	W.D.	Calibration	T(deg)								
0TR02.BMP	2	Standard	Off	Manual	2004/7/9 14:09	20kV	0kV	Off	x120	29.9mm	UnCalibrated	89.26								
0TR02.BMP	2	Standard	Off	Manual	2004/7/9 14:09	20kV	0kV	Off	x120	29.9mm	UnCalibrated	88.41								
0TR02.BMP	2	Standard	Off	Manual	2004/7/9 14:09	20kV	0kV	Off	x120	29.9mm	UnCalibrated	86.98								
0TR02.BMP	2	Standard	Off	Manual	2004/7/9 14:09	20kV	0kV	Off	x120	29.9mm	UnCalibrated	90.38								
0TR02.BMP	2	Standard	Off	Manual	2004/7/9 14:09	20kV	0kV	Off	x120	29.9mm	UnCalibrated	89.47								

In case of measurement on SEM, "File" is not put in saved data.

Note that the comment shall be written before carrying out measurement. The comment is stored together with measured data when a measurement is performed.

6.3 ESED (low-vacuum secondary electron detector) (Option)

This detector is a special accessory to the Scanning Electron Microscope and is used to observe the ESED (low vacuum secondary electron) image.
The ESED carries out gas amplification of the secondary electron which is generated from the specimen by aggressively utilizing the gas in the low vacuum atmosphere, and detects the generated ESED signal.
By doing so, an ESED image equivalent to the secondary electron image in a high vacuum mode can be observed in a low vacuum mode.

6.3.1 Appearance

The appearance of the ESED is shown below. The ESED is attached to the left front of the specimen chamber in the Scanning Electron Microscope main unit.

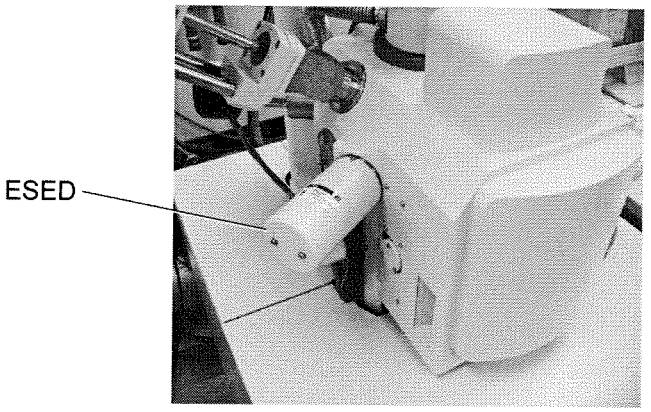


Fig. 6.3-1 Appearance of the ESED

6.3.2 Cautions on Using the ESED

⚠ **WARNING:** Do not open the cover of the detector or the scanning electron microscope main unit. Death or serious injury may occur due to electric shock.

⚠ **CAUTION:** Connect the ground cable correctly. If the ground cable is not connected correctly, not only will the system operate abnormally, but also there is a danger of electric shock.

NOTE: Ground other optional equipments correctly. If the ground cable is not connected correctly, ESED might not operate normally. In that case, ground the equipments to the specimen chamber with ground cables.

NOTE: Do not set a wireless apparatus such as a cellular phone close to the ESED. Since the ESED amplifies very small currents, it may cause image distortion by the external electric wave.

NOTE: The ESED image has noises in the TV or FAST, Slow1 scan. These scans are not so suitable for observation, suitable for searching for a specimen.

6.3.3 Usage

(1) In the **VACUUM MODE** block of the Cond. tab, select VP-SEM to set the inside of the specimen chamber to a low vacuum. After that, set it to an arbitrary degree of vacuum using the Setting Vacuum slider.

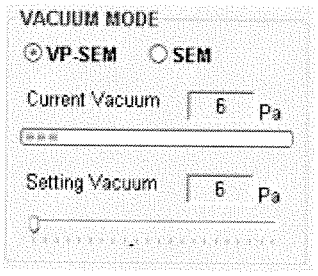


Fig. 6.3-2 VACUUM MODE Block

(2) After the evacuation is complete, apply the accelerating voltage.
See 3.3 Applying the Accelerating Voltage.

(3) In the **DETECTOR** block of the Image tab, click the rightmost radio button and then select **ESED** from the list box. The **DETECTOR** block changes to the ESED operation menu, and an ESED image can be observed.

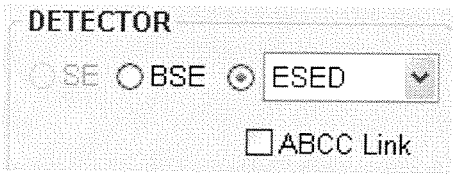


Fig. 6.3-3 DETECTOR Block

IMPORTANT:	In high magnification observation, the image shifts by several micrometers due to the characteristics of the detectors when the detector is changed.

IMPORTANT:	The image darkens for a short time due to the characteristic of ESED after the selection of ESED.

(4) If a check mark is placed in the **ABCC Link** check box, **ABCC** will be automatically executed when the detector is changed. Also, when the Gain is changed, **ABCC** will be executed.

Refer to 6.3.5 Observation of the ESED Image to set the conditions in order to acquire clearer images.

6.3.4 ESED Operation Menu

The ESED operation menu used to observe the ESED image is explained below.

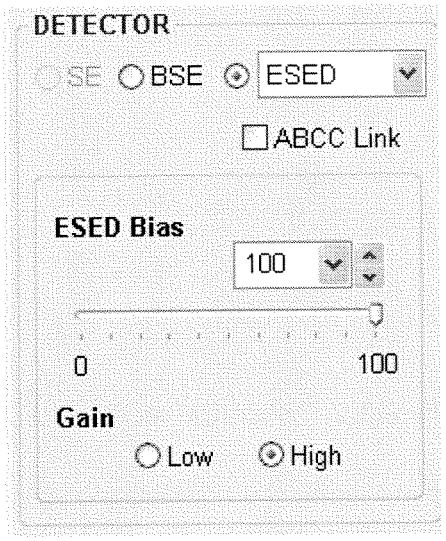


Fig. 6.3-4 ESED Operation Menu

(1) **ESED Bias**
This controls the voltage to generate the gas amplification. It is expressed with an index between 0 and 100, and can be selected either by the slider or from the list box. When the index is enlarged, more ESED signal is obtained.

(2) **Gain**
Gain changes by switching from **Low** to **High** and vice versa. In **High** gain, the ESED image with the more contrast can be observed. Select the gain according to the signal amount.

6.3.5 Observation of the ESED Image

The observation condition for the ESED image is described below. Refer to 3.10 Image Quality of the S-3400N Instruction Manual on how the normal SEM observation condition, for the influences on image quality such as accelerating voltage.

(1) Standard ESED Observation Conditions
The standard ESED observation conditions are shown in Table 6.3-1. Many parameters must be set in order to observe the ESED image. Use Table 1 as a reference to set the parameters. The setting of the vacuum must be determined by the specimen. The hydrated specimen must be observed in a low vacuum to prevent moisture from evaporating. Similarly, observe the specimen in a low vacuum when the observation is difficult by the charge-up.

Table 6.3-1 ESED Observation Conditions

	High Resolution Observation	Normal Observation
Accelerating Voltage	30 kV	5 kV to 25 kV
Probe Current	30	40 to 60
Vacuum	60 Pa	60 Pa to 120 Pa
WD	5 mm to 7 mm	5 mm to 15 mm
Objective movable aperture	#4	#2 to #3
ESED Bias	100	70 to 90
Gain	High	High or Low

(2) ESED Observable Range
When performing the observation using the ESED, the accelerating voltage, the probe current and the vacuum must be set within the range shown in Table 6.3-2. In ranges other than this, a good ESED image may not be obtained.

Table 6.3-2 Observable Range

	Observable Range
Accelerating Voltage	5 kV and above
Probe Current	30 to 80
Vacuum	40 Pa and above

6.3.6 Mutual Limitation between T and Z axes when the ESED is Attached (Type I and Type II stages)

When the ESED is attached, a new limitation occurs in the specimen stage axis drive range. The limitation occurs in the - direction of T-axis drive range in two specimen stub sizes: ϕ51 mm and ϕ77 mm.
When the Type I stage is used and the ESED is attached, ϕ51 mm and ϕ77 mm specimen stub must be used in a larger angle than the tiltable angle shown in Table 6.3-3.
When the Type II stage is used, new tiltable angles are displayed in the **Z/TILT** block of the **Stage** tab. Operate it within the range.

Table 6.3-3 Tiltable Range when Type I Stage is used

ϕ51 mm specimen stub

Z [mm]	Tiltable Angle
5	0 °
10	0 ° to 14 °
15	-5 ° to 34 °
20	-5 ° to 90 °
25	-15 ° to 90 °
30	-20 ° to 90 °

ϕ77 mm specimen stub

Z [mm]	Tiltable Angle
5	0 °
10	0 ° to 10 °
15	-5 ° to 20 °
20	-5 ° to 30 °
25	-15 ° to 46 °
30	-20 ° to 65 °

IMPORTANT: Set Z and T axes within the allowable range; otherwise, the specimen may strike the objective lens or detectors and cause damage to both specimen and them.

Refer to the following items of the scanning electron microscope main unit instruction manual for the limitation of the other specimen stub size.
3.5.6.4 Tilt and Z Axes Limitations
3.5.7.12 Movable Range and Limitation by Optional Detectors

6.3.7 Change by the vacuum in the ESED bias

The ESED changes the maximum and minimum voltage of the **ESED bias** using the degree of vacuum in order to observe a better ESED image. Please note that by changing the degree of vacuum, the **ESED bias** index or brightness and contrast of image may also be changed.

6.4 Multi Sample Holder (ϕ 15 mm × 4 p)

6.4.1 Composition

(1) Multi Sample Holder
(2) ϕ 15 mm Specimen Stub (×4 p)

6.4.2 Appearance and Each Part Name of Multi Sample Holder (ϕ 15 mm × 4 p)

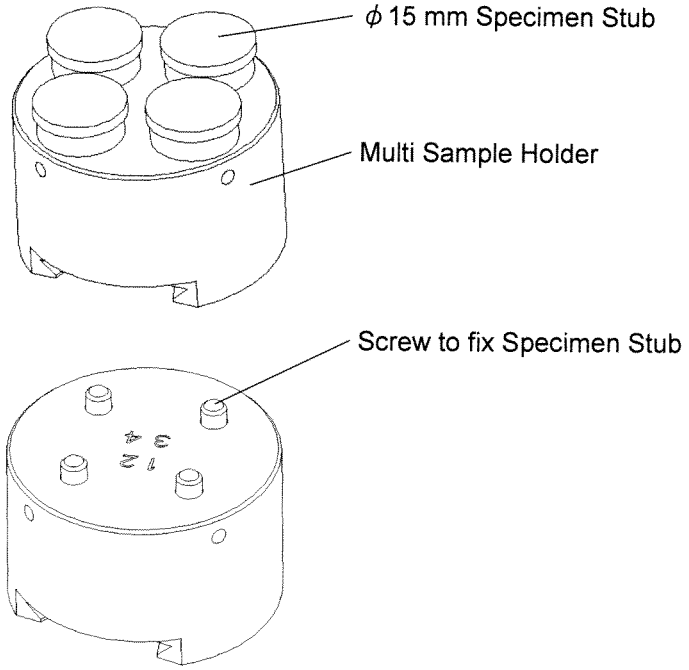


Fig. 6.4-1 Multi Sample Holder

6.4.3 Specification

Maximum sample (Height) : 55 mm

IMPORTANT:	Specimen should be within the specimen stub. If they are not properly set, the specimen can touch the backscattered electron detector, potentially causing damage to the detector.

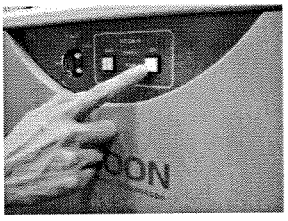
6.4.4 Loading and Detaching of Specimen Stub

The specimen stubs can be fixed by screwing in a fixing screw on the multi-sample holder. When you want to detach the specimen stub from the multi- sample holder, turn contrary to the direction that screws in.

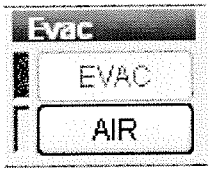
6.4.5 Specimen Exchange (Removing the Specimen from the Specimen Chamber)

(a) Click the **OFF** button on the Control Panel to shut the accelerating voltage off.

(b) Press the **AIR** button on the EVAC Panel or click the **AIR** button on the upper right section of the Control Panel. Air is introduced into the specimen chamber. The **Specimen Setting** window appears. After confirming the content of the dialog, click the Specimen Setting button.



EVAC Panel



Control Panel

Fig. 6.4-2 AIR Button (Air Leak of the Specimen Chamber)

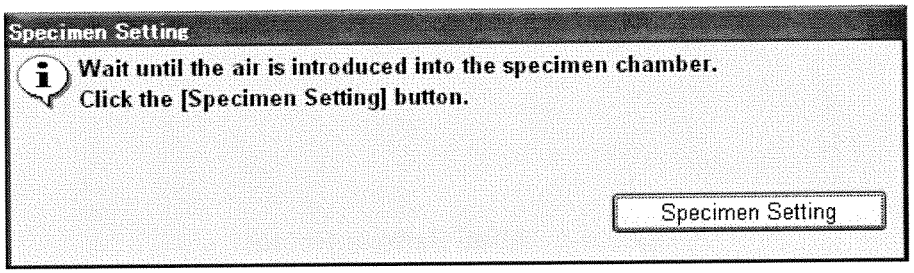


Fig. 6.4-3 Specimen Setting Window

When installing the Faraday cup (option)
Draw out the Faraday cup from the specimen chamber. The **Specimen Setting** button becomes effective. And then, click the **Specimen Setting** button.

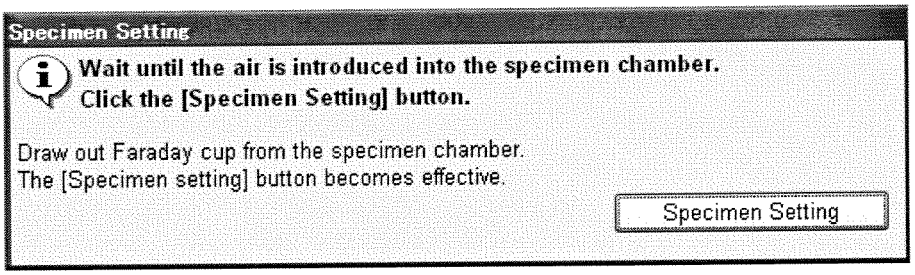


Fig. 6.4-4 Specimen Setting Window (When installing the Faraday cup)

(c) After introducing air into the specimen chamber, draw out the stage to the position where the stage stops completely.
[When executing observation]
Remove the specimen holder and click the **OK** button on the **Specimen/Detector Setting** window.
[When finishing observation]
Remove the specimen holder. Grip handles by both hands and insert the stage in the specimen chamber slowly. Click the **Exit SEM Manager** button to finish the program. Then, push the **EVAC** button to evacuate.

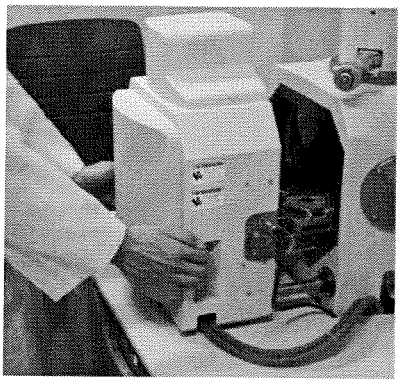


Fig. 6.4-5 Pulling out the Stage

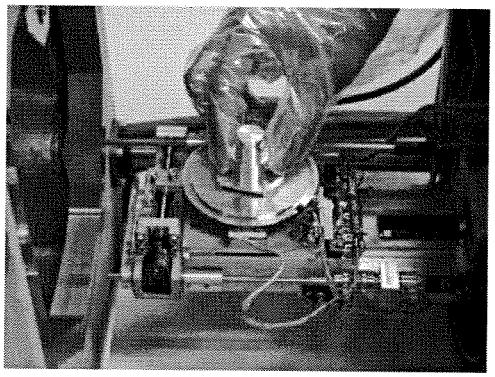


Fig. 6.4-6 Removing the Specimen Holder

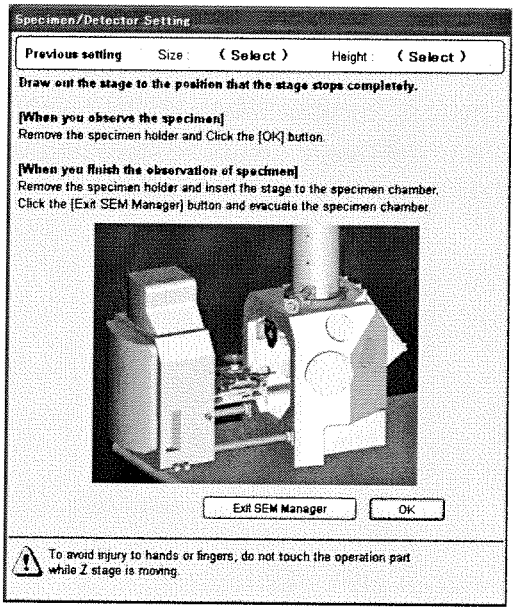


Fig. 6.4-7 Specimen/Detector Setting Window 1

IMPORTANT:	When setting the specimen, draw out the specimen stage to the position where the stage stops completely.

6.4.6 Setting the Specimen Size and Height

(1) **Specimen/Detector Setting** window appears.
Set the specimen **Size** and **Height** with this window.

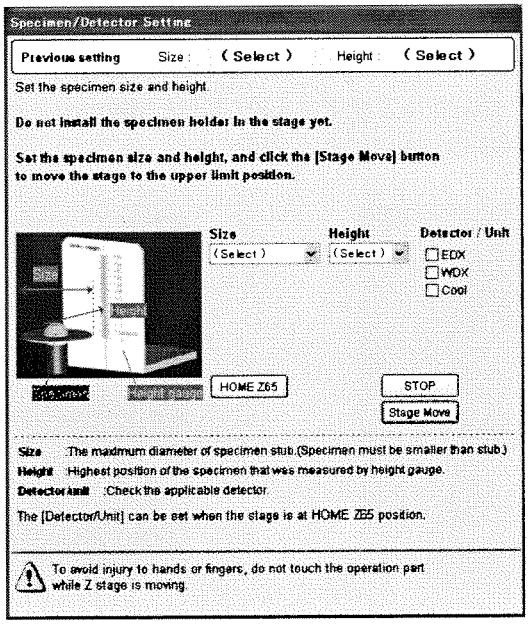


Fig. 6.4-8 Specimen/Detector Setting Window 2

(2) Measure the specimen **Size** and **Height** with the height gauge.
Read off the highest point of the specimen with the height gauge. Subtract 4mm from the height measured with the height gauge. This value becomes the specimen height.
Be sure to read off the highest spot of the specimens.

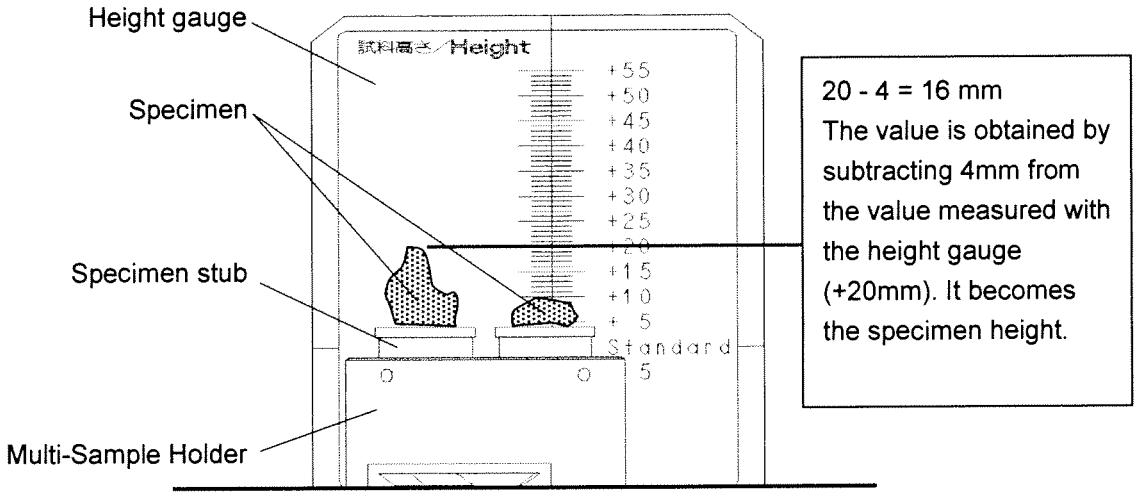


Fig. 6.4-9 Measurement of the Sample Height

(3) Setting the specimen with **Specimen/Detector Setting** window.

(a) Setting the specimen **Size**
Select the specimen size [15mm × 4] from the pull-down list of the specimen **Size**.

(b) Setting the specimen **Height**
Select the value obtained by subtracting 4mm from the specimen height measured with the height gauge. The value can be selected from the pull-down list of the specimen **Height**.

(c) Setting the **Detector/Unit**
The setting of **Detector/Unit** can be executed when the specimen stage is at the specimen exchange position.
Move the specimen stage to the exchange position by clicking the **HOME Z65** button. The buzzer keeps ringing while the stage is operating. Click the **STOP** button when stopping the movement of the stage.

NOTICE: Click the **HOME Z65** button so that the specimen stage moves to the specimen exchange position when stopping temporarily the specimen stage by clicking the **STOP** button while moving the stage to the specimen exchange position.

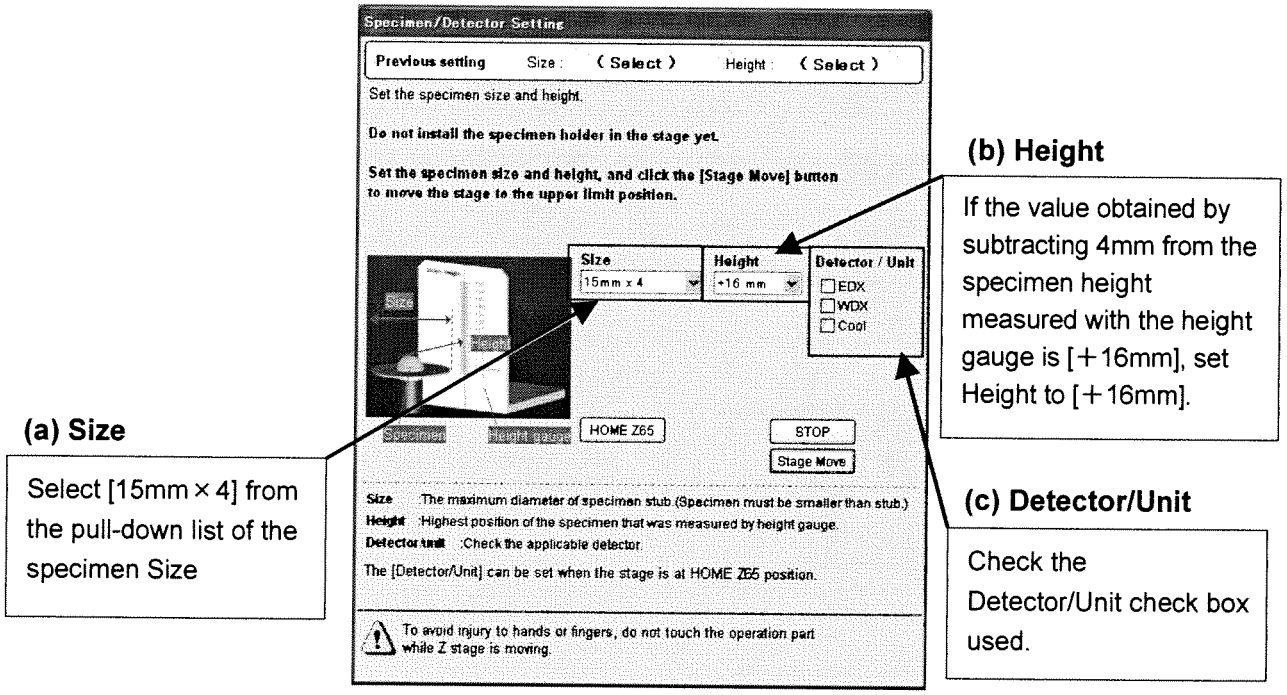


Fig. 6.4-10 Setting Size and Height of the Specimen

⚠ **CAUTION:** To avoid injury to hands or fingers, do not touch the operating parts while the Z stage is moving.

IMPORTANT: Execute the specimen setting surely. If set wrongly, the specimen might touch the BSE detector when moving the specimen stage, and both might be damaged.

(4) Move Specimen stage Z-axis to the upper limit position.
Do not install the specimen holder in the stage yet.
Confirm that the stage was pulled forward completely.
Click the **Stage Move** button so that the stage moves to the upper limit position. The buzzer keeps ringing while the stage is operating. Click the **STOP** button when you want to stop the movement of the stage.
The buzzer sound is stopped when the stage moves to the upper limit position, and the **Specimen/Detector Setting** window changes as shown in Fig. 6.4-11.

IMPORTANT: Click the **Stage Move** button with the specimen stage pulled forward completely. When the stage is moved to the upper limit position with specimen holder installed in the stage and inserted into the specimen chamber, the specimen might touch the check gauge or the BSE detector and damage them.

⚠ CAUTION: To avoid injury to hands or fingers, do not touch the operating parts while the Z stage is moving.

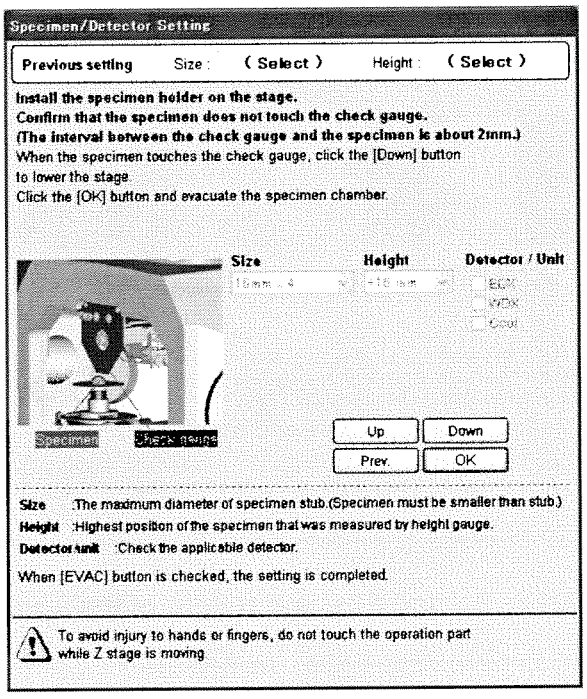


Fig. 6.4-11 Specimen/Detector Setting Window 3

(5) After confirming that the specimen stage moved to the upper limit position, install the specimen holder in the stage.
Insert the specimen stub assembly into the specimen holder completely.
Install the specimen holder in the stage.

(6) Make sure that the specimen **Height** is set properly.
Insert the stage slowly into the specimen chamber while holding the knobs at both sides of the stage. At this time, make sure that the specimen can go through without interfering with the check gauge. If the specimen does not touch the check gauge and the interval between the specimen and the check gauge becomes about 2 mm, height of the specimen is set correctly.

IMPORTANT: When confirming the specimen height setting, the specimen might touch the check gauge and get the damage. Bring the specimen slowly toward the check gauge.

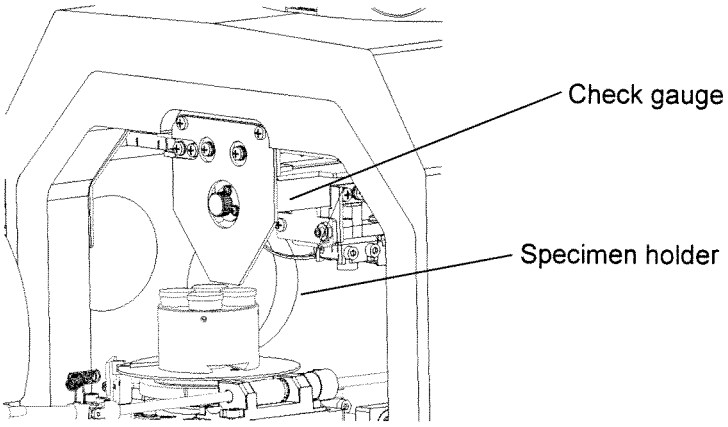


Fig. 6.4-12 Confirming the Height Setting

In the case of wrong **Height** setting, the specimen will touch the check gauge.
Click the **Back** button on the **Specimen/Detector Setting** window to return to the setting screen and set the **Height** again.
When adjusting the gap a little, click the **Down** button to change the **Height** setting. Clicking the **Down** button can lower the stage Z-axis by 1 mm. At this time, specimen **Height** on the GUI is automatically changed.
If the stage Z-axis is lowered too much, click the **Up** button to raise the stage Z-axis and adjust it. Clicking the **Up** button can raise the stage Z-axis by 1 mm.

(7) After confirming the setting of specimen height, click the **OK** button.

(8) Evacuate air from the specimen chamber. Evacuate air from the specimen chamber. Press the **EVAC** button on the front of the **EVAC** panel or click the **EVAC** button on the control panel to start evacuating the specimen chamber. The **EVAC** switch blinking changes into a steadily lit state in about 2 minutes, and the specimen can be observed by applying an accelerating voltage.

EVAC Panel Control Panel

Fig. 6.4-13 EVAC Button (Evacuating the Specimen Chamber)

⚠ **CAUTION:** When changing the specimen, operate the stage with the knob and be careful that your fingers are not caught between the stage and the specimen chamber.

IMPORTANT: Do not touch the moving parts such as gears and driving screws nor get your clothes caught in the mechanism when you bring the hand close to the movement mechanism in the stage at the specimen exchange, etc.

IMPORTANT: The specimen chamber cannot be evacuated unless the stage is set firmly in the specimen chamber.

IMPORTANT: When clicking **EVAC** button with the specimen setting uncompleted, the following **NOTICE** window appears. Click **AIR** button to set it again.

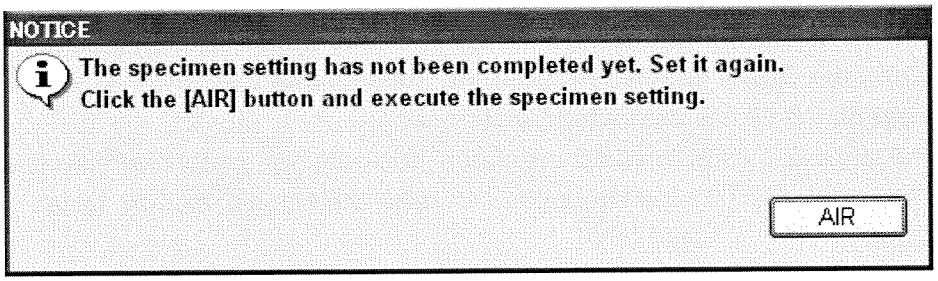


Fig. 6.4-14 NOTICE Window

6.4.7 Specified Movement of Specimen Position

Clicking the **Multi Holder** button on the X,Y,R-block in the Stage tab.
Bring up **Multi Holder** window shown below so that the X and Y axes can be moved between the specimen loaded on the Multi Holder.
In Fig. 6.4-14, items 1, 2, 3, 4 represent specimen position on the Multi Holder.
Clicking the **Move** button at this point, X and Y axes move to the selected specimen position. If the R-axis is not 0°, clicking an item resets the R-axis to 0°.

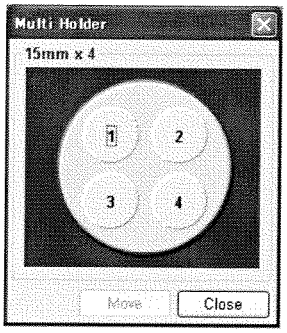


Fig. 6.4-15 Multi Holder Window

The following specimen positions (mechanical coordinates) are available:
1: X=69 mm, Y=34 mm
2: X=51 mm, Y=34 mm
3: X=69 mm, Y=16 mm
4: X=51 mm, Y=16 mm

6.5 Plastic Embedded Sample Holder (ϕ 25.4 mm × 4 p)

6.5.1 Composition

(1) Plastic Embedded Sample Holder

(2) Directions for the use of Plastic Embedded Sample Holder (ϕ 25.4 mm × 4 p)

6.5.2 Appearance and Each Part Name of Plastic Embedded Sample Holder (ϕ 25.4 mm × 4 p)

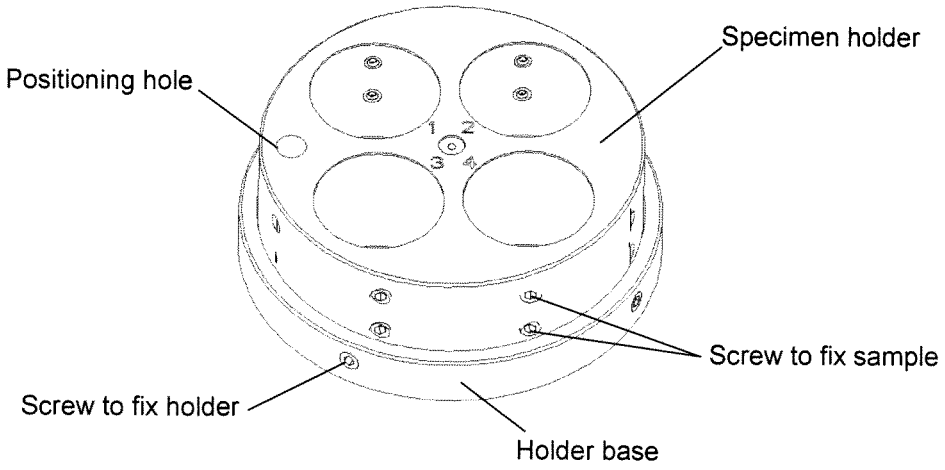


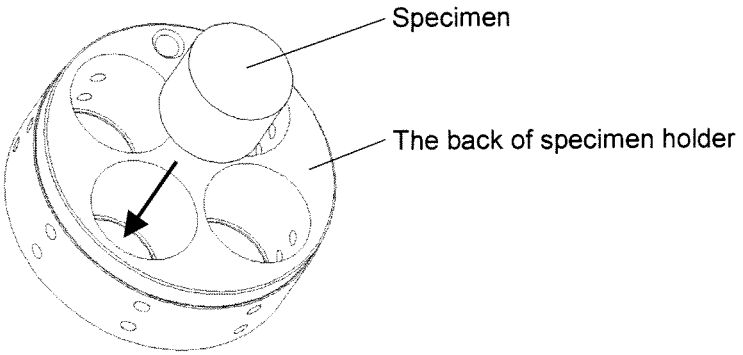
Fig. 6.5-1 Plastic Embedded Sample Holder

6.5.3 Specification

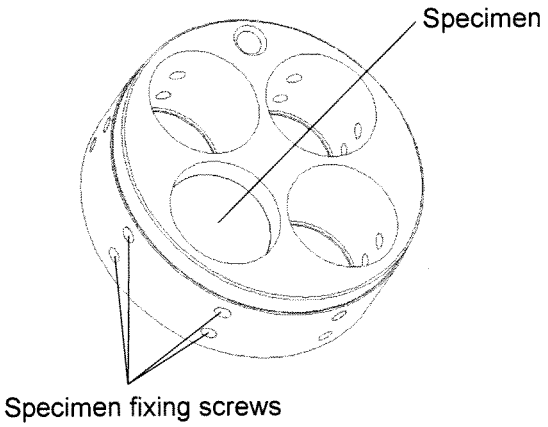
- Specimen Size: ϕ 25.4 mm
- Specimen Height: 10 to 25 mm

6.5.4 Method of Installing Specimen

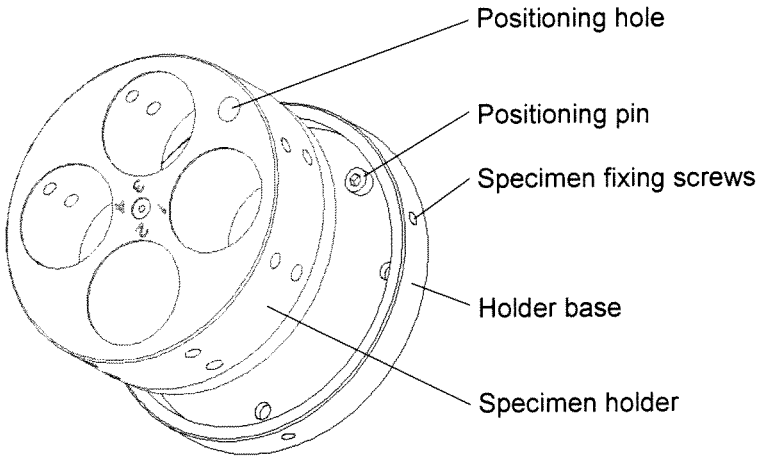
(1) Insert the specimens to the specimen holder from the backside of the holder.



(2) Tighten the specimen fixing screws with an accessories Allen wrench so that the specimen should not move.



(3) Load the specimen holder to the holder base. Insert the positioning pin to the positioning hole and tighten the holder fixing screws with an accessories Allen wrench.

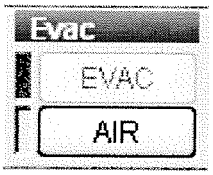


6.5.5 Specimen Exchange (Removing the Specimen from the Specimen Chamber)

(1) Click the **OFF** button on the Control Panel to shut the accelerating voltage off.

(2) Press the **AIR** button on the EVAC Panel or click the **AIR** button on the upper right section of the Control Panel. Air is introduced into the specimen chamber. The **Specimen Setting** window appears. After confirming the content of the window, click the **Specimen Setting** button.

EVAC Panel



Control Panel

Fig. 6.5-2 AIR Button (Air Leak of the Specimen Chamber)

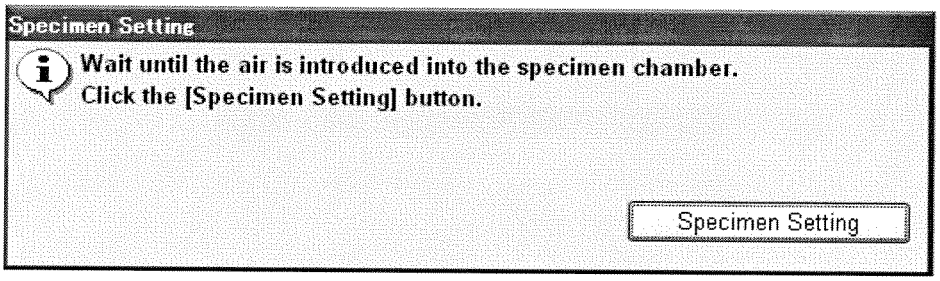


Fig. 6.5-3 Specimen Setting Window

When installing the Faraday cup (option)
Draw out the Faraday cup from the specimen chamber. The **Specimen Setting** button becomes effective. And then, click the **Specimen Setting** button.

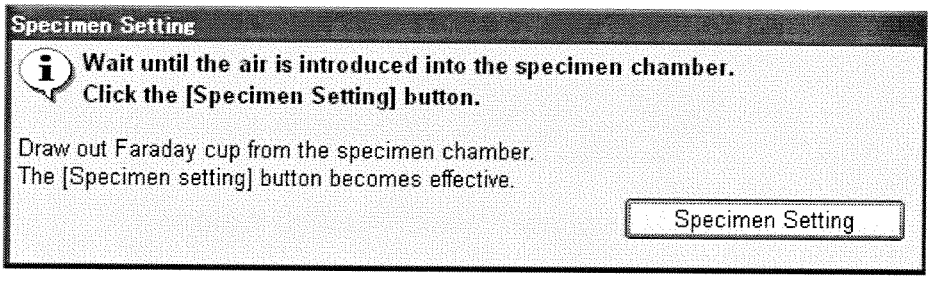


Fig. 6.5-4 Specimen Setting Window (When installing the Faraday cup)

(3) After introducing air into the specimen chamber, draw out the stage to the position where the stage stops completely.
[When executing observation]
Remove the specimen holder and click the **OK** button on the **Specimen/Detector Setting** window.
[When finishing observation]
Remove the specimen holder. Grip handles by both hands and insert the stage in the specimen chamber slowly. Click the **Exit SEM Manager** button to finish the program. Then, push the **EVAC** button to evacuate.

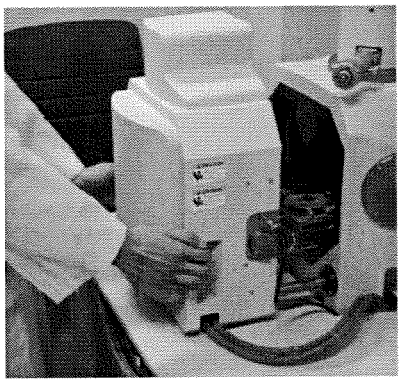


Fig. 6.5-5 Pulling out the Stage

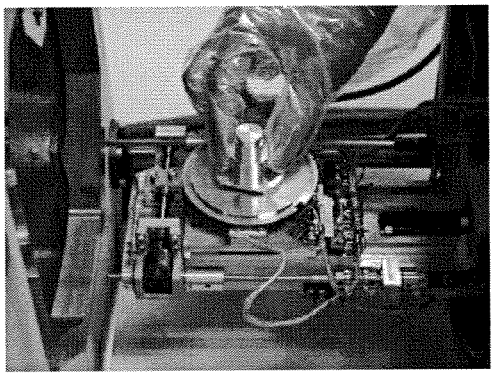


Fig. 6.5-6 Removing the Specimen Holder

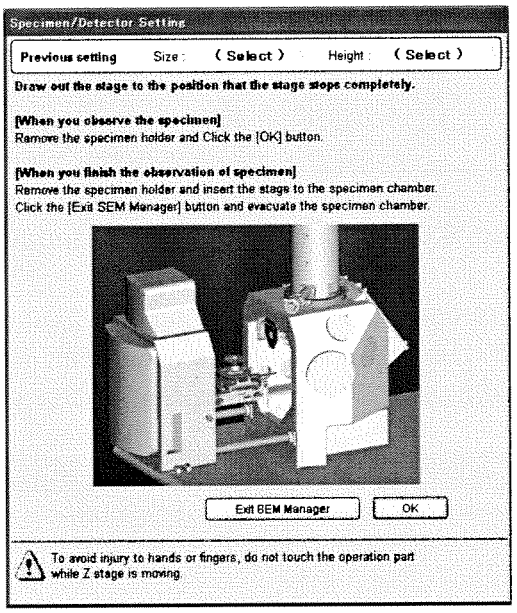


Fig. 6.5-7 Specimen/Detector Setting Window 1

IMPORTANT: When setting the specimen, draw out the specimen stage to the position where the stage stops completely.

6.5.6 Setting the Specimen Size and Height

(1) **Specimen/Detector Setting** window appears.
Set the specimen **Size** and **Height** with this window.

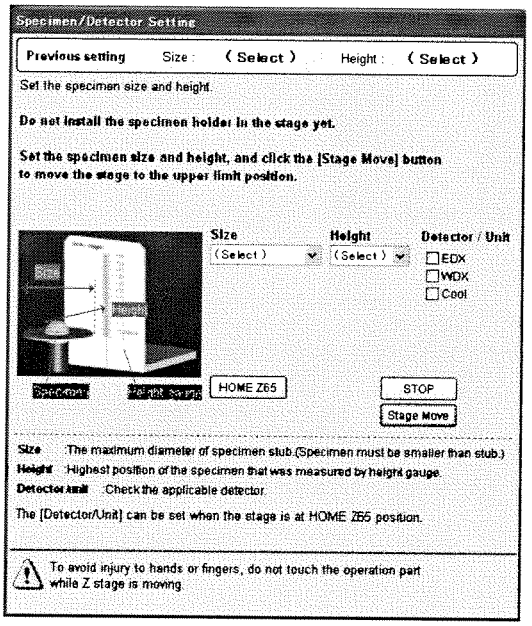


Fig.6.5-8 Specimen/Detector Setting Window 2

(2) Setting the specimen with **Specimen/Detector Setting** window.

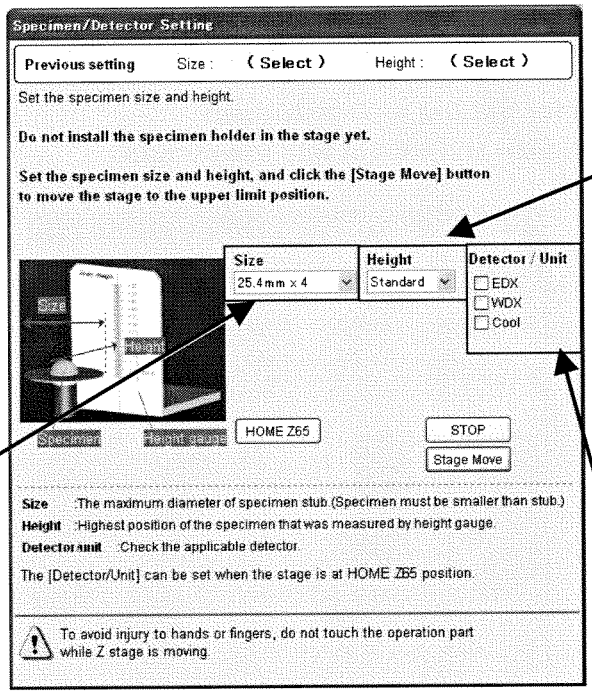
(a) Setting the specimen **Size**
Select the specimen size [25.4mm × 4] from the pull-down list of the specimen **Size**.

(b) Setting the specimen **Height**
The height of the specimen is fixed to **Standard**.

(c) Setting the **Detector/Unit**
The setting of **Detector/Unit** can be executed when the specimen stage is at the specimen exchange position.
Move the specimen stage to the exchange position with clicking the **HOME Z65** button.
The buzzer keeps ringing while the stage is operating. Click the **STOP** button when stopping the movement of the stage.

NOTICE: Click the **HOME Z65** button so that the specimen stage moves to the specimen exchange position when stopping temporarily the specimen stage by clicking the **STOP** button while moving the stage to the specimen exchange position.

6.5 Plastic Embedded Sample Holder (ϕ 25.4 mm × 4 p)



(a) Size

In this specimen holder, **Size** is set to 25.4mm×4.

(b) Height

When the size is set to 25.4mm, the height of the specimen is fixed to Standard.

(c) Detector/Unit

Check the Detector/Unit check box used.

Fig. 6.5-9 Setting Size and Height of the Specimen

> ⚠ **CAUTION:** To avoid injury to hands or fingers, do not touch the operating parts while the Z stage is moving.

> **IMPORTANT:** Execute the specimen setting surely. If set wrongly, the specimen might touch the BSE detector when moving the specimen stage, and both might be damaged.

(c) Move Specimen stage Z-axis to the upper limit position.
Do not install the specimen holder in the stage yet.
Confirm that the stage was pulled forward completely.
Click the **Stage Move** button so that the stage moves to the upper limit position. The buzzer keeps ringing while the stage is operating. Click the **STOP** button when you want to stop the movement of the stage.
The buzzer sound is stopped when the stage moves to the upper limit position, and the **Specimen/Detector Setting** window changes as shown in Fig.6.5-9.

IMPORTANT: Click the **Stage Move** button with the specimen stage pulled forward completely. When the stage is moved to the upper limit position with specimen holder installed in the stage and inserted into the specimen chamber, the specimen might touch the check gauge or the BSE detector and damage them.

⚠ **CAUTION:** To avoid injury to hands or fingers, do not touch the operating parts while the Z stage is moving.

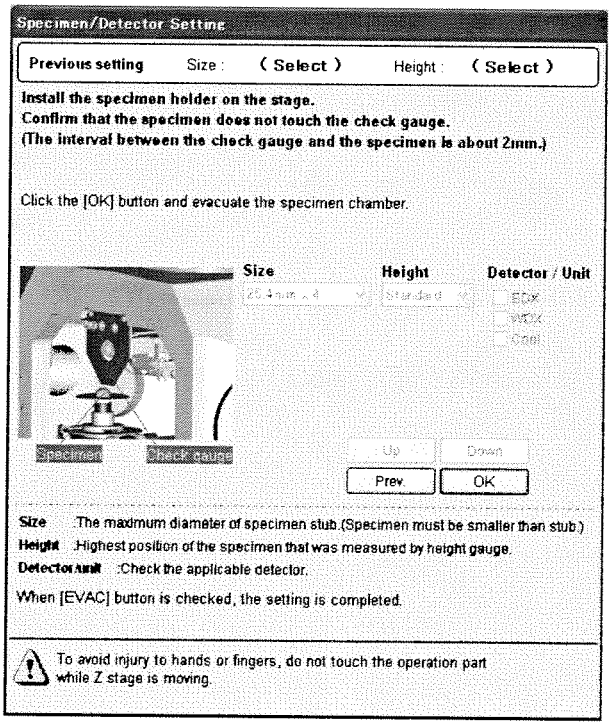


Fig. 6.5-10 Specimen/Detector Setting Window 3

(d) After confirming that the specimen stage has moved to the upper limit position, install the specimen holder in the stage.

(e) Make sure that the specimen **Height** is set properly.
Insert the stage slowly into the specimen chamber while holding the knobs at both sides of the stage. At this time, make sure that the specimen can go through without interfering with the check gauge. If the specimen does not touch the check gauge and the interval between the specimen and the check gauge becomes about 2 mm, height of the specimen is set correctly.

IMPORTANT: When confirming the specimen height setting, the specimen might touch the check gauge and get the damage. Bring the specimen slowly toward the check gauge.

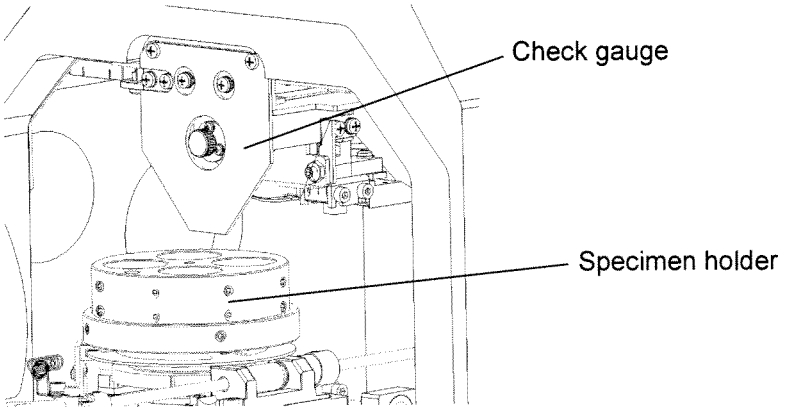
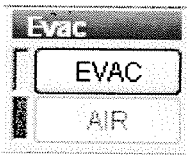


Fig. 6.5-11 Confirming the Height Setting

(f) The **Height** is set to Standard. Therefore, the **Up/Down** button cannot be used.
Click the **OK** button.

(g) Evacuate air from the specimen chamber. Press the **EVAC** button on the front of the **EVAC** panel or click the **EVAC** button on the control panel to start evacuating the specimen chamber. The **EVAC** switch blinking changes into a steadily lit state in about 2 minutes, and the specimen can be observed by applying an accelerating voltage.

EVAC Panel



Control Panel

Fig. 6.5-12 EVAC Button (Evacuating the Specimen Chamber)

⚠ **CAUTION:** When changing the specimen, operate the stage with the knob and be careful that your fingers are not caught between the stage and the specimen chamber.

IMPORTANT: Do not touch the moving parts such as gears and driving screws nor get your clothes caught in the mechanism when you bring the hand close to the movement mechanism in the stage at the specimen exchange, etc.

IMPORTANT: The specimen chamber cannot be evacuated unless the stage is set firmly in the specimen chamber.

IMPORTANT: When clicking **EVAC** button with the specimen setting uncompleted, the following **NOTICE** window appears. Click the **AIR** button to set it again.

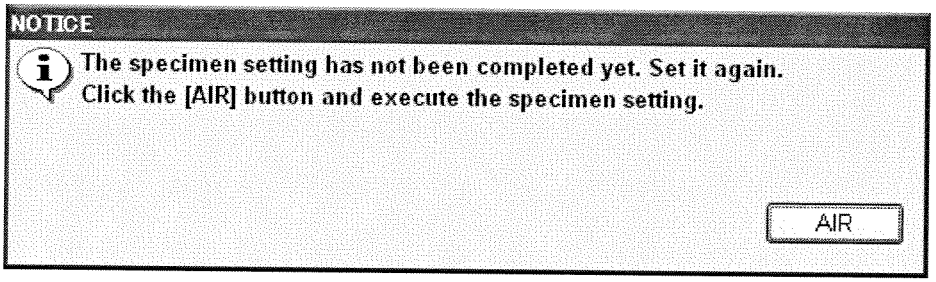


Fig. 6.5-13 NOTICE Window

6.5.7 Specified Movement of Specimen Position

Clicking the **Multi Holder** button on the X, Y, R-block in the Stage tab.
Bring up **Multi Holder** window shown below so that the X and Y axes can be moved between the specimen loaded on the Multi Holder.
In Fig. 6.5-14, items 1, 2, 3, 4, and F represent specimen position on the Multi Holder and the Faraday cup position.
Clicking the **Move** button at this point, X and Y axes move to the position of selected specimen and Faraday cup. If the R-axis is not 0°, clicking an item resets the R-axis to 0°.

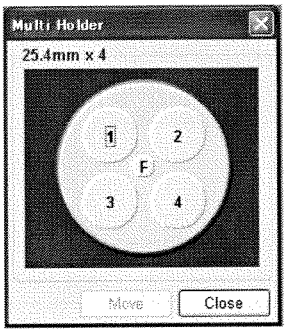


Fig. 6.5-14 Multi Holder Window

The following specimen positions (mechanical coordinates) are available:
1: X=74 mm, Y=39 mm
2: X=46 mm, Y=39 mm
3: X=74 mm, Y=11 mm
4: X=46 mm, Y=11 mm
5: X=60 mm, Y=25 mm, Z=10 mm, T=0° , R=0°

APPENDIX

Message List

The table below lists messages that can appear when the S-3400N is being used.
Messages without a message code are for instructions, simple notifications, or confirmation messages; they are not included in the table below.
Message codes listed below that are marked with an * appear as error codes.

Code	Message Text	Explanation and Countermeasure
*1301	Repair unsuccessful.	Failed to repair or optimize database file using SEM Data Manager - Tool – Database Utility or S-3400N – Help – Maintenance function. If you tried and failed to repair database when the code 2014 error appeared, contact a service engineer.
*1302	Optimize unsuccessful.	
2000	Invalid input data	These messages will be shown when input data is not correct. Confirm acceptable data and then, input again.
2001	Invalid data (out of range)	
2002	Only a number is acceptable.	
2003	Invalid Data.	
2004	The name is used in the system.	S-3400N uses this login name. Use other names.
2007	Invalid login name.	Use a login name already registered. [S-3400] is the default login name. Note that capital and small letters are distinguished for login names. Confirm your input.
2008	The password you typed is incorrect.	You entered incorrect password. Note that capital and small letters are distinguished for login names. Confirm your input.
*2010	Specified file is different from the condition file for PC_SEM. SEM Parameters will be initialized.	The file for operation condition is not correct. When this message is shown, check if other application is using files of extension pm1.
*2014	Database not found	Failed to access database files of S-3400N or SEM Data Manager. If the message is shown when you are using SEM Data Manager, try to repair the file [SDM.sdb] using Tool – Database Utility. If it is shown when you are operating SEM, try to repair files using Help - Maintenance function.
2016	Specified file not moved because source and destination folders are the same.	This message will be shown when you have specified the same directory as of the source files for the target directory in Batch Process - Move File command. Specify a directory other than that of source files for the target directory.
2017	Is already Exist.	This message will be shown when the input User name (or login name) is already used. Specify another name.
2031	Use as Magnification Lower than x5,000	This message will be shown when you click the Get Image button at a higher magnification than ×5,000.

Code	Message Text	Explanation and Countermeasure
*2032	Timeout error.	This message will be shown when operations such as auto focusing did not end within specified period. If it happens frequently, contact a service engineer.
2034	Rotate R-axis with 90 degree pitches.	The rotation angle is limited to only 90 deg steps.
*2035	Failed in the capture.	Image capturing failed. If the error is repeated, contact a service engineer.
2036	Image Processing is not applied for the selected Capture resolution.	Image Processing function on the operation panel is applicable to 1280 × 960 pixels or smaller capture size. Capturing will be performed without processing when you click OK button.
*2040	This is not 8 bits image file.	Some commands in the SEM Data Manager handle 8 bit gray scale images only.
*2041	The size of image exceeds the maximum resolution 2560x1920.	SEM Data Manager has some restrictions on image size, depending on the type of processing required.
2042	The size of image exceeds the maximum resolution 2560x1920.	
2044	The size of image exceeds the maximum resolution 2560x1920.	
2049	Start Password locking of Windows. Scan mode and scan speed will be set to Normal, Slow1 when Windows is unlocked. You need a password for Windows logon to unlock.	Before performing password locking, this message should be checked. If password locking interferes with operation, it should be canceled.
*2060	Insufficient memory space in a temporary drive. At least 400MB free area is necessary for startup.	These messages will be shown when vacant area of the hard disk is not enough for the process to be executed. Delete unnecessary files and allow more space than specified.
*2061	Insufficient memory space in a temporary drive. At least 20MB free area is necessary for executing this process.	
*2062	Insufficient memory space in a temporary drive. At least 10MB free area is necessary for executing this process.	
2065	Free space in temporary drive is 30MB or less. System may become unstable. Please quit PC-SEM program and free up the disk space.	

Code	Message Text	Explanation and Countermeasure
2070	For correct operation of the PC-SEM, set the Display properties at 1280x1024 pixels for the desktop area. And confirm setting of the color palette and the refresh rate are optimal value to PC and the monitor. (Recommended setting: Full color (about 16 million), 60Hz or 75Hz)	During program startup, the system checks the Desktop settings, and if the settings indicated on the left are not in effect, it generates this message. If this happens, cancel the S-3400N startup process, change Desktop settings as appropriate, and restart Windows.
2101	Please input file name.	Input a file name and then, click the Save button.
2102	Please input user name.	Input or select a user name and then, click the Save button.
2103	Input sample name, limit is 40 bytes.	These messages will be shown when you input too many characters. Input within specified number of characters.
2104	Input keyword, limit is 20 bytes.	
2105	Auto increment counter has reached 99. Please use another file name.	Quick saving allows up to 99 file names. Use another file name.
2106	Input comment sentence, limit is 80 bytes.	This message will be shown when you input over 80 characters for comment.
2107	Please input comment.	CD Measurement option – [Calibration] Input a comment before clicking the Apply button.
2108	File name is duplicated.	This message will be shown when you have specified a file name already used. Use another name.
2109	File name is too long.	Up to 255 characters are acceptable for a file name including drive name, folder name, and extension.
2110	User table is not empty. Delete all lists or images by using Remove List Command or Delete Image Command before deleting User table.	If a user account is to be deleted in SEM Data Manager, the image list for that user must be empty. Execute either the [Remove List] command (removing the list only from the database) or [Delete Image] (also deleting image files) command to delete the list, and then remove the user.
2111	Cannot save in the Folder.	Specify another folder.
2112	Invalid character is included.	The input possibly includes characters not allowed (¥ / : ; * ? " < > | ! ' &).
2113	Please input No. of Quick Save within the range from 1 to 99.	Quick saving allows up to 99 file names. Specify a start number smaller than 99.
*2121	The number of written items exceeds the maximum. More items cannot be input.	Number of texts or graphics exceeds allowable number. Delete some of texts or graphics to add new one.
2140	Invalid file name.	The file name possibly includes characters not allowed (¥ / : ; * ? " < > | ! ' &).
2141	File name is too long. Up to 255 characters are acceptable for a file name including folder name.	Use file name shorter than 255 characters including folder name and extension.
2142	Invalid User name.	The User name possibly includes characters not allowed (¥ / : ; * ? " < > | ! ' &).

Code	Message Text	Explanation and Countermeasure
2143	User name is too long. Up to 64 characters are acceptable.	Use User name shorter than 64 characters.
2144	Invalid Sample name.	The Sample name possibly includes characters not allowed (¥ / : ; * ? " < > | ! ' &).
2145	Sample name is too long. Up to 40 characters are acceptable.	Use Sample name shorter than 40 characters.
2146	Invalid Keyword.	The Keyword name possibly includes characters not allowed (¥ / : ; * ? " < > | ! ' &).
2147	Keyword is too long. Up to 20 characters are acceptable.	Use Keyword shorter than 20 characters.
2149	Comment is too long. Up to 80 characters are acceptable.	Use Comment shorter than 80 characters.
2151	Invalid file name.	The file name possibly includes characters not allowed (¥ / : ; * ? " < > | ! ' &).
2152	File name is too long. Up to 200 characters are acceptable for a file name including folder name.	Use file name shorter than 200 characters including folder name and extension.
2153	To use Data No. Save, set Data Number to ON, Auto Increment to ON, and put "-" plus number to the end of the Data number.	To save a file by attaching a data number to the file name, the settings indicated in the message must be specified. Perform appropriate settings according to the message.
*2200	The new and confirmed passwords do not match. Please type them again.	Input both new and confirmation password again. Note that capital and small letters are distinguished.
2202	Cannot delete this login name.	This login name is not allowed to delete.
2210	Capacity of floppy disk in not enough.	Check the floppy disk.
2211	The disk is Write-protected.	
2212	There is not floppy disk.	
*2213	Cannot save the file.	
3901	The limits is bytes.	You entered too long a login name or password.

Code	Message Text	Explanation and Countermeasure
*5000	X-axis parameter error (Max) Please check sample size with Stage Control Window.	X or Y-axis position is at the limit. You can drive the stage towards reverse direction.
*5001	X-axis parameter error (Min) Please check sample size with Stage Control Window.	
*5002	Y-axis parameter error (Max) Please check sample size with Stage Control Window.	
*5003	Y-axis parameter error (Min) Please check sample size with Stage Control Window.	
*5004	Z-axis parameter error(Max)	These errors will not happen by usual operation. Turn the STAGE POWER switch to off and turn it on again. It these errors occur again, contact a service engineer.
*5005	Z-axis parameter error(Min)	
*5006	T-axis parameter error(Max)	
*5007	T-axis parameter error(Min)	
*5008	R-axis parameter error(Max)	
*5009	R-axis parameter error(Min)	
*5020	Cannot execute while drive X-axis	Possibly the initialization is in progress. Wait for a few minutes. If the message is shown even when about 10 minutes has passed, shut the stage power off once and then, turn it on.
*5021	Cannot execute while drive Y-axis	
*5022	Cannot execute while drive Z-axis	
*5023	Cannot execute while drive T-axis	
*5024	Cannot execute while drive R-axis	
*5025	Cannot execute while drive stage by track ball or joy stick	This message will be shown when operation on the GUI and by the trackball or joystick is generated simultaneously.

Code	Message Text	Explanation and Countermeasure
5040	Cannot execute while not initialize X-axis	Initialization of each axis in progress. Wait until initialization ends.
5041	Cannot execute while not initialize Y-axis	
5042	Cannot execute while not initialize Z-axis	
5043	Cannot execute while not initialize T-axis	
5044	Cannot execute while not initialize R-axis	
*5075	Stage over run error (X-CCW)	This message will be shown when each axis is driven over its limit. It will be recovered automatically.
*5080	Stage over run error (X-CW)	
*5085	Stage over run error (Y-CCW)	
*5090	Stage over run error (Y-CW)	
*5101	Stage over run error (Z-CCW)	
*5102	Stage over run error (Z-CW)	
*5103	Stage over run error (T-CCW)	
*5104	Stage over run error (T-CW)	
5985	Set Z-axis so as 40 deg. or more tilt is possible.	This calibration operation tilts stage to 40 deg. Set Z-axis where 40 deg. or more tilting angle is allowed.
5987	Set Z-axis so as 20 deg. or more tilt is possible.	This calibration operation tilts stage to 20 deg. Set Z-axis where 20 deg. or more tilting angle is allowed.
5988	Extract optional detector(s) for the calibration.	Extract optional detector(s) for the calibration.
5989	Set specimen height error within -0.5mm to +0.5mm to keep calibration accuracy.	Set specimen height error within -0.5 mm to +0.5 mm to keep calibration accuracy.
5999	1st and 2nd alignment point are too near, or Y coordinates of the two points are too near. Change coordinates of the two alignment points.	Separate two aligned points by at least 10 mm. Same X coordinate value for two alignment points can not be used.
6000	Too near to stage limit. Set 1mm or more.	The alignment position is too near the stage limit. Set 1 mm or more away from the limit.
6001	No data alignment 2.	No data for 2nd alignment position is registered.
6002	Incorrect alignment calculation value.	Alignment result seems incorrect. Possibly alignment operation was done on incorrect point.
6003	R-axis must be the same as the first alignment point.	1st and 2nd alignment points shall be at the same rotation angle.

Code	Message Text	Explanation and Countermeasure
6004	The selected sample height cannot be set by present detector/unit.	Due to a conflict between specimen size, specimen height, the type of detector/unit used, this operation cannot be performed. The current settings should be checked and modified as appropriate.
6005	The selected detector/unit cannot be set by present sample height.	
6006	The selected sample size cannot be set by present sample height.	
6007	The selected sample height cannot be set by present sample size.	
6008	The selected sample size cannot be set by present detector/unit.	
6009	The selected detector/unit cannot be set by present sample size.	
6701	AFC Error. Check Filament setting.	This message appears if an error occurs in the Auto Filament Setting executed in the Auto Beam Setting (ABS). The current filament settings should be checked and modified as appropriate.
6702	ABA Error. Set No.1 or open the movable objective aperture, open Alignment dialog and adjust Beam Tilt/Shift manually.	This message appears if an error occurs in the Auto Beam Alignment (ABA) executed in the Auto Beam Setting (ABS). The objective lens movable aperture should be rechecked.
6703	AFC Error.	This message appears if an error occurs in the Auto Focus (AFC) process executed in the Auto Beam Setting (ABS).
*7012	HV forced OFF due to vacuum error.	This message appears if the vacuum level in the specimen chamber or electron gun declines during image observation and the acceleration voltage is automatically shut off. If this happens, wait until the vacuum level is restored, and then turn on the acceleration voltage. This error is also generated if an attempt is made to perform specimen chamber AIR operation with HV still turned on.

Code	Message Text	Explanation and Countermeasure
7069	Auto alignment process has not completed due to un-suitable SEM conditions. Set SEM conditions according to the following procedure. (1) In the case where focus is improper: The sample must suit focus to the scope of control or suit the stage position. (2) In the case where the aperture alignment is almost the limit of the range: Reset the aperture alignment and focus the image again.	This message appears if an error occurs in the midst of aperture alignment or automatic stigma axial alignment. The corrective action indicated in the message should be taken.
7070	Auto alignment process has not been completed due to the condition where the stigma-alignment and/or the stigma adjustment are almost at the limit of the range. Carry out the auto stigma-alignment again after clicking the Default button and selecting appropriate view field.	
7071	Auto alignment process has not completed due to un-suitable SEM image. Focus the image and/or select a suitable view field having some distinctive and clear for the image.	
*7072	Auto alignment process has not completed due to the system trouble on the S-3400N. Contact a service engineer for the troubleshooting.	This is an auto axial alignment software error. Call a service engineer.
*7200	Abnormal temperature rise occurred in the power supply. Shut down the PC and turn the [MAIN] switch off. Restart the microscope after about half an hour. When this message is shown again, contact a service engineer.	This is an OVERHEAT error in the power supply. Shut down the PC, turn off the Main switch, wait 30 minutes, and then restart the system. If the problem persists, call a service engineer.

Code	Message Text	Explanation and Countermeasure
*7304	Evacuation system is not working. Check power switch.	The system fails to start due to an evacuation system error. Shut down the PC, turn off the Main switch, wait 30 minutes, and then restart the system. If turning off the Main switch does not shut off the power, turn off the Main breaker in the back of the system, and restart the system after the power is completely shut off. If the problem persists, call a service engineer.
7310	Abnormality in the EVAC system control power supply was detected. Shut down the PC , turn the [MAIN] switch off and contact a service engineer. Moreover, after abnormality is detected, the main power supply will be turned off in about ten minutes automatically.	According to the message, call a service engineer.
7311	The vacuum exhaust was not normally done or the vacuum leakage is occurred. Confirm whether the specimen stage and the specimen chamber have stuck or the thing doesn't narrow. And confirm the vacuum leaks in the specimen chamber installation part of various detectors, then push the [EVAC] switch. When it occur again, contact a service engineer.	This message appears if the evacuation of the specimen chamber fails within a specified length of time. Follow the tips given in the message.
7312	The EVAC system vacuum valve doesn't work normally. Shut down the PC , turn the [MAIN] switch off and contact a service engineer.	According to the message, call a service engineer.
7313	The rotary pump doesn't work. Shut down the PC , turn the [MAIN] switch off and contact a service engineer. Moreover, after abnormality is detected, the main power supply will be turned off in about ten minutes automatically.	
7314	Abnormality of the Pirani vacuum gauge was detected. Start again after the [MAIN] switch is turned off after PC is shut down, and the system stops completely. When this message is shown again, contact a service engineer.	

Code	Message Text	Explanation and Countermeasure
7315	The error of the TMP vacuum pump was detected. Shut down the PC and turn the [MAIN] switch off. Restart the microscope after about half an hour. When this message is shown again, contact a service engineer.	This is a TMP vacuum pump error. Shut down the PC, turn off the Main switch, wait 30 minutes, and then restart the system. If the problem persists, call a service engineer.
7316	The vacuum exhaust with the TMP vacuum pump was not normally done. Shut down the PC and turn the [MAIN] switch off. Restart the microscope after about half an hour. When this message is shown again, contact a service engineer.	
7317	When using air compressor, check the valve at the air output. When using utility air, check the air supply. Evacuation sequence will recover when the air supply becomes normal pressure. If the alarm can not be recovered, shut down the PC, turn the [MAIN] switch off and contact a service engineer.	This message appears if the pressure of the compressed air that drives the vacuum valve falls. Follow the tips given in the message.
7318	The vacuum pumping system is set for the maintenance mode. Shut down the PC, turn the [MAIN] switch off and contact a service engineer.	This error message, which appears if the evacuation system is in the manual mode for service engineers, is not displayed under normal conditions. If this message comes on, shut down the PC, turn off the Main switch, and then call a service engineer.
7319	The vacuum link interlock operates, and AIR or the low vacuum mode is prohibited. Turn off HV of the device such as WDX or shut the gate valve and release the vacuum link interlock. Shut down the PC, turn the [MAIN] switch off and contact a service engineer when the error doesn't recover.	This message appears if the specimen chamber is exposed to the atmosphere or a low-vacuum mode operation is performed when an external device (e.g., WDX) to which the vacuum-interlocked protection circuit is connected is running an analysis. Stop the analysis process being conducted on the external device, such as WDX. If the external device involved is a WDX, close the gate valve, release the vacuum interlock, and then perform the operation. If the error message appears even when a vacuum interlock protection circuit is not connected or under conditions not described above, call a service engineer.

Code	Message Text	Explanation and Countermeasure
7320	An abnormal power supply (Vacc) in the electron gun control power supply was detected. Shut down the PC and turn the [MAIN] switch off. Restart the microscope after about half an hour. When this message is shown again, contact a service engineer.	This message appears if the electron gun-controlling power supply unit detects an error during a self test. It is possible that the error is due to malfunction or equipment error from isolated noises, in which case shut down the PC, turn off the Main switch, wait 30 minutes, and then restart the system. If the problem persists, call a service engineer.
7321	An abnormal power supply (Vfilament) in the electron gun control power supply was detected. Shut down the PC and turn the [MAIN] switch off. Restart the microscope after about half an hour. When this message is shown again, contact a service engineer.	
7322	An abnormal power supply (Vbias) in the electron gun control power supply was detected. Shut down the PC and turn the [MAIN] switch off. Restart the microscope after about half an hour. When this message is shown again, contact a service engineer.	
7323	An abnormal power supply (Vbiasselect) in the electron gun control power supply was detected. Shut down the PC and turn the [MAIN] switch off. Restart the microscope after about half an hour. When this message is shown again, contact a service engineer.	
7324	The electron gun interlock switch worked. Shut down the PC, turn the [MAIN] switch off and contact a service engineer.	This message appears if the interlock switch for the electron gun unit is activated when the acceleration voltage is still on. Shut down the PC, turn off the Main switch, and then call a service engineer.
7325	Over current protection of the electron gun operated. Please confirm the setting of the filament.	This message appears if the protection circuit is activated due to a surge in emission current due to a filament height settings. See the filament replacement/servicing procedures in the Help menu to check the filament settings.

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Requirements for conformity

1. For the customer in the EU area

This instrument requires the following conditions to conform with the LVD directive and EMC directive of the EU.

(1) Connect to the power supply with the below specifications
Power voltage: Single phase 200 – 240 V±10%
Frequency: 50/60 Hz
Capacity: 2 kVA
Grounding resistance of less than 100 Ω

(2) Set up with the below parts that conform to the EC directives
- Step-down Transformer
(Isolation transformer from 200 V – 240 V to 100 V)
- Oil Rotary Pump
- Compressor
- Monitor

2. For the customer except for the EU area

CE Marking is not applied.

DECLARATION OF CONFORMITY

We, Hitachi High-Technologies Corporation
882 Ichige, Hitachinaka-shi, Ibaraki-ken,
312-8504 Japan

declare under our sole responsibility that the product:

Product: Scanning Electron Microscope
Model: S-3400N

to which this declaration relates is in conformity with the following Directives and Standards:

Council Directive: 2004/108/EC,
2006/95/EC
Applicable Standards: EN61326-1: 2006 Class A,
EN61010-1: 2001

CE Marking is affixed in 2004.

Authorized representative in EU:

Name: Hitachi High-Technologies Europe GmbH
Address: Europark Fichtenhain A12, 47807 Krefeld,
F. R. Germany

Place: Japan
Date: Nov 26, 2008

M. Maki

Masanori Maki
Senior Engineer
Quality Assurance Dept.

P/N 52E-7684-2

SERVICE OFFICE LOCATIONS

(SEM, Nano-Prober, TEM, FIB, Peripheral Device)

Region	Address	Tel. FAX
Asia/Oceania		
[Korea]		
Hitachi High-Technologies Korea Co., Ltd. Service Div.	8F, Young Poong Bldg, 33 Seorin-Dong, Chong Ro-ku, Seoul, 110-752, KOREA	(82)27547654 (82)27547655
RIGONG INTERNATIONAL INC. Head Office	Annjay Tower 18th-19th, 718-2, Yeoksam-Dong, Gangnam-Gu, Seoul 135-080 Korea	(82)2516-2636 (82)2516-5362
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E HONG INSTRUMENTS CO., LTD.	2FL., NO.157, SEC.2, FU HSING S. RD., TAIPEI 106, TAIWAN, R.O.C.	(886)2-2755-2266 (886)2-2707-7693
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TECHCOMP LTD.	9/F., Wah Hung Centre, 41 Hung To Road, Kwun Tong, Kowloon, Hong Kong	(852)27519488
TECHCOMP LTD. Beijing Office	No.41 Gu Lou West Street Xi Cheng District, Beijing, 100009, CHINA	(86)10-6401-0651 (86)10-6406-0202
TECHCOMP LTD. Shanghai Office	9/F, Hua lin Building, 190 Cao Xi Road, SHANGHAI 200235 CHINA	(86)21-6487-0138 (86)21-6487-0142
Techmax International Trading (Shanghai) Co., Ltd	2012404 Rm.1503, No.53, Lane 1880, Long-Yang Road, Pu-Dong New Area, Shanghai, P. R. China	(86)21-5843-5613 (86)21-5891-2502
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Hitachi High-Technologies (Singapore) Pte. Ltd. Ang Mo Kio Office	10 Ang Mo Kio Street 65, #05-15 Techpoint, Singapore 569059	(65)6481-2050 (65)6481-8089
Quasi-S Pte Ltd	25 Mandai Estate #06-11, Innovation Place Tower 1, Singapore 729930	(65)6383-4386 (65)6383-3071
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COAX GROUP CORPORATION LTD.	1131/325,327,328 Nakornchaisri Road, Kwang Thanon Nakornchaisri, Khet Dusit, Bangkok 10300 Thailand	(662)6682436 (662)2437386
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Forevision Instruments (India) Pvt. Ltd.	Plot No:35, Sai Ram Avenue, 1st Floor, Samathapuri, Nagole X Roads, Hyderabad - 500035, INDIA	(91)40-2404-2353 (91)40-2404-2383
[Pakistan]		
Noor (Private) Limited	2nd Floor, Naqi Market, 75-Shahrah-e-Quaid-e-Azam, Lahore 54000, Pakistan	(92)42-6362211 (92)42-6373320
[Vietnam]		
Red Star Vietnam Company Limited	17 Pham Hung, Cau Giay, Hanoi, Vietnam	(84)4-3556-7371 (84)4-3556-7382
[Australia]		
Meeco Holdings Pty. Ltd.	PO Box 639, Round Corner 2158 (6 Farmridge Way, Glenhaven 2156) NSW, Australia	(61)2-8850-7155 (61)2-8850-7855

U.S.A.

Hitachi High-Technologies America, Inc.

EMD (SMD, NSD, EED) Headquarters*	5100 Franklin Drive, Pleasanton, CA 94588-3355	(1)925-218-2800 (1)925-218-2900
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HTA Corp. Headquarters	10 North Martingale Road, Suite 500, Schaumburg, IL 60173-2295	(1)847-273-4141 (1)847-273-4407

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Hitachi High-Technologies Canada Inc.	89 Galaxy Blvd, Suite 14 Rexdale, Ontario M9W 6A4	(1)416-675-5860 (1)416-675-0061

Europe

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Hitachi High-Technologies Europe GmbH Head Office, Service Dept.	Europark Fichtenhain A12 47807 Krefeld, F.R. Germany	(49)2151-6435-400 (49)2151-6435-449
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ELEXIENCE	9, rue des Petits-Ruissaux 91370 Verrieres-le-Buisson Cedex-France	(33)1-6953 80-00 (33)1-6011 98-09
[Spain, Portugal]		
MONOCOMP S.A.	Virgen de la Fuencisla, 25 28027 Madrid, Spain	(34)91-326 7497 (34)91-326 7608
[Italy]		
NanoVision S.r.l.	Via Santa Margherita, 115 2047 Brugherio, Italy	(39)039-2878 358 (39)039-2878 197
[Poland, Czech, Slovakia]		
COMEF APARATURA	Ul. Kalinowa 41, 40-750 Katowice, Poland	(48)32-203-4149 (48)32-203-5823
[Hungary, Romania]		
AURO-SCIENCE CONSULTING	Drotos U.1, 1300 Budapest, Pf.243 Hungary	(36)1-242-1390 (36)1-242-1391
[Sweden, Denmark, Norway, Finland, Iceland]		
Spectral Solutions	Vallgatan 5, 170 67 Solna Sweden	(46) 8 655 25 60 (46) 8 655 25 98

Sales representative

The addresses and telephone numbers of the service offices listed above are subject to change without prior notice.

As of Jan. 1, 2011

NOTE: For inquiries about the amount of radiation emitted from this instrument, please contact the asterisked service offices listed above.