

**INSTRUCTION MANUAL**

**FOR**

**MODEL SU6600**

**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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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.
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# PREFACE

Thank you very much for purchasing the Model SU6600 Schottky emission scanning electron microscope.

The SU6600 Hitachi Scanning Electron Microscope (the “SU6600” for short) is designed to observe and evaluate specimens, prepared for use in the SU6600, by using an electron beam accelerated at 500 V to 30 kV as an electron source.

High vacuum and high voltage are used in operation of the SU6600. For ensuring safety in the use of this product, the user is requested to acquire a basic knowledge of high vacuum and high voltage through safety-related technical training. Moreover, for efficient operation of this product, it is recommended that the user be acquainted with the basics of electron microscopy.

Before attempting operation, be sure to read this manual carefully together with instruction manuals accompanying accessories. Please acquaint yourself with this product and its accessories.

Keep this manual handy for easy reference when necessary.

## ABOUT THIS MANUAL

- The SU6600 comprises a main unit and optional accessories. This instruction manual includes descriptions of the outline, functions, operations and maintenance procedures of the main unit. For each optional accessory, refer to its accompanying instruction manual.

- This instruction manual consists of the following six sections:

Section 1	INSTALLATION (Installation Requirements, Materials to be Prepared by User)
Section 2	FUNCTIONS (Control Knobs and Switches)
Section 3	OPERATION (Image Observation, Saving/Outputting Image Data)
Section 4	MAINTENANCE (Maintenance of Each Component Unit, Troubleshooting, Procedure on Occurrence of Power Line Failure)
Section 5	REPLACEMENT PARTS
Section 6	ACCESSORY OPERATION

- The operating and maintenance instructions and cautionary matters for the SU6600 are contained in this manual.
- First of all, read “IMPORTANT” and “SAFETY SUMMARY” included at the beginning of this manual for ensuring safety in operation of the SU6600.

# IMPORTANT

## Warranty on Product

The SU6600 is warranted to be free from defects in material or workmanship under normal use within the product specifications indicated in this manual and under conditions given below.

This warranty is void if the instrument is not used in accordance with the instruction manual.

### (1) Scope of Warranty

Any parts that prove to be defective in design or workmanship during the warranty period will be repaired, adjusted or replaced without charge.

A substitute part may be used for repair, or replacement with an equivalent product may be made instead of repair.

Such system components as a personal computer and printer to be upgraded frequently for improvement may not be available in original versions at the time of replacement.

Note that this warranty does not apply to the instrument after it is discarded, or if modified by the user or resold without permission from the manufacturer, nor does it apply to consumable parts, or any failure of lifetime-expired parts.

The manufacturer assumes no liability for any damage to data or application software due to any possible fault or failure of this instrument.

### (2) Warranty Period

One (1) year from the date of delivery and installation.

### (3) Limitations and Exclusions on Warranty

Note that the following cases are excluded from the scope of this warranty.

- (a) Failure due to operation at a place not meeting the installation requirements specified by the manufacturer.
- (b) Failure due to use of power supply voltage/frequency other than specified by the manufacturer or due to abnormality in power supply.
- (c) Corrosion or deterioration of the tubing due to impurities contained in gas, air or cooling water supplied by the user.
- (d) Corrosion of the electric circuits or deterioration of the optical elements due to highly corrosive atmospheric gas such as chlorine gas.
- (e) Failure due to use of hardware, software or spare parts other than specified by the manufacturer.
- (f) Failure due to improper handling or maintenance by the user.
- (g) Failure due to maintenance or repair by a service agent not approved or authorized by the manufacturer.
- (h) Failure due to relocation or transport not approved by the manufacturer after initial installation.

- (i) 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 substances, etc.
- (j) Failure due to a consumable or component part that has already reached the end of its useful lifetime.
- (k) Failure due to disassembly, modification or relocation not approved by the manufacturer.
- (l) After disposal of this instrument, or after its resale/relocation without prior approval from the manufacturer.
- (m) Failure due to use not described in the manual or improper repair not approved by the manufacturer.
- (n) Failure of parts excluded from the warranty in the instruction manual or other documents.
- (o) Failure of the workstation/personal computer used in the system, or damage to the system software, application software or data due to power interruption or momentary power voltage drop caused by lightning or the like.
- (p) Failure of the personal computer in the system, or damage to the system software, application software or data due to disconnection of main power to the personal computer without taking the specified normal shutdown procedure.
- (q) Failure of the hardware, or damage to the system software, application software or data due to computer virus infection.

#### **(4) Disclaimer of Warranty**

THE MANUFACTURER MAKES NO WARRANTIES, EITHER EXPRESS OR IMPLIED, EXCEPT AS PROVIDED HEREIN, INCLUDING WITHOUT LIMITATION THEREOF, WARRANTIES AS TO MARKETABILITY, MERCHANTABILITY, FOR A PARTICULAR PURPOSE OR USE, OR AGAINST INFRINGEMENT OF ANY PATENT. IN NO EVENT SHALL THE MANUFACTURER BE LIABLE FOR ANY DIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY NATURE, OR LOSSES OR EXPENSES RESULTING FROM ANY DEFECTIVE PRODUCT OR THE USE OF ANY PRODUCT.

NO ORAL OR WRITTEN INFORMATION OR ADVICE GIVEN BY THE MANUFACTURER, ITS DEALERS, DISTRIBUTORS, AGENTS OR EMPLOYEES SHALL CREATE A WARRANTY OR IN ANY WAY INCREASE THE SCOPE OF THIS WARRANTY.

## **Leakage X-Ray Radiation from This Instrument**

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.

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 SU6600 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 SU6600.

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 are revised, use the SU6600 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 SU6600.

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.

## Radiation from the Laser Light Source

The CD-ROM or CD-R/W drive incorporated in the personal computer (PC) of this instrument is equipped with a laser light source. The PC is designed to meet the safety requirements specified in such industrial standards as the International Electrotechnical Commission (IEC) 60825, and the laser device arrangement conforms to the Class-1 Laser Device Standards stipulated in the Federal Regulations of the U.S.A. Under normal operating conditions, laser radiation harmful to human health will not leak out of this instrument.

However, to be on the safe side, please observe the following cautionary instructions:

- Do not open the panel of the laser device. There are no user-serviceable components in the laser device.
- For any laser light source, it is not allowed for the user to make control adjustment.
- Refer repair servicing to qualified service personnel.

Laser device data:

Type of laser device	Semiconductor GaAIAs
Wavelength	780 ±35 nm
Angle of divergence	53.5 ±0.5 deg.
Output power	0.2 mW or 10,869 W m <sup>-2</sup> sr <sup>-1</sup> max.
Polarization	0.25, circular
Numerical aperture	0.45 ±0.04 inch

## Installation, Relocation and After-sale Technical Service

### (1) Installation and Relocation

- (a) Installation of this instrument shall be carried out by or under supervision of qualified service personnel of the manufacturer or its authorized service agent. It is not permitted for the user to carry out installation.
- (b) Before installation of this instrument, the user is requested to make preparations for satisfying the installation requirements with reference to this manual.
- (c) When relocation of this instrument becomes necessary after initial installation (delivery), please notify the nearest sales representative or service office of Hitachi High-Technologies Corporation. Relocation service will be available on a chargeable basis.

### (2) After-Sale Technical Service

- (a) For after-sale technical service, contact the nearest sales representative or service office of Hitachi High-Technologies Corporation.
- (b) After the warranty period, a maintenance/inspection service agreement is also available. For further information, contact the nearest sales representative of Hitachi High-Technologies Corporation.
- (c) Maintenance technical service will be available for ensuring normal operation of the instrument for a period of ten years after its delivery. Note that such system component units as a personal computer and printer to be upgraded frequently for improvement may not be available in original versions at the time of replacement. In this case, it will be required to purchase a substitute or equivalent product.  
Even after a lapse of ten years following the date of delivery of the instrument, maintenance technical service will be available provided that necessary units or parts are obtainable. Note, however, that this statement does not represent any extension of the above-mentioned useful service life of the instrument.

## Disposal of This Instrument and Its Parts

In the present design, this instrument does not use materials that would directly cause environmental disruption.

Note, however, that the environmental protection laws and regulations may be revised or amended. Therefore, be sure to consult your local Hitachi High-Technologies Corporation sales representative or service office when planning to dispose of this instrument or its parts.

Lithium batteries are used in the personal computer of this instrument. When disposing of the lithium batteries, strictly follow the laws, ordinances, and regulations regarding industrial waste disposal and environmental protection.

Oil is used in the oil rotary pumps of this instrument. When disposing of the oil, strictly follow the laws, ordinances, and regulations regarding industrial waste disposal and environmental protection.

## **Technical Seminars and Training for Customers**

For ensuring safety and high accuracy in operation of the instrument, technical seminars and training courses are available at the manufacturer or your site.

For further information, contact the nearest sales representative of Hitachi High-Technologies Corporation.  
(The technical seminars and customer training courses are available on a chargeable basis.)



## **Useful Life of Instrument**

This instrument has a useful service life of ten 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 present instruction manual.

## **Other Precautions**

### **Handling of Chemicals**

- (a) The user is responsible for following relevant legal standards and regulations in the handling, storage and discarding of chemicals to be used for cleaning this instrument.
- (b) Chemicals shall be handled, stored and discarded as instructed by respective suppliers.

### **Notice on This Instruction Manual**

- (a) The information contained in this manual and other technical documents accompanying the instrument is subject to change without notice for product improvement.
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- (c) No part of this manual may be reproduced or transmitted in any form or by any means without the express written permission of Hitachi High-Technologies Corporation.



# SAFETY SUMMARY

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## General Safety Guidelines

Before using the Model SU6600 SE SEM, be sure to read the following safety instructions carefully.

The hazard warnings which appear on the warning labels on the instrument or in the manual have one of the following alert headings consisting of an alert symbol  and signal word DANGER, WARNING, or CAUTION.

	:	The alert symbol shown at left precedes every signal word for hazard warnings, and appears in safety-related descriptions in the manual. To prevent possible hazards or injury, be sure to follow the safety precautions preceded by this symbol.
	<b>DANGER:</b>	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
	<b>WARNING:</b>	Indicates a potentially hazardous situation which, if not avoided, will or can result in death or serious injury.
	<b>CAUTION:</b>	Indicates a hazardous situation which, if not avoided, will or can result in minor or moderate injury, or serious damage to the product.
	<b>CAUTION:</b>	Indicates a potentially hazardous situation which, if not avoided, will or can result in damage to the product or property.

In addition, the signal word NOTE, not directly concerned with personal safety issues, is used in this manual.

<b>NOTICE:</b> Used to indicate an instruction for proper operation, accurate measurement, or prevention of occurrence of a trouble in the instrument.
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# SAFETY SUMMARY

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## Common Safety Precautions

### Prior to Use

- Before using the instrument, be sure to read this instruction manual carefully to attain a full understanding of its operations.
- Keep the instruction manual handy nearby so it can be referred to whenever needed.
- Be sure to observe the procedures specified in the manual.
- Be sure to understand and follow all the safety instructions given in the manual.
- Be sure to observe all the hazard warnings attached to the instrument or provided in the manual. Failure to do so could result in personal injury or damage to the instrument.
- Be sure to follow all the methods of use instructed in the manual for proper application of the product.
- Absolutely avoid modifying the product, using non-specified parts, or removing safety devices as it could be hazardous.
- Do not perform any operation or action other than described in the manual. On occurrence of any trouble in the instrument, notify the nearest sales representative or service office of Hitachi High-Technologies Corporation.
- When using chemicals for the instrument, be sure to provide proper ventilation of the room. Inadequate ventilation could endanger human health.
- Most of the operations of the instrument are made while watching the display. Long hours of watching the display could harm one's vision and other parts of the body due to fatigue. Appropriate labor standards should be set up and observed.
- Keep in mind that the hazard warnings in the manuals or on the product cannot cover every possible case, as it is impossible to predict and evaluate all circumstances beforehand. Always be alert and use your common sense.

Be sure to observe the cautionary instructions mentioned above.

If not, the results of specimen observation/evaluation will be inaccurate and personal injury may be incurred.



# SAFETY SUMMARY

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## Common Safety Precautions (Cont'd)

### In Use

- If an abnormality such as unusual noise, odor, fuming or gas leakage occurs during operation of the instrument, immediately shut down power supply, close the main gas valve, and take proper safety measures as required. Then, notify the nearest service office of Hitachi High-Technologies Corporation.
- This instrument is equipped with protective devices such as fuses, overcurrent detectors, fault current detectors, and alarm indicators. These protective devices come into action on occurrence of an abnormality in the instrument. If any one of the protective devices is activated, contact qualified service personnel. Turning power on again without removing the cause of the abnormality concerned could result in fuming, ignition or other accidental events.

### Installation, Maintenance, and Relocation

- At the time of delivery, installation of the instrument shall be carried out by or under supervision of qualified service personnel of the manufacturer or its authorized service agent for ensuring safety and high accuracy in operation of the instrument. It is not permitted for the user to carry out installation.
- After completion of installation, check that all the standard parts are equipped. If the instrument is made active with any one of the standard parts not equipped, a failure could occur and result in a hazardous condition. If any item is missing or damaged or if you have any question, notify the installation personnel at site or the nearest sales representative or service office of Hitachi High-Technologies Corporation.
- The life-limited parts described in this manual must be replaced at the specified cycles. If operation is continued without replacing them, the instrument may malfunction or a safety problem might occur.
- The maintenance and checkup procedures to be taken by the user are only those described in the manual. When taking the maintenance and checkup procedures described in the manual, attain a clear understanding of them. Do not perform other maintenance and checkup procedures to avoid jeopardizing safety and causing troubles in the instrument.
- After installation, do not relocate the instrument. If the instrument is relocated, vibration or impact applied during relocation could cause a malfunction in the optical components that have been adjusted precisely.
- If any warning/caution label has become illegible due to deterioration with age or it has been damaged due to any cause, notify the nearest service office of Hitachi High-Technologies Corporation for replacement with a new one.



# SAFETY SUMMARY

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## DANGER, WARNING and CAUTION Indications in the Manual

Shown below are the cautionary instructions contained in this manual and their locations.

- The indication “ DANGER” does not apply to this instrument.



## WARNING Indications

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### Burns due to Oil Rotary Pump

- Before proceeding to maintenance of the oil rotary pump, wait for a while until it becomes sufficiently cool.  
If the oil rotary pump is forced to stop due to occurrence of an abnormality, it remains extremely hot for a certain period of time. To prevent burns, never touch the oil rotary pump immediately after it is forced to stop.
- The surface temperature of the oil rotary pump becomes approx. 70 °C during its operation. To prevent burns, never touch the oil rotary pump while it is running.  
(Section 4 - MAINTENANCE)

### Electric Shock due to High Voltage

- Potentially dangerous electric currents, 100 V AC and 30 kV DC, are present inside this instrument. Touching the inside of the instrument could cause an electric shock.  
If you access the internal parts or circuits by removing a cover from the main unit, control unit or power supply unit while power is connected to this instrument, you could receive an electric shock, resulting in fatal or serious injury.  
Never remove any cover from the instrument while power is connected to it.
- Before removing the HV cable, be sure to perform the shutdown procedure, and verify that the two indicators (FL and HV) located on the ion pump cover are off.  
(Section 4 - MAINTENANCE)

### Damage to Pacemakers

- The magnetic field from the ion pump unit of the system (10 mT around the ion pump, and approximately 1 mT outside of it) can potentially damage a pacemaker. Any person wearing a pacemaker should stay at least 0.6 m from the system.  
(Section 4 - MAINTENANCE)



# SAFETY SUMMARY

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## WARNING Indications (Cont'd)

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### Burns due to Contact with High-Temperature Part (at the time of electron gun/ion pump baking)

- When the electron gun/ion pump is baked for maintaining its high-vacuum performance, it is heated up to approx. 250 °C.  
To prevent burns, never touch the electron gun/ion pump at the time of baking.
- After completion of baking, it will take approx. six (6) hours for the electron gun/ion pump to cool down to a near-room-temperature level. Remember that the electron gun/ion pump remains extremely hot for this period of time after baking. To prevent burns, never touch the electron gun/ion pump until it becomes sufficiently cool. (Section 4 - MAINTENANCE)
- The inside of the cover can be hot during baking or a cooling off period. Do not touch the cover. (Section 4 - MAINTENANCE)

### Injury due to Lifting Heavy Object

- The vibration isolating weight of the instrument weighs around 40 kg. Attempting to lift it by yourself could result in injury.  
Two persons or else a suitable transporting machine should be used for lifting and carrying the weight. (Section 1 - INSTALLATION)
- The rotary pump is a heavy object, weighing approximately 30 kg. If it must be lifted for oil change, either two persons must lift it or use hauling equipment. Any relocation of the rotary pump or the weight is performed by the Service Department; it should not be performed by customer personnel. (Section 4 - MAINTENANCE)

### Injury from Spraying Drain

- Because the inside of the compressor is at a high pressure, any abrupt operation during draining can cause the drain to spray, potentially resulting in the danger of eye injury. When draining, slowly turn the drain while avoiding standing directly in front of it.
- To avoid potential damage due to corrosion, the compressor should be drained every day. (Section 4 - MAINTENANCE)



# SAFETY SUMMARY

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## CAUTION Indications

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### Fatigue due to Long-Hour Operation

- If you keep working with the display monitor and keyboard for long hours, your eyes and body will be fatigued to jeopardize your health. To prevent this, take a break for about 10 to 15 minutes per hour during operation. (Section 3 - OPERATION)

### Injury from Sharp Objects

- Protruding objects, such as movable apertures and vacuum pipes, are located on the upper part of the specimen exchange chamber. When peering into the inside of the specimen chamber, use caution so that you do not bump your head against any of those objects.

(Section 3 - OPERATION)

### Injury from Pinching in the Open/Close Unit

- Your fingers can be pinched in the open/close unit, potentially resulting in injury. When opening or closing the exchange chamber, be careful not to get your finger caught.
- Your fingers can be pinched in the open/close unit, potentially resulting in injury. When attaching the stage, be careful not to get your finger caught.

(Section 3 - OPERATION)

### Replacing Finite-Life Components

- The rotary pump, which is a finite-life component, should be replaced every five years. (Section 4 - MAINTENANCE)

### Injury from Damage

- Do not get on the display or the table for the main unit. The table, made with resin, can be damaged, resulting in injury to the operator.

(Section 4 - MAINTENANCE)

### Corrosion Damage

- To avoid potential damage due to corrosion, the compressor should be drained every day. (Section 4 - MAINTENANCE)

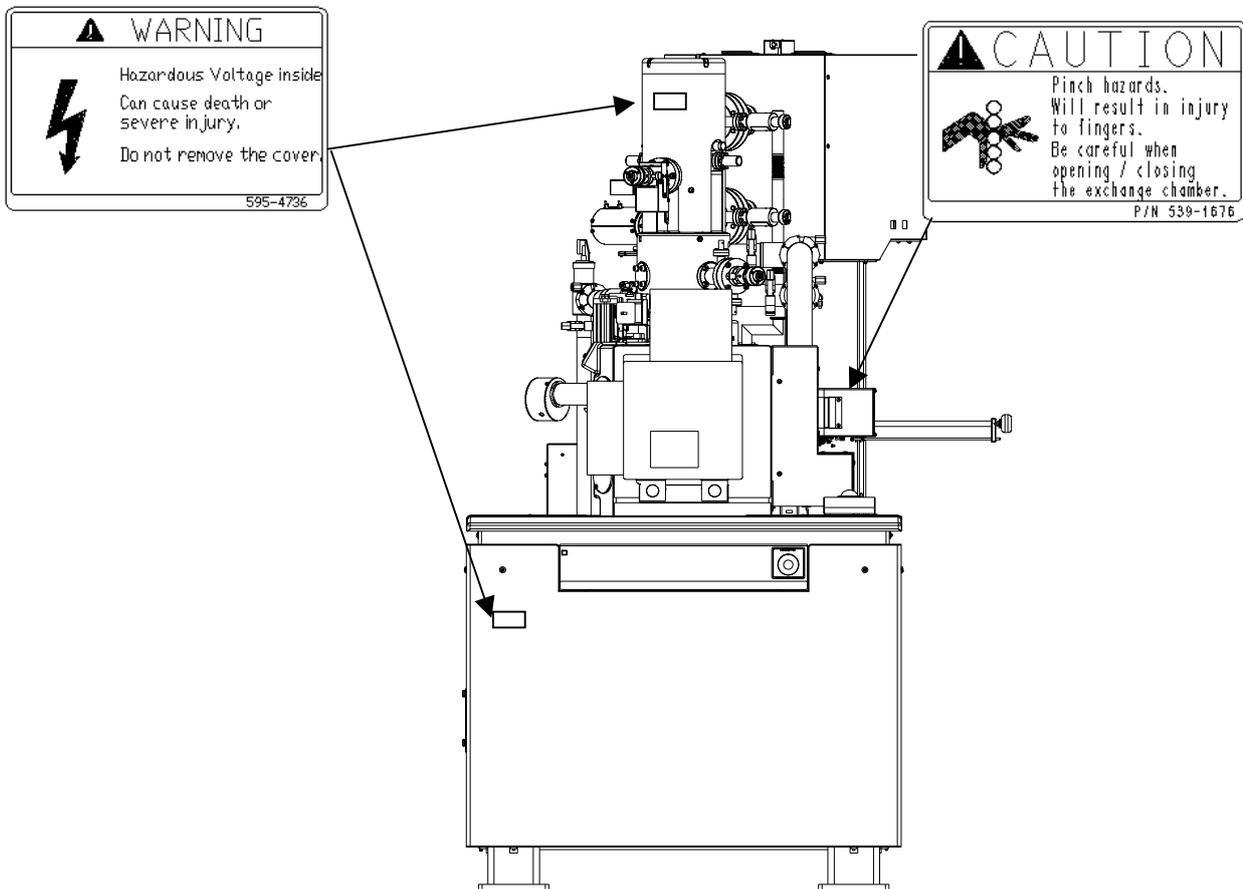


# SAFETY SUMMARY



## WARNING and CAUTION Labels on Instrument

The following WARNING and CAUTION labels are attached on the SU6600 SE SEM. Check each of the WARNING and CAUTION labels attached on the instrument. In periodic maintenance, clean the WARNING and CAUTION labels on the SU6600 SE SEM and put things in order so that they can be viewed from a safe distance. If any WARNING or CAUTION label has become illegible due to deterioration with age or has been damaged due to any cause, notify the nearest service office of Hitachi High-Technologies Corporation for replacement with a new one.



(Front View)

### WARNING and CAUTION Labels on the Main Unit

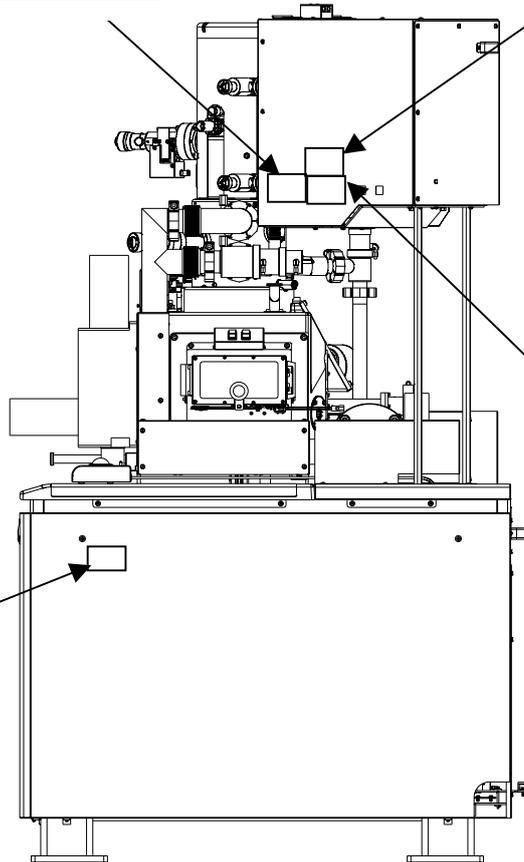




# SAFETY SUMMARY



## WARNING and CAUTION Labels on Instrument (Cont'd)



(Right Side View)

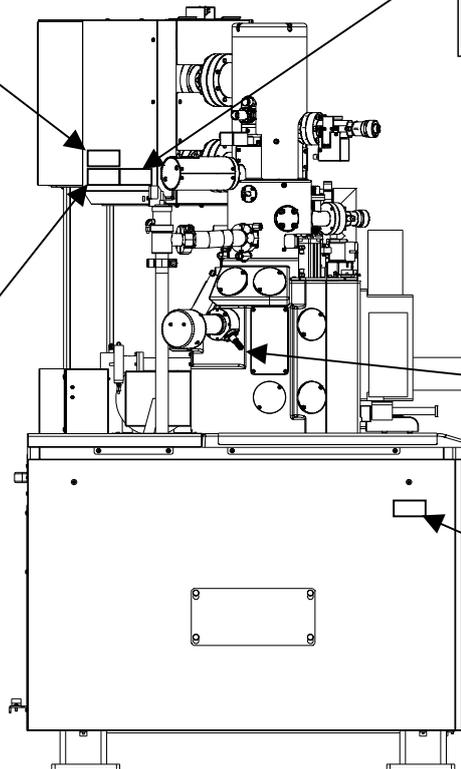
### WARNING Labels on the Main Unit



# SAFETY SUMMARY



## WARNING and CAUTION Labels on Instrument (Cont'd)



(Left Side View)

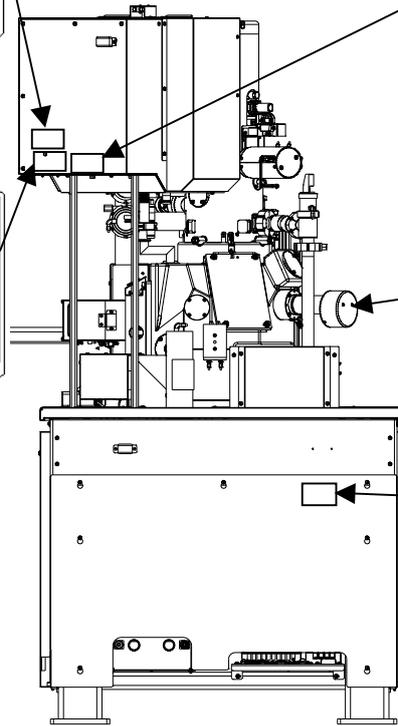
## WARNING Labels on the Main Unit



# SAFETY SUMMARY

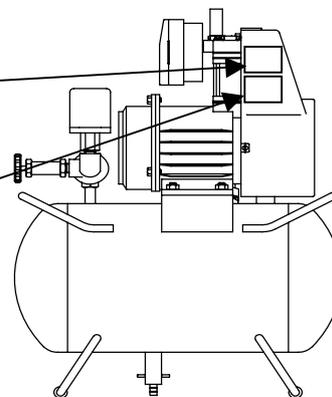
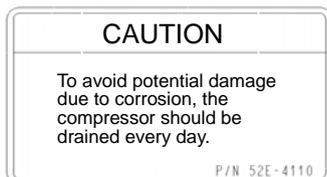


## WARNING and CAUTION Labels on Instrument (Cont'd)



(Rear View)

## WARNING and CAUTION Labels on the Main Unit



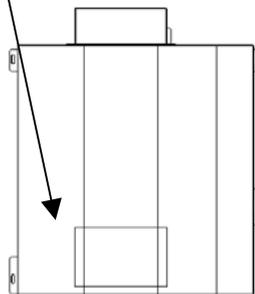
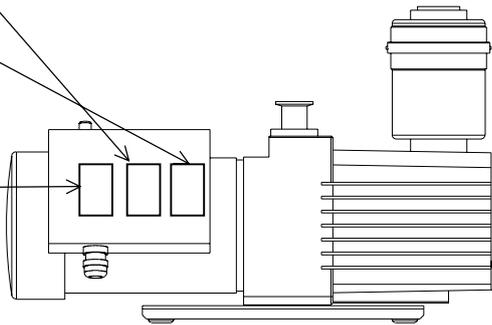
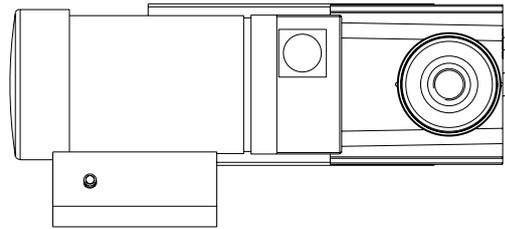
## WARNING and CAUTION Labels on the Compressor



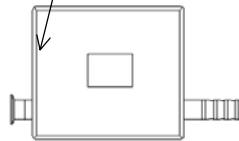
# SAFETY SUMMARY



## WARNING and CAUTION Labels on Instrument (Cont'd)



**Baking Cover**  
(Front view)



**Vibration Isolating Weight**  
(Top view)

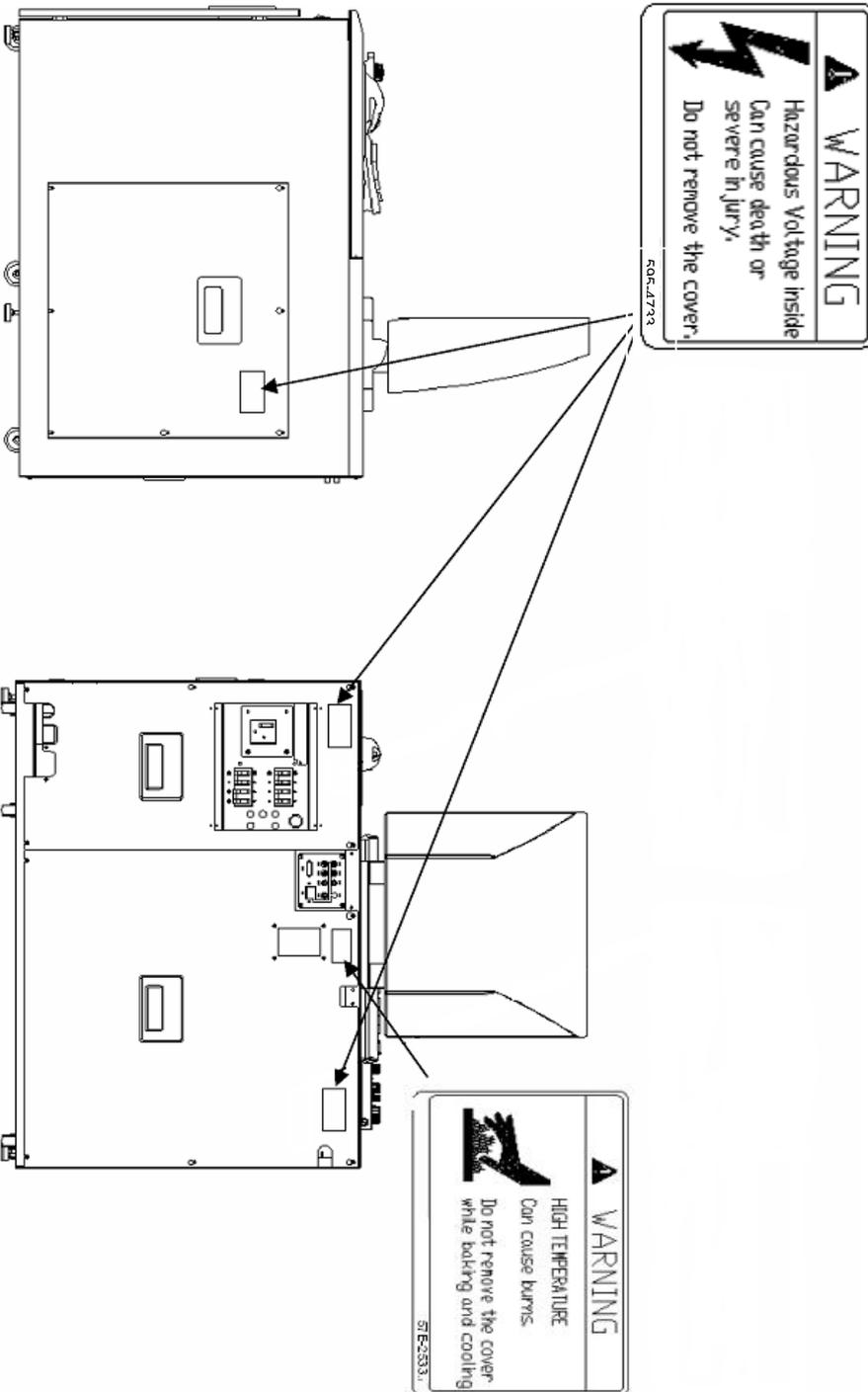


# SAFETY SUMMARY



## WARNING and CAUTION Labels on Instrument (Cont'd)

WARNING and NOTICE Labels on the Display Unit

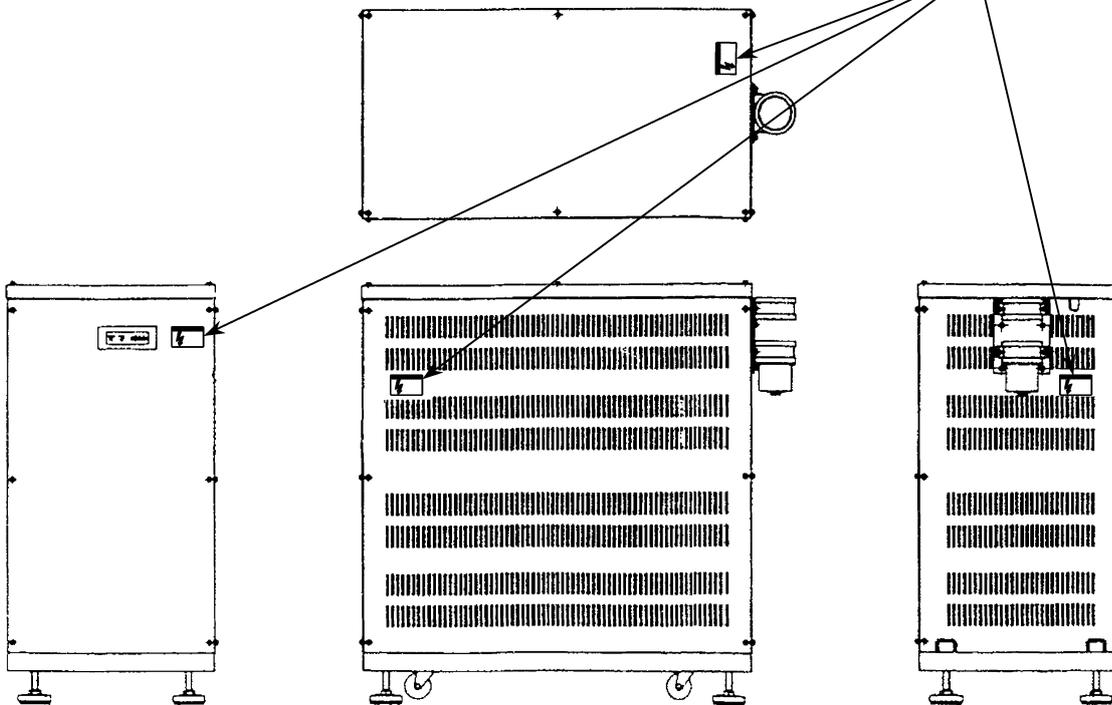
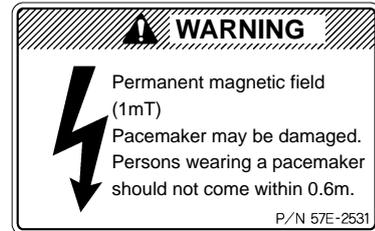
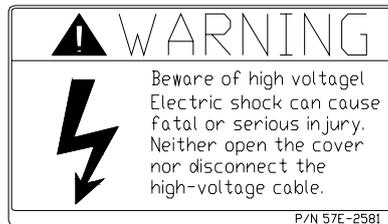




# SAFETY SUMMARY



## WARNING and CAUTION Labels on Instrument (Cont'd)



## WARNING and NOTICE Labels on the HV TANK Unit



# SAFETY SUMMARY

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## Precautions for Proper Use

### - Precautions for Ensuring Normal Operation of the SU6600 SE SEM -

#### Power Requirements and Grounding Connection

- (a) Make sure that an AC single-phase power voltage of 100 V, 4 kVA (50/60 Hz) is supplied to the SU6600 SE SEM. The power supply should remain on continuously.
- (b) Provide grounding connection to a ground terminal having a ground resistance of 100 ohms or less. The ground terminal must not be common to other electrical equipment, i.e., exclusive grounding connection should be made to the ground terminal.

#### Disclaimer of Liability for Industrial Properties of a Third Party

Hitachi High-Technologies Corporation does not assume any liability for a third party's claim regarding infringement of any patent rights or industrial properties with respect to products manufactured through use of instruments supplied by Hitachi High-Technologies Corporation or its related companies or with respect to applications of said instruments.

#### Data Backup

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.

#### Other Application Software

Other application 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 an 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

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## Precautions for Proper Use (Cont'd)

### Protection against Computer Viruses

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

Computer and storage media are shipped after confirming with anti-virus software that they are free of such viruses.

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 media and network connection have to be checked with an anti-virus software before inserting into the PC that is a part of this system. To connect with the network, it is recommended to install a firewall between the PC of this system and the network. Firewall installation is to be done by the user at his/her own responsibility. Note that we do not guarantee protection against all viruses just by installing a firewall. The user is requested to prepare a proper anti-virus software and carry out virus removal at his/her own responsibility. We do not guarantee the anti-virus software itself.

Note, however, that conducting a computer virus check during operation of this system may cause incorrect operation of the system control program. The user is requested to observe the following.

- (1) Set the switch of the virus monitoring function at OFF during operation of this system.
- (2) If an anti-virus software has a regular scanning function, avoid virus scan during the operation of this system and conduct the virus scan while the system control program is not working.





# SAFETY SUMMARY

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## Precautions for Proper Use (Cont'd)

### Environment Settings in Personal Computer

In the personal computer (PC) of this instrument, the following environment settings for execution of the PC SEM control program have been made prior to shipment from the factory. Do not change these environmental settings in the PC for ensuring normal operation of the instrument.

(a) USB Port Connection

In the SU6600, the PC serving as a user interface unit is connected to the SEM control processor through the Universal Serial Bus (USB). The USB port 1 is assigned for this connection. In cases where a USB-compliant external device such as an external storage unit or printer is used, note that the availability of USB ports is limited. For details, refer to the description concerning the handling of the PC.

(b) Display Screen Setting

The SU6600 is equipped with image display hardware.

For operation of this hardware, the display properties are preset as follows; 1280x1024 pixels, 24-bit true colors, 60-75Hz refreshing. If these properties are changed, normal imaging will not be provided.

(c) Task Setting for SEM

In addition to the control program, a variety of programs including DLL files are used for operation of the instrument.

If the Windows directory file is removed or the Registry settings are changed, unpredictable results could occur in operation of the instrument. Note also that task or process files should not be deleted using the Task Manager.

(d) Task Display Setting for IME (Input Method Editor for the Japanese Language)

The Microsoft IME tool (Japanese-language input tool) is presented on the topmost position of the screen in the default setting condition. Since the IME tool is not used for operation of the instrument, put it onto the Taskbar.



# SAFETY SUMMARY

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## Precautions for Proper Use (Cont'd)

(e) Screen Saver Setting

On the Screen Saver tab page of the Display Properties dialog box, do not turn on the check box of "Password Protected", or a SEM image will not be displayable after restoration. To lock the Windows when you leave the PC temporarily, use the password lock function that is available through SU6600 GUI operation.

(f) Power Management Setting

In the power management function of the PC, the power save mode has been turned off prior to shipment from the factory. Do not turn on the power save mode. If the power save mode is set up, command communication between the PC and SEM is disconnected to disable normal operation of the instrument.

(g) Virtual Memory Setting

Do not change the virtual memory setting on the Performance tab page of the System Properties dialog box.

(h) Names of Image Files

Saved image data files are administered by the SEM Data Manager. Do not change or delete the names of saved image data files by using the Windows File Manager or Explorer.

If the name of an image data file is changed or deleted, there occurs a discrepancy between administration data of the SEM Data Manager and actual data. In this case, the SEM Data Manager issues an error message indicating a reference-disabled condition. If this error message is presented, remove the name of the image data file concerned from the administration data by using the Remove List function (Batch Process) of the SEM Data Manager. If the image data file concerned is necessary, reregister it by using the Add From File function.



# SAFETY SUMMARY

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## Precautions for Proper Use (Cont'd)

### OS Operation with SU6600 Control Program Active

The Task Manager can be launched from the Taskbar or by pressing the Ctrl, Alt, and Del keys at the same time. However, if the current task is terminated or put in the standby/pause/logoff state, normal operation may not be resumed at the time of recovery. In this case, cancel the Task Manager to terminate the SU6600 control program.

### USB Device Connection

When connecting a USB-compliant external device such as an external storage unit or printer to the PC, follow the instructions given below.

- (1) The USB port 1 is assigned for connection between the PC and the SEM control processor. Note that the availability of USB ports is limited. For details, refer to the description concerning the handling of the PC.
- (2) Where a magneto-optical disk drive is connected, a heavy-load command execution such as disk formatting or massive data copying may have an adverse effect on operation of the instrument. To avoid this, quit the SU6600 control program once and then carry out a heavy-load command as mentioned above.
- (3) The error message "USB Not Connected" may be issued while the SU6600 control program is active. In this case, the subsequent instrument operations are disabled. If this message is presented, exit Windows, shut down the PC, and turn off the power switch of the display monitor. Then, wait for 30 seconds at least, and turn power on for restarting.



# SAFETY SUMMARY

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## Precautions for Proper Use (Cont'd)

### Use of Another Windows Application

During execution of the SEM control program, particularly during image capture, image file transfer or photograph recording, do not run another Windows application (such as the printer application program or Internet Explorer) to prevent possible corruption of data.

### Power Interruption

On occurrence of a momentary power voltage drop due to power interruption or lightning, the PC of this instrument may become faulty or the system software, application software or data may be damaged.

For protection against a possible momentary power voltage drop, it is advisable to use an AC uninterruptible power supply unit.

### Power Supply to Personal Computer (PC)

Do not turn off the DISPLAY switch during operation of the instrument. If so, power to the PC is disconnected. If power to the PC is turned off while the hard disk or floppy disk is being accessed, the PC may become faulty or data/software stored in it may be damaged. Before turning off the DISPLAY switch, terminate the SU6600 control program and take the Windows shutdown procedure (for automatic power-off). After making sure that the message "It is now safe to turn power off" appears on the monitor, turn off the DISPLAY switch.

If the PC hangs up due to any cause, take the procedure described in 4.4.11 for ensuring the integrity of data stored in it.

# PRECAUTIONS ON HANDLING

For the sake of safety, the following points should be taken into consideration.

## 1. PRECAUTIONS FOR TRANSPORT



### CAUTION

- (1) Customers must not attempt to transport the instrument by themselves since it is dangerous. It must be transported under the supervision of our qualified specialists.
- (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 200 kg. Should the table be lifted, the display unit might fall and be damaged. Hence, it is recommended to remove the table and transport the display unit independently when moving the instrument.
- (3) The housing supports should be fitted in place before transport.

## 2. PRECAUTIONS FOR POWER CONNECTION



### WARNING

- (1) Do not remove the front, rear and top covers of the housing and display unit. The high voltage circuit within the unit constitutes a shock hazard.
- (2) Connect the grounding wire correctly. Otherwise, not only will the instrument fail to operate normally but also there is a shock hazard. Grounding should be left to the service engineer.
- (3) Avoid touching the connector of high voltage unit and the cable head of high voltage transformer. The high voltage unit and the high voltage transformer voltages are from 10 kV to 30 kV, so handling of dangerous parts such as high voltage connector and cable head should be left to the service engineer.
- (4) Do not touch the areas marked HAZARD. These areas are supplied with high voltage.
- (5) Before replacing a fuse, turn off the main switch on the distribution board and make sure that the AC power supply is off. If not, the AC power line near the fuse may cause an electric shock.
- (6) To avoid burns, never touch the electron gun when it is being baked or during the cooling off period.



## CAUTION

- (1) Never touch the electron gun with bare hands in the course of baking and cooling. High temperature during baking may cause burns.
- (2) When using liquid nitrogen, wear leather gloves and protective glasses. There is danger if it touches the skin as it can cause frostbite. Also, make sure there is enough ventilation in the room to prevent oxygen deprivation.
- (3) When the anti-contamination trap is filled with liquid nitrogen, do not allow air to leak in the specimen chamber. This will cause the deterioration of vacuum, leading to frost in the anti-contamination trap.
- (4) When setting the specimen tilt and the stage Z to minimum, there is a danger of contact that could scratch the specimen or objective lens. Be sure to use the special height gauge for setting the specimen and set the specimen height to be not more than 0.5 mm higher than the level gauge.
- (5) Be careful not to hit your head when checking the specimen chamber because the movable aperture and secondary electron detector, etc. are sticking out of the top area of the specimen exchange chamber.
- (6) Do not place objects containing a magnetic powder in the specimen chamber. The magnetism of the objective lens will attract the powder and it will attach to the magnetic pole of objective lens. This causes a deterioration of performance.
- (7) Since a magnetic specimen is strongly attracted by the magnetic field of the objective lens, secure it tightly to the specimen stage. If it is not tight enough, it may be drawn to the objective lens and cause problems.
- (8) The oil rotary pump is a heavy object that weighs 30 kg. Be very careful if it must be lifted or moved when performing maintenance.
- (9) When performing maintenance on the compressor, open the drain valve slowly and drain the condensed water from the tank gradually. High air pressure inside the tank can cause dangerous splashing and spraying of condensation if the drain is opened too quickly.

## NOTICE:

- (1) Allow an interval of at least 5 seconds between turning on or off the **EVAC POWER** and **DISPLAY POWER** switches.
- (2) Replace the oil filter of the oil-sealed rotary pump every six months.
- (3) For the air compressor, perform draining of water, etc. with reference to the check card attached to the instrument.

- (4) Do not press the **EMERGENCY** switch except in emergencies. Using this switch causes a complete instrument shutdown that will necessitate complete instrument restarting.
- (5) When attaching the electron gun cover, upon baking the gun, make sure the lead wires are not touching the heater.

### 3. GENERAL PRECAUTIONS

- (1) Maintenance items other than those described in this manual should be left to the service engineer.
- (2) Replacement of the SE (Schottky emission) tip should be performed by a Hitachi High-Technologies Corporation service representative.

### 4. MEASURES FOR EMERGENCY

- (1) Turn off the main switch on the distribution board.
- (2) After taking steps (1) and (2), carry out other suitable measures.
- (3) Inform the service company.

### 5. CAUTIONS ON OPERATION

- (1) During operation, occasionally confirm that the ion pumps are in a stable state.  
**IP1**  $2 \times 10^{-7}$  Pa or better  
**IP2**  $1 \times 10^{-5}$  Pa or better
- (2) When leaving the instrument, press the **HV OFF** switch.
- (3) Avoid using excessive fixing agent (conductive paste or the like) when setting the specimen onto the specimen stub. It might contaminate the specimen.
- (4) When HV off operation is impossible because of a software lock-up, the HV is shut off by turning display power switch to off.  
In this case, however, the gun air lock valve (GV) will not be closed. Press the Air switch to introduce air into specimen exchange chamber. It will close the valve.

(5) Operation of gate valve of WDX detector

The interior of the optional WDX detector is evacuated by TMP via the specimen chamber of the SEM. If the gate valve of the WDX is closed, the WDX will be cut off from the SEM specimen chamber whereby evacuation will stop and the internal pressure will rise. And if the gate valve is opened with the interior of WDX detector at a high pressure, the pressure in the SEM specimen chamber will also rise and may cause the electron gun and/or TMP to malfunction. Be careful about the following points in operating the WDX gate valve.

- (a) Do not leave the WDX gate valve closed for a long time. The valve should not be closed for more than one hour so that the internal pressure of WDX detector can be kept low.
- (b) Prior to opening the WDX gate valve, be sure to turn OFF the SEM HV.
- (c) After opening the WDX gate valve, check via the vacuum indicator on evacuation control panel on the front of SEM main unit that the pressure of the SEM specimen chamber has returned to the normal level.
- (d) If leaving the WDX gate valve closed for a long time is unavoidable, take the following procedure when opening it again.
  - With the WDX gate valve kept closed, let air into the SEM specimen chamber temporarily.
  - Evacuate the SEM specimen chamber and when it reaches around 50 Pa, open the WDX gate valve.

## 6. OTHERS

- (1) Keep the instrument installation room under the following conditions even when the instrument is not in operation.

Room temperature    5 to 25 °C

Humidity            Less than 60%

Evacuation must be performed continuously even when the instrument is not used for a long time. An uninterruptible power supply must be provided for this purpose.



## 7. ABOUT THE SE ELECTRON GUN

<Principle of SE electron gun>

The principle of the SE electron gun is illustrated in Fig. 1. The gun consists of a cathode, suppressor electrode, and first and second anodes.

An extracting voltage ( $V_{ext}$ ) is applied between cathode and first anode, and electrons are emitted from the cathode. The electrons are further accelerated by means of accelerating voltage ( $V_{acc}$ ).

For the SE tip (cathode), an SE (Schottky Emission) electron source having a needle-shaped ZrO/W tip is utilized which is normally heated to a temperature of about 1700 K by means of heating power supply  $V_f$ .

$V_s$  is a suppressor voltage used to control unwanted thermo emission.

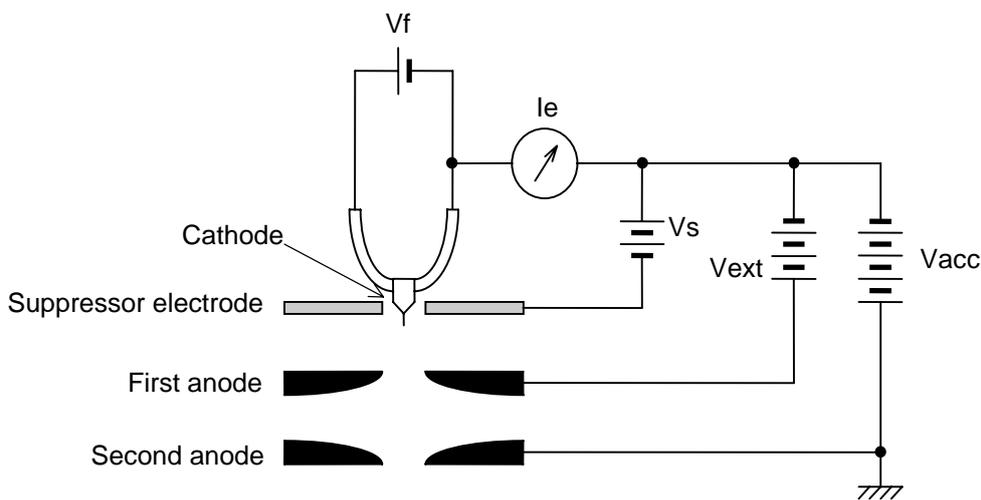


Fig. 1 Principle of SE Electron Gun

- NOTICE:**
1. The extracting voltage  $V_{ext}$  is sometimes referred to as  $V_1$ . Varying this voltage enables increasing or reducing the emission current  $I_e$ . GUN brightness appearing on the HV control dialog of the display unit is used to control the emission current from the gun by varying the extracting voltage.
  2. Accelerating voltage  $V_{acc}$  is also referred to as  $V_0$ . This is variable from 0.5 kV up to 30 kV in the SU6600.
  3. The HV power unit that controls the electron gun is usually operated continuously like the pump power unit, whereby  $V_f$ ,  $V_s$ ,  $V_{ext}$  and  $I_e$  are maintained at the set values.  $V_{acc}$  is set via the accelerating voltage on HV control dialog of the display unit.
  4. The SE electron source was proposed by Dr N.W. Swanson et al. in the 1980s, and is widely used as an electron source in electron beam systems because of the outstanding stability of its emission current.  
The stability of electron current is dependent on the vacuum level around the tip. An ultrahigh vacuum of  $10^{-7}$  Pa is thus required. And, continuous heating is essential for maintaining the electron current stability.

## 8. Handling of PC

The PC has been set as follows when the instrument is shipped from the factory.

### 8.1 Login User Name

This is set as follows at shipment from the factory.

User Name	Password	Group Having Access Right	Application
SU6600	None	Power Users	Used for SEM operation. System environment cannot be set.
Administrator	hitachi	Administrators	Used for system management. System environment setting etc. can be made.
SEM	****	Administrators	Used for SEM maintenance. Do not change the settings.

- Notes:**
1. Settings of Administrator for User name and PC-SEM for Password are permitted. Refer to the WINDOWS SECTION of the instruction manual for the password setting method.
  2. To create a new user name, select "Administrators" or "Power Users" for the "Group having access right". If set to "Users", the PCSEM control software will not function normally.

## 8.2 Setting of Window Properties

Click the right-hand button of the mouse on Desktop and select “Properties” from the menu that appears.

### Desktop tab

Background: (none)

### Screen Saver tab

Screen saver : (none)

Monitor power supply

(click power button) : power setting (always ON), monitor power OFF, hard disk power OFF, and set system standby and system pause condition to “none”.

### Design tab

Window and buttons : Windows XP style

Color scheme : setting (blue)

Effect (click Effect button) : Remove check from “Smoothen edges of screen font by following method”.  
(If check mark is left at the above item, the data display characters will not be so legible when displaying a SEM image of high brightness.)

### Setting tab

Window resolution : 1280 × 1024 pixels

Window color : maximum (32 bits)

Windows refresh rate (click Detail setting button and select Monitor tab) : 60 Hz (in case of LCD monitor)

### 8.3 Security Setting for Drive D

The hard disk drive of the PC-SEM of the Windows XP model is partitioned into drives C and D. Drive D should be used for saving data on SEM images etc. If two or more OS login user names are set for drive D, then "Full control" should be set for the access right for the group name "**Everyone**" to allow sharing of data. Data read/write to drive D is thus permitted for all of the login users via this setting. If this setting is not made, then data read/write to drive D will be prevented because of a discrepancy in login user names, and SEM images may not be saved by means of SEM control software or SEM Data Manager. Refer to the description below for the setting method. (To change this setting, a sufficient understanding of Windows setting procedure is essential.)

- (1) Select drive D by means of Explorer, then select **Folder Option** from **Tool** on the menu displayed.
- (2) Select **Display** tab on the **Folder Option** dialog, remove the check from **Use simplified file sharing** on the **Detail setting** list, then click **OK**.
- (3) Select drive D via Explorer, then click the right-hand button of the mouse and select **Properties**.
- (4) Select **Security** tab on **Properties** dialog, then select **Everyone** from the **Group name or user name** list. (If **Everyone** doesn't appear on the list, click **Add** button, click **Detail setting** button on the **Select user or group** dialog that appears, then click **Search now** button and **Everyone** will appear on the list, so click **OK**.) Next, put a check at **Full control** on the **Everyone access right** list and click **OK**.

## 8.4 Task Bar Setting

The task bar is set as follows at shipment from the factory. Even if this setting is changed, the SEM software operation will not be affected.

- (1) Language bar : Set at minimum.
  
- (2) Task bar (click right-hand button of mouse on task bar and select **Properties**) : Put a check at **Hide task bar automatically**.
  
- (3) Start menu (select **Start** menu tab) : Select [**Start** menu].

# SPECIFICATION

## 1. Specifications for Hitachi SU6600 SEM

### 1.1 Resolution

1.2 nm (Accelerating voltage 30 kV WD=5mm) Magnification 180,000x

3.0 nm (Accelerating voltage 1 kV WD= 4 mm) Magnification 80,000x

3.5 nm (Accelerating voltage 30 kV WD=8mm specimen chamber vacuum 10Pa) Magnification 80,000x

### 1.2 Magnification

X 10 ~ X 600,000

### 1.3 Electron Optics

- (1) Electron gun ZrO/W Schottky emission type
- (2) Accelerating voltage (Vacc) 0.5 to 30 kV (in 100 V steps)
- (3) Lens 3-stage electromagnetic lens, reduction type
- (4) Objective lens aperture Movable aperture (4 holes selectable/alignable outside the column).  
Self-cleaning thin aperture
- (5) Astigmatism correction coil  
(stigmator) Electromagnetic type
- (6) Scanning coil 2-stage electromagnetic-deflection type

## 1.4 Specimen Stage

Motion	
X Traverse	0 to 110 mm (continuous)
Y Traverse	0 to 110 mm (continuous)
Z Traverse	4.0 to 40.0 mm (continuous)
Tilt	-5° to +70°
Rotation	360° (continuous)
Specimen size	Max. 150 mm (diameter) (airlock type specimen exchange)

## 1.5 Display Unit

- (1) Display type Flicker- free image on PC monitor (full scanning speeds)
- (2) Viewing monitor Type 19 (or appropriate size) LCD  
(1280 × 1024 pixels)
- (3) Scanning modes Normal scan,  
Reduced area scan,  
Line scan,  
Spot analysis,  
Average concentration analysis,  
Split/Dual magnification
- (4) Scanning speeds TV scan : (640 × 480 pixel display: 25/30 frames/s)  
Fast scan : (full screen display: 6.25/7.5 frames/s)  
Slow scan : (full screen display: 1/0.9, 4/3.3, 20/16, 40/32, 80/64 s/frame)  
(640 × 480 pixel display: 0.5/0.4, 2/1.7, 10/8, 20/16, 40/32 s/frame)  
  
For photographing:  
(2560 × 1920 pixels: 40/32, 80/64, 160/128, 320/256 s/frame)  
(Values indicated above are at 50 Hz/60 Hz.)  
  
TV : NTSC signal
- (5) Signal processing modes Automatic brightness control,  
Gamma control,  
Automatic focus,  
Automatic stigmator





# INSTALLATION CONDITIONS

## 1. Power Requirements

100 V AC ( $\pm 10\%$ ), single phase, 50/60 Hz, 4 kVA

For using a voltage other than 100 V AC, an isolation transformer should be provided by the user.

User should provide exclusive grounding of less than 100 ohms in ground resistance.

## 2. Physical Dimensions

Main unit : 840 (W) × 966 (D) × 1660 (H) mm..... 670 kg

Display unit : 1000 (W) × 1005 (D) × 1200 (H) mm.... 205 kg

HV tank unit : 754 (W) × 394 (D) × 775 (H) mm..... 140 kg

Oil rotary pump : 526 (W) × 235 (D) × 306 (H) mm..... 28 kg

Air compressor : 400 (W) × 230 (D) × 550 (H) mm..... 18 kg

Weight : 200 (W) × 180 (D) × 160 (H) mm..... 40 kg

## 3. Installation Environment

### 3.1 Ambient Temperature

15 °C to 25 °C (temperature variation 0.5 °C/10 min)

### 3.2 Relative Humidity

Less than 60%, without condensation

### 3.3 Stray Magnetic Field

	Accelerating Voltage	Working Distance	Magnification	Frequency Component Synchronous with Power Supply AC Magnetic Field (effective value)	Frequency Component Asynchronous with Power Supply DC Magnetic Field Fluctuation	Change with Time (drift)
Allowable value	30 kV	5.0 mm	180,000×	150 nT (horizontal) 240 nT (vertical)	170 nT (horizontal) 270 nT (vertical)	200 nT/min (horizontal) 490 nT/min (vertical)
	1 kV	4.0 mm	80,000×	80 nT (horizontal) 120 nT (vertical)	90 nT (horizontal) 120 nT (vertical)	300 nT/min (horizontal) 500 nT/min (vertical)

nT: Nano Tesla

### 3.4 Floor Vibration

Allowable horizontal amplitude (X, Y)		Allowable vertical amplitude (Z)	
Frequency	Amplitude	Frequency	Amplitude
1.0 Hz	18 $\mu\text{m}$ p-p or less	1.0 Hz	40 $\mu\text{m}$ p-p or less
1.5 Hz	8.4 $\mu\text{m}$ p-p or less	2.0 Hz	21 $\mu\text{m}$ p-p or less
2.0 Hz	2.9 $\mu\text{m}$ p-p or less	3.0 Hz	8.2 $\mu\text{m}$ p-p or less
2.5 Hz	3.4 $\mu\text{m}$ p-p or less	4.0 Hz	3.3 $\mu\text{m}$ p-p or less
3.0 Hz	6.2 $\mu\text{m}$ p-p or less	5.0 Hz	1.1 $\mu\text{m}$ p-p or less
4.0 Hz	5.3 $\mu\text{m}$ p-p or less	5.5 Hz	1.0 $\mu\text{m}$ p-p or less
5.0 Hz	5.2 $\mu\text{m}$ p-p or less	6.0 Hz	1.0 $\mu\text{m}$ p-p or less
6.0 Hz	3.3 $\mu\text{m}$ p-p or less	7.0 Hz	1.0 $\mu\text{m}$ p-p or less
7.0 Hz	2.9 $\mu\text{m}$ p-p or less	8.0 Hz	1.2 $\mu\text{m}$ p-p or less
10.0 Hz	6.0 $\mu\text{m}$ p-p or less	10.0 Hz	1.4 $\mu\text{m}$ p-p or less

The allowable amplitude corresponds to an image deviation of less than 0.2 mm on a micrograph at magnification 220,000 $\times$

### 3.5 Acoustic Noise

Sound waves are liable to cause image disturbance (similar to that caused by floor vibration). Acoustic noise should be kept under the levels indicated below.

These levels cause an image fluctuation corresponding to about 0.2 mm on micrograph data (125  $\times$  95 mm) at a magnification of 180,000 $\times$ .

Frequency: f (Hz)	Allowable Noise Level
$f \leq 140$	72 dB or less
$140 \leq f \leq 250$	60 dB or less
$250 \leq f \leq 800$	57 dB or less
$800 \leq f \leq 2000$	52 dB or less

# MODEL SU6600 SCHOTTKY EMISSION SCANNING ELECTRON MICROSCOPE (User's Operation/Maintenance Edition)

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# 1. INSTALLATION

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

## 1.1 Installation Requirements

### 1.1.1 General

For installing the Model SU6600, the sites and conditions mentioned below must be avoided.

- (1) Room located in the vicinity of transformer substation
- (2) Room located in the vicinity of elevator
- (3) Location near electric equipment consuming a large quantity of power (e.g., electric furnace) or its power supply
- (4) Location near spark discharge source or high-frequency apparatus
- (5) Room filled with gas which corrodes metals
- (6) Place exposed to direct sunlight or strong draft
- (7) Dusty place
- (8) Location subjected to severe vibrations
- (9) Using ground wire common to other electric equipment
- (10) Location adjacent to radio or sound wave source

### 1.1.2 Room Temperature, Humidity and Altitude y

- (1) Room temperature 15 to 25 °C  
Temperature fluctuation should preferably be less than 5 °C during operation of the instrument.
- (2) Humidity 60% or less  
The instrument should desirably be operated in an air-conditioned room.
- (3) Altitude Up to 2000 m

### 1.1.3 Line Power Requirement

- (1) Single-phase AC 100 V, 4 kVA, 50/60 Hz (for main unit)  
Continuous energization is required. And, the allowable line voltage fluctuation is  $\pm 10\%$  maximum.

**NOTICE:** Line power fluctuation should be slow; an abrupt fluctuation is not permitted.

- (2) The main column unit should be located within 10 m of the power distribution board on the wall (since input AC cord is only 10 m long).
- (3) Be sure to use an exclusive power switch on the distribution board, which is provided by the user, and feed the power through the switch.

### 1.1.4 Grounding

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.

### 1.1.5 Water Supply and Drain

The SU6600 does not require water supply or drainage.

### 1.1.6 Stray Magnetic Field

You should measure the stray magnetic field at the installation room for the Model SU6600 in advance. When the requirements given in Table 1-1 are satisfied, no image trouble will occur.

Avoid locations at which abrupt electric current change or magnetic field change might occur due to the presence of a large-sized magnetic clutch or power cable for other equipment.

**Table 1-1 Stray Magnetic Field (at image recording)**

	Accelerating Voltage	Working Distance	Magnification	Frequency Component Synchronous with Power Supply AC Magnetic Field (effective value)	Frequency Component Asynchronous with Power Supply DC Magnetic Field Fluctuation	Change with Time (drift)
Allowable value	30 kV	5.0 mm	180,000×	150 nT (horizontal) 240 nT (vertical)	80 nT (horizontal) 120 nT (vertical)	200 nT/min (horizontal) 490 nT/min (vertical)
	1 kV	4.0 mm	80,000×	80 nT (horizontal) 120 nT (vertical)	90 nT (horizontal) 120 nT (vertical)	300 nT/min (horizontal) 500 nT/min (vertical)

nT: Nanotesla

**NOTICE:**

1. The frequency component synchronous with power supply (AC magnetic field) is an effective value. Therefore, its allowable value should be increased to 2.8 times for evaluation in terms of p-p (peak to peak) value.
2. The DC magnetic field fluctuation stands for a rapid change of stray magnetic field over time. A gradual and moderate change over time is handled as a slow variation (drift).
3. The variation (drift) of stray magnetic field signifies a difference (maximum drift) between the maximum and minimum levels within the specified time (1 minute).
4. The allowable value of AC magnetic field is determined so that image distortion (elongation, contraction or curving) at the specified magnification will not exceed 0.5 mm.

5. The allowable value of DC magnetic field fluctuation is determined so that image disturbance (image shift or spike noise) at the specified magnification will not exceed 0.2 mm on a micrograph.
6. The allowable value of variation (drift) in stray magnetic field is determined so that image sway due to that variation will not exceed 0.5 mm on a micrograph taken at the specified magnification.
7. Fluctuation-free DC component (excluding terrestrial magnetic field) of stray magnetic field will not cause the electron beam to sway. Therefore, image remains unaffected so far as the field strength is within a few ten  $\mu\text{T}$ .
8. The allowable values given in Table 1-1 are applicable at the specified working distances. At a longer working distance, the allowable value of stray magnetic field becomes smaller. (Namely, image is apt to be affected by stray magnetic field.)

### 1.1.7 Floor Vibration

You should measure the floor vibration at the place for installing the Model SU6600 in advance. When the requirements given in Table 1-2 are satisfied, no image trouble will occur.

If the instrument is installed on the first floor in a reinforced concrete or steel frame building, the instrument performance will not be degraded by external vibrations so long as vibration sources such as heavy-duty machine tools or transportation facilities (electric car, for example) are not operated nearby.

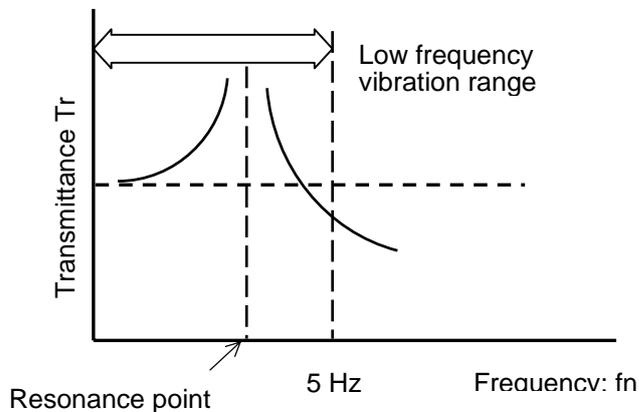
**Table 1-2 Allowable Vibration**

Allowable horizontal amplitude (X, Y)		Allowable vertical amplitude (Z)	
Frequency	Amplitude	Frequency	Amplitude
1.0 Hz	18 μm p-p or less	1.0 Hz	40 μm p-p or less
1.5 Hz	8.4 μm p-p or less	2.0 Hz	21 μm p-p or less
2.0 Hz	2.9 μm p-p or less	3.0 Hz	8.2 μm p-p or less
2.5 Hz	3.4 μm p-p or less	4.0 Hz	3.3 μm p-p or less
3.0 Hz	6.2 μm p-p or less	5.0 Hz	1.1 μm p-p or less
4.0 Hz	5.3 μm p-p or less	5.5 Hz	1.0 μm p-p or less
5.0 Hz	5.2 μm p-p or less	6.0 Hz	1.0 μm p-p or less
6.0 Hz	3.3 μm p-p or less	7.0 Hz	1.0 μm p-p or less
7.0 Hz	2.9 μm p-p or less	8.0 Hz	1.2 μm p-p or less
10.0 Hz	6.0 μm p-p or less	10.0 Hz	1.4 μm p-p or less

The allowable amplitude corresponds to an image deviation of less than 0.2 mm on a micrograph at a magnification of 180,000×.

Figure 1-1 shows the relation between frequency of floor vibration and vibration transmittance of the instrument. Since the vibration transmittance is maximum at the resonance point (about 2 Hz) of the anti-vibration mount provided with the instrument, the allowable amplitude is minimum at this point.

**NOTICE:** Please consult with us if the floor vibration exceeds the allowable values.  
(Vibration should be measured in advance if it is expected to cause a disturbance.)



**Fig. 1-1 Vibration Transmittance - Frequency Characteristics**

### 1.1.8 Power Line Noise and Electric Field Noise

Image troubles may be observed when a device as given in Table 1-3 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 SU6600 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 1-3 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 commutator 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	Disturbance signal*	Industrial high frequency heater, high frequency electric welder, microwave oven
	Medical high frequency equipment	Disturbance signal*	VHF/UHF fulgurators, electric scalpel
	Equipment utilizing ultrasonic wave	Disturbance signal*	Flaw detector, depth sounder, fish finder, ultrasonic cleaner
Power equipment	Power cable (transmission line)	High voltage, large 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
		Reflection	From car body
Internal combustion engine	Automobile	Electric discharge	Ignition system
		Other	Dynamo, voltage regulator, wiper, horn, winker
Wireless communication facilities	Large-power transmission equipment	Signal radiation*	Broadcasting equipment, radar
		Disturbance radiation	High-frequency transmitter

\* The asterisked signal is required in the relevant system, but becomes a disturbance signal for other systems.



### 1.1.9 Disturbance by Sound Waves

Sound waves (vibrations of air) adversely affect the Model SU6600 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 SU6600.

If such equipment exists, then check for noise level.

The effect of noise on a SEM image varies with the noise frequency. The allowable sound pressure level (C characteristic) at the SU6600 installation site versus noise frequency is indicated in Table 1-4.

In general, the sound pressure level decreases with an increase of noise frequency, and the frequency varies with the cause of the noise.

It is therefore necessary to carry out noise frequency analysis at the installation site of the SU6600 to check the degree of noise (effective factor) in each case. If the noise frequency matches the resonance frequency of the instrument, then image disturbance may occur even when noise is within the allowable level.

(Allowable level will decrease below 60 dB at a noise frequency around 150 Hz ( $\pm 10$  Hz), and the level will also decrease below 57 dB at a noise frequency around 370 Hz ( $\pm 10$  Hz).)

**Table 1-4 Allowable Noise Level (C characteristic)**

Frequency: f (Hz)	Allowable Noise Level
$f \leq 140$	72 dB or less
$140 \leq f \leq 250$	60 dB or less
$250 \leq f \leq 800$	57 dB or less
$800 \leq f \leq 2000$	52 dB or less

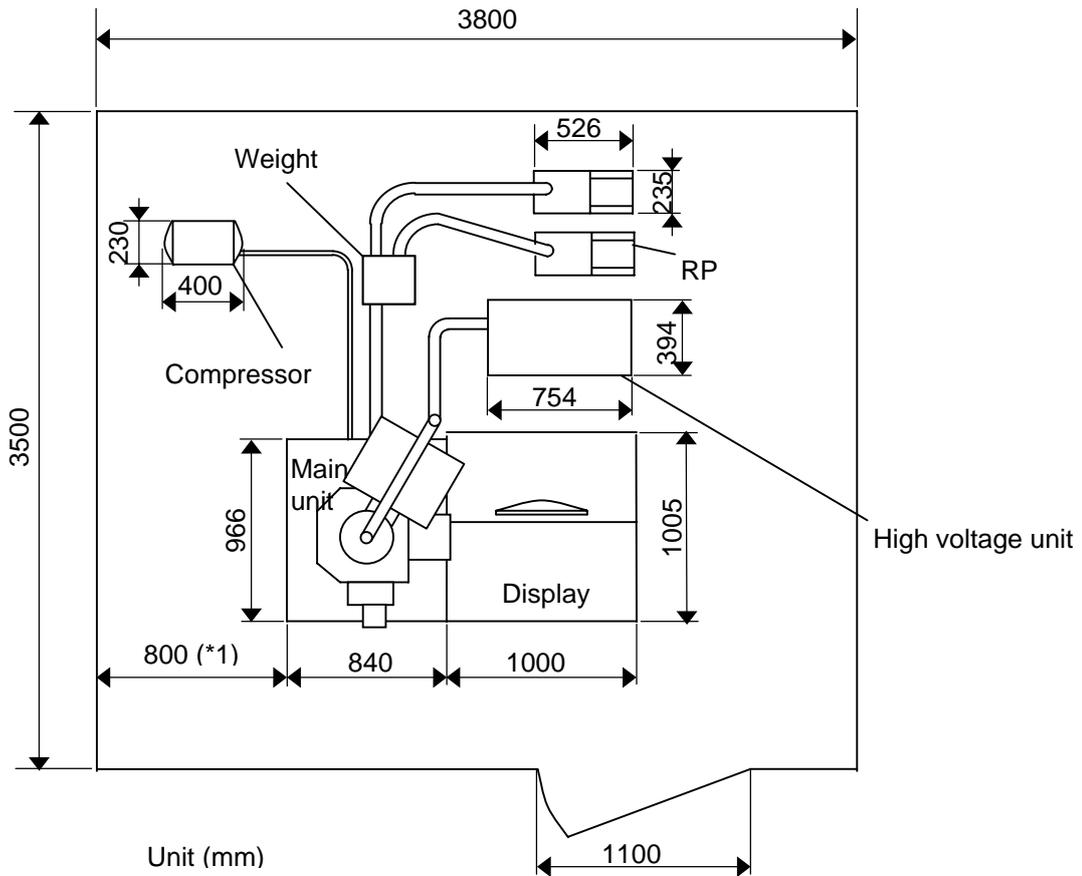
### 1.1.10 Site Requirements

- (1) Space required  
A room of about 3.8 m  $\times$  3.5 m is desirable.
- (2) Minimum dimensions of entrance  
1.1 m (W)  $\times$  1.8 m (H)
- (3) Durability of floor

$$\frac{\text{Floor loading capability (N/m}^2\text{)}}{3} \geq \frac{\text{Total weight of equipment (kg)} \times 9.8}{\text{Floor area of the room (m}^2\text{)}}$$

- (4) Instrument layout  
See Fig. 1-2 for a layout example.

1.1 Installation Requirements



\* Separate from the wall by 800 mm or more to allow maintenance.

**Fig. 1-2 Installation Layout Example**

**NOTICE:** 1. A space of around 800 mm must be reserved on the left side of the instrument for maintenance.

## 1.2 Items for Customer to Prepare

The items indicated in Table 1-5 should be prepared by the customer prior to installation.

**Table 1-5 Items for Customer to Prepare**

<b>Name of Item</b>	<b>Quantity</b>	<b>Remarks</b>
Ethanol	500 mL	Used for cleaning parts
Acetone	500 mL	Used for cleaning parts
Vacuum evaporator	1 set	Used to evaporate carbon onto specimen or to bake aperture plate
Magnetron sputtering coater	1 set	Used to coat metal onto specimen, or to coat metal onto aperture plate after baking
Ultrasonic cleaner	1 set	Used for cleaning parts
Desiccator or the like	1 set	For storing specimens and parts
Stereo-microscope	1 set	For checking specimens
Both-side conductive tape	1 roll	For fixing large specimens (in low-magnification use)
Conductive paste	20 g	For fixing specimens (in high-magnification use)

## 1.3 Wiring

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

Only cautions with respect to wiring are described here.

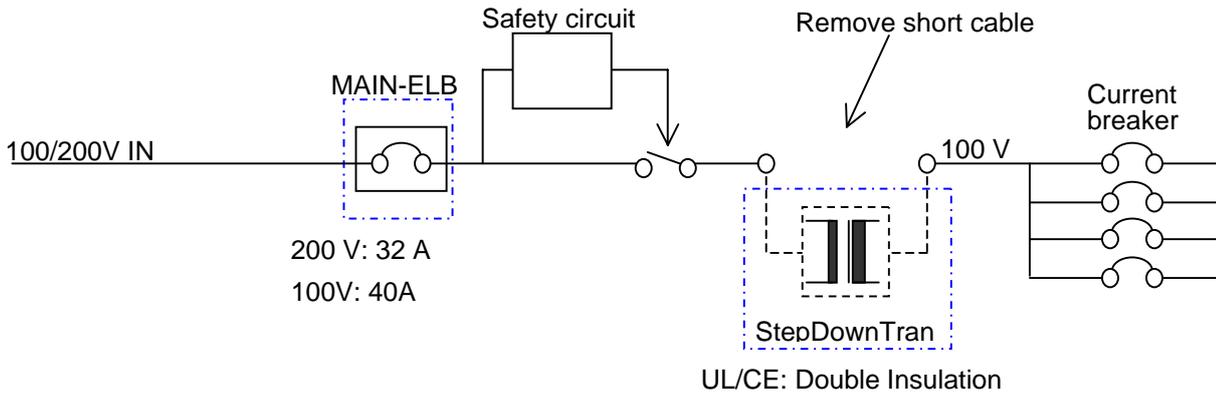
### 1.3 Wiring

#### 1.3.1 Power Supply and Ground Wiring

The instrument operates only with a power supply of AC100 V.

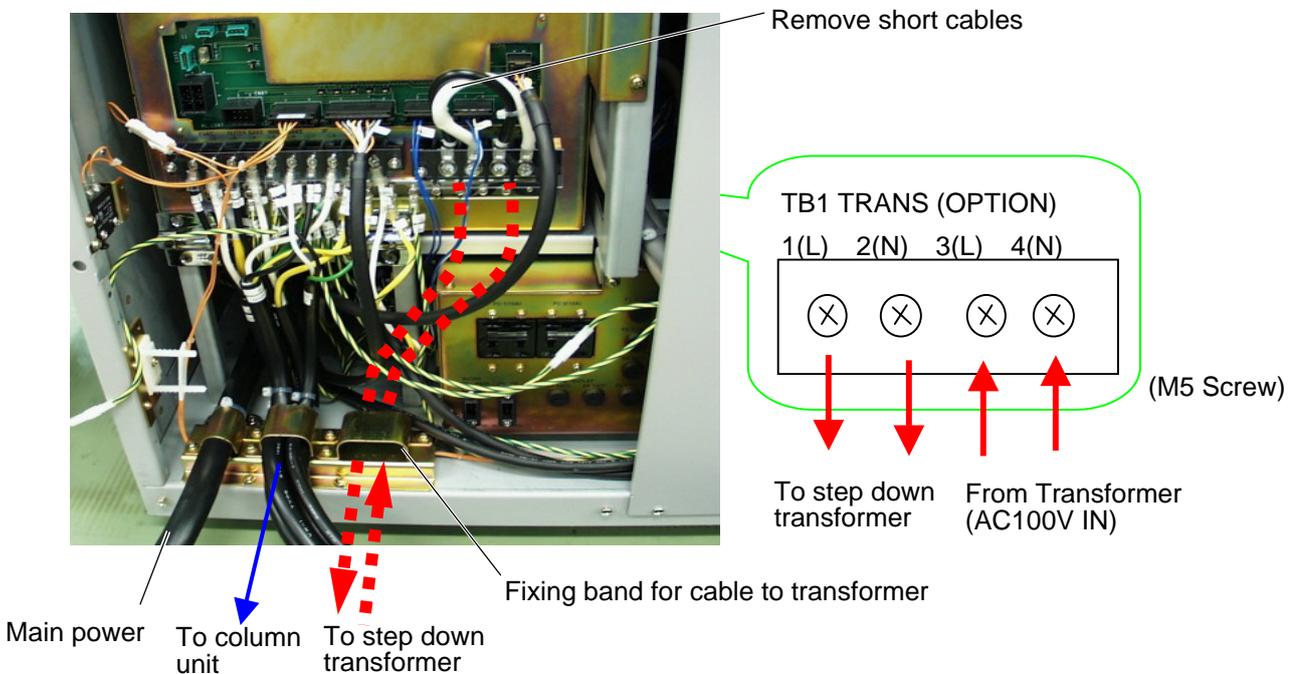
If using a power voltage other than AC100 V, the double insulation transformer (option) is required.

The transformer shall be positioned after the MAIN switch of SU6600. Fig. 1-3 shows connection of the step down transformer.



**Fig. 1-3 Connection of the Step down Transformer (1)**

To connect the transformer, remove the left side part of the rear cover of display unit. Remove the two short circuit cables connected on the TB1 terminal of the power distribution unit. Connect the input cable of the transformer to 1(L) and 2(N), and the output cable of the transformer to 3(L) and 4(N) terminals of the TB1. Refer to the following Fig. 1-4 for connection.



**Fig. 1-4 Connection of the Step down Transformer (2)**

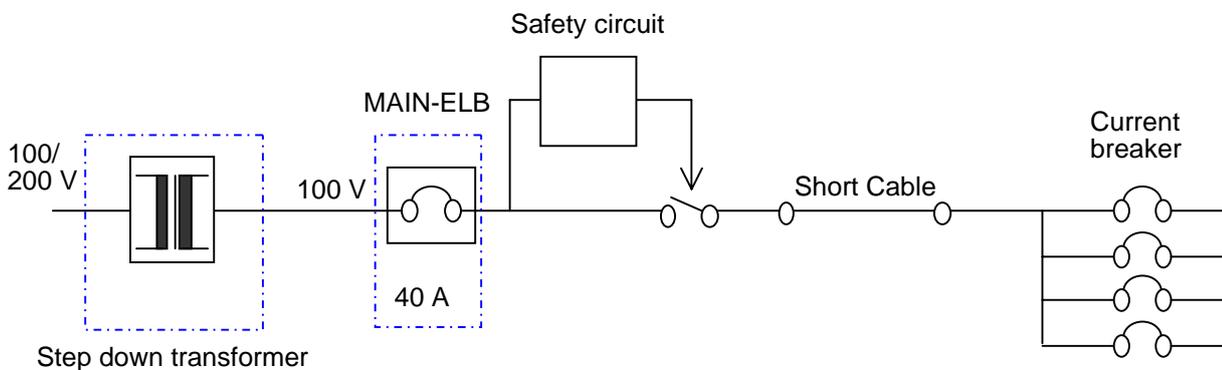
The cables of the step down transformer shall be prepared locally with the transformer.  
Use cables of 8 square mm diameter with M5 wire terminal.

**CAUTION:** Be sure that the output of the step down transformer is AC 100 V  $\pm$  10%. Irregular connection causing higher voltage will result in serious damage to the equipment.

Alternately the step down transformer may be located at the input of SU6600.  
In this case, connect the input of the transformer to the main breaker of the site power supply.

Connect the output to the Main breaker (ELB) of SU6600. Refer to Fig. 1-5 for the connection.

However, the former method (locating the step down transformer next to the SU6600 main breaker) is strongly recommended for safety.



**Fig. 1-5 Connection of the Step down Transformer (3)**

In both of the above cases, ground the instrument at a grounding resistance lower than 100 ohms. The grounding terminal must not be common to other electric equipment, i.e. exclusive grounding should be provided.

**NOTE:** The instrument is provided with one of the following two types of main ELB.

- (1) For use with 200 to 240 V power line  
Leakage current breaker (with key lock, CE/UL conformity)
 

Capacity	: 6.4 kVA
Maximum current	: 32 A
Sensitive current	: 30 mA
Short-circuit breaking capacity:	25 kA
- (2) For use with 100 V power line  
Leakage current breaker (without key lock, CE or UL non-conformity)
 

Capacity	: 4 kVA
Maximum current	: 40 A
Sensitive current	: 30 mA
Short-circuit breaking capacity:	5 kA

Instruments shipped to the USA and Europe and required to meet the S2 guideline are provided with the type in (1) above.

## 2. FUNCTIONS

Figure 2-1 shows the appearance of the Model SU6600. X-ray analysis units (EDX and WDX) and the crystal orientation measurement units (EBSP), which are optional hardware, are not included with the SU6600.

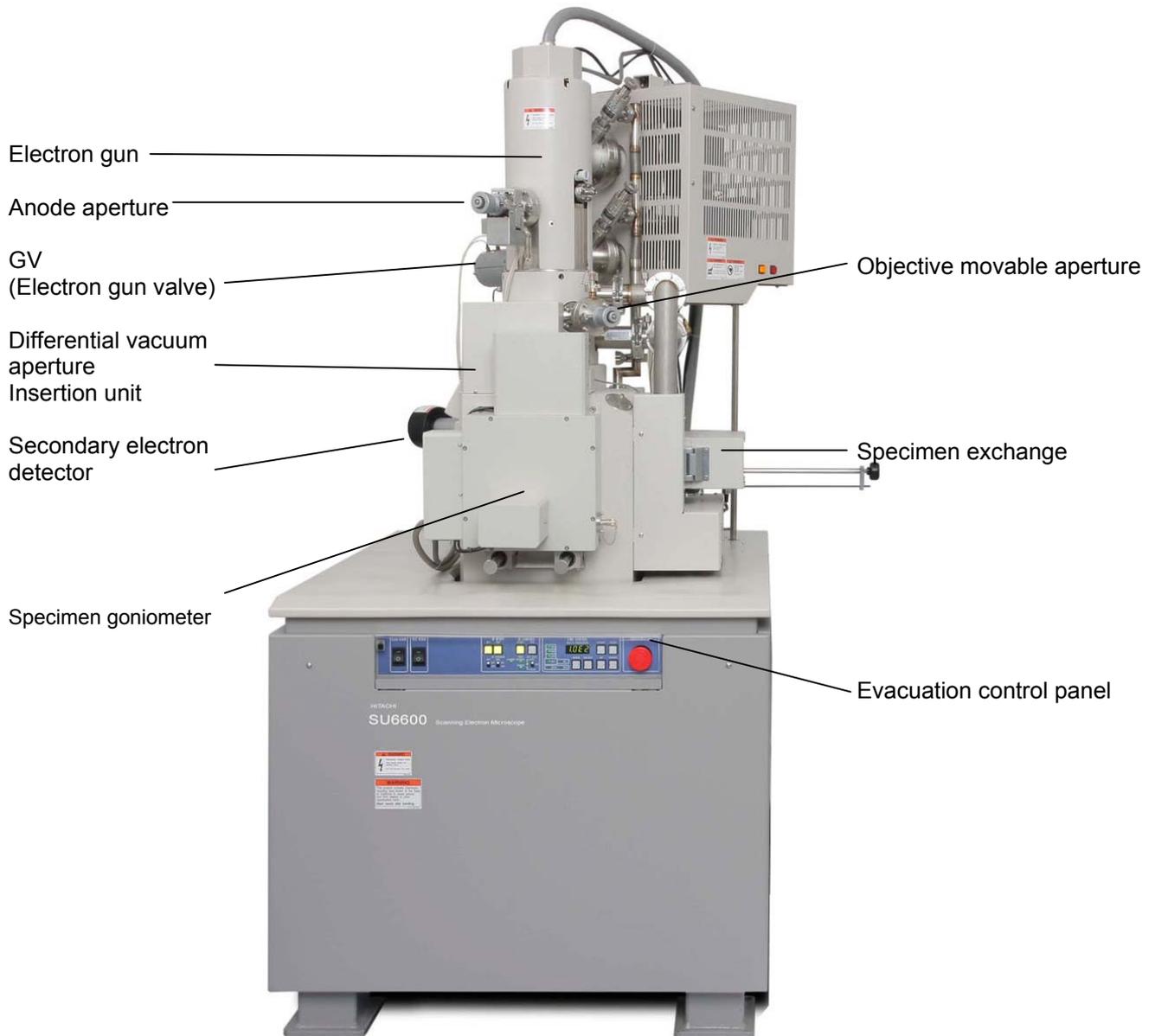


**Fig. 2-1 Model SU6600 System**

## 2.1 Control Knobs and Switches on Main Unit

### 2.1.1 Main Unit (Column)

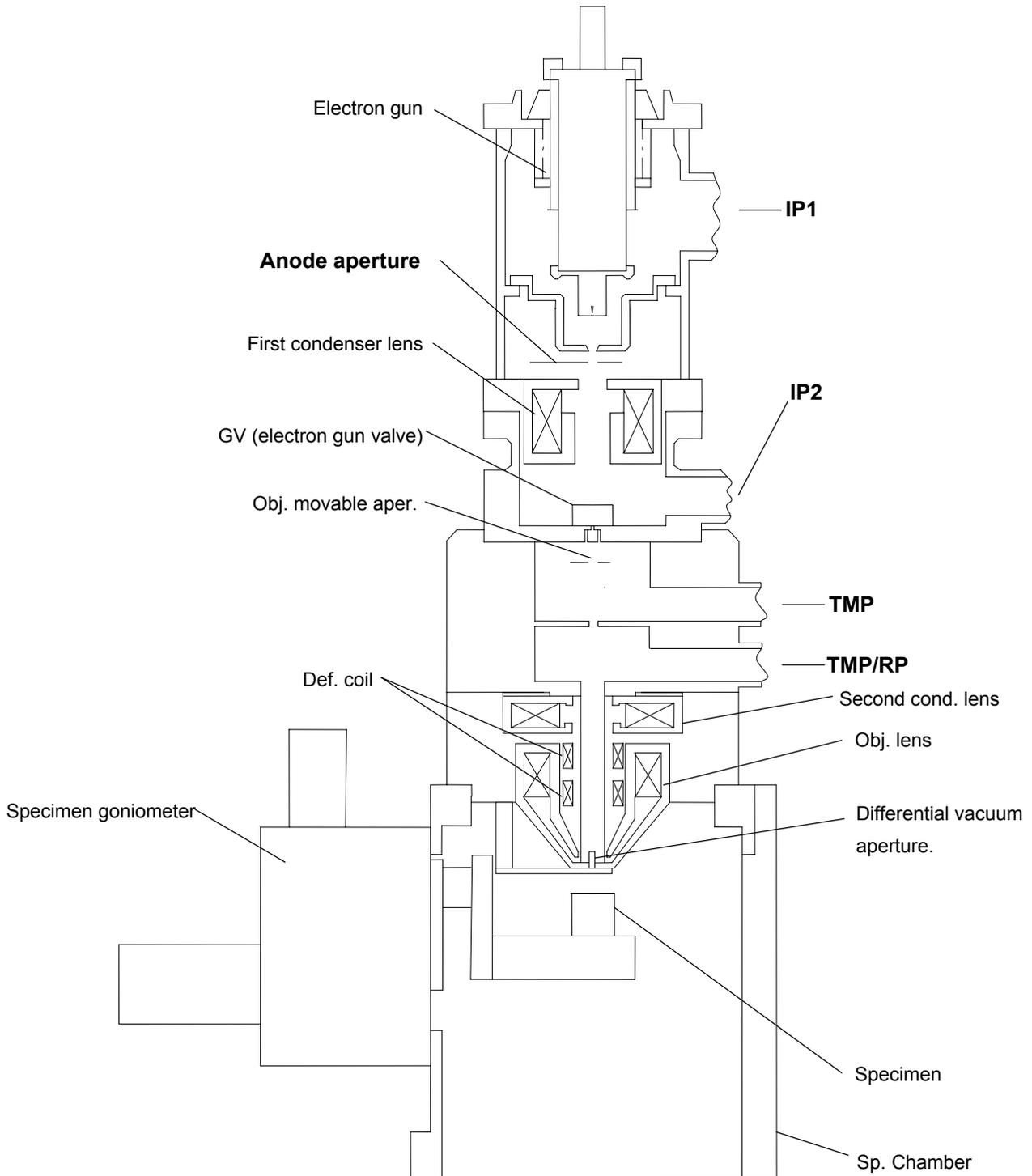
Figure 2-2 shows the appearance of the SU6600 main unit.



**Fig. 2-2 SU6600 Main Unit**

### 2.1.2 Electron Optical Column

Figure 2-3 shows the sectional view of the SU6600 column.

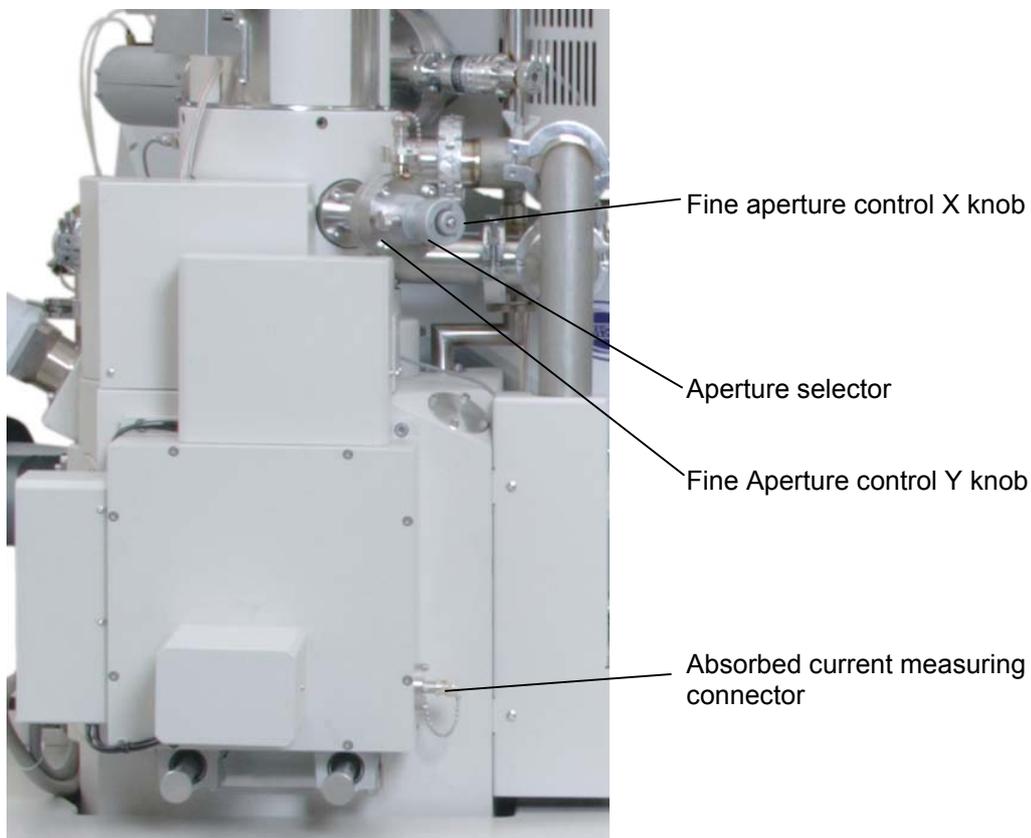


**Fig. 2-3 Sectional View of SU6600 Column**



### 2.1.3 Specimen Stage

Figure 2-4 shows the appearance of specimen stage.

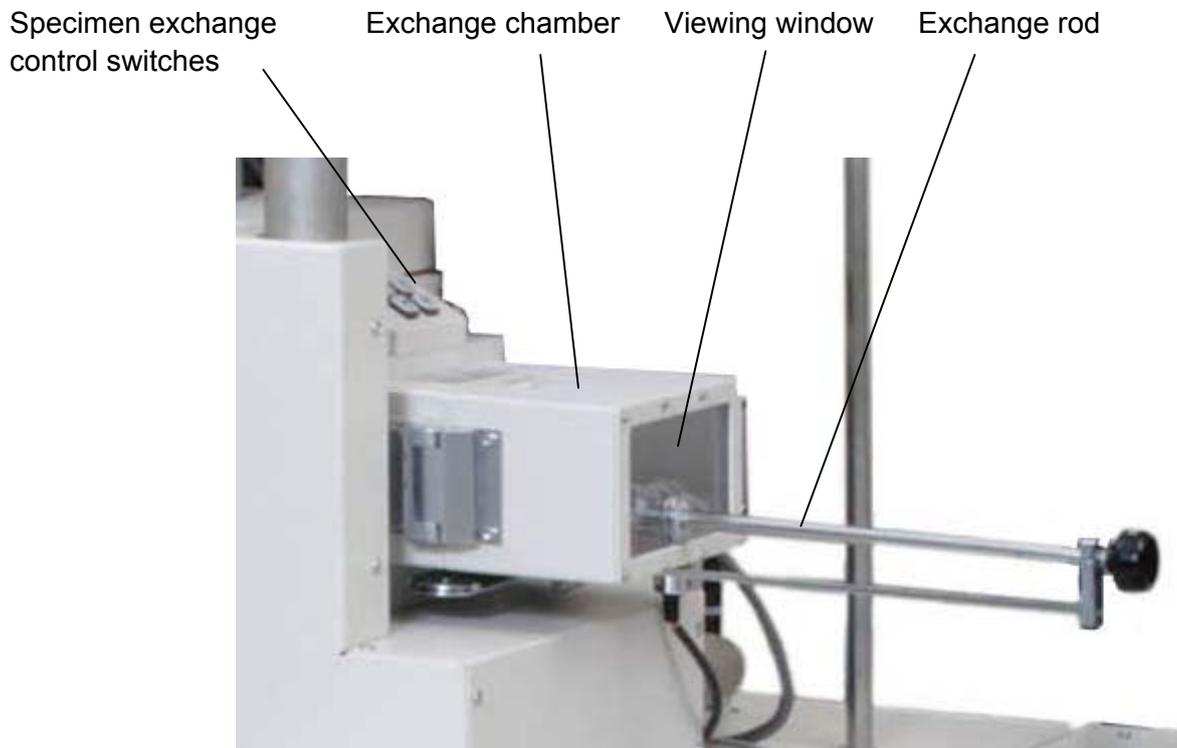


**Fig. 2-4 Large Specimen Stage**

- Range of movement in X direction : 0 to 110 mm
- Range of movement in Y direction : 0 to 110 mm
- Range of movement in Z direction : WD = 4 to 40 mm  
(X-ray analysis position is at 15 mm working distance)
- Range of movement in R direction : 360° continuously
- Range of movement in T direction : -5° to 70°

## 2.1.4 Specimen Exchange

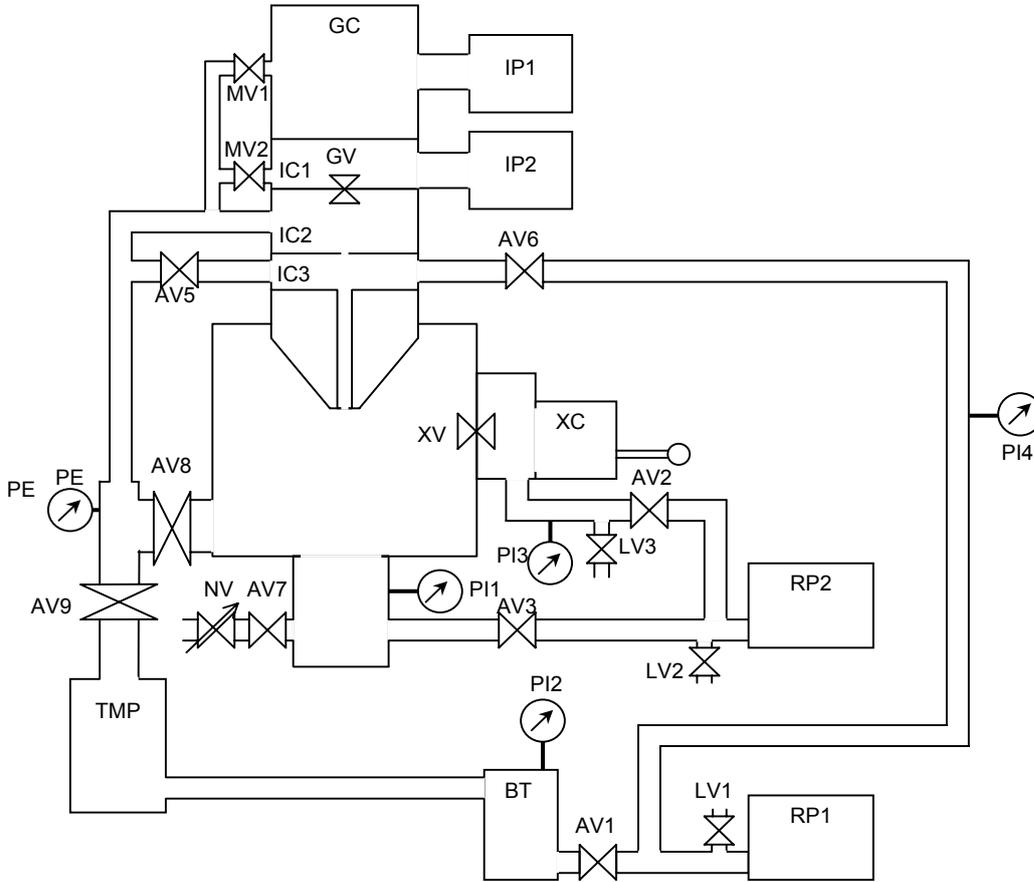
Figure 2-5 shows the specimen exchange.



**Fig. 2-5 Specimen Exchange**

### 2.1.5 Evacuation System

Figure 2-6 shows the block diagram of evacuating system.

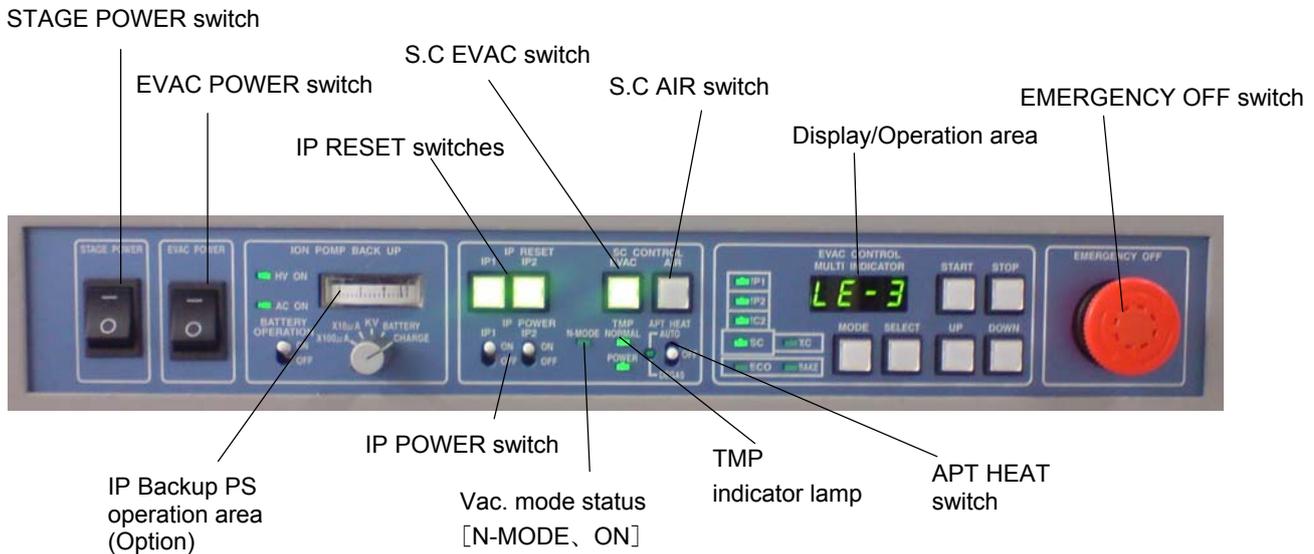


**Fig. 2-6 Evacuating System**

- IP1, IP2 : Ion pumps
- TMP : Turbo-molecular pump
- RP1~RP2 : Rotary pump
- BT : Buffer tank  
Keeps backing pressure for the TMP while RP is evacuating specimen exchange chamber.
- XV : A gate valve between the specimen chamber and the specimen exchange chamber, the XV opens during specimen exchange and closes during image observation.
- MV1, MV2 : Manual valves to evacuate gun and intermediate chambers
- GV : An isolation valve between the electron gun and the specimen chamber, the GV works in tandem with the application of a high voltage to the electron gun and operates automatically.
- AV1~AV9 : Auto valves  
These valves operate automatically, such as during the switching between high- and low-vacuum modes, by means of evacuation system control signals.
- NV : This is a needle valve that control the vacuum level in the specimen chamber in low-vacuum mode.
- LV1~LV2 : Leak valves to vent rotary pumps
- LV3 : Leak value that vents the specimen exchange chamber.
- PI1~PI4 : Pirani vacuum gauges (for measuring low vacuum levels)
- PeG : Penning vacuum gauge (for measuring high vacuum levels)

## 2.1.6 Evacuation Control Panel

Figure 2-7 shows the control panel for evacuation.



**Fig. 2-7 Evacuation Control Panel**

- |                             |   |  |
|-----------------------------|---|--|
| EMERGENCY OFF switch        | : | Shuts down SU6600 entirely in an emergency.  |
| EVAC POWER switch           | : | Main switch of evacuation system.  |
| STAGE POWER switch          | : | Main switch of stage controller .  |
| IP Backup PS operation area | : | Optional ion pump backup power supply operation area.  |
| IP POWER switches           | : | Power switches of ion pump high voltage.   |
| IP RESET switches           | : | Reset switches of ion pump high voltage.<br>Lamps inside of switches light up when IP high voltage is ON.  |
| SC EVAC switch              | : | Starts specimen chamber evacuation. The lamp blinks while the sequence is progressing.   |
| SC AIR switch               | : | Starts introduction of air into specimen chamber.  |
| Vacuum mode indicator light | : | Lights up when the specimen chamber is in the low-vacuum mode.   |
| TMP indicator lamps         | : | POWER lamp indicates TMP power is ON. NORMAL shows the TMP is in a normal running state.   |
| APT HEAT switch             | : | When turned to AUTO, the heaters of objective lens aperture and aperture under the gun valve will turn on when specimen chamber vacuum is high. When turned to <b>DEGAS</b> , the heater is kept at higher temperature for degassing. Set to <b>AUTO</b> for normal operation. The lamp is lit while heater current is ON. |

### 2.1.7 Evacuation Control Panel (Display/Operation Area)

Figure 2-8 shows the Display/Operation area.

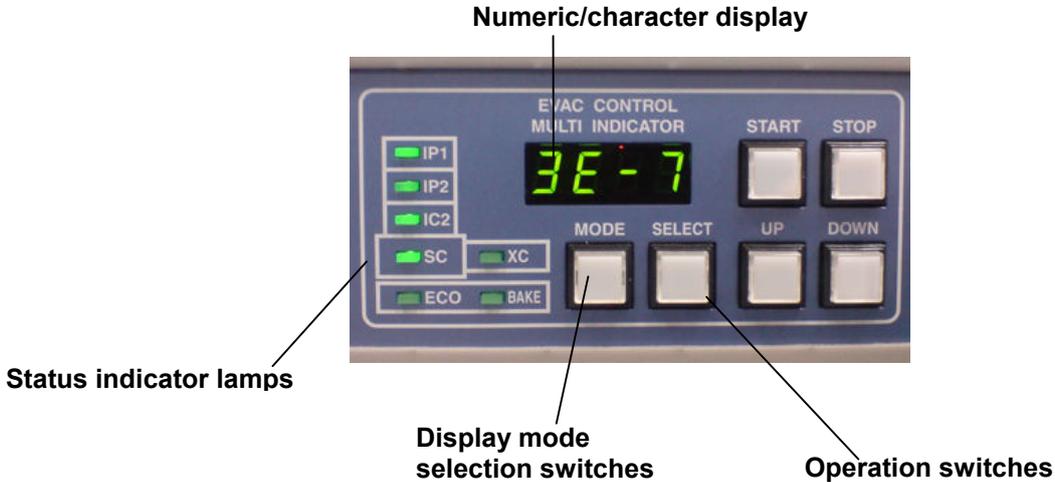


Fig. 2-8 Display/Operation Area

Vacuum of each chamber, status of evacuation sequence and messages are displayed on this area.

- Status indicator lamps :

When each lamp (IP1 to BAKE) is lit, it shows that the corresponding chamber has good vacuum. A blinking lamp shows that the numeric/character display is indicating vacuum of the corresponding chamber. For example, when the SC lamp is blinking and the displayed value is 3E-3, it indicates that vacuum of specimen chamber is  $3 \times 10^{-3}$  Pa.

- Display mode selection switches :

**MODE** : By pressing this switch, the blinking status indicator lamp will move to the next one, in the order of IP1→IP2→IC2→S.C→XE→ECO→BAKE→Initial (no indication).

**SELECT**: When the above status is in Initial, ECO or BAKE, the SELECT switch further changes the numeric/character display to lower level indication.

- Operation switches :

**UP DOWN** switch : Increase or decrease time setting for ECO mode and BAKE mode.

**START STOP** switch: Start and stop baking and ECO mode.

- Numeric/character display :

Indicates status code, vacuum, time and messages.

The display status changes as in the following table by depressing the MODE switch.

Display Status	Status Indicator Lamp	Numeric/Character Display	Description
Initial status	No lamp blinks	No indication	(Normal running status)
IP1	IP1 lamp blinks	IP1 vacuum	XE-Y (X-Y Pa)
IP2	IP2 lamp blinks	IP2 vacuum	XE-Y (X-Y Pa)
IC2	IC2 indicator blinks	IC2 vacuum level	XE-Y (X <sup>-Y</sup> Pa)
S.C	S.C lamp blinks	Specimen chamber vacuum	XE-Y (X-Y Pa)
XC	XC lamp blinks	Specimen exchange chamber vacuum	XE-Y (X-Y Pa)
ECO	ECO lamp blinks	00.00	Evacuation start time (refer to 3.9.17 )
BAKE	BAKE lamp blinks	10.00	Baking time (refer to 4.9 )

In the initial status, the display status changes as in the following table by depressing the SELECT switch.

Display Status	Numeric/Character Display	Description
Initial status	No indication	(Normal running status)
Date	XX.XX	month. day
Time display	XX.XX	Time display (in hours and minutes)

Other indications will appear on the numeric/character display.

Numeric/Character Display	Description
APXX	Waiting cooling time for the aperture heater before stopping evacuation or introducing air into specimen chamber. XX is in minutes.
PdXX	Waiting for TMP to stop its revolution. Pd means "Power Down". XX is in minutes
E-XX	Alarm or error message. XX is number of the message.
POFF	"Power off". It shows that the evacuation power (pumps, valves) is shut off (control power supply is on).

The following tables show alarms or error messages and how to recover from an error.

Errors with (\*) mark are caused by failure of the equipment.

[Error or warning that can potentially be generated even if the system is not faulty]

Message No.	Description	Recovery Procedure
E13 (+ buzzer)	Specimen exchange chamber is not closed when the chamber is to be evacuated.	Close the chamber.
E20 (+ buzzer)	Specimen exchange rod is not at proper position when the GV is to be closed.	Pull out the rod fully.
E22 (+ buzzer)	Aperture heater current is off while the <b>APERT HEAT</b> switch is at <b>AUTO</b> or <b>DEGAS</b> .	<ul style="list-style-type: none"> <li>• Check the heater cable connection between the cable connected from the lower side of the objective lens aperture unit and the electron gun valve aperture.</li> <li>• If the alarm cannot be recovered, turn <b>APERT HEAT</b> switch to <b>OFF</b> to stop the alarm.</li> <li>• Contact the service engineer because operation without heating the aperture will cause contamination on the aperture plate.</li> </ul>
E23 (+ buzzer)	Air pressure for driving valves is lower than its limit value. Evacuation sequence stops.	<ul style="list-style-type: none"> <li>• When using an air compressor, check the valve at the air output.</li> <li>• When using utility air, check the air supply.</li> <li>• Evacuation sequence will recover when the air supply becomes normal pressure.</li> <li>• If the alarm cannot be remedied, contact the service engineer.</li> </ul>

## [Alarms related to gun baking]

Message No.	Description	Recovery Procedure
E31 (+ buzzer)	HV cable head is not placed to the cable holder properly.	Refer to 4.9.
E32 (+ buzzer)	Baking protection cover is not attached.	
E34 (+ buzzer)	Ion pump high voltage is not applied.	
E35 (+ buzzer)	Ion pump 1 vacuum degraded while baking	
E36 (+ buzzer)	Baking time setting is not correct.	

## [Alarms related to ECO mode setting]

E37 (+ buzzer)	Start gun baking while in ECO mode	Refer to 3.9.17 .
E38 (+ buzzer)	Evacuation start time must be 5 hours or more from present time.	
E39 (+ buzzer)	Start ECO mode while gun baking	
E99 (+ buzzer)	When one of the conditions E01 to E25 occurs or the exchange rod sensor is off, the condition is flagged as an error.	Check the condition of the exchange rod; if it is normal, contact the service engineer.

## [Errors due to equipment failure]

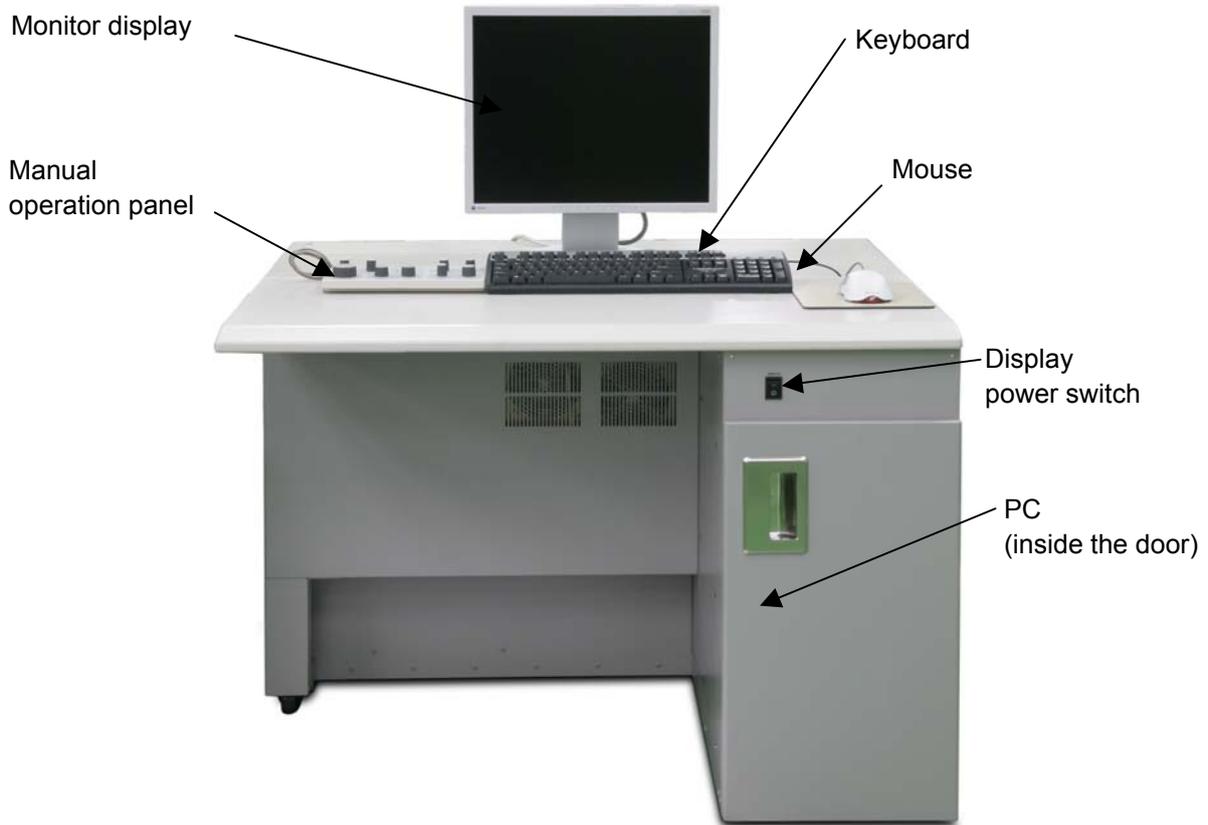
E01 (*)	Control power supply error (DC 24 V)	Contact the service engineer. (Error E05 or E08 may be shown by power supply error)	
E02 (*)	Control power supply error (DC 15 V)		
E03 (*)	Control power supply error (DC 12 V)		
E04 (*)	Vacuum valve did not work correctly		
E05/E06 (*)	Rotary pump (or dry pump) is not working		
E07 (*)	XV did not work correctly		
E08 (*)	Filament of Pi gauge broken		
E09 (*)	Faulty Penning gauge.		
E10 (+ buzzer)	TMP failure		<ul style="list-style-type: none"> <li>• Turn the EVAC POWER switch to OFF. After "POFF" is indicated, turn the switch to ON.</li> <li>• If the error message appears again contact the service engineer.</li> </ul>
E11 (+ buzzer)	TMP backing pressure is too high.		



## 2.2 Control Knobs and Switches on Display Unit

### 2.2.1 Display Console

Figure 2-9 shows the display unit.

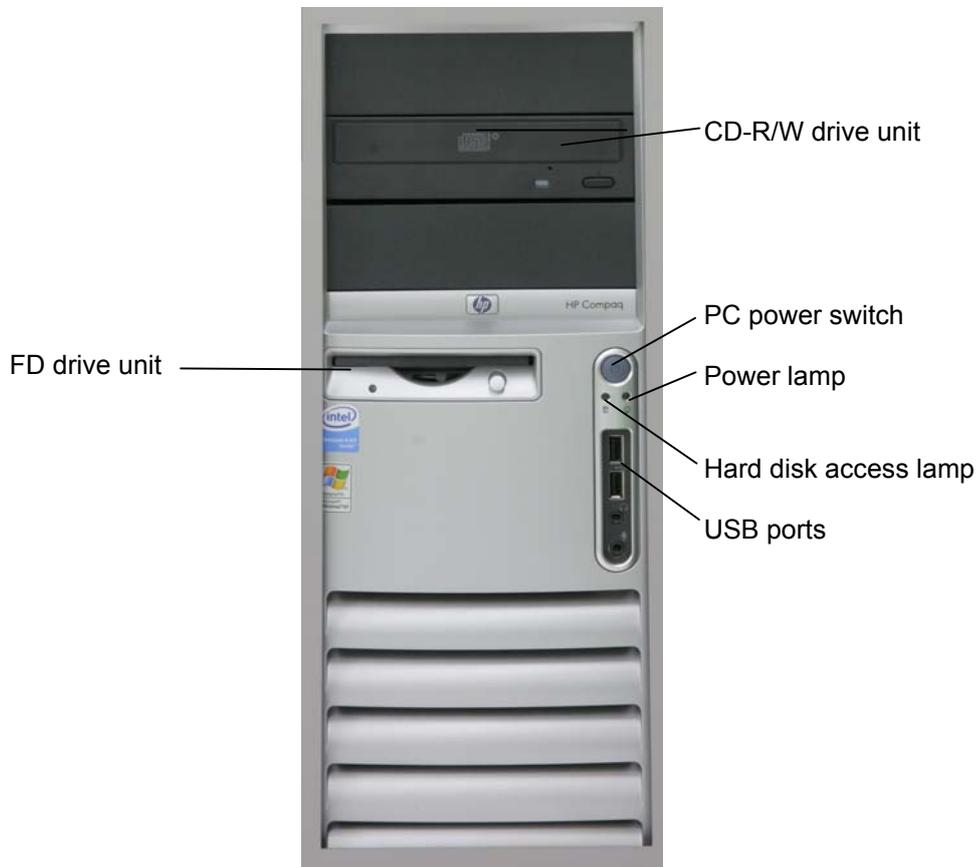


**Fig. 2-9 Display Unit**

- PC : SEM control personal computer. Located inside 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.
- Display power switch : Power switch of display unit. Power of PC also controlled with the switch. Be careful not to shut the power switch off before shutting down PC.

## 2.2.2 PC (Personal Computer)

Figure 2-10 shows the front panel of PC.

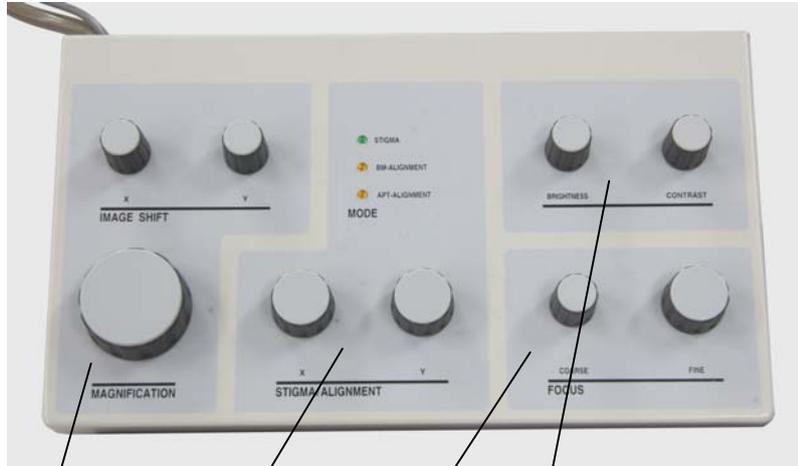


**Fig. 2-10 PC Panel**

- PC power switch : Power switch of PC. Usually the switch need not be used. PC power is controlled with display power switch.
- FD drive unit : Floppy disk drive. Be careful not to insert or remove disk while the access lamp is lit.
- CD-ROM drive unit : CD-ROM drive. Optionally changed to CDR/W drive.
- Hard disk access lamp : Shows that hard disk is being accessed.
- USB ports : Ports for USB interface equipments.  
Note that using USB interface equipments possibly causes some trouble to SEM operation.

### 2.2.3 Manual Operation Panel

Figure 2-11 shows the manual operation panel.



Magnification/Image shift control section

Stigma/alignment adjusting section

Brightness/Contrast adjusting section

Focus adjusting section

**Fig. 2-11 Manual Operation Panel**

- Stigma/alignment adjusting section

[Stigma/alignment] [X], [Y] knobs :

Used for astigmatism correction in a usual practice. In the electron optics alignment mode, these knobs serve for alignment adjustment.

- Focus adjusting section

[Focus] [Coarse] [Fine] knobs :

Used for coarse and fine focus adjustment.

- Magnification/Image shift control section

[Magnification] knob : Used for magnification setting.

[Image Shift] knobs : Move image by electronic image shift.

- Brightness/Contrast adjusting section

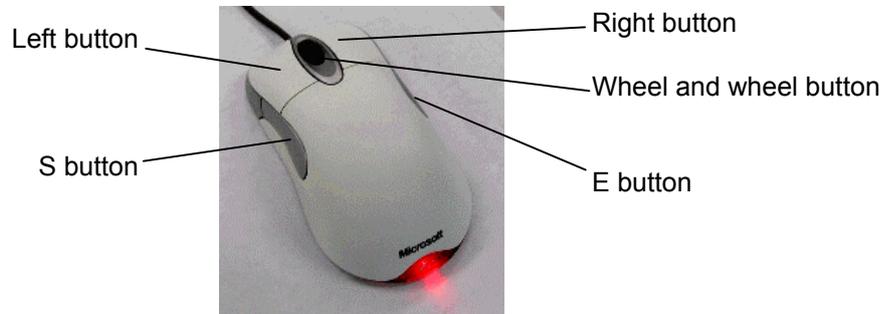
[Brightness] knob : Used for brightness adjustment.

[Contrast] knob : Used for contrast adjustment.

## 2.2.4 Mouse and Trackball

Figure 2-12 shows the mouse.

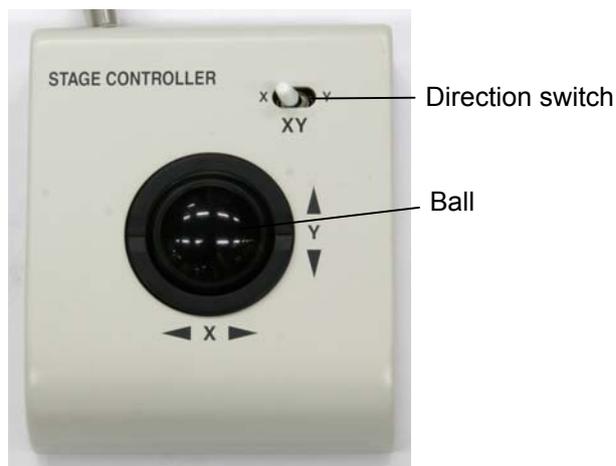
The mouse has an additional two side buttons, S and E buttons.



**Fig. 2-12 Mouse**

Figure 2-13 shows the trackball unit.

It is used for stage X and Y-axis manual operation.



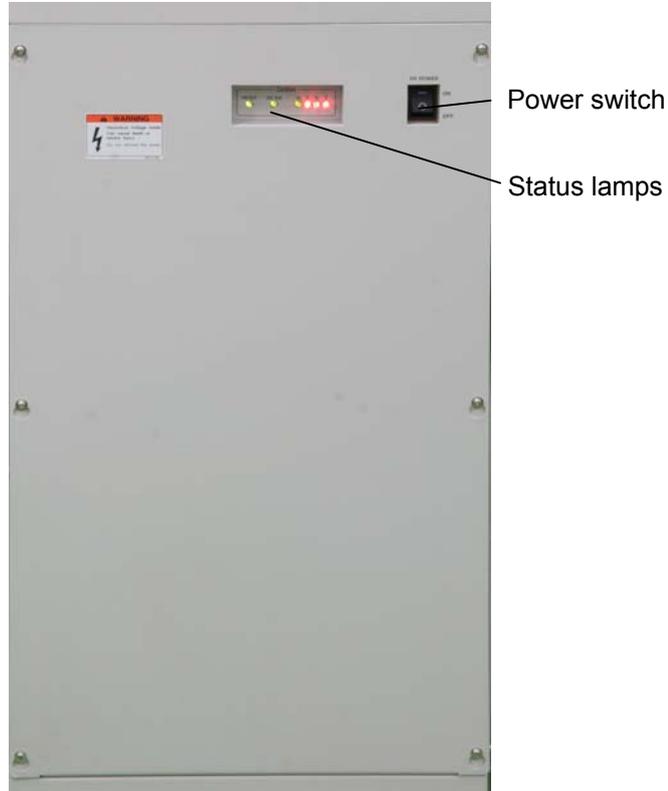
**Fig. 2-13 Manual Operation Panel**

The trackball drives the stage in X and Y directions so the image will move in the direction of ball rotation. The movement directions can be reversed (refer to < 3.9.14 >).

Direction of stage movement can be limited only to X (horizontal) or Y (vertical) by setting the Direction switch to X or Y. Usually set it at XY for both X and Y direction control.

### 2.2.5 GUN High-Voltage Power Supply Unit

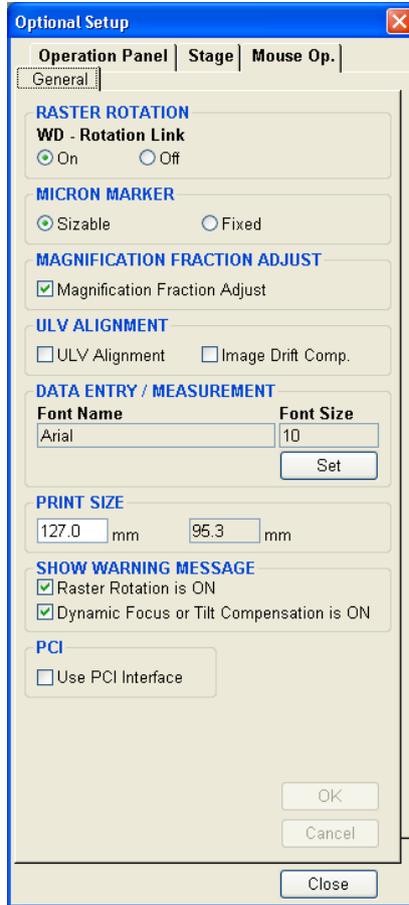
Figure 2-14 shows the GUN high-voltage power supply unit.



**Fig. 2-14 GUN High-Voltage Power Supply Unit**

- Power switch : GUN high-voltage power can be turned on when the ion pump power is supplied.  
The GUN high-voltage power shall be turned on before turning the Display power on. Do not turn GUN high-voltage power switch off while the Schottky emitter is working. Perform GUN Shutdown before turning the switch off.
  
- Status lamps : GUN high-voltage power can be turned on when the ion pump :
  - PROTECT lamp : Green when working normally. Red color shows occurrence of some error.
  - CPU RUN lamp : Green color shows the control computer is running.  
Red color shows occurrence of some error.
  - V0, V1, Vs, If lamp : Red color shows that high-voltage or current of each is applied.

## 2.3 Graphical User Interface (GUI)



### 2.3.1 Starting the PC and Login in the SU6600 Program

Use the following steps to logon to Windows XP.

- (1) Starting up the PC  
Turn the display power switch on. For some models of PC, the power switch of the PC should be turned on.
- (2) Login  
A message requesting a login 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 login dialog window will appear. Enter login name and password.  
Use login name “**SU6600**” to operate SU6600. Initially no password is set for it.  
The user may set or change the password (refer to the manual of Windows XP).

**NOTICE:** Initially the following settings are made when the instrument is shipped from the factory.

**Administrator:** Administrator level, no password

**SU6600:** Power user level, no password

(“SU6600 ” is set to **Power User** level because, unlike NT, the Windows XP does not allow changing the registration of User level.)

For operation of Windows, refer to the instruction manual for Windows XP <sup>(R)</sup>.

SU6600 control program will start up automatically. When starting SU6600 control program after once terminating it, select Start – PC\_SEM on the taskbar. If a shortcut to it has been created, double-clicking the PC-SEM  icon will start the SU6600 control program.

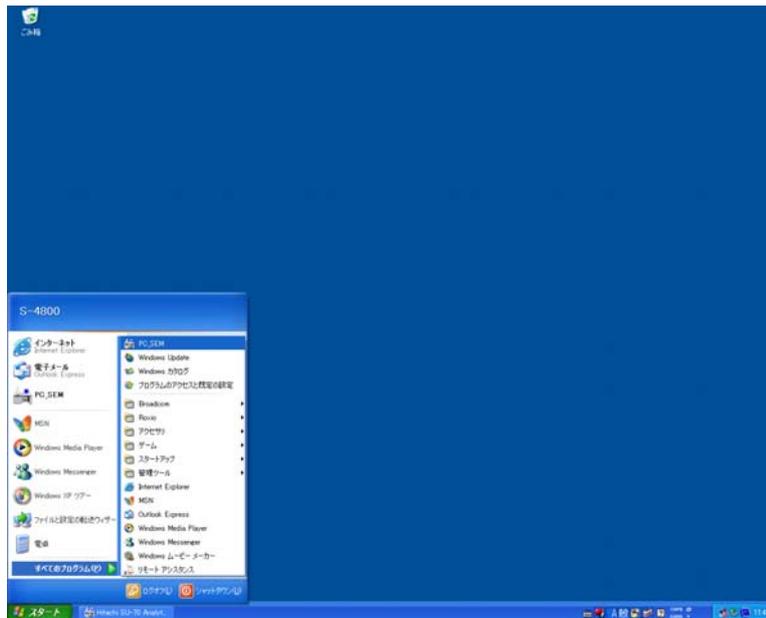


Fig. 2-15 Example of the Windows Desktop

(Windows XP <sup>(R)</sup> is a trademark of Microsoft Corp.)

The SU6600 login dialog window will open.



**Fig. 2-16 SU6600 Login Dialog Window**

At the first startup after installation of the program, use the login name [**SU6600**] and click the **OK** button. You need no Password.

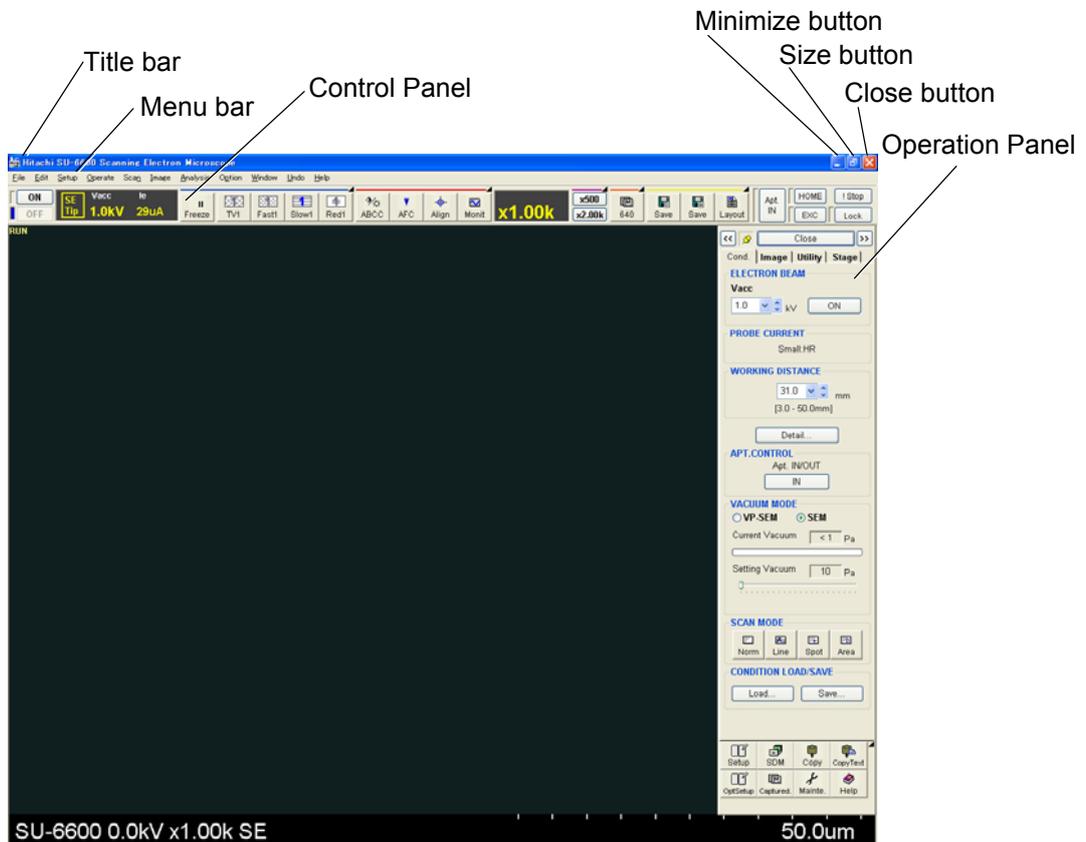
After login names and passwords have been set, input the name and the password and then click the **OK** button.

- NOTICE:**
- The system supervisor shall be responsible for setting and maintaining login names and passwords.  
Refer to < 3.9.16 >
  - Setting or change of password for a login name once registered with the above operation can be made using the Password Setting dialog window.  
Refer to < 3.9.15 >



### 2.3.2 SU6600 SEM Main Window

Figure 2-17 shows the main window for operation of the microscope.



**Fig. 2-17 SU6600 Main Window**

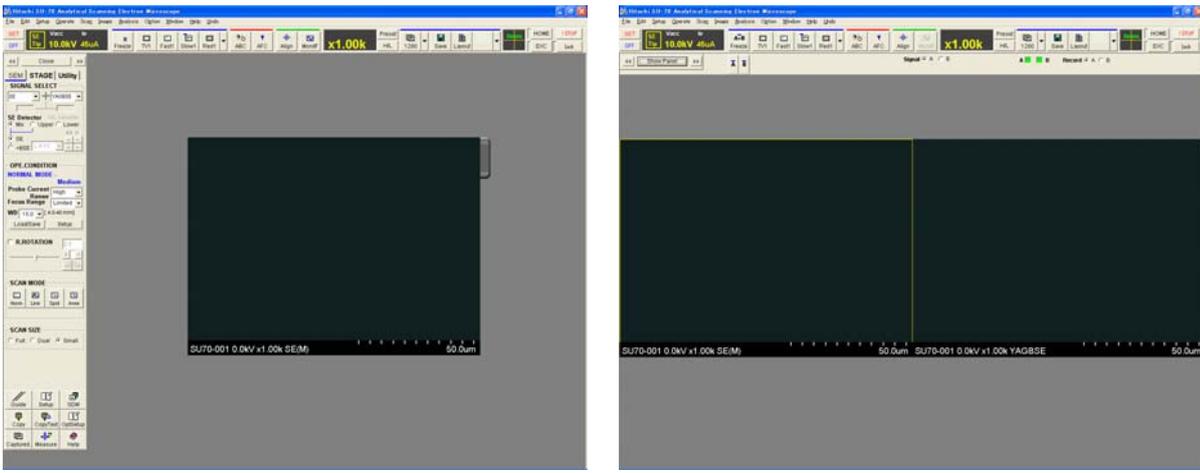
- Title bar: Shows the window title.
- Minimize button: Minimizes the window size. The window is iconized and placed on the Task bar.
- Size button: The window status becomes Normal type. You can change the window size. Clicking the button changes it to Maximize button.
- Close button: Terminates the SU6600 operation program and closes the window.
- Menu bar: Clicking a main menu on the menu bar shows a pull-down menu. Click 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: Basic functions are placed on the operation panel. It has three tabs - SEM (basic functions), STAGE (Stage operation) and Utility.

The  button hides the panel, and alternate  shows it again. Position of the panel can be moved to left or right side with  and  buttons.

To fix the panel, click the yellow thumbtack (  ) button.

Three modes of scanning image display are available, Full screen (shown on previous page), Small screen (Fig. 2-18 left) and Dual screen (Fig. 2-18 right).



**Fig. 2-18 SU6600 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. Usual operation can be carried out using the **Control panel** and the manual operation panel.

(2) **Operation panel**

The Operation Panel is divided into four tabs” **Cond.**, **Image**, **Utility**, and **Stage**.

- **Cond.** tab  
This tab contains controls related to the setting of conditions on the electron optical system.
- **Image** tab  
This tab contains controls related to the setting of an image display size and the detector.
- **Utility** tab  
This tab contains controls related to utility functions.
- **Stage** tab  
This tab contains controls for the 5-axis motor drive stage.

The controls provided on the **Cond.**, **Image**, and **Utility** tabs are user-selectable, and any functions that are not needed can be deleted.

To set a condition, from the **Option** menu, run **Optional Setup – Op. Panel Setting**.

In addition, up to eight tool buttons can be set at the bottom of the Operation Panel. The tool buttons provided there can be selected by executing the **Assignment Tool Buttons** from the **Option** menu.

(3) **Menu bar**

Most functions are executed from the menu bar.

(4) **Mouse operation** on the scanning image

The S button of mouse changes operation on the scanning image alternately.

The following operations are available using the mouse.

- Image adjustment  
Focusing, astigmatism correction and brightness/contrast adjustment
- Stage operation  
X/Y operation as with joystick, plus rotation, Z and tilt control and image shift
- Image shift

- (5) **Popup menu**  
Clicking the wheel button of mouse shows a popup menu.
- (6) **Shortcut keys**  
Some shortcut keys are specified.

### 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 < 3.12 >.
  - **Direct Save and Quick Save**  
Saves the images being observed, including images frozen by the Run/Freeze switch and the images captured and displayed on an observation image.  
Characters and graphics written with the data entry tool, when saved while displayed on the image area, are embedded in the image. The same applies to measurements and text obtained by the measurement function.  
To save an image, either click the **Save**  button on the Control Panel or execute **Direct Save** from the **File** menu. A **Save Image** window that allows you to save the image by assigning a name opens in the figure below.
  - **Layout Print**  
Opens the **Report Generation** dialog window. Use it for printing images to a Windows-supported printer.  
To print captured images, use **Layout Print**  button on the **Captured Image** window. And for saved images, use the print function on the **SEM Data Manager**.  
Refer to < 3.9.10 >.
  - **Assignment Record Buttons**  
This option allows you to assign Record Function buttons in the Control Panel.
  - **Password Lock**  
Starts the windows password lock. To unlock Windows, you need the password for Windows login.  
Refer to < 3.9.20 >
  - **Exit**  
Closes SEM operation.

(2) **Edit** menu:

The Edit menu includes commands for copying displayed images and attributes to the Windows clipboard.

- Copy Image  
Copies displayed images to the Windows clipboard.  
Refer to < 3.9.11 >.
- Copy Attribute  
Copies data of the displayed images to the Windows clipboard.  
Refer to < 3.9.12 >.

(3) **Setup** menu:

The Setup menu includes commands for opening the Setup dialog windows for operation of HV, column and others.

- GUN Startup  
Startup GUN operation. Activate the Schottky emission.
- GUN Shutdown  
Shutdown GUN power supply and stops emission.
- GUN valve  
Open the tool window for opening/closing operation of gun isolation valve. Use it for vacuum conditioning after venting air into specimen chamber.
- Optics  
Opens the Optics tab of the Setup dialog window. Use it to select the optimal electron optical column condition.  
Refer to < 3.4.2 >.
- Condition Load  
Opens the Op. Cond. Tab of the Setup dialog window.  
Use it for loading and reproducing previously saved electron optical column conditions.  
Refer to < 3.9.6 >.
- Condition Save  
Opens the Op. Cond. Tab of the Setup dialog window.  
Use it for saving present electron optical column conditions.  
Refer to < 3.9.6 >.
- Image Display  
Opens the Image tab of the Setup dialog window. Use it for setting the preset magnification, contrast and brightness of ABCC, and capture speed.  
Refer to < 2.3.9.2 >.
- Data Display  
Opens the Record tab of the Setup dialog window. Use it to turn data display On/Off and select specific information to be printed on the image.  
Refer to < 2.3.9.3 >.
- Mag. Preset Setup  
A magnification preset **Setup** window opens.

(4) **Operate** menu:

The Operate menu includes commands for column alignment, motorized stage (Type 2 instrument only), auto functions etc.

- **Alignment**  
Opens the Alignment dialog window. Use it for column alignment.  
Refer to < 3.4.3 >.
- **Alignment-Next**  
Changes to next (or previous) alignment function.
- **Image Adjustment**  
Displays an **Image Adjustment** window for adjusting the focus, stigma, brightness, or image shift.  
Reference: 3.5.3, and 3.5.4.
- **ABCC**  
Executes automatic brightness and contrast control.  
Refer to < 3.5.4 >.
- **Auto Focus**  
Executes automatic focusing.  
Refer to < 3.5.5 >.
- **Auto Stigma**  
Executes automatic astigmatism correction.  
Refer to < 3.5.5 >.
- **Assignment Auto Buttons**  
Assigns Auto Image Adjustment Function buttons on the Control Panel.
- **Focus Monitor**  
Starts Focus Monitor mode.  
Refer to < 3.5.5 >.
- **BC Monitor**  
Starts BC Monitor mode.  
Refer to < 3.5.4 >.
- **DeGauss**  
Use to carry out Degauss operation.

(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 >.
- **Capture Setup**  
For image capture, this function allows you to select the captured image size (in pixels) 640×480 to 5120×3840 capture speed/number of images to be integrated.  
Refer to < 3.6.3 >.
- **Split DM Mode**  
Activates **Split/Dual Mag** mode.  
Refer to < 3.9.2 >.
- **Scan Speed**  
Selects scanning speed.  
Refer to < 3.5.3 >.
- **Assignment Speed Buttons**  
Specifies scanning speed of each of 4 scanning speed buttons.  
Refer to < 3.5.3 >.
- **Scan Size**  
Selects the size of scanning image display (Screen mode) from **Full**, **Dual** and **Small**.  
Refer to < 3.9.1 >.

(6) **Image** menu:

The Image menu includes commands for signal processing of optional detectors.

- Opt. Signal Processing  
Opens the **Opt Signal Processing** dialog window.  
Refer to < 3.9.5 >.
- Show Histogram  
Shows a histogram of the image presently observed.  
Refer to < 3.5.4 >

(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 >.
- Spot Analysis  
Selects **Spot** 1 and 2 mode alternately.  
Refer to < 3.9.4 >.
- Area Analysis  
Selects **Area analysis** 1 and 2 mode alternately.  
Refer to < 3.9.4 >.
- Oblique  
Opens **Oblique** image window and displays bird's-eye view of viewing images.  
Refer to < 3.9.13 >.
- Measure  
If the CD-Measurement option is installed, the **CD Measurement** dialog window is brought up.

(8) **Option** menu:

The Option menu includes commands for optional functions.

- Lock Controls  
Opens **Lock Controls** dialog window.  
Manual operation panel and trackball (joystick) can be locked to avoid unintended operation during, for example, long-time analysis. Unlocking also can be done on this dialog window.
- Optional Setup - Op. Panel Setting  
Opens **Optional Setup** tab of the **Operation Panel** dialog window.  
Use for arrangement of functions on the **Operation Panel**.  
Refer to < 3.9.14 >.
- Optional Setup - Stage  
Opens **Stage** tab of the **Optional Setup** dialog window.  
Use for setting parameters of stage control function.  
Refer to < 3.9.14 >.



- **Optional Setup - Mouse Operation**  
Opens **Mouse** tab of the **Optional Setup** dialog window.  
Use for setting sensitivity of mouse operation.  
Refer to < 3.9.14 >.
- **Optional Setup - General**  
Opens **General** tab of the **Optional Setup** dialog window.  
Use for setting various operation parameters.  
Refer to < 3.9.14 >.
- **Assignment Tool Buttons**  
This function allows you to select tool buttons to be assigned to the **Operation Panel**.  
Refer to < 3.9.14 >
- **Mouse Mode**  
This function allows you to select a mouse operation mode from **None**, **Image adjustment**, **Stage X/Y/R/Z/T**, **Stage X/Y/R**, and **Stage X/Y**.
- **Login Setting**  
Opens the **Login Setting** dialog window. Use it for setting login names and passwords for users. The dialog window can be opened only when logged in with the system manager's login name.  
Refer to < 3.9.16 >.
- **Password Setting**  
Opens the **Password Setting** dialog window. Use it for setting or changing the password for the login name of the current user.  
Refer to < 3.9.15 >.
- **Stage Calibration**  
This function launches the Calibration function that improves the accuracy of the stage eucentric rotation function.  
Refer to < 3.5.6.12 > – (2)
- **Stage Program Download**  
Use for upgrading stage controller program.  
Refer to < 3.9.25 >.

(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 < 3.6.3 >.
- Close All  
Closes all dialog windows except for the Scanning Image window.

(10) **Undo** menu:

Returns to the status prior to conducting the following operation.

- Auto Focus  
If the results of auto-focusing are poor, resets the focus to the previous condition.
- Auto Stigma  
If the results of auto-stigma are poor, resets the stigma to the previous stigma correction condition.
- ABCC  
If the results of ABCC are poor, resets the ABCC to the previous condition.
- Stage Drive  
When the stage is moved by specifying a destination, this function allows you to return the stage to the previous position.

(11) **Help** menu:

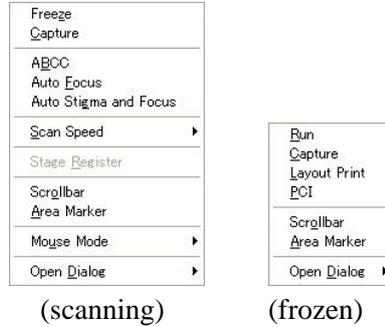
Opens Help for SU6600 SEM operation.

- Maintenance  
Opens the **Maintenance** dialog window. Use it for checking status of the evacuation system, gun baking and ECO mode setting.  
Refer to < 4.9 >  
Refer to < 3.9.17 >
- Index  
Displays the table of contents of help information.
- Search  
Displays a help keyword search window.
- About FE-PC SEM  
Indicates the version of SU6600 PC-SEM.

### 2.3.5 Popup Menu

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

Refer to < 2.2.4 >



**Fig. 2-19 An Example of Popup Menu**

(1) Open when scanning

- Freeze  
Freezes scanning.
- Capture  
Starts image capturing.
- ABCC  
Executes automatic brightness and contrast control.
- Auto Focus  
Executes automatic focusing.
- Auto Stigma  
Executes automatic astigmatism correction.
- Scan Speed  
Selects scanning speed.
- Stage Register  
Register the present stage position for the Sample Map function.
- Scrollbar  
Show or hide scrollbars for adjusting focus, stigma, brightness and contrast.
- Area Marker  
Show or hide the area marker.
- Mouse Mode  
Exchanges modes of mouse operation in order.  
Same function as the mouse's S button.
- Open Dialog– Setup  
Opens the Setup dialog window.

- Open Dialog– Captured Image  
Opens the Captured Image window.
- Open Dialog– Sample Map  
Opens the Sample Map dialog window.

(2) Open when frozen

- RUN  
Runs scanning.
- Save  
Opens the **Save Image** dialog window. Use it for saving viewed images to a disk.
- Layout Print  
Opens the **Report Generation** dialog window. Use it for printing viewed images.

### 2.3.6 Control Panel

Contains the most frequently used controls such as for image observation, and image recording. Normal operations can be performed using the **Control panel** and the manual operation panel.

#### 2.3.6.1 Functional Blocks on the Control Panel

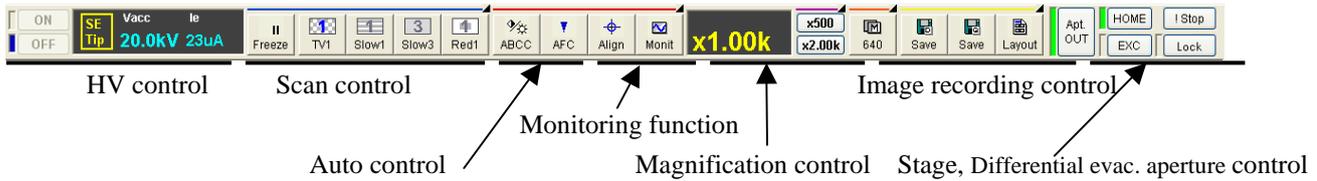


Fig. 2-20 Control Panel

#### 2.3.6.2 HV Control Block

- (1) **HV ON/OFF** and **HV** indicator



Fig. 2-21 HV ON/OFF and HV Indicator

**HV** indicator shows status of electron gun and vacuum condition. The **ON** and **OFF** button controls applying and shutting off the accelerating voltage. The **HV** indication and button status will be changed according to gun and specimen chamber vacuum and gun status as follows.

- (a) **SE Tip** indication: **SE Tip** indicates gun condition as follows.

Gun vacuum	High		Low
Gun status	Emission inactive	Emission active	
Indication	Yellow-Blue blink	Yellow	Blue

- (b) **Vacc** and **le** indication: Indicate accelerating voltage and emission current. The accelerating voltage value is actual value applied and the selected value when off. Color indication changes as follows.

Color	Status	(detail)
Blue	Vacc can not be applied	Gun emission inactive or specimen chamber low vacuum
Yellow-Blue blink	Vacc can not be applied	Gun emission active and specimen chamber high vacuum
Yellow	Vacc is applied	Gun emission active, Vacc applied and specimen chamber high vacuum

- (c) **ON** and **OFF** button: **ON** button is enabled when the gun emission is active and the specimen chamber vacuum is high. Click **ON** button to apply the accelerating voltage. The button is changed to **Set** when the accelerating voltage is applied. Click the **OFF** button to shut down the accelerating voltage. The gun emission remains active during this operation.

(2) **HV control** dialog window **ELECTRON BEAM** block

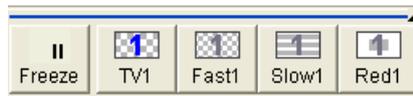
To change the accelerating voltage or to adjust emission current, click on the **HV indicator**. The following ELECTRON BEAM block opens under the **HV indicator**.



**Fig. 2-22 Electron Beam Block**

- **Vacc select**  
 button shows a pull-down list of HV values. Select a voltage. HV value is increased or decreased with  button in 100 V steps. When HV has been applied, click **SET** button after changing HV value.
- **GUN Brightness-Extraction Voltage**  
 To adjust emission current, usually change extraction voltage.  
 button shows a pull-down list of 5 brightness numbers and corresponding extraction voltage value. Select a higher voltage to increase or a lower voltage to decrease the emission current. The 5 voltage values will be set at installation. Typical values are 1.5/1.6/1.8/1.9/2.0kV. (These values may be different from the typical value according to emitter characteristics)  
 Usually use number 3, use smaller numbers for low accelerating voltage-high resolution observation, use number 4 or 5 for applications need larger probe current. (At number 4 or 5, larger probe current will be attainable. However, some vibration like noise may appear on high magnification image.)
- **GUN Brightness-Suppressor Voltage**  
 Suppressor electrode voltage is shown here (display only). The suppressor voltage is set before shipping, or during maintenance by service engineer to an adequate value for the emitter.  
 For other display items, refer to < 3.4.3 >.

**2.3.6.3 Scan Control Block**



**Fig. 2-23 Scan Control Block**

This function allows you to select a scanning speed and specify (Run) / (Freeze).

(1) **Run button**

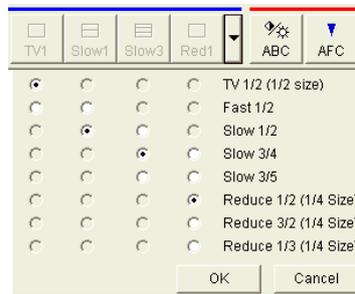
These are scanning start/stop buttons. During scanning, the button displays ; when the scanning is stopped, it displays .

Clicking the button during scanning causes the scanning process to stop at the end of the frame being scanned. During this time, the display in the upper left area of the image shows "Going to Freeze", which turns into "Freeze" when the scanning has stopped.

To stop the scanning process during slow scan, without waiting for the scan to reaching the end during "Going to Freeze", click the button again.

Refer to < 3.5.3 >.

- (2) **Scan speed** buttons (TV1 to Red1 in above picture)  
8 scanning speeds are assigned to 4 buttons. Each of buttons sets 2 scanning speeds alternately. To assign scanning speed to each button, click  button. The following dialog will be shown.



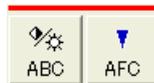
**Fig. 2-24 Scan Control Dialog**

On a given button, select the speed to be assigned to the button, and click the  symbol there to turn it into a . Clicking **OK** changes the speed to the newly assigned one.

Refer to < 3.5.3 >.

#### 2.3.6.4 Auto Function and Monitor Function Block Control

- (1) **Auto function**



**Fig. 2-25 Auto Control Block**

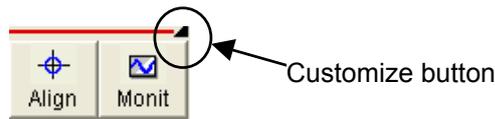
- (a) **ABCC**  
Starts auto brightness/contrast adjustment (ABCC). If the results of the ABCC are not adequate, you can change the reference brightness and contrast in the Image tab of the Setup dialog window. ABCC is applicable to SE and YAG BSE signal.
- (b) **AFC**  
Starts Auto Focus.  
When the magnification is lower than 5,000 $\times$ , 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 $\times$ . Fine focus works correctly under the 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.



(c) **ASFC** (auto-stigma)

This function performs an automatic correction of stigma aberration. Although the range over which stigma adjustments can be performed does not depend on the magnification, more detailed images can be produced by performing micro-adjustments using a knob after the execution of the ASFC function.

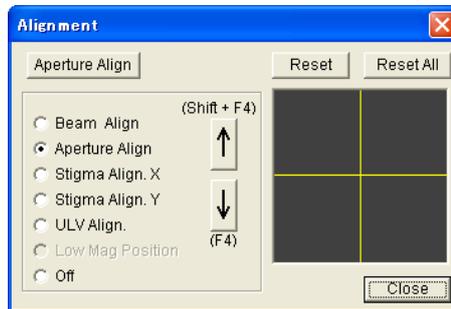
(2) **Monitoring Function**



**Fig. 2-26 Monitoring Function**

(a) **Align**

Opens **Alignment** dialog window and starts **Aperture alignment**. Refer to < 3.4.4 >.



**Fig. 2-27 Alignment Window**

(b) **Monit**

Waveform monitor mode is activated. The **Focus monitor** and **B/C monitor** modes are set alternately by clicking the button.

At the first click, a waveform is displayed for monitoring the focus. The magnification is set at 1,000×. Focus the image so that the waveform shows sharp peaks.

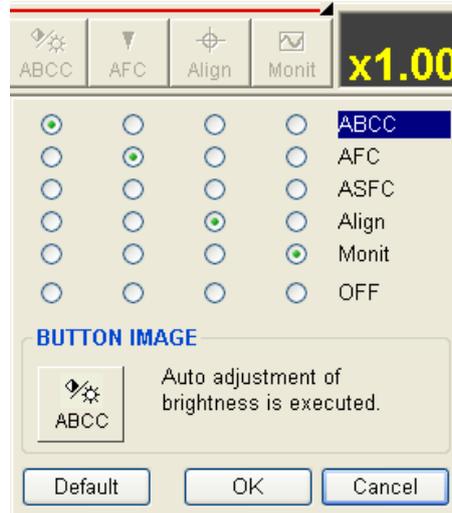
The next click changes the mode to **B/C monitor**. A waveform and reference lines are displayed for monitoring contrast (amplitude of the waveform) and brightness (vertical level of the waveform). When the maximum and minimum values of the waveform are adjusted to fit within the upper and lower reference lines, appropriate brightness and contrast will be obtained.

To terminate the **Focus monitor** and **B/C monitor** mode, click the **Cancel** button in the message dialog shown while in the monitor modes, or click one of the scan speed buttons.

Refer to < 3.5.4 > and < 3.5.5 >.

### (3) Customizing Auto and Monitor Function buttons

Click the customize button (  ) or right-click the mouse on one of Auto or Monitor function buttons. The dialog window for selecting the buttons is displayed as shown in the figure below.



**Fig. 2-28 Auto and Monitor Function buttons Control Dialog**

Select the desired function for each button on the selection screen. Buttons are changed when **OK** is clicked.

### 2.3.6.5 Magnification Control

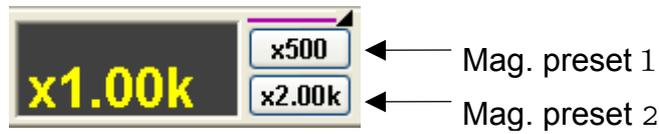


Fig. 2-29 Magnification Control

(1) **Magnification indicator**

Indicates magnification.

In this area, 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.

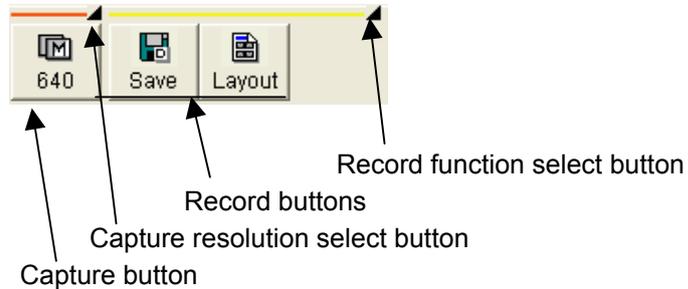
Alternately, click the area with the right button to increase or with the left button to decrease the magnification stepwise.

(2) **Magnification preset**

Clicking the  button located in the upper right area of the magnification display brings up a magnification preset window. If the current magnification is at a preset value, the characters PM appears in the upper right corner of the magnification display. Magnification preset levels can be specified in **Setup** and **Mag. Preset Setup**.

### 2.3.6.6 Image Recording Controls

This block allows you to capture and record images.



**Fig. 2-30 Image Recording Controls**

(1) **Capture button**

Captures an image with pre-specified image resolution and scanning speed.

Image resolution is selectable with the right side button and by opening the resolution list.

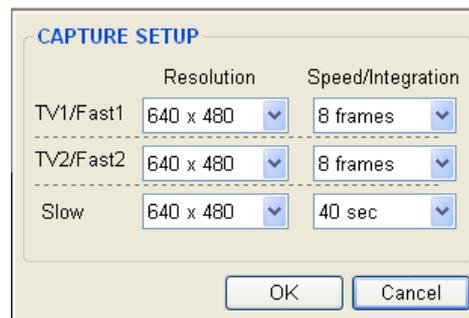
Select scanning speed on the **Image** tab of the **Setup** dialog window.

When capture is started with **TV** or **FAST** scanning speed, frame integration is performed.

When started with **SLOW** scanning speed, an image is captured at slow scan.

(2) **Capture resolution** select button

Pressing the  button in the **Setup** window brings up the resolution selection menu shown below, from which the resolution can be selected.



**Fig. 2-31 Image Recording Control**

(3) Recording function buttons

Various recording functions to be used can be arranged in this window. The following three recording functions are available:



**Direct save**

Saves the currently displayed image in a file with a resolution of 640x480 if the size of the image being observed is **Small** or **Dual**; or 1280x960 if it is **Full**.



**Quick save**

Saves the current image at the resolution that was set with the Capture Resolution button. The image name to be saved is registered in terms of a date and a data number. When more than one image is captured, the data number is incremented. With an image capture using the Capture button or Direct Save, the electron beam scanning remains frozen after the image is saved; however, in Quick save, the electron beam scanning goes into the Run state after an image capture or save, which is convenient when images are to be captured successively.

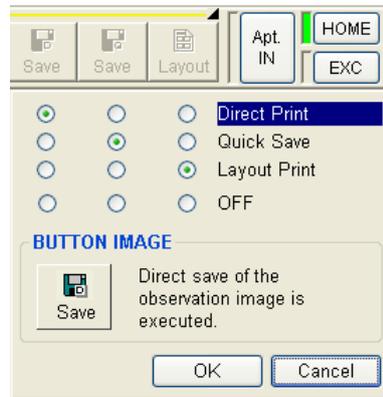


**Layout**

Captures an image in Direct Save and transfers it to the **Report Generation** software.

(4) Recording function selection buttons

Clicking this button displays the selection dialog box below the above-mentioned three recording function buttons. From the selection dialog box, functions can be assigned to the three buttons. The ✖ **OFF** option blanks out the content of a given button.



**Fig. 2-32 Recording Function Selection Dialog Box**

### 2.3.6.7 Stage, Image Shift Control



**Fig. 2-33 Stage, Image Shift Control**

- (1) **Aperture IN/OUT** button  
 This button allows you to insert and retract the differential vacuum aperture into and out of the end of the objective lens. When the aperture is in, the display frame to the left of the button is green. The aperture must always be inserted when the specimen chamber is to be set in the low-vacuum mode.
  
- (2) **HOME** button  
 Moves the stage to its home position ( $X=35$ ,  $Y=55$  mm ,  $Z=31$  mm ,  $T=0^\circ$  ,  $R=0^\circ$  ). The indication window beside the button is green when the stage is at home position.
  
- (4) **EXC** button  
 Moves the stage to the position for specimen exchange ( $X=35$ ,  $Y=0$  mm ,  $Z=31$  mm ,  $T=0^\circ$  ,  $R=0^\circ$  ). The indication window beside the button is green when the stage is at the specimen exchange position.
  
- (4) **!STOP** button  
 Use this button to stop stage movement when, for example, it has been started with incorrect stage coordinate value.
  
- (5) **Lock** button  
 Z and T axes are locked or released by clicking this button. The indication window beside the button is red when the stage is locked, and the button is changed to **Release**. Z and T axis operation is disabled while the stage is locked.

### 2.3.6.8 Extension for Dual Screen Mode

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



Fig. 2-334 Control Panel (Dual screen mode)

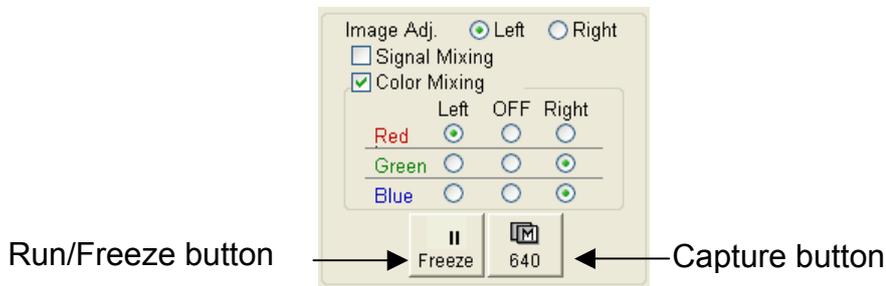


Fig. 2-35 Color Synthesis Block

(1) **Image Adj.**

Selecting **Right** or **Left** allows you to specify whether the Brightness and Contrast knobs on the Manual Operation Panel will adjust the right or left screen. The Brightness and Contrast functions of the on-image mouse operation work only on the given image. In the settings illustrated in the figure above, the signal (for example, a secondary electron image) assigned to the left side is red, and the signal (for example, a back-scattered electron image) is green and blue, and the image with these signals superimposed is displayed on the right side.

(2) **Signal Mixing**

Adds the image signal displayed on the left screen to the image signal displayed on the right screen, and displays the results on the right screen.

Use the  button in the [Image Adj.] block to start or stop scanning two images simultaneously.

The  button in the **RIGHT** or **LEFT** block is used to start or stop scanning images on the right or left screen, respectively, independently.

(3) **Color Mixing**

Displays and superimposes two images based on two types of image signals in different colors to display a color-synthesized image. The colors of the right and left images in the dual-screen display images are selected from red, green, and blue. The synthesized image is displayed on the right side.

(4) **Run/Freeze** button

Starts and stops the scanning process.

(5) **Capture** button

Captures an image.

(6) **Left block/Right** block

The Left block is associated with the left screen, and the Right block with the right screen. These blocks can be used to select, capture, or save the image displayed on a screen-by-screen basis.



### 2.3.7 Operation Panel

The Operation Panel, which is used to set various observation conditions, is comprised of four tabs. The **Cond.** and **Utility** tabs relate to SEM operations, whereas the **Image** tab relates to image signals and image processing. The **Stage** tab allows you to operate the stage.

The text below describes the functions of the blocks on the **Cond.** and **Utility** tabs, as well as the blocks on the **Image** tab. (The **Stage** tab is explained in the section on stage operation (3.5.6)).

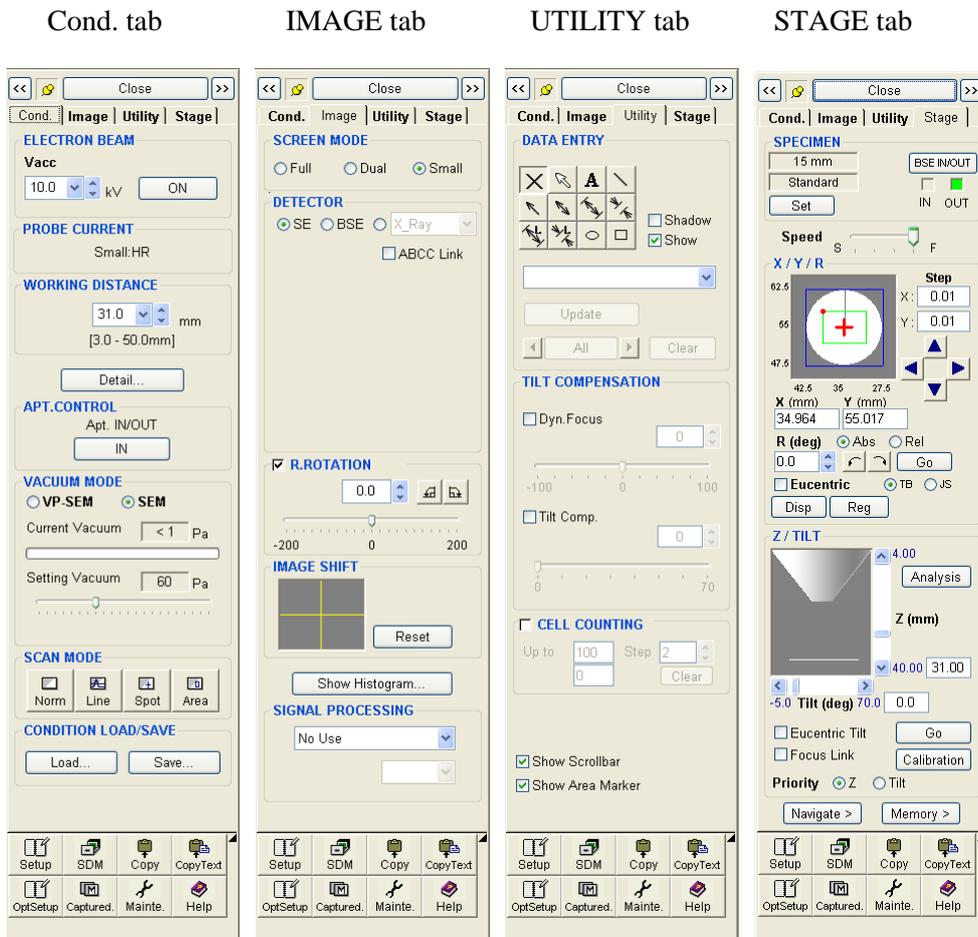


Fig. 2-36 Operation Panel

### 2.3.7.1 ELECTRON BEAM Block

This block allows you to select an accelerating voltage. Pressing the  button brings up a list of accelerating voltages from which an accelerating voltage can be selected. Up to four accelerating voltages assigned are stored in the list. The  button allows you to change an accelerating voltage in 0.1kV increments. An accelerating voltage can also be specified by directly entering a numerical value in the accelerating voltage box.

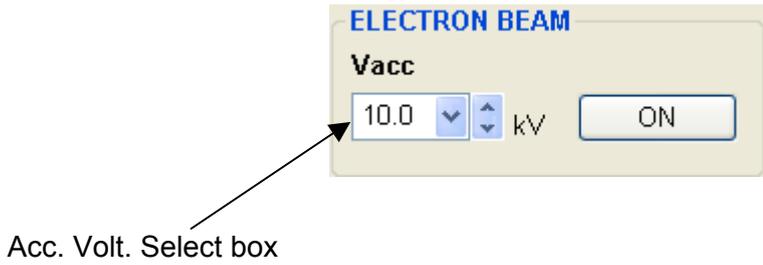


Fig. 2-37 Electron Beam Block

### 2.3.7.2 PROBE CURRENT Block

Displays the currently set probe current mode.



Fig. 2-38 Probe Current Block

### 2.3.7.3 Focus Position (W.D.) [WORKING DISTANCE] Block

Displays the current working distance (the focus position calculated from the lens current). When a numerical value is directly entered in this box or a desired value is selected from the WD list which is displayed when the  button is clicked, a lens current is calculated and assigned so that focusing is effected at that working distance. Also, by pressing the  button, you can change the working distance in minimum increments. The block can be used for focusing when the Z-axis of the stage is moved or when a working distance must be set accurately during an EDX analysis. The WD range display indicates the working distance range available in the currently selected mode and accelerating voltage.



Fig. 2-39 Focus Position Block

#### 2.3.7.4 Detail Button

Pressing the **Detail** button allows you to set the electron optical system details. For further information on this topic, see 3.4.3 Electron optical system condition settings.

#### 2.3.7.5 APT.CONTROL Block

Inserts and retracts the differential evacuation aperture.



Fig. 2-40 Differential Evacuation Aperture Block

#### 2.3.7.6 VACUUM MODE Block

This block allows you to select between the low-vacuum mode **VP-SEM** and the high-vacuum mode **SEM**. The **VP-SEM** mode allows you to set a vacuum level by means of the vacuum level adjustment slider in a 10Pa to 300Pa range.

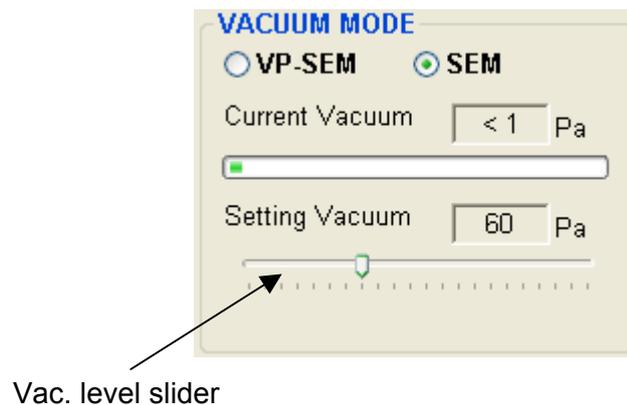


Fig. 2-41 Vacuum Mode Block

### 2.3.7.7 SCAN MODE Block

Specifies a scanning mode.

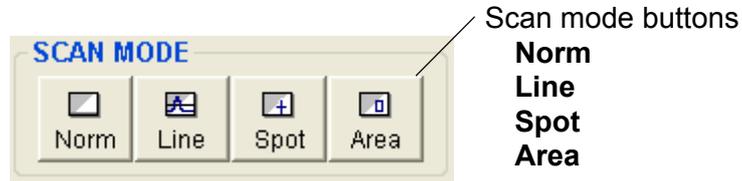


Fig. 2-42 Analysis Mode Block

- (1) Scanning mode button: **Norm** (Normal)  
Sets the scanning mode to Normal (normal observation mode).
- (2) Scanning mode button: **Line**  
Sets the scanning mode to the line analysis mode and toggles between 1 (position set) and 2 (line analysis).
- (3) Scanning mode button: **Spot**  
Sets the scanning mode to the spot analysis mode and toggles between 1 (position set) and 2 (spot analysis).
- (4) Scanning mode button: **Area**  
Sets the scanning mode to the average density analysis mode and toggles between 1 (position set) and 2 (average density analysis).

### 2.3.7.8 CONDITION LOAD/SAVE Block

This block allows you to open a tab that saves or loads electron optical system condition settings. By loading an observation condition, you can reproduce a previously saved observation condition.



Fig. 2-43 Condition Load/Save Block

### 2.3.7.9 SCREEN MODE Mode

Changes image display sizes.



Fig. 2-44 SCREEN MODE Block

- (1) **Full:** Full screen (Full) mode  
Displays an image on the entire Desktop.
- (2) **Dual:** Dual mode  
Displays two reduced-size images side by side, which can be used to compare and observe images based on different signals on the right and left.  
Also, this mode can be used to observe color-synthesized images.
- (3) **Small:** (Small) mode  
Displays an image by reducing it. To the extent that the number of pixels that make up the image is reduced, and the rapid speed (the frame speed) is increased. In situations where the amount of signal is small and the noise level is high, the Small mode can make the image easier to see than the full screen display.

### 2.3.7.10 Detector Block

This block allows you to select a detector, such as a secondary-electron detector, a back-scattered electron detector, and \* Miscellaneous detectors (\* : Optional).

When the **ABCC Link** is checked, the system automatically adjusts the brightness and contrast when the **Probe Current** mode is changed or detector settings are modified.

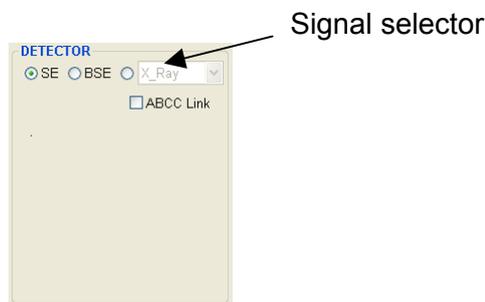
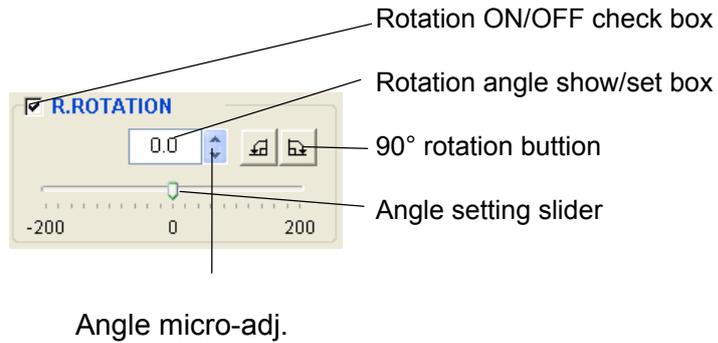


Fig. 2-45 Signal Selection Block

### 2.3.7.11 R. ROTATION Block

This block is used to set a raster rotation, which is a function that rotates the direction in which the electron beam is scanned to rotate the orientation of a displayed image.



**Fig. 2-46 Raster Rotation Block**

- (1) **Rotation ON/OFF check box**  
Click this check box to set a check mark in it which enables the raster rotation.
  
- (2) **Rotation angle show/set box**  
Displays the current angle of rotation. Entering an angle from the keyboard in this box and pressing the Enter key causes the image to rotate by that angle.
  
- (3) **Angle-setting slider**  
By moving the slider with the mouse to the right and left, you can continuously change the angle of rotation. Alternately, by clicking the side of the slider, you can increase or decrease the angle in 0.5-degree increments.
  
- (4) **Angle micro-adjustment button**  
By clicking the up and down arrows, you can increase or decrease the angle in 0.1-degree increments.
  
- (5) **90° rotation button**  
Rotates the image in 90° degree increments.

### 2.3.7.12 IMAGE SHIFT Block

Indicates the amount of image shift (a function that moves the observation area by shifting the electron beam irradiation position) in terms of a cross mark position. Pressing the reset button resets the cross mark at the mid-point of the movable range.



Fig. 2-47 Image Shift Block

### 2.3.7.13 Show Histogram Button

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.

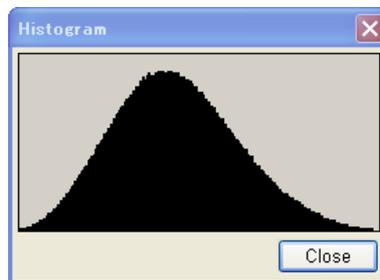


Fig. 2-48 Histogram Window

### 2.3.7.14 SIGNAL PROCESSING Block

Applies real time digital image processing to the scanning image.

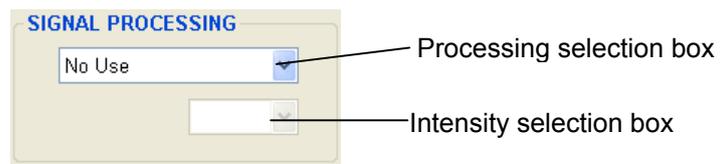


Fig. 2-49 Signal Processing Block



(1) **Signal Processing selection box**

Selects a processing.

- **Smooth**

Applies pixel averaging spatial filtering. Reduces snow noise.

Effective especially in case of high magnification image where the beam spot size is larger than pixel size. For low magnification images having fine structures, it may cause some degradation of sharpness.

Two processing intensities selectable.

- **Sharpen**

Increases sharpness of scanning image.

Two processing intensities selectable.

It may increase noise when the original image contains snow noise.

- **Edge Enhance**

Similar but stronger processing than Sharpen.

- **Invert**

Color inversion. Results in a negative image.

- **Gamma**

Gamma correction.

-5 to +5 selectable.

(2) **Intensity selection box**

Selects a processing intensity.

**NOTICE:** The signal processing is not applicable when operating with **Dual** screen mode.  
It is possible to apply similar spatial filtering to saved images using the **SEM Data Manager**.  
The SEM Data Manager provides a large number of image processing functions.

(3) **Option Signal** button

Opens the **Opt Signal Processing** dialog window for analog signal processing of an optional detector signal.

### 2.3.7.15 DATA ENTRY Block

Used for drawing text and graphics on the scanning image.

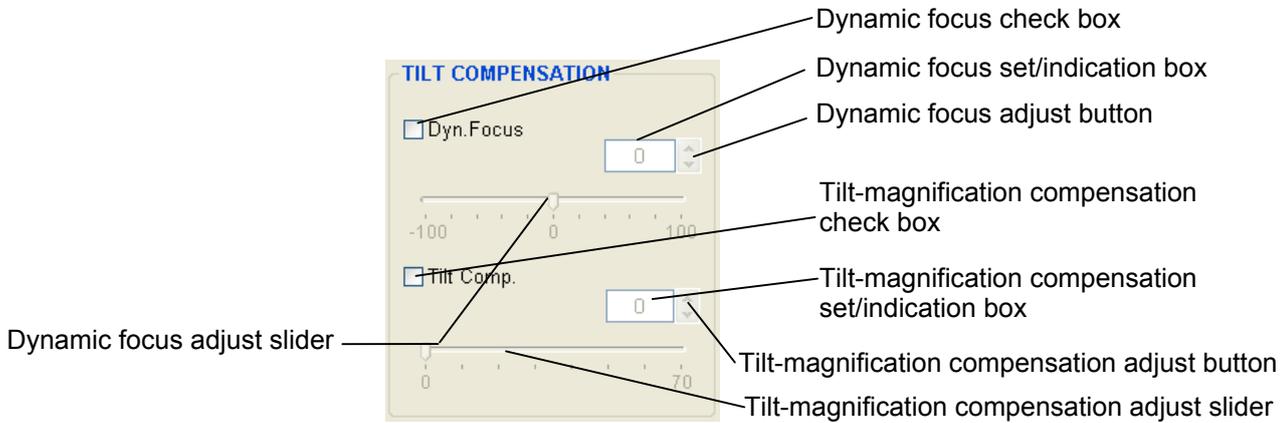
Refer to < 3.9.8 >.



**Fig. 2-50 DATA ENTRY Block**

### 2.3.7.16 TILT COMPENSATION Block

Specimen tilting causes defocusing and magnification change in the tilt direction. Tilt compensation is used to correct the two phenomena.



**Fig. 2-51 TILT COMPENSATION Block**

(1) **Dynamic focus**

Dynamic Focus scans the focal length linked with the scanning position. When a specimen is tilted, 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.

(2) **Tilt compensation**

When a specimen is tilted, magnification along the tilted direction is **cos (tilting angle)** lower than that of a non-tilted direction. As a result, the image appears to be contracted in the tilted direction. The image magnification can be corrected in all directions by using Tilt Compensation function. Refer to < 3.9.9 >.

### 2.3.7.17 Cell Counting Block



Fig. 2-52 CELL COUNTING Block

Used for cell counting operation. Refer to < 3.9.22.2 > for detail.

### 2.3.7.18 Scroll Bar and Area Marker Block



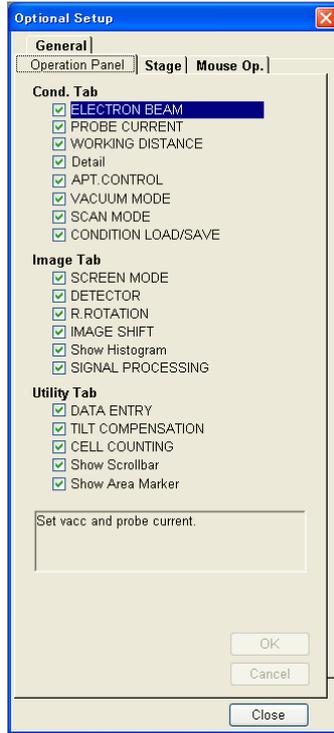
Fig. 2-53 Scroll Bar and Area Marker Block

- (1) **Show Scrollbar** checkbox  
Scrollbars for stigma, brightness and contrast are shown around the scanning image when **Show Scrollbar** is checked.
  
- (2) **Show AREA Marker** checkbox  
The area marker, which is a crosshair cursor appearing at the center of scanning image, is shown when **Show Area Marker** is checked.

### 2.3.7.19 Show/Hide Operation Panel Control Blocks

This function allows you to select blocks to be displayed on the **Cond.**, **Image**, or **Utility** tab. By hiding the functions that are not used, ease of use can be improved. The layout of blocks on this menu can be specified for each user login.

On the **Option** menu, selecting **Optional Setup – Op.Panel Setting** opens the following dialog box:



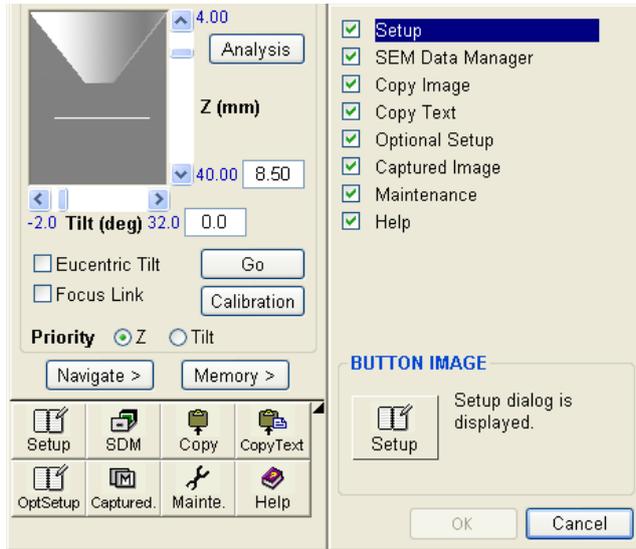
**Fig. 2-54 [Op. Panel Setting] Dialog Box**

The names of blocks and check boxes are displayed side by side. Clicking the name part of a block displays a brief explanation of the block. Placing a check mark in the check box displays the block in the function tab.

**2.3.7.20 Tool Buttons**

Eight tool buttons are placed on lower end of the Operation panel.

Buttons can be selected eight functions.



**Fig. 2-55 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 checkbox of the function to be placed.

Function of each tool button is as follows.



**Setup**

Open the **Setup** dialog window. The **Column** tab is brought forward.  
Refer to <2.3.9 Setup Dialog Window>.



**SDM**

Open the **SEM Data Manager** window. Use it to file images.  
Refer to <2.3.11 SEM Data manager Window>.

<3.12 Using SEM Data manager>.



Copy

### **Copy**

The current image is copied to the clipboard in bitmap form.



CopyText

### **Copy Text**

Collection parameters for the current image is copied to the clipboard in a text format.



OptSetup

### **Optsetup**

Opens the Optional Setup dialog window.

Refer to <2.3.7.19 Show/Hide Operation Panel Control Blocks>.



Captured.

### **Captured.**

Opens the **Captured Image** window.

Refer to <2.3.10 Captured Image window>.



Mainte.

### **Mainte.**

Opens the **Maintenance** dialog window.

Refer to <2.3.12 Maintenance Dialog Window>.



Mainte.

### **Help**

Opens the help for SU6600.

## 2.3.8 Mouse Operation on the Scanning Image

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

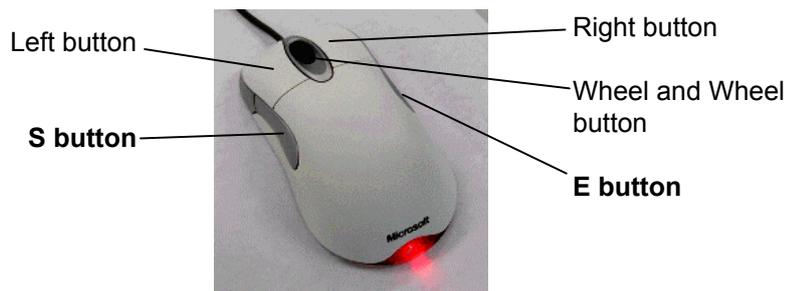
### 2.3.8.1 Exchanging Mouse Control Functions

Mouse operation tools are divided into three groups, focus/stigma/contrast/brightness and specimen stage and no operation.

The **S button** of the mouse exchanges the above groups in the following order.

The group exchanging is also possible with the **Mouse Mode** of popup menu.

- (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)



**Fig. 2-56 Mouse**



### 2.3.8.2 Focus/Stigma/Contrast/Brightness Adjustment

The function of the mouse pointer is changed, corresponding to its position as shown below.



**Fig. 2-57 Mouse Control (Focus/Stigma/Contrast/Brightness)**



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 **Utility** tab, adjustment scrollbars are placed on the scanning image area.

It is possible to operate with these scrollbars.

Stigma:

This scrollbar is displayed when stigma correction is performed with the mouse on the image so that the amount of correction applied can be monitored. By checking the **Scroll Bar** check box, you can display the scroll bar continuously and perform stigma corrections on the scroll bar.

B/C (brightness/contrast): 

This scrollbar is displayed when a brightness/contrast adjustment is performed with the mouse on the image so that settings specified can be monitored. By checking the **Scroll Bar** check box, you can display the scroll bar continuously and perform brightness/contrast adjustments on the scroll bar.

Focus: 

This scrollbar is displayed when a focus adjustment is performed with the mouse on the image so that the amount of focusing can be monitored.

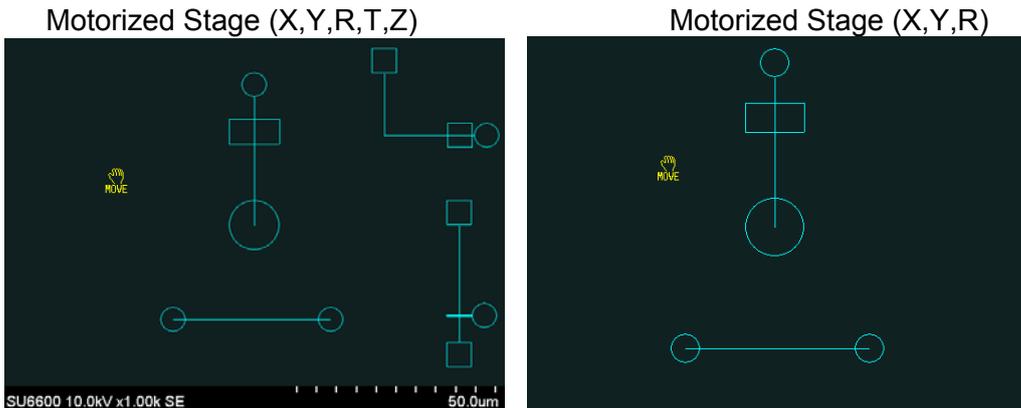
The above scroll bar appears when the mouse button is held down, provided that the **Show Scrollbar** option on the **Utility** tab of the Operation Panel is not checked. When the **Show Scrollbar** option is checked, the scroll bar appears continuously so that the amount of focusing can be adjusted by directly operating the scroll bar with the mouse.

### 2.3.8.3 Stage and Image Shift Tools

The following controls for operating the stage are displayed on the image:

By using the tools on the image, the X, Y, R, T, and Z axes of the stage can be manipulated.

Reference: 3.5.6 *Operating the specimen stage*



Motorized Stage (dragging with mouse)

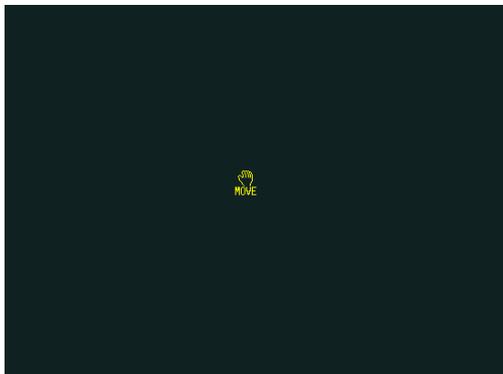


Fig. 2-58 Mouse Control (stage)

### 2.3.9 Setup Dialog Window

The **Setup dialog** window has four tabs. To open the dialog 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	:	Opens Optics tab
Setup – Condition Load	:	Opens Op. Cond tab
Setup – Condition Save	:	Opens Op. Cond tab
Setup – Image Display	:	Opens Image tab
Setup – Data Display	:	Opens Record tab
- (3) Operation Panel, **Cond.** block, **Detail** button:  
**Optics** tab
- (4) Operation Panel, **Cond.** block, **Detail** button **Load/Save** button:  
**Op. Cond** tab

#### 2.3.9.1 Optics Tab

Sets conditions for the electron optical system. This tab can be opened by clicking the Operation Panel, **Cond.** block, **Detail** button, the **Setup** menu, **Optics** command, or the Operation Panel Tool button area **Setup** button.

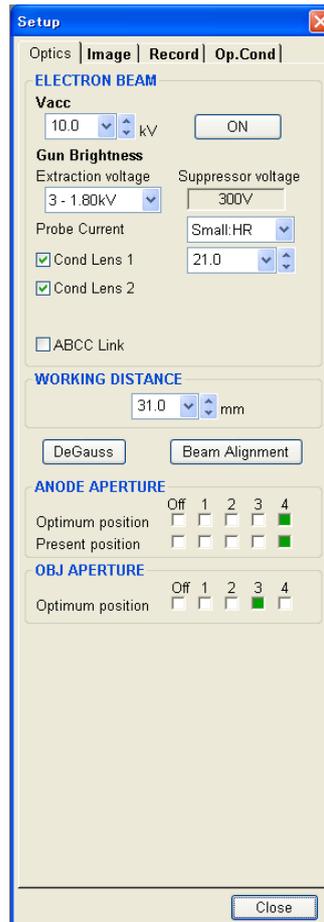


Fig. 2-59 Setup Dialog Box – [Optics] Tab

(1) **ELECTRON BEAM** block

- (a) Sets an accelerating voltage. Clicking the  button displays a list of accelerating voltages on a pulldown list, from which a desired value can be selected. Or, use the  button to change the accelerating voltage either up or down in minimum increments, and then click the SET button.

(b) **Gun Brightness**

- **GUN Brightness – Extraction voltage:**

To increase or decrease the emission current, normally you vary the Extraction voltage. Clicking the  button displays a list of GUN brightness values (1-5) and the associated extraction voltages in a pulldown list, from which a desired value can be selected. Extraction voltages associated with five values are specified at the time of system installation (the default values are 1.5/1.6/1.8/1.9/2.0 kV, which can be changed according to the condition of the tip).

Normally, use the value 3. For high-resolution observation under a low-accelerating voltage, use a low value. In application that require a large probe current, use either 4 or 5. (The value 4.5, which produces a large probe current, has the drawback of creating noise on high magnification images.)

- **GUN Brightness – Suppressor voltage:**

Displays a suppressor voltage; this is for display only, not for setting (a suppressor voltage is set at the time of shipping or during maintenance by a service engineer, according to tip characteristics).

(c) **Probe Current Range**

Within the three **Probe Current** modes, probe current can be finely adjusted by changing C1 (condenser lens) excitation. The range of adjustment is divided into two ranges. **Small:HR** (smaller probe current), **Medium**(medium probe current) and **Large:Analy** (large probe current) which can be selected.

(d) **Cond Lens 1**

The check box sets excitation of the 1st Condenser Lens On or Off.

Usually set it On (checked).

Select an excitation value with selection box. The range is 1.0 to 32.0.

Higher number results in stronger excitation and small probe current.

For fine setting, use the up-down  buttons.

Probe current is minimum when Probe Current Small: HR and Cond Lens1=32, and is maximum when Probe Current Large: Analy and Cond Lens1=1.

(e) **Cond Lens 2**

The check box sets the excitation of the 2nd Condenser Lens On or Off.

Usually set it On (checked).

(f) **ABCC Link**

With this item checked, the system automatically adjusts (ABCC) the brightness and contrast when any of the following operating conditions is modified:

- Probe Current mode
- Specimen bias voltage settings
- Detector settings

(2) **WORKING DISTANCE** block

Present working distance value calculated from objective lens excitation is indicated in the box.

Also objective lens excitation is calculated and set so as electron beam focuses at a working distance specified by selecting it on the pull down list shown by clicking  button, or by numerical input to the box.

(3) **Degauss** button

The Degauss operation eliminates hysteresis of the magnetic field in the objective lens.

When focus is changed a large amount, the accuracy of the magnification or alignment of the electron optical axis may degrade due to hysteresis of the focusing magnetic field.

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

After changing focus widely.

Before adjusting the electron optical axis alignment.

Degaussing is automatically effected when WD is changed in the **Column Condition** area, when the accelerating voltage is changed, or when a new **Probe Current** range is selected.

**REFERENCE:** The F2 hotkey is also available for degauss operation.

(4) **Beam Alignment** button

Use this button to start **Beam Alignment** mode. It is necessary when the **Probe Current** mode or **Probe Current** range is changed.

(5) **ANODE APERTURE** block

The number (size) of the anode aperture (aperture placed just under the electron gun) should be changed when **Probe Current** mode is changed.

The green colored box of **Optimum position** indicates the optimum number of the aperture for the present selected **Probe Current** mode. (When **Probe Current** mode is set to **Large:Analy**, optimum number of the aperture is No.2 (shown in green color), but No.1 (shown in yellow color) is also available to get a larger probe current )

The colored box of **Present position** shows actual present aperture position. The box color is green when the position is correct, and red if not set to the optimum position.

Set anode aperture to the indicated optimum number.

If the preset aperture number is smaller than the optimum number (aperture size is larger than the optimum), a warning message will be shown. This is because in that condition, the electron beam size at the fixed aperture near gun valve will become larger than the aperture hole size and may cause contamination.

(6) **OBJ APERTURE** block

The green colored box of **Optimum position** indicates the optimum number of the Objective lens aperture for the present selected **Probe Current** mode.

Set Objective lens aperture to the indicated optimum number.

No position sensor is attached to objective lens aperture and no warning message will be shown because there is no contamination possibility even if the aperture number is not set to the optimum number.

### 2.3.9.2 Image Tab

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



**Fig. 2-60 Image Tab**

- (1) **ABCC block (SE)**  
If the results of ABCC are not adequate, you can change the reference brightness and contrast. The default is 0, and the value can be adjusted in  $\pm 5$  increments.
  
- (2) **ABCC block (BSE)**  
Sets ABCC contrast and brightness levels for back-scattered electron images. Adjust this value if the results of an ABCC are not adequate. The default is 0, and the value can be adjusted in  $\pm 5$  increments.
  
- (3) **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 or 4 for Fast1 and 4 or 8 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 observed image.

(4) **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 **Image** is selected with the **Background** select buttons, the line profile is overlaid on the image. When **Black** is selected, only the line profile is shown on the screen.

### 2.3.9.3 Record Tab

Sets the data display (a function that displays observation conditions on the image).

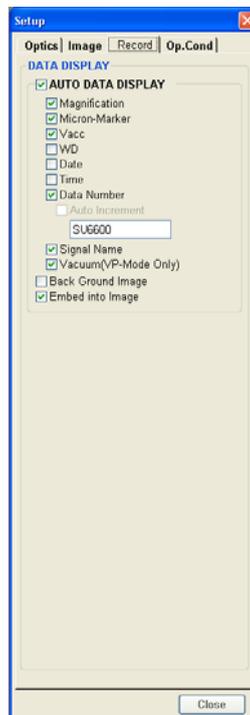


Fig. 2-61 Record Tab

(1) **DATA DISPLAY** block(a) **Auto Data Display**

Auto data display is engaged when this box is checked.



(b) **Magnification to Time** and **Signal Name** checkboxes

These items are included in data display if checked.

(c) **Data Number** input box

Input a 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 image captured.

(d) **Back Ground Image** checkbox

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** checkbox

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**, and **Copy** commands.

### 2.3.9.4 OP. Cond Tab

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

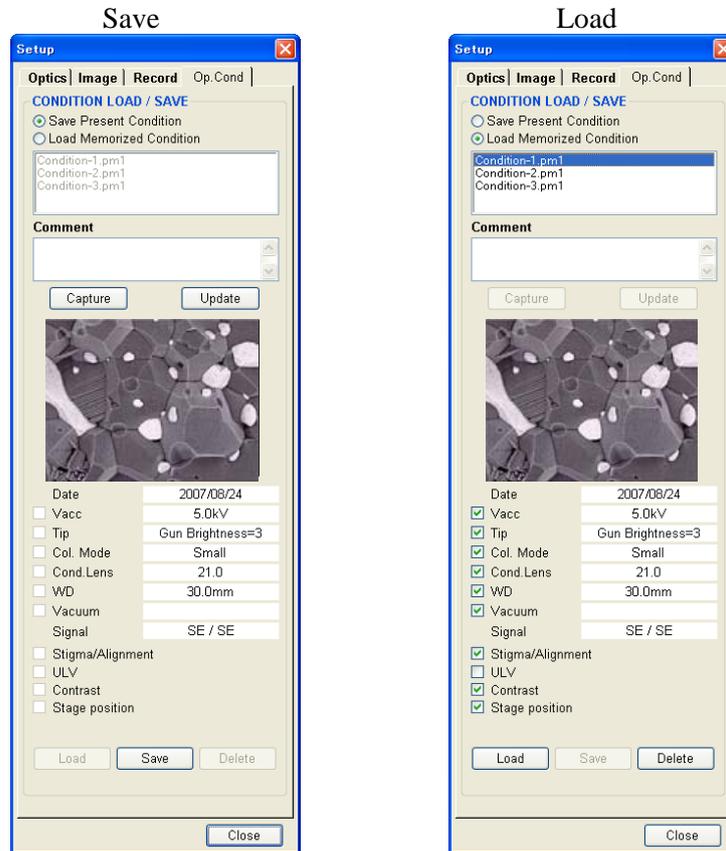


Fig. 2-62 Setup Dialog – Observation Condition Tab

For details of operation, refer to < 3.9.6 >.

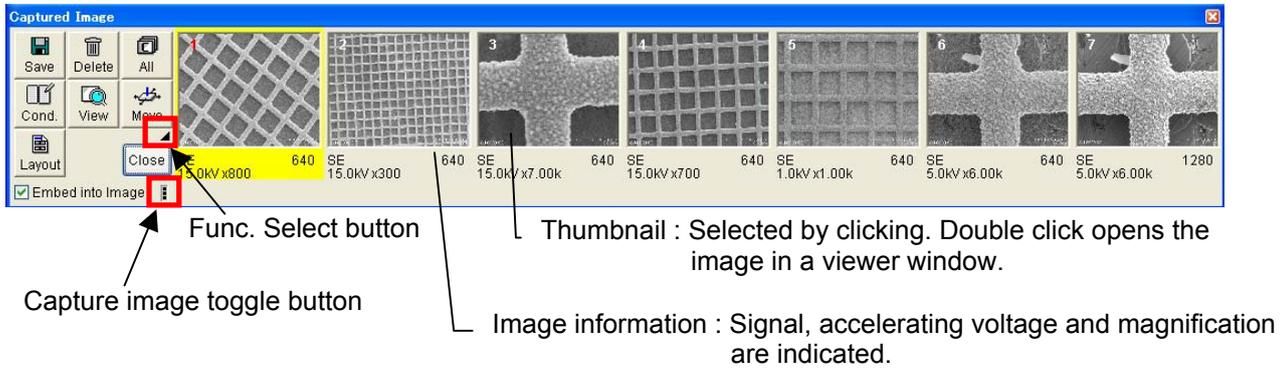
### 2.3.10 Captured Image Window

Captured images are displayed as thumbnails in this window.

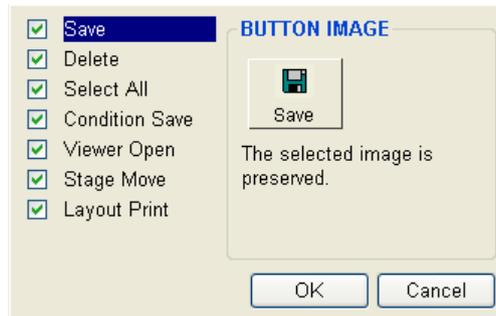
It opens when you have captured an image. Also it will open by selecting **Captured Image** command from the **Window** menu or using the short-cut key (**Ctrl + L**).

The yellow border shows the presently selected image. Tool buttons placed in the window effect the selected image. To select multiple images, click the thumbnails while pressing down the Ctrl key. The window shows up to 16 images. When 7 or more images are captured, a scrollbar will be shown, and the images can be scrolled horizontally. Captured images can be arranged vertically by pressing the Capture image toggle button.

Pressing the  Function Selection button displays a function button selection dialog box underneath the Capture window. The function buttons can be toggled between Show/Hide by turning the check box on/off.



**Fig. 2-63 Captured Image Window**



**Fig. 2-64 Function button selection dialog**



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



**Delete button:** Deletes the selected image.



**All button:** Selects all the images that appear in the **Captured Image** display.



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



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



**Move button:** Moves the stage to the position where the selected image was captured. It is active for motorized stages.



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



**Close button:** Closes the window. Closing the window does not clear the 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.

Refer to < 3.6.3 >, < 3.6.5 > and < 3.9.10 >

### 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.

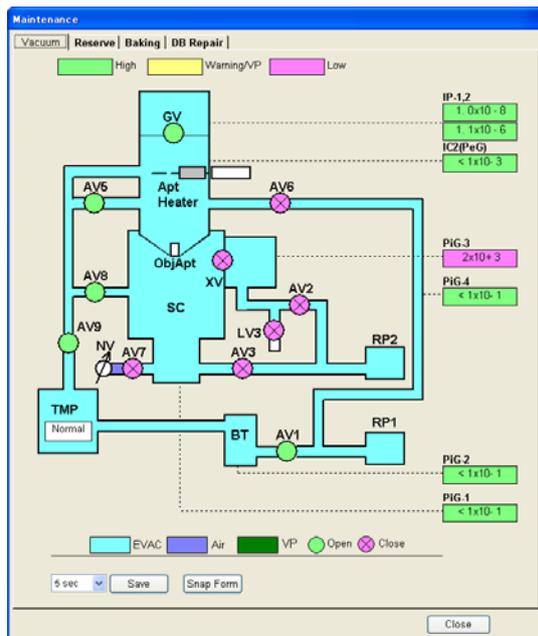
For details, refer to < 3.12 >.

### 2.3.12 Maintenance Dialog Window

The **Maintenance** dialog window is used for checking the status of the Evacuation system, gun baking operation and ECO mode settings. To open the dialog window, select the Maintenance command from the Help menu.

#### (1) Vacuum tab

The vacuum exhaust system chart is display, with the vacuum degree displayed in each part.



**Fig. 2-65 Maintenance Window – Vacuum tab**

(a) Vacuum exhaust system chart

Shows evacuation status (light blue : evacuated, purple : vent, green : VP-mode) and valve status with symbols.

(b) Vacuum degree

Vacuum degree of ion pumps(IP1,2) and Vacuum gauges(PeG-1, PiG-1,2,3,4) are displayed in Pa.

(c) save button

This button starts recording of vacuum degree with the interval set in the box to the left. It is for service engineer.

(2) Reserve tab

It is used to start the ECO mode.

Refer to < 3.9.17 >.

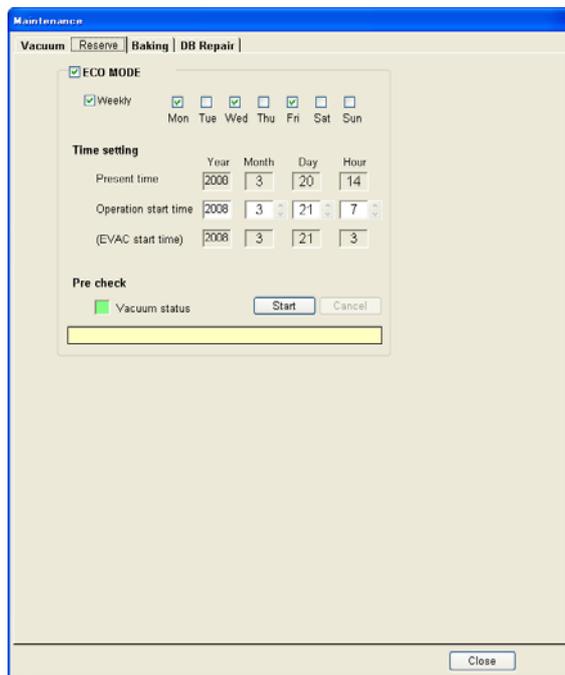
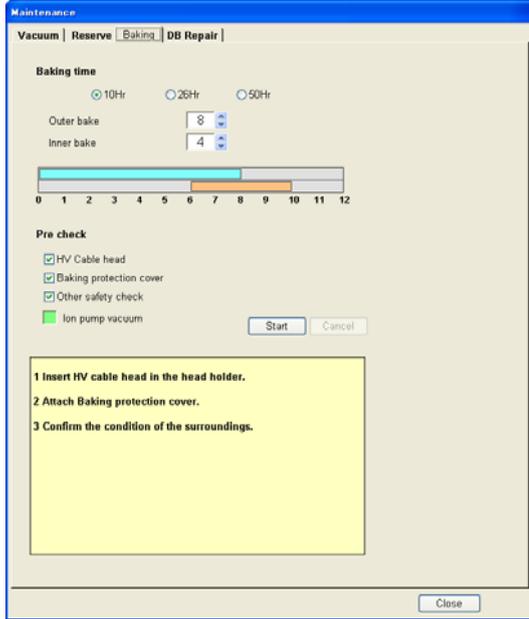


Fig. 2-66 Maintenance Window – Reserve tab

(3) **Barking tab**

It is used to set and start electron gun baking.

Refer to < 4.9 >.

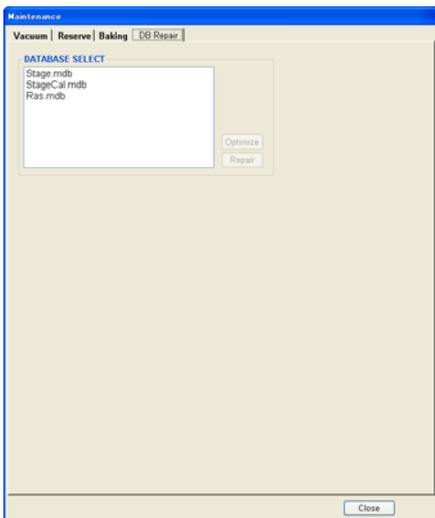


**Fig. 2-67 Maintenance Window – Baking tab**

(4) **DB Repair tab**

It is used to optimize and to repair the database for the SEM application.

Operate when asked by a service engineer.



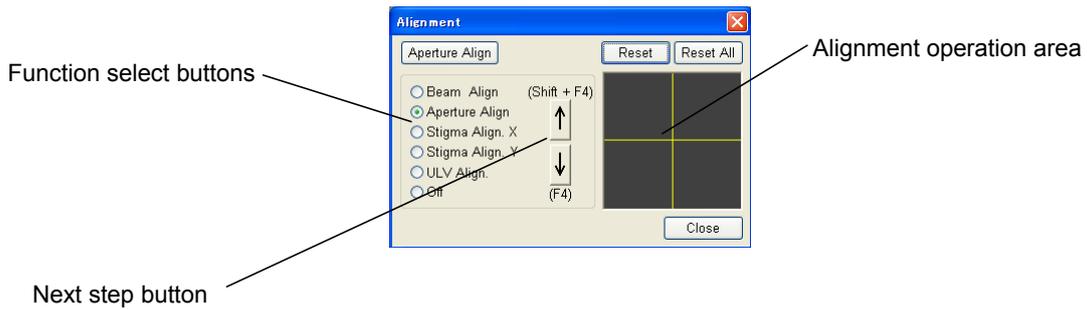
**Fig. 2-68 Maintenance Window – DB Repair tab**

### 2.3.13 Alignment Dialog Window

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

To open the dialog window, click the **Align**  button on the **Control panel** or select the **Alignment** command from the **Operate** menu.

Refer to < 3.4.4 >.



**Fig. 2-69 Alignment Window**

- (1) **Alignment** select buttons  
Starts each alignment function. **Off** stops functions.
- (2) **Aperture Align** button  
Starts Aperture Alignment function. It is the same as the **Aperture Align** select button. But it is an independent button since it is frequently used.
- (3) **Reset** button  
Resets the alignment of the selected function.
- (4) **Reset All** button  
Resets the alignment of all functions.
- (5) **Alignment** operation  
This area is used for adjustment operation. When the mouse area pointer is  , you can make adjustment both in X or X direction by moving the mouse while pressing the left button. When the mouse pointer is  or  , adjustment is restricted to X or Y direction.
- (6) **Close** button  
Stops alignment operation and closes the dialog window.
- (7) **Next step** button  
Activates the next (↓) or previous (↑) alignment function.



**REFERENCE:** F4 key steps to the next alignment function, and Shift + F4 key to the previous function.

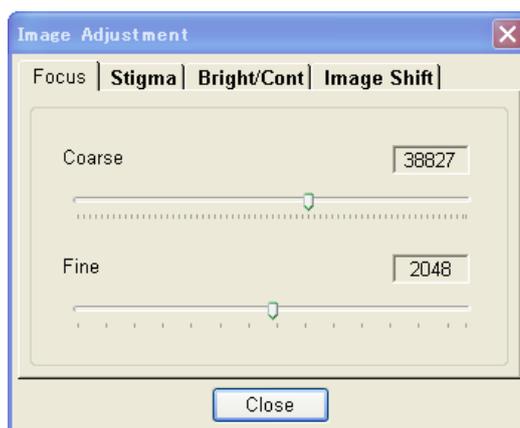
### 2.3.14 Image Adjustment Window

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 Compansation function.

That function is useful to observe the inclined sample.



**Figure 2-70 Image Adjustment Window**

### 2.3.15 CD Measurement Dialog Window (option)

This function is used to perform measurements, which can be activated by selecting either the **Measure**  button on the Operation Panel or **CD Measure** from the **Analysis** menu. For operation, see the Instruction Manual of the Measure function.

### 2.3.16 Login Setting Dialog Window

The window opens by selecting the **Login Setting** command from **Option** menu. This is available only when logged in with the login name [SU6600].

You can create or change the login name and password for each user. Refer to < 3.9.16 >.



Fig. 2-71 Login Setting Dialog Window

### 2.3.17 Oblique Dialog Window

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

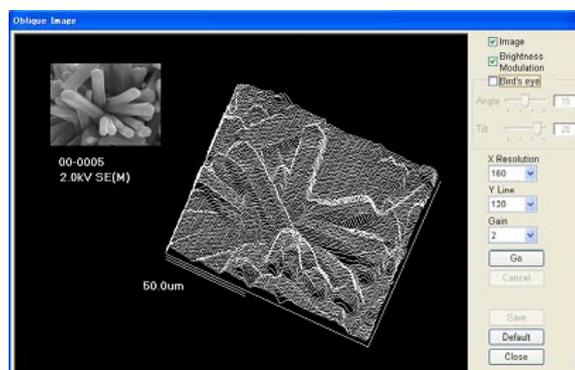


Fig. 2-72 Oblique Dialog Window

Refer to < 3.9.13 >.

### 2.3.18 Password Setting Dialog Window

Use the **Password Setting** dialog window for setting or changing the password for the login name of the current user.

To open this dialog window, select the **Password Setting** command from the **Option** menu.



Fig. 2-73 Password Setting Dialog Window

Refer to < 3.9.15 >.

### 2.3.19 Save Image Dialog Window

The **Save Image** dialog window is used for saving scanning images or captured images.

To save scanning images, use the **Direct Save** button on the **Control panel**. Use the save button on the **Captured Image** window to save captured images.

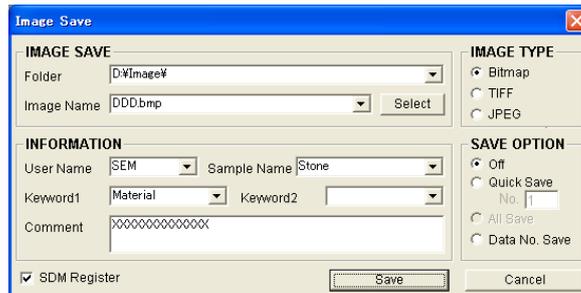


Fig. 2-74 Save Image Dialog Window

Refer to < 3.6.4 > and <3.6.5 >.

**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.

### 2.3.20 Opt Signal Processing Dialog Window

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

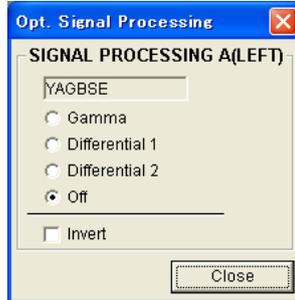


Fig. 2-75 Opt Signal Processing Dialog Window

Refer to < 3.9.5 > - (2).

### 2.3.21 Split/Dual Mag Controller

Split Screen mode displays two images in the viewing area, and allows images having different signals and be displayed at different magnifications. The Split Screen mode is available in **Full** and **Small** screen modes. To open this controller, select the **Split DM** command from the **Scan** menu.

Pressing the **Detector** button opens a window that allows you to select signals to be displayed on the right and left screens.

Refer to < 3.9.2 >.

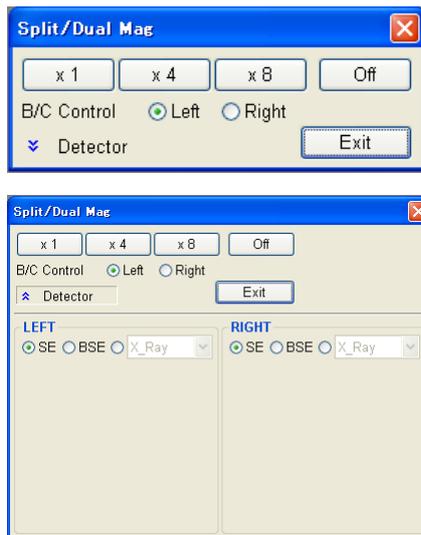
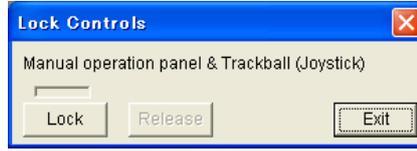


Fig. 2-76 Split/Dual Mag Controller

### 2.3.22 Lock Controls dialog window

To open the Lock Controls dialog window, select the **Lock Controls** command from the **Option** menu. This window stays on top of the desktop.



**Fig. 2-77 Lock Controls Dialog Window**

To lock the manual operation panel and trackball (or joystick), click the **Lock** button. The color of indicator box above the button is red when these are locked.

Use it, for example, during long term analysis operation where unwanted touching of the manual controls is undesirable.

(Operations using the mouse on the image are not locked.)

### 2.3.23 GUN Valve Dialog Window

To open the **GUN Valve** dialog window, select the **GUN Valve** command from the **Setup** menu.



**Fig. 2-78 GUN Valve Dialog Window**

- **Manual Operation, Open**  
Click to open the gun valve.  
The color of indication box at the left of the button is red when the valve is open.
- **Manual Operation, Close**  
Click to close the gun valve.
- **Display window left of the Open Button**  
This window turns red when the gun valve is open.
- **Preset Count**  
Select the number of automatic open-close operations.

- **START**

Start the preset number of open-close operations with about a 10 seconds period.

After venting and pumping the specimen chamber, there may be a case that the gun high voltage is shut off at the moment of gun valve opening after applying accelerating voltage, due to temporary degradation of the gun chamber vacuum.

Repetition of open and closing of the gun valve will solve the problem.

The **GUN Valve** controls are provided for this operation. The **Open** and **Close** button operate it manually. It is repeated automatically for a preset number by clicking the **Start** button.

Gun valve operation is possible when the specimen chamber vacuum is high and gun is in shutdown status.

**NOTICE:** The gun isolation valve operation is necessary only when the above problem occurs.

Contact a service engineer if the above gun shutdown occurs, and carry out the isolation valve operation following his instruction.

If the gun valve is closed while open from reasons other than the close operation on the **GUN Valve** window, for example by specimen exchange chamber gate valve opening, the indication box color will be kept red despite it being closed.

This mismatch between the actual valve status and the indication is recovered by an open or close operation.

### 2.3.24 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 key.

They are;

Ctrl + O : Open SEM Data Manager

Ctrl + P : Print

Ctrl + C : Copy Image

Ctrl + L : Open **Captured Image** window

Ctrl + B : Changes Alignment mode to the **Beam Align** step

Ctrl + A : Changes Alignment mode to the **Aperture Align** step

Ctrl + X : Changes Alignment mode to the **Stigma Align X** step

Ctrl + Y : Changes Alignment mode to the **Stigma Align Y** step

Ctrl + Z : Changes Alignment mode to the **ULV Align** step

Ctrl + S : Changes Alignment mode to the **Off** step

F1 : Help is opened

F2 : Activates the Degauss function.

F5 : Runs or stops scanning alternately

F4 : Changes Alignment mode to the next step.

Shift + F4 : Changes Alignment mode to the previous step

## 3. OPERATION

Shown below is the procedural flow of the S6600 SEM operation. For details, refer to each subsection.





## 3.1 Preliminary Operation

### 3.1.1 Check of Column Vacuum

At the beginning of SEM operation, check the evacuation control panel. The following conditions must be met.

For operation of the evacuation system, refer to the description in 2.1.5 through 2.1.7 of chapter 2.

- (1) Lamps of **IP1** and **IP2** RESET switches are lit.



**Fig. 3-1 Evacuation Control Panel/Operation Area**

- (2) Ion pump readings are better than the following.

IP1:  $2 \times 10^{-7}$  Pa (display: 2E-7)

IP2 :  $1 \times 10^{-5}$  Pa (display: 1E-5)

(Pressing MODE switch on the evacuation control panel cycles forward the blinking of the status display lamps. Read the vacuum when the corresponding IP1 or IP2 lamp is blinking.)

If vacuum readings do not satisfy the above conditions, gun baking is required. Refer to < 4.9 >



**Fig. 3-2 Evacuation Control Panel/Display**

- (3) **EVAC POWER** switch is set at — (ON).
- (4) **TMP POWER** and **NORMAL** lamps and the lamp of **SC EVAC** switch are lit.



**Fig. 3-3 Evacuation Control Panel/Operation Area**

- (5) Vacuum of S.C (specimen chamber) is better than  $2 \times 10^{-3}$  Pa (display: 2E-3). (Read the vacuum when S.C status indicator lamp is blinking upon pressing MODE switch on the evacuation control panel.)



**Fig. 3-4 Evacuation Control Panel/Display**

- (6) **APT. HEAT** switch is set to **AUTO** and the **HEAT** lamp is lit.

If the objective lens aperture or the aperture of the electron gun valve is contaminated due to electron beam irradiation, charge-up will produce an irregular electric field and degrade the image quality, and the image will drift because of a micro-discharge. These phenomena will appear particularly at a low accelerating voltage. The aperture is therefore heated to about 150 °C to suppress the adhesion of contaminants to one tenth or less of the amount at room temperature.



**Fig. 3-5 Evacuation Control Panel/Operation Area**

<Usual method of use>

The **APT. HEAT** switch on the evacuation control panel is kept in **AUTO**. As long as the evacuation power supply (**EVAC POWER**) is at ON (-), heating will continue, even if the display power is turned OFF.

<Operation at maintenance>

- At introduction of air into specimen chamber:  
Before introducing air into the specimen chamber for cleaning the objective lens aperture etc., first make sure there is no liquid nitrogen in the optional Dewar vessel. (Introducing air into the specimen chamber in the condition where the anti-contamination trap is cooled will cause fogging and a deterioration of the vacuum.)  
Holding down the S.C. CONTROL **AIR** switch for at least three seconds will cause the AIR lamp to blink. If the **APT. HEAT** switch has been ON up to this point, the heating current will be stopped automatically, and after a wait of about 30 minutes (to preclude oxidation of the heated objective lens aperture through contact with air), the turbo-molecular pump comes to a stop, followed by the start of air introduction. (During the waiting time, **APxx** (xx stands for remaining waiting time in minutes) appears on the vacuum indicator.)  
By leaving the **APT. HEAT** switch at OFF, the waiting time will be shortened. (Time when heater was turned off is monitored internally, and the 30-minute wait begins at the turnoff point.)
- Process after aperture cleaning:  
When the S.C. CONTROL **EVAC** switch lamp changes from blinking to solidly lit, following the start of evacuation, set the **APT. HEAT** switch to **DEGAS**, wait about one hour, then set this switch to **AUTO**. This is to discharge adsorbed gas by keeping the aperture at a higher temperature than that employed during use.
- Method of cleaning aperture:  
Refer to Section 4 Maintenance in the manual for details.  
After use at a low accelerating voltage and high magnification (1 kV and  $\times 20,000$  or higher, for instance), a good image quality can be obtained by carrying out sputter coating with Pt-Pd, Au-Pd etc. following baking.

### 3.1.2 Startup of Display

- (1) Set the DISPLAY switch at - and press the PC power switch to turn ON the PC (this procedure is unnecessary when instrument is set so that PC power on is linked with the DISPLAY switch).



**Fig. 3-6 Display Power Switch**

- (2) Windows XP will start up and a message requesting that you key in “Ctrl + Alt + Delete” simultaneously will appear. Pressing these keys will display the login dialog window. Now enter a login name and password and the Windows XP program will start. The following settings are made for the login when the instrument is shipped from the factory.

- Administrator (Administrator level, password “hitachi”)
- SU6600 (Power user level, no password)

Reference: See Startup of SU6600 Control Program in 2.3.1.

- (3) The SU6600 control program starts up automatically and the SU6600 login dialog window appears.



**Fig. 3-7 Login Window**

Enter a login name and password and click OK, then the SEM main window will appear. At shipment of the instrument, the login name “SU6600” (without password) is set in default. Refer to 3.9.15 and 3.9.16 for setting/deletion of password and login name.

### 3.1.3 Startup/Shutdown of Electron Gun

With the Schottky emitter, an extracting electric field is applied to the tip that is heated to approximately 1700K to obtain emission current.

Normally the current for heating the tip and the extracting electric field are applied continuously to maintain the output of emission current. When starting, the vacuum gun valve between electron gun and specimen chamber is opened, an accelerating voltage is applied and the electron beam is irradiated onto the specimen.

In the following explanation, the procedure for setting the status in which the emitter is heated and emission current is extracted is called “startup of electron gun” while the transition from emission status to non-emission status upon cutting off the extracting electric field and heating current is referred to as “shutdown”.

A good balance between heating temperature and extracting electric field is very important for the Schottky emitter, and time is allotted via a prescribed sequence for both startup and shutdown of the gun. Also, during the several hours from the completion of electron gun startup until emission current reaches a certain level, the emission current is gradually increased.

This is the reason that the tip remains on, even when the instrument is not being used.

#### 3.1.3.1 Startup of Electron Gun

(1) Power-on procedure

Set the power switch of the gun HV power supply to ON and then turn ON the power switch of the display unit. (If the gun HV power supply is OFF at the point where the display unit power is turned ON, the SU6600 control software will not start up. In such case, shut down the PC and turn OFF the display unit power once, then turn ON power again in the aforementioned sequence.)

(2) Startup of Electron Gun

After starting the SU6600 control program, if the SE Tip indication on the HV indicator is flashing in yellow-blue, the electron gun can be started up.

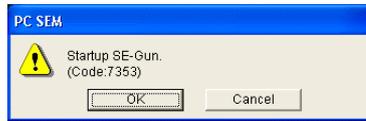
(If the SE Tip indication is steady at blue, it means the electron gun chamber vacuum level is inadequate and the gun cannot be started. And if the indication is steady at yellow, it indicates the gun is already started.)

Select **GUN startup** from the **Setup** menu.



Fig. 3-8 Setup Menu

A confirmation message will now appear.



**Fig. 3-9 Startup SE-GUN confirm message**

Click **OK** here and the GUN startup window shown below will appear.



**Fig. 3-10 GUN startup Window**

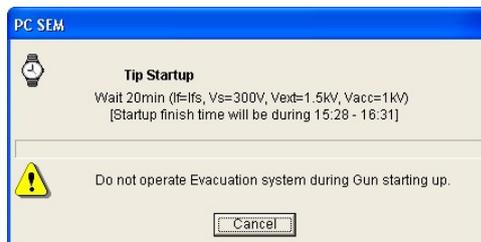
Indicated here is whether the **Elapsed time from previous GUN shutdown** is “less than 8 hours” or “8 hours or more”. The startup sequence varies according to the elapsed time. This time will be automatically calculated, and normally should not be changed.

If you wish to change it, click **Change** button and a time change dialog will appear. The setting can be changed here.

**Specified filament current** is the heating current for bringing the emitter heating temperature to the prescribed level. This current value differs slightly for each emitter, and the value for the presently attached emitter is set. This setting also should not be changed as a rule.

(If requested by the service representative, change the setting as instructed. Upon clicking the **Set** button, a dialog for changing the current will appear.)

Clicking the **OK** button will start the electron gun. During the startup, the message indicated below will be displayed.



**Fig. 3-11 Tip Startup message**

The anticipated time until completion of startup appears in this message. Since the startup sequence changes with the status along the way, an interval is provided for the time until completion. This interval becomes narrower as the sequence proceeds.

The time normally required for electron gun startup is as follows.

- 1 to 2 hours when **Elapsed time from previous GUN shutdown** is less than 8 hours.
- 3 to 4 hours when **Elapsed time from previous GUN shutdown** is 8 hours or more.

Note that the SEM cannot be operated during this startup period.

**NOTICE:** Do not close the SU6600 program, shut down the PC nor turn OFF the display power before the completion of electron gun startup. Also avoid operating the evacuation system (such as introduction of air into specimen exchange chamber XC-AIR) etc.) since the startup would be halted.

The completion message indicated below will appear when the startup is finished.



**Fig. 3-12 Tip startup finish Message**

The emission current will be slightly less than the final steady value, but will gradually increase and reach this value in a few hours after the completion of startup. During this time, application of accelerating voltage and carrying out operations for image observation or analysis are of course possible. But for an application that requires probe current to be stable for a long time, better results will be available by waiting about half a day after the completion of gun startup.

**NOTICE:** A description such as “tip startup normally completed, emission current too low” may appear on the startup completion message. This appears when the prescribed process is carried out during the startup with the emission current being less than 6  $\mu\text{A}$  at the end of the startup sequence. If this is the case, leave the system for a while (a few hours). If the electron gun high-voltage power supply indicators are all lit solidly green when the emission current has diminished significantly or the tip startup process has terminated normally, contact the service engineer.

### 3.1.3.2 Shutdown of Electron Gun

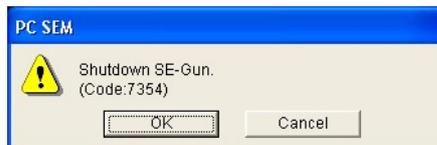
It is normally not recommended to shut down the electron gun at the end of the daily operation. It should be shut down when the instrument will not be used for a long period or when all the power to the instrument must be cut off for some reason.

Select **GUN shutdown** from the **Setup** menu.



**Fig. 3-13 Setup Menu**

A confirmation message will now appear.



**Fig. 3-14 Shutdown SE-GUN Confirm Message**

Click **OK** to execute the shutdown, or else click **Cancel** to abort the shutdown.

In the case of shutdown, the voltage and current are gradually reduced according to a prescribed sequence. The shutdown takes about four minutes, and when completed, a completion message will appear.



## 3.2 Specimen Setting and Specimen Exchange

### 3.2.1 Cautions on 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. Use of an excess amount of paste will cause considerable out-gassing in the vacuum, resulting in a deterioration of the vacuum level and probable contamination.
- (3) Select the correct specimen stub for each specimen. 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.

### 3.2.2 Specimen Preparation According to Materials

The method of specimen preparation varies with materials. Below are preparation methods for typical 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:  
Coating with conductive materials is recommended. To observe these kinds of specimens without a conductive coating use low accelerating voltages (1 kV or lower). However, coated particles may be more visible at higher magnifications.
- (3) Biological specimens:  
After dehydration, dry the specimen by using a method such as critical point drying, freeze drying or other drying techniques, and then coat the specimen with conductive material. A cryogenic system is available as an option.
- (4) X-ray analysis specimens:  
Generally, polish the surface of the specimen, and then fix it to the specimen stub using carbon paste. Non-conductive specimens should be coated with carbon using a vacuum evaporator.

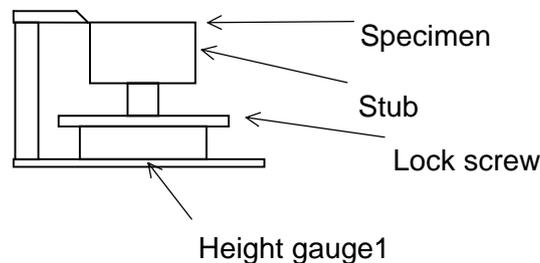
**CAUTION:** The furnished specimen stub is a round type. For mounting a specimen of square or other form, select a suitable stub so that the entire specimen will fit onto the center of the stub. With a motor-driven stage, the movable range on X and Y axis is restricted to within the diameter of the stub. In consideration of this, a movable range limit is applied upon calculating the safe operating range for Z and Tilt axes.

For instance, if a specimen of 50 mm square is attached to a specimen stub of 50 mm diameter and rotated 45°, the specimen size in X, Y direction will become 70 mm, and safety cannot be assured with a 50 mm specimen size setting. In such case, either use a specimen stub of 75 mm (3 inches) or else make a specimen setting of 75 mm (3 inches) and not 50 mm (2 inches), with reference to setting of specimen size and detector in 3.5.6.4.

### 3.2.3 Adjustment of Specimen Height

#### (1) Setting the Specimen Height (standard setting)

Put the specimen stub on the specimen holder and adjust it to the proper height using the specimen height gauge as shown in the figure. To adjust, loosen the lock screw and adjust the specimen height so that the highest point of the specimen is the same as the bottom of the height gauge. Then, tighten lock screw. The height from the bottom of specimen holder to the specimen surface is 36 mm.

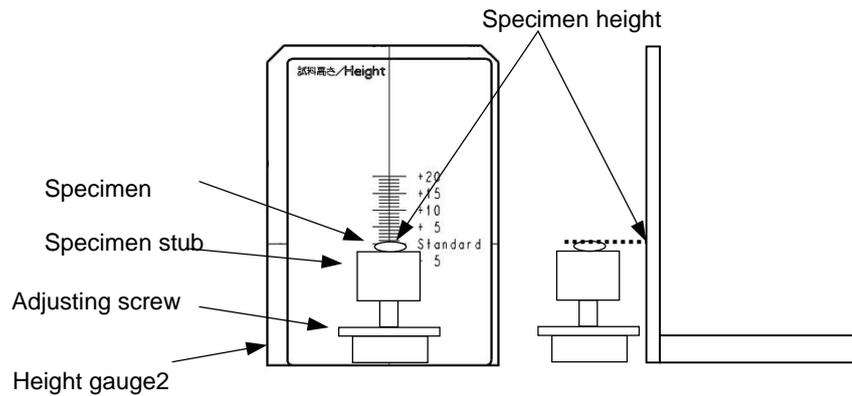


**Fig. 3-15 Measurement of Specimen Height**

#### (2) Setting the Specimen Height (Height setting)

Use the height gauge to read the height of the specimen. Be sure to read off the highest spot of the specimens. Select a difference from the standard specimen height in the Height pull-down list (-2mm to +16mm).

For details, refer to <3.5.6.4>



**Fig. 3-16 Measurement of Specimen Height**

**CAUTION:** Specimen height must be adjusted carefully. In the [Stage] tab on the Operation Panel, check the display of the [SPECIMEN] block. The sample size and height are displayed. In [Size], select the size of the sample to be observed; in [Height], select the value of the highest spot on the loaded sample as measured with a sample height gauge. If it is higher than this, the specimen may strike the objective lens and cause damage when operating at a short working distance or at a high tilt angle. Also, accurate setting of specimen height minimizes image shift during specimen tilting.

**CAUTION:** Note that the specimen holder is the same one as used for the S-4800 FE-SEM. Although the standard height of specimens in the SU6600 is the same as the type II of the S-4800, in the SU6600 specimens with a maximum height of 40 mm can be observed. An attempt to use a specimen set in the SU6600 in the S-4800 or SU-70 carries the risk of the specimen touching the gate valve between the specimen exchange chamber and the specimen chamber.

### 3.2.4 Setting and Check of Specimen Exchange Position

Click the **EXC** button on the control panel and the specimen stage will move to the specimen exchange position. A little time may be required depending on the present position of the specimen. Upon reaching the exchange position, the indicator at the left of the **EXC** button will change to green.



**Fig. 3-17 Specimen Exchange Position Set Button**

Specimen exchange position:

X: 35.0 mm Y: 0.0 mm (different from home position)  
R: 0° T: 0° Z: 31 mm

**NOTICE:** Do not repeat clicking the **EXC** or **HOME** button during stage movement. Otherwise the **!STOP** (emergency stop) button may become ineffective.

**NOTICE:** With the stage at the exchange position, only the **HOME** and **EXC** buttons can be operated. It is the same if you stop the stage motion with the **!STOP** button before the stage reaches the exchange position. Other stage operations are not allowed.

### 3.2.5 How to Set the Specimen in Place

(1) Removal of Specimen from Specimen Chamber

- Click **OPEN** button on the operating section above the specimen exchange chamber.



**Fig. 3-18 Specimen Exchange Chamber Operation Area**

The exchange chamber is once evacuated, and then the gate valve opens.

If the buzzer rings three times upon clicking the **OPEN** button, it may be that the stage is not located at the specimen exchange position. Check the stage position, and after moving it to the exchange position, click the **OPEN** button again.

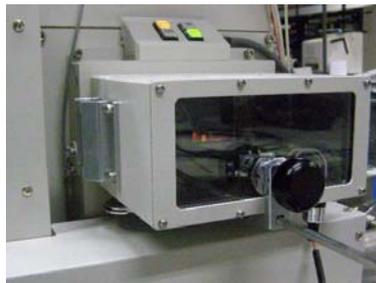
Refer to < 3.5.6.16 >.

- Turn the knob of specimen exchange rod clockwise until the UNLOCK letters face upward as indicated below, then insert the rod until its tip enters the specimen holder.



**Fig. 3-19 Specimen Exchange Rod**

The rod is correctly inserted if its knob is positioned as shown in the figure below.



**Fig. 3-20 Specimen Exchange Chamber**

- Now turn the knob of the rod counterclockwise until the LOCK letters face up as shown below, and then pull out the rod. Look into the chamber and make sure the specimen holder comes out together with the rod, and pull out the rod completely.



**Fig. 3-21 Specimen Exchange Rod**

- Click the **AIR** button on the operating section above the specimen exchange chamber. The gate valve will close and air will enter the exchange chamber. In about 15 seconds, the buzzer will sound to indicate the completion of venting.
- Open the exchange chamber, turn the knob of the specimen exchange rod clockwise until the UNLOCK letters face up, and then remove the specimen holder from the end of the rod.



**Fig. 3-22 Specimen Exchange Chamber**

**NOTICE:** Do not hold the specimen exchange rod when opening and closing the specimen exchange chamber. The rod may bend and disable specimen exchange.

(2) Opening of Specimen Exchange Chamber from an Evacuated Condition

- Click the **AIR** button on the operating section above the specimen exchange chamber. The gate valve will close and air will enter the exchange chamber. In about 15 seconds, the buzzer will sound to indicate the completion of venting.
- Open the specimen exchange chamber.

(3) Mounting of Specimen

- Turn the knob of specimen exchange rod until the UNLOCK letters face upward, and then insert the rod until its tip enters the specimen holder.
- Now turn the knob of the rod until the LOCK letters face upward, pull the specimen holder lightly and make sure it is firmly attached to the rod.



**Fig. 3-23 Specimen Holder Set**

- Pull out the rod completely and close the exchange chamber.
- Click the **OPEN** button on the operating section above the specimen exchange chamber. The exchange chamber will be evacuated, then the gate valve will open and the buzzer will sound to indicate the completion of evacuation.
- While looking into the chamber, insert the exchange rod and set the specimen holder securely onto the holder receptacle of the stage.
- Turn the knob of the specimen exchange rod clockwise until the UNLOCK letters face upward, and then pull out the rod.
- Click the **CLOSE** button on the operating section above the specimen exchange chamber. The gate valve will close, and when a sufficient vacuum level is reached in the specimen chamber, HV can be applied in about 30 seconds.

**⚠ CAUTION:** In the valve unit, fingers can be caught, potentially resulting in injury. When opening or closing the exchange chamber, use caution so that fingers are not pinched.

**⚠ CAUTION:** Be careful not to hit your head against projections such as objective movable aperture or secondary electron detector when looking into the specimen exchange chamber.

### 3.3 Setting a Vacuum Mode and Applying an Accelerating Voltage

Before applying an accelerating voltage, set a vacuum mode in which the specimen is to be observed, according to the material or condition of the specimen. Normally, when observing a non-conducting specimen, use the low-vacuum mode to prevent any charge-up on the specimen. When observing in the low-vacuum mode, insert the differential vacuum aperture into the end of the objective lens. Insert the differential vacuum aperture on the operation screen. Maintain the emission continuously, and apply the accelerating voltage when performing an observation/analysis after setting the appropriate vacuum mode. Use the electron gun by turning the accelerating voltage on, and turning off the accelerating voltage only when finished.

The text below describes the situation where the electron gun is in the emitting.

For a description of electron gun start-up or shutdown operation, see Section 3.1.4.

#### 3.3.1 Setting a Vacuum Mode

Specify the desired vacuum level with the vacuum mode (high- or low-vacuum) in which observation is to be conducted or when the low-vacuum mode is to be used.

The text below describes procedures for switching vacuum modes.

#### 3.3.2 Vacuum Mode Switchable Conditions

Switching vacuum modes requires the insertion of the differential vacuum aperture into the end of the objective lens. Vacuum level switching operation is disabled if a differential vacuum aperture is not inserted into the end of the objective lens.

(1) Aperture insertion/retraction operation

The differential vacuum aperture can be inserted into and retracted from the end of the objective lens by clicking the **Apt. IN/OUT** button on the stage/FOV move control unit on the Control Panel and clicking the **APT/ CONTROL** button on the Operation Panel Observation **Cond.** tab.

Control Panel



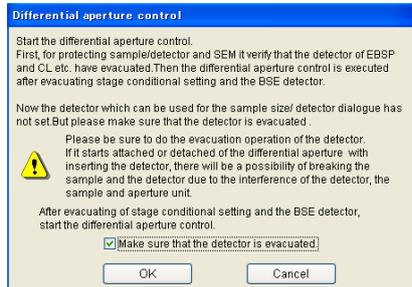
Fig. 3-24 Control Panel

Operation Panel



Fig. 3-25 Operation Panel

Clicking the **Apt. IN/OUT** button and the **IN** button brings up the differential vacuum aperture control dialog box. Verify the contents of the box, place a check mark in the check box, and press the **OK** button to start the aperture insertion operation.

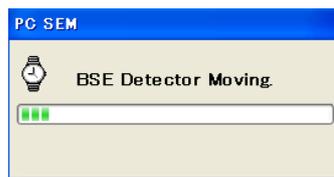


**Fig. 3-26 Differential aperture control Dialog**

**NOTICE:** For protection of the specimen, detectors, and stage, verify that the EBSP and CL detectors are retracted, stage condition, and retract the BSE detector. Inserting or retracting the differential vacuum aperture with a detector inserted can cause the detector or the specimen to touch the differential vacuum aperture, thus potentially damaging the specimen and the detector.

**NOTICE:** When inserting a differential vacuum aperture, in some cases the objective movable aperture must be re-aligned. If a circular image is not produced in the beam alignment mode when the probe current or the accelerating voltage is changed, or if the image is extremely dark when the contrast is adjusted, set the objective movable aperture to position 0, perform beam alignment, and a mechanical re-adjustment of the objective movable aperture.

The following message appears when the aperture is being inserted:



**Fig. 3-27 Differential aperture Moving Message**

Upon normal completion of the aperture insertion operation, the message disappears, and the indicator on the left side of the **Apt. IN / OUT** button on the Control Panel turns green, and the **Apt. IN / OUT** button on the Operation Panel is also enclosed in a green frame.



**Fig. 3-28 Control Panel**



## Operation Panel



**Fig. 3-29 Operation Panel**

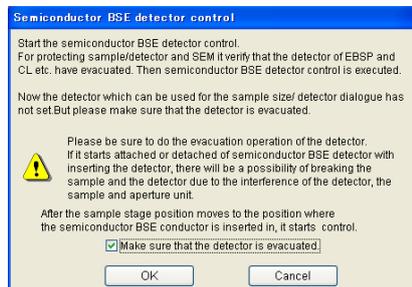
Also, to retracting the aperture, click the Aperture Out button. As the differential vacuum aperture control dialog box appears again, perform the same operation as aperture insertion.

### (2) BSE detector insertion/retraction operation

Since secondary-electron detector is for a high vacuum, it cannot be used in low-vacuum mode, a backscatter electron (BSE) detector must be used.

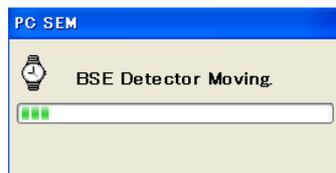
The BSE detector can be inserted into and retracted from the underside of the objective lens by clicking the **IN/OUT** button located in the **Set Specimen** function on the **Stage** tab of the Operation Panel. When the BSE detector is inserted, the IN display frame remains green; when the BSE detector is retracted, the OUT display frame turns green.

Pressing the **BSE IN / OUT** button displays a semiconductor BSE detector dialog box. After verifying the contents of the box, place a check mark in the check box, and press the OK button to start the BSE detector insertion operation.



**Fig. 3-30 Semiconductor BSE detector control Dialog**

**NOTICE:** For protection of the specimen, the detectors, and the SEM, verify that the EBSP and CL detectors are retracted. Inserting or retracting the BSE detector with a detector inserted can cause the detector or the specimen to touch the BSE detector, thus potentially damaging the specimen and the detector. The following message appears when the BSE detector is being inserted:



**Fig. 3-31 BSE Detector Moving Message**

Upon normal completion of the BSE detector insertion operation, the message disappears, and the IN display frame turns green.



**Fig. 3-32 SPECIMEN Block**

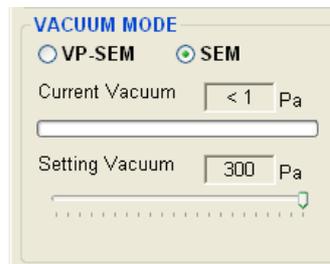
To retract the BSE detector, click the **BSE IN / OUT** button. As the semiconductor BSE detector control dialog box re-appears, perform the same operation as insertion.

**NOTICE:** If the stage is initialized during the insertion of a BSE detector, it may take approximately 10 minutes before the initialization process terminates.

(3) Vacuum mode switching operation

Low- and high-vacuum modes can be switched by clicking the **VACUUM MODE** button located on the **Cond.** tab of the Operation Panel, and a vacuum level can be set by dragging the Vacuum Level knob.

The aperture cannot be retracted in the low-vacuum mode. To retract it, first switch to the high-vacuum mode.



**Fig. 3-33 VCCUM MODE Block**

### 3.3.3 Condition Permitting Application of Accelerating Voltage

The accelerating voltage can be applied when **SE Tip** is indicated steadily in yellow (indicating that electron gun is started) and **Vacc** (accelerating voltage) and **le** (emission current) indications flash alternately between yellow and blue (indicating that specimen chamber is at a good vacuum level) on the HV indicator of the control panel. The **ON** button at the left of the HV indicator is therefore operable.

The **le** value does not vary with the ON/OFF switching of accelerating voltage, and is normally within a range of about 10 to 50  $\mu$ A.

If **SE Tip** is indicated steadily in blue, it means the electron gun cannot be started up due to a problem with the vacuum level. If this indication flashes alternately between yellow and blue, it means the gun has not been started and the startup operation is required.

If both **Vacc** and **le** are indicated in blue, it means the conditions are not yet satisfied.

Check the vacuum level of the specimen chamber (refer to section 3.1.1). Also the gate valve of the specimen exchange chamber must be closed and the **EVAC** switch lamp on the operating section of the exchange chamber must be lit.

Accelerating voltage is indicated in yellow during its application.

**REFERENCE:** Indicated below is the relationship between vacuum, electron gun status and HV indication.



**Fig. 3-34 SE-GUN Control Area**

(1) **SE Tip** indication

Indicates the electron gun status. This varies as shown in the table below.

Electron Gun Vacuum	High Vacuum		Low Vacuum
Electron Gun Startup Status	Shut Down	Started Up	
Indication color	Alternates between yellow and blue	Steady in yellow	Steady in blue

(2) **Vacc** and **le** indication

**Vacc** indicates accelerating voltage while **le** indicates emission current. The set accelerating voltage is indicated regardless of ON/OFF condition.

The indication color represents the following.

Indication Color	Status	Description
Steady in blue	Accelerating voltage cannot be applied	Electron gun is shut down or specimen chamber vacuum is inadequate
Alternates between yellow and blue	Accelerating voltage can be applied	Electron gun is started up and specimen chamber vacuum is good
Steady in yellow	Accelerating voltage is applied	

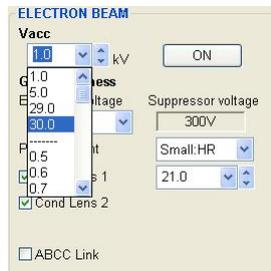
(3) **ON** and **OFF** buttons

When the conditions are OK for application of accelerating voltage to the electron gun (good vacuum level in electron gun and specimen chambers), the **ON** button becomes effective and the **Vacc** and **le** indications flash alternately between yellow and blue. Clicking **ON** button applies the accelerating voltage and **Vacc** and **le** light up steadily in yellow. In this condition, the **ON** button is changed to read **SET**. This is used when changing the accelerating voltage.

### 3.3.4 Setting of Accelerating Voltage and Emission Current

Click the accelerating voltage indicator and the HV setting dialog will open.

- (1) Select a desired accelerating voltage (Vacc) from the list. Or, enter a value from the keyboard (and press Enter key).  
If necessary, the up/down arrow buttons  can be used to set a desired value (in 100 V steps). (To change the accelerating voltage with the up/down arrow buttons  during application of the HV, you must click the **SET** button after selecting a voltage.)



**Fig. 3-35 ELECTRON BEAM Block**

- (2) To change the emission current, you must change the setting of Extraction voltage under **Gun Brightness**. The Extraction voltage is selectable from five preset values. The higher the Extraction voltage numeral, the higher the emission current and probe current as well. The Extraction voltage at “3” is normally used, and for a higher probe current, select “4” or “5”. When observation of high-resolution SEM images is the object, use a setting of “2” since a large probe current is unnecessary. And, a setting of “2” or “1” may be suitable for observation near the resolution limit at a low accelerating voltage. Note that this setting can be changed regardless of whether accelerating voltage is being applied.



**Fig. 3-36 ELECTRON BEAM Block**

**NOTICE:** With regard to **Extraction voltage - Gun Brightness**

- It is recommended to use a setting of “3” normally for observation/analysis.
- Since a lower emission and probe current provides a smaller variation width in beam energy, an Extraction voltage setting of “2” or “1” may be better for observing high-resolution SEM images or for observation near the resolution limit at a low accelerating voltage.
- At a setting of “4” or “5”, probe current will be approximately 1.3 or 1.6 times the value obtained at “3”.
- When using high magnification under a large probe current condition obtained by selecting “4” or “5”, the image may sway similar to vibration disturbance. Therefore, since an increase of magnification is usually considered to be unnecessary in analytical applications under a large probe current, a condition that places priority on the merits of a large probe current should be selected.

**NOTICE:** When accelerating voltage has been changed, be sure to carry out electromagnetic alignment.

### 3.3.5 Application of Accelerating Voltage

Make sure that **SE Tip** is lit in yellow and **Vacc** and **Ie** flash alternately between yellow and blue on the HV indicator of the control panel, then click **ON** button at the left of HV indicator and accelerating voltage (Vacc) will be applied. The electron gun airlock valve will open automatically.



**Fig. 3-37 SE-GUN Control Area**

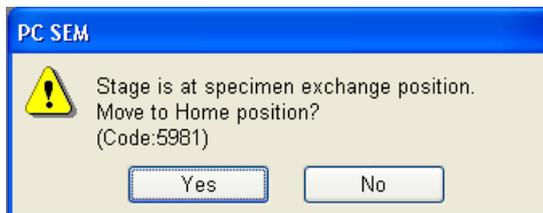
During the application of accelerating voltage, the **ON** button will read **SET**. Upon changing the voltage with the up/down arrow buttons, the voltage will actually be changed upon clicking the **SET** button.

**NOTICE:** When accelerating voltage has been changed, be sure to carry out electromagnetic alignment.

**REFERENCE:** Warning message with respect to specimen exchange position at HV ON

Although HV application is possible even at the position where specimen was exchanged near the end of the Y axis of the specimen stage, the specimen may not be located under the beam in such case, and instrument malfunction or erroneous operation may result.

To prevent this, the PC SEM message will appear if HV is applied at the specimen exchange position. By clicking **Yes** here, the stage will be moved to the home position.



**Fig. 3-38 Stage confirm Message**

## 3.4 Adjustment of Electron Optics

### 3.4.1 Probe Current Modes

The SU6600 provides various electron optical modes to enable a broad range of applications from ultrahigh resolution image observation to analysis by way of EDX, WDX, EBSP etc. Select a suitable mode in accordance with your application.

Probe current modes available are Small:HR, Medium and Large:Analy. Select a suitable mode in accordance with your application. Mode selection is done by means of Column tab on the Setup dialog or by selecting a diameter (No.) of anode aperture (movable aperture just below electron gun) and OBJ aperture (objective lens aperture).

**CAUTION:** If the anode aperture is used for a long time in a condition where its present position No. is smaller than the optimum position No., the electron beam will irradiate the area around the fixed aperture of the gun valve section and cause contamination. So avoid leaving the instrument for a long time with the accelerating voltage applied in a condition where the optimum and present positions of the aperture do not match.

#### (1) Explanation of Each Mode

- **Small:HR:**  
This mode is selected for high resolution observation. It is mainly used for image observation applications where a large probe current is unnecessary. Anode aperture is set at No. 4 and OBJ aperture at No. 3 in this mode.
- **Medium :**  
This is selected for high-speed EDX analysis, EBSP analysis etc. where a comparatively large probe current is needed. It is useful for applications where a probe current from several nA (low accelerating voltage) up to several ten nA (high accelerating voltage) is required. Since a larger probe current is used, image resolution is lower than in the Small:HR mode. Anode aperture is set at No. 3 and OBJ aperture at No. 2 in this mode.

- **Large:Analy** : This is selected for applications (such as WDX) that require an even larger probe current than obtained in the Medium mode. Since the probe current is large, image resolution is lower than in the Small:HR and Medium modes. Anode aperture is usually set at No. 2 and OBJ aperture at No. 1 in this mode. An even larger probe current can be obtained by setting anode aperture at No. 1, and condenser lens 1 at 1 to 7.

The table below shows the optimum settings of anode and OBJ apertures and applications for each probe current mode.

Mode	Anode aperture	OBJ aperture	Application
Small:HR	No. 4	No. 3	High resolution observation
Medium	No. 3	No. 2	EDX, EBSP analysis etc.
Large:Analy	No. 2 (No. 1)	No. 1	Where large probe current is required as in WDX etc.

**NOTICE:** The probe current obtainable in each probe current mode varies with the accelerating voltage.

(2) How to Set Probe Current Mode

Select a probe current mode as described below.

- 1) Click either the **Beam Align** button in the **Alignment** window or the **Beam Alignment** button located on the **Optics** tab of the **Setup** dialog to set the beam alignment mode. Use the STIGMA / ALIGNMENT knob on the Manual Operation Panel so that the circular image is brought to the center of the window.

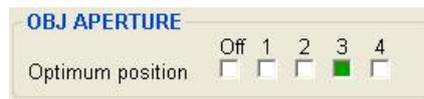
**NOTICE:** When executing the beam alignment mode, avoid operating the STIGMA/ALIGNMENT knobs on the manual control panel or the alignment control area on the Alignment window.

- 2) Select a mode in the Probe Current mode selector box under the Optics tab on Setup dialog.

In this case, the optimum and present positions of the anode aperture will not match. The aperture No. presently set for the anode aperture is detected by a position sensor, and if the present No. is smaller than the optimum No., a warning message indicating to change to the optimum position will appear. Click OK button here and the message will disappear.

**CAUTION:** If the anode aperture is used for a long time in a condition where its present position No. is smaller than the optimum position No., the electron beam will irradiate the area around the fixed aperture of the gun valve section and cause contamination. So avoid leaving the instrument for a long time with the accelerating voltage applied in a condition where the optimum and present positions of the aperture do not match.

- 3) Check the OBJ APERTURE block under the Optics tab on the Setup dialog. Indicated here in green is the optimum (or recommended) aperture No. for the probe current mode setting. Select an OBJ aperture No. in accordance with the indication.



**Fig. 3-39 OBJ APERTURE block**

**REFERENCE:** Even if the objective lens aperture setting differs from the recommended No., there is no need to worry about contamination, and therefore an aperture position sensor is not equipped. Nor is a warning message issued.

- 4) Operate the OBJ aperture fine adjustment knobs (X,Y) and bring the round image obtained in beam alignment mode to the window center. If the image does not appear, adjust the contrast to brighten the image. Note that the aperture fine adjustment knobs should be operated slowly and gently.



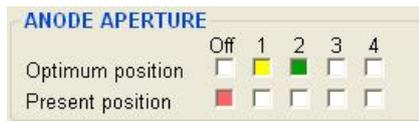
**Fig. 3-40 OBJ Aperture fine adjustment knob**

**NOTICE:** This adjustment involves the mechanical position adjustment of the aperture, using an aperture hole adjustment knob. The STIGMA/ALIGNMENT knob on the Manual Operation Panel or the Alignment Operation area in the **Alignment** window should not be touched.

- 5) Check the ANODE APERTURE block under the Optics tab on the Setup dialog. Indicated at

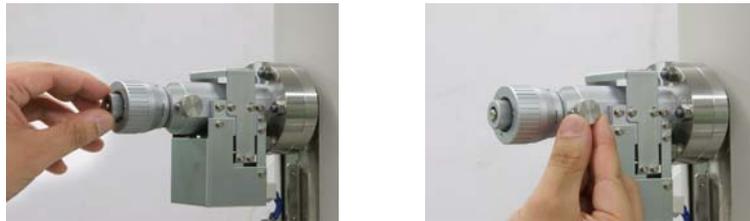


Optimum position is the recommended aperture No. for the presently set probe current mode. The No. in green is the recommended one. Although No. 2 is recommended when Large: Analy is selected for probe current mode, a larger probe current will be obtained by selecting No. 1. This No. will be indicated in yellow. Indicated at Present position is the actually set aperture No. detected by the position sensor. When the Optimum and Present positions match, the Present position will appear in green, and when they don't match, it will appear in red. Set the No. indicated at Optimum position for the anode aperture, then confirm that the Present and Optimum positions match.



**Fig. 3-41 ANODE APERTUR block**

- 6) Operate the anode aperture fine adjustment knobs (X, Y) and bring the round image obtained in beam alignment mode to the window center. If the image does not appear, adjust the contrast to brighten the image. Note that the aperture fine adjustment knobs should be operated slowly and gently.



**Fig. 3-42 Anode Aperture fine adjustment knob**

- 7) Turn OFF the beam alignment mode.

### 3.4.2 Setting of Electron Optical Parameters

Select electron optical parameters according to your purpose or the specimens to be observed. Conditions can be set using the **Cond.** block of the Operation Panel. Detailed settings can be specified on the **Optics** tab of the Setup dialog box.

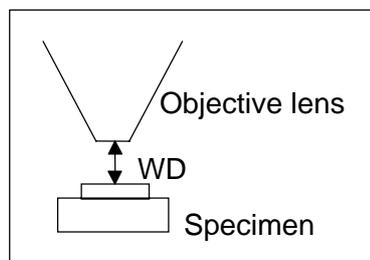
### 3.4.2.1 Setting Conditions on the Operation Panel

Setting parameters that are frequently used are provided on the **Cond.** tab of the Operation Panel.



**Fig. 3-43 ELECTRON BEAM Block**

- (1) Accelerating voltage (Vacc) setting  
This button allows you to set an accelerating voltage (Vacc) and turn it on and off.
- (2) PROBE CURRENT display  
Displays the currently set probe current mode. A probe current mode can be set by clicking the **Detail...** button and operating the **ELECTRON BEAM** block of the **Setup** dialog box.
- (3) Setting of WD (working distance)  
Working distance (WD) is the distance between the bottom face of the objective lens and the surface of the specimen. The Z-axis scale of the specimen stage corresponds to the WD.



**Fig. 3-44 Definition of WD**

By clicking ↓ button and selecting a WD from the list that appears, the objective lens current will be set so that focusing can be made at that WD. (Actual specimen position is adjusted with the Z-axis of specimen stage.)

For x-ray analysis, the same WD (15 mm) should be used in order to maintain the x-ray take-off angle of the detector. First set WD to 15 mm on the OPE-CONDITION block, and then by adjusting the specimen stage Z-axis to obtain focus, the positional relation between x-ray detector and analytical point on the specimen can be set to the desired one even for a specimen having a considerably irregular surface.

By changing the WD, the restrictions on resolution, depth of focus and specimen tilt angle will also vary. The following table shows the relationship between WD and resolution, focus depth and specimen tilt angle.

	Short	← WD →	Long
Resolution	High	←————→	Low
depth of focus	Shallow	←————→	Deep
Specimen tilt angle	Small	←————→	Large

### 3.4.2.2 Details Setting on the Optics System

To specify detailed settings, click the **Detail...** button in the **Cond.** block to open the **Optics** tab of the **Setup** dialog box in front (this can also be opened by clicking the HV display unit on the Control Panel).

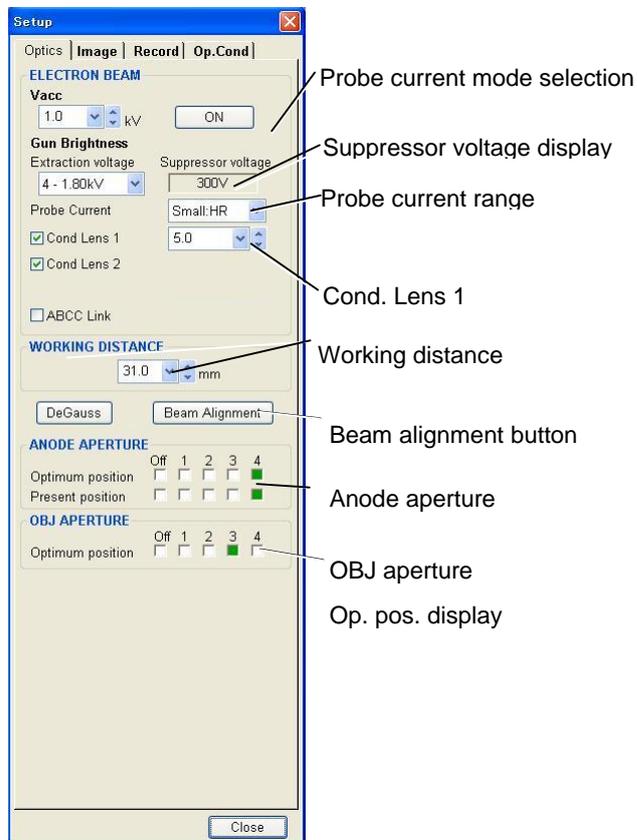


Fig. 3-45 Setup Window

(1) Setting of Probe Current mode

Click ↓ button and select either Small:HR, Medium or Large:Analy from the displayed list.

Small:HR mode puts priority on high-resolution observation.

Medium is selected when a comparatively large probe current is required for high-speed EDX analysis, EBSD analysis etc.

Large:Analy is selected when an even larger probe current is needed.

(Probe current obtained in each probe current mode varies with the accelerating voltage.)

**NOTICE:** Albeit depending on the shape and material of the specimen to be observed, in a condition where the probe current is large, when an observation is conducted by TV scanning or at a Slow 1/2 scanning speed, if the screen contains bright horizontal lines, all the horizontal lines may appear dark. Since this problem does not occur at scanning speeds slower than Slow 3, when capturing an image, use a scanning speed from Slow 3 to 5.

(2) **Cond Lens 1** check box/lens setting

The probe current can be adjusted by adjusting the excitation current of Condenser Lens 1. Select a value (1.0 to 32.0) from the list. If further micro-adjustments are needed, use the Up/Down buttons  to set a value in 0.1 increments. Numbers can also be entered from the keyboard (press the Return key to apply). The greater the list value, the higher the lens current, and the smaller the probe current. A probe current is determined by combining it with the aforementioned probe current mode.

The Small:HR probe current mode and a Condenser Lens 1 value of 32 produces a minimum probe current; the Large:Analy probe current mode and a Condenser Lens 1 value of 1 yields a maximum probe current.

Also, unchecking this function reduces the excitation current of Condenser Lens 1 to zero. Normally leave this function checked, and uncheck it (OFF) only when mechanical axial adjustments are to be performed.

**NOTICE:** Normally, the probe current is adjusted by using the probe current mode and by setting Condenser Lens 1. However, if it is desired to modify the probe current without changing lens conditions, you can also use **GUN Brightness – Extraction voltage** (Refer to < 3.4.2 >).

(3) **Cond Lens 2** (second condenser lens)

There is only an ON/OFF setting (using the check box) for the second condenser lens. This item is normally set at ON (checked), and is set at OFF (check removed) for conducting mechanical axial alignment.

(4) Degauss operation

The degaussing operation eliminates residual magnetism from the objective lens magnetic field. When the focus is changed greatly, magnification accuracy may decrease and/or the electron optical axis may deviate somewhat due to residual magnetism. To prevent this, click the **DeGauss** button in the following cases.

- After greatly changing the focus
- Before alignment of the electron optics

Note that degaussing will be executed automatically in the following cases.

- After application or change of accelerating voltage
- After setting the WD
- After changing the probe current

**REFERENCE:** The F2 hot key activates degaussing without opening the Setup dialog window.

(5) Setting of ABCC Link

This item is used to set whether or not to perform the automatic brightness and contrast adjustment function when the following operational statuses are changed.

- (a) Probe current mode
- (b) Detector setting

### 3.4.3 Electron Optical Axis Alignment (electromagnetic alignment)

To obtain the maximum performance from the instrument, carry out alignment of the electron optical axis prior to image observation. Also carry out the following alignments when accelerating voltage, probe current mode, probe current range, first condenser lens setting and/or WD has been changed.

If the image position shifts during focusing or astigmatism correction, perform aperture alignment or stigma alignment X, Y.

There are also instances in which an optimum resolution can be obtained by slightly shifting the optical axis from the condition where image movement is minimized with the aperture alignment function at low accelerating voltage, particularly in using the optional deceleration function.

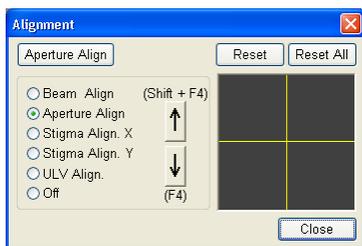
In such case correction can be made via ULV Alignment.

Since this instrument has a teaching function (function for automatically saving the latest alignment data), image observation can be made under the same conditions as obtained in the previous alignment (combination of accelerating voltage, probe current range, magnification mode (High Mag/Low Mag), first condenser lens setting) with a minimum of adjustment.

To conduct electromagnetic alignment, open the Alignment window by clicking **Align**  button on the control panel.

**NOTICE:** Carry out mechanical axial alignment after waiting at least two hours following the start of heating the objective lens aperture. If alignment is attempted just after starting the aperture heating, the axial alignment status will deviate due to thermal expansion of the aperture.

**NOTICE:** For more effective use of the teaching function, it is recommended to carry out degaussing by clicking the **DeGauss** button after focusing and then perform the electromagnetic alignment.

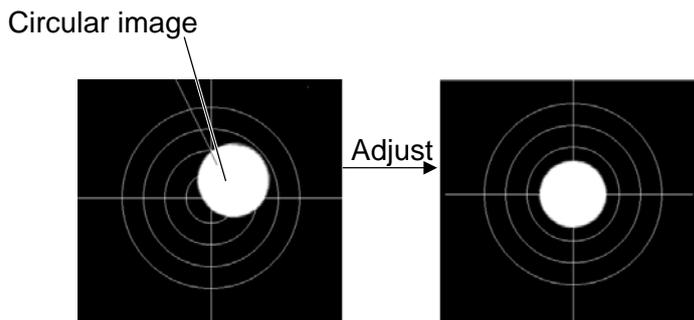


**Fig. 3-46 Alignment Window**

(1) **Beam Alignment**

Beam alignment is needed in order to align the electron beam down the center of the electron optical column and through the center of the objective lens aperture.

- (a) Click **Beam Align** button and a circular marker and circular image (of the objective lens aperture) will appear on the window. If the image doesn't appear, adjust the contrast until it does.
- (b) Adjust the STIGMA/ALIGNMENT knobs on the manual control panel, or bring the mouse cursor onto the alignment area of the Alignment window and, while holding down the left-hand button of the mouse, move the mouse and bring the circular image to the center of the screen.
- (c) After this adjustment, click the Off button on the Alignment window.
- (d) Adjust the contrast to obtain a clear image.



**Fig. 3-47 Beam alignment**

**NOTICE:**

- If a circular image doesn't appear even under the maximum contrast setting, click the **Reset All** button in the Alignment window and set the first condenser lens at the Small:HR (21), then perform beam alignment.
- If the electron beam is not focused near the specimen surface, the circular image may be distorted or partially blocked. In such case, bring the center of the bright portion of the image to the screen center, turn off the beam alignment temporarily, adjust the focus on the specimen and carry out beam alignment again. If the image, upon aligning with the screen center, is considerably blocked or is not in a circular form, perform mechanical axial alignment as in section 3.11.
- Beam alignment is a function that aligns the central orbit (optical axis) of the electron beam with the center of the objective aperture. The circular image displayed during this operation reflects the shape of the electron beam directed to the objective aperture. Because the SU6600 contains more differential vacuum apertures than systems dedicated to high vacuum levels, the displayed image may fail to produce a perfect circle when mechanical axial alignment is performed during beam alignment. However, the electron beam passing through the objective aperture undergoes a stigma correction by the stigma corrector provided underneath the aperture. For this reason, beam aligned images that are elliptic do not lead to a reduced SEM resolution.

(2) **Aperture Alignment**

Aperture alignment is needed to align the electron beam through the center of the objective lens. Unless this alignment is made correctly, the image position may shift during focusing and/or a sufficient resolution and image quality may not be obtained.

- Set the magnification to about  $\times 5,000$  to  $\times 10,000$ , and bring a point of interest to nearly the center of the screen.
- Focus the image and correct the astigmatism.
- Click **Aperture Align** button on the Alignment window to set up the aperture alignment mode, then the focus and image position will vary cyclically.
- Adjust the STIGMA/ALIGNMENT knobs on the manual control panel, or bring the mouse cursor onto the alignment area of the Alignment window and, while holding down the left-hand button of the mouse, move the mouse and minimize the image movement.
- Increase the magnification to several ten thousand times and make a final aperture alignment.
- When the alignment is finished, click Off button on the Alignment window.

**NOTICE:** When you have greatly changed the focus, it is recommended to perform degaussing of the objective lens by clicking **DeGauss** button on the Column tab of Setup window, and then perform the alignment. (Degaussing can also be executed by using the F2 hot key without opening the Setup window.)

**NOTICE:** Since a precise aperture alignment is difficult at low magnifications ( $\times 10,000$  or lower), first carry out a coarse alignment at low magnification and then increase the magnification to several ten thousand times and perform a finer alignment. Note that a correctly adjusted focus is essential for a precise aperture alignment.

**REFERENCE:** By clicking **Align** button on the control panel, you can enter aperture alignment mode directly from the usual image observation status. This is convenient for executing aperture alignment alone when the image moves considerably during focusing.

(3) **Stigma Alignment X, Y**

Stigma alignment is carried out to minimize image movement that occurs when correcting astigmatism. This alignment is also necessary to ensure a correct auto stigma operation.

- (a) Set the magnification to about  $\times 10,000$  to  $\times 50,000$ , and bring a point of interest to nearly the center of the screen.
- (b) Focus the image and correct the astigmatism.
- (c) Click **Stigma Align. X** button on the Alignment window and the image position will vary cyclically.
- (d) Adjust the STIGMA/ALIGNMENT knobs on the manual control panel, or bring the mouse cursor onto the alignment area of the Alignment window and, while holding down the left-hand button of the mouse, move the mouse and minimize the image movement.
- (e) Click **Stigma Align. Y** button on the Alignment window and the image position will vary cyclically.
- (f) Adjust the STIGMA/ALIGNMENT knobs on the manual control panel, or bring the mouse cursor onto the alignment area of the Alignment window and, while holding down the left-hand button of the mouse, move the mouse and minimize the image movement.
- (g) Click the Off button on Alignment window when the adjustment is finished.

**NOTICE:** Stigma alignment may cause deviation of the aperture alignment. So repeat the aperture alignment after completing stigma alignment (X, Y). Note that stigma alignment is not changed by aperture alignment.

(4) **ULV Alignment** (off-axis chromatic aberration correcting function)

There are instances in which an optimum resolution can be obtained by slightly shifting the optical axis from the condition where image movement is minimized with the aperture alignment function at low accelerating voltage, particularly when using the optional deceleration function. In such case correction can be made via ULV Alignment.

This function is effective at low accelerating voltages of 2 kV or less. Whether or not to use the function is selectable by way of option setting.



(a) Selection of ULV alignment function

Open the General tab of Optional Setup dialog from the Option menu.

This function is activated by putting a check mark in the ULV Alignment check box of the ULV Alignment area. The function is set at off (unchecked) at shipment of the instrument or when software version is updated. It may be left at off when not using the deceleration function, when not using a low accelerating voltage of 2 kV or less, when not using a high magnification (of around  $\times 50,000$  or higher) at low accelerating voltage, or when a good image can be observed without making this alignment.

Refer to option setting in section 3.9.14 for details.

(b) Operation method

When the above mentioned check box is checked, the **ULV Align.** radio button will be displayed. (The radio button will be invalid when the accelerating voltage is above 2 kV.)

First complete the usual axial alignments.

Then observe a specimen of fine structure at a high magnification of around  $\times 50,000$  or higher. Carry out focusing and astigmatism correction to obtain the best possible image. In this status, click the **ULV Align.** button to enter the ULV alignment mode. Adjust the STIGMA/ALIGNMENT (X,Y) knobs on the control panel to obtain an optimum image. When the adjustment is finished, click Off button to release the ULV alignment mode. Once the adjustment has been made, you may proceed with the usual operation.

When you have changed the accelerating voltage, readjustment will be necessary. (Once you have adjusted it at a certain accelerating voltage, the adjusted data will be saved for that voltage. So upon selecting that voltage again, the previously adjusted condition will be set up.)

**NOTICE:** When the sequential alignment functions are changed via  $\uparrow \downarrow$  buttons or function keys (F4, Shift+F4), the ULV alignment mode will be skipped. This mode will be activated only when intentionally selected.

Refer to < 2.3.22 >.

### 3.5 Operation for Image Observation

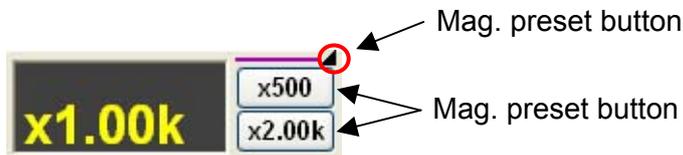
Follow the operation below for observation of a scanning image.

- Selecting Magnification..... (3.5.1)
- Selecting Scanning Speed..... (3.5.2)
- Image Brightness and Contrast Adjustment ..... (3.5.3)
- Focus and Astigmatism Correction..... (3.5.4)
- Operation of the Specimen Stage..... (3.5.5)

#### 3.5.1 Selecting Magnification

There are several ways to select a magnification.

- (1) Dragging the mouse in the **Magnification indication** area on the **Control panel**.  
 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.



**Fig. 3-48 Magnification Control Area**

- (2) Clicking the mouse button in the Magnification indication area  
 Magnification increases in incremental steps by clicking the right button and decreases by clicking the left button.

In the above motion operation, the left button makes change in small increments, and the right button in large increments.

- (3) Using a preset magnification  
 Clicking the preset button on the magnification indicator sets the magnification to a preset value, and clicking it again resets it to the original value. When the preset value is active, the characters **PM** are displayed to the right of the magnification indicator. You can specify a preset value, and then use the above operations to change the magnification. The value of a preset magnification can be changed by pressing the magnification preset button to bring up a magnification preset dialog box.  
 If a value set in the preset magnification option is smaller than the minimum magnification that can be set for a working distance, the preset value is set to the minimum allowable magnification.

**NOTICE:** Fractional magnification auto-correction function

The calculation of an image magnification involves the use of a working distance (the distance from the objective lens to the surface of the specimen). Because working distances are calculated based on the excitation current through the objective lens, a change in focus varies the magnification, and results in a fractional magnification.

When recording an image, to prevent recording the image with a fractional magnification, during an image recording operation (image capture or direct shooting), if the magnification is fractional, you can capture an image or shoot a picture by resetting the magnification to a whole number closest to the current value.

Notice that is recording operations are performed after a magnification preset operation in a condition in which a magnification operation is not performed (in the condition where the characters **PM** is visible in the magnification display window), the magnification is reset to the preset magnification.

Placing a check mark on **Magnification Fraction Adjust** in the **General** tab in the **Optional Setup** window causes an automatic magnification correction of fractional magnification values.

Refer to < 3.9.14 >.

### 3.5.2 Scanning Speed and Run/Freeze

The system supports 12 scanning speeds, which can be used as needs dictate.

A scanning speed can be specified by using four scanning speed buttons located on the Control Panel.

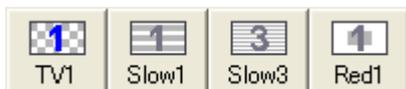


Fig. 3-49 Scanning Control Area

Each button is assigned two speeds, that toggle. The assignment of scanning speeds to the buttons can be customized. Refer to < 2.3.6.3 >.

Beam scanning control is performed by using the RUN button  (or the  button during a run). In the RUN state, the electron beam repeatedly scans on the specimen, and the displayed image is updated as the scanning progresses. During that operation, the yellow characters “RUN” in the upper left area of the displayed image blink. Clicking the **Freeze** button causes the scanning process to stop at the end (the lower edge) of the frame being scanned. During that time, the display indicates “Going to Freeze”, which changes to “Freeze” when the scanning has stopped.

- (1) TV scanning modes (TV1/2)



These modes are used to find a field of view or for the coarse adjustment of focus/stigma. They are also useful for the observation of specimens, not amenable to slow-scan observation, that tend to charge up easily. These modes produce an improvement in image quality (S/N) through frame averaging (recursive filtering). TV1 and TV2, while sharing the same scanning speed, can be set to different levels of frame averaging. The greater the number of averaged frames, the higher image quality at the expense of a longer image persistence and poorer adherence to FOV motions and focusing operations.

In full screen mode, enabling TV scanning reduces the image size in half.

For specifying the number of frames to be averaged, assign TV1 or TV2 values in the **FAST SCAN AVERAGING** block on the **Image** tab of the **Setup** dialog box. Recommended values are 4 for TV1 and 8 or 16 for TV2.

- (2) FAST scanning modes (Fast 1/2)



This mode, which performs scanning at a speed one-half the speed of TV scanning, produces an improvement in image quality through frame averaging (recursive filtering). This mode is useful for finding a field of view or for the coarse adjustment of focus/stigma. FAST 1 and FAST 2, which share the same frame speed, can accept separate assignments of the number of frames to be averaged on a frame basis. The FAST mode represents the highest speed in full screen mode.

For specifying the number of frames to be averaged, assign FAST 1 or FAST 2 values in the **FAST SCAN AVERAGING** block on the **Image** tab of the **Setup** dialog box. Recommended values are 2 or 4 for FAST 1 and 4 or 8 for FAST 2.

(3) SLOW scan modes (SLOW1/2)  

These modes allow you to perform ordinary image observations and FOV search. While delivering a high repeat speed, SLOW 1/2 are not AC power-synchronized, and they are subject to power supply frequency disturbance under conditions of high magnification, low accelerating voltage, and long WD.

Slow1 : approximately 1 second/frame (full screen), or approximately 0.5 second/frame (reduced display)

Slow2 : approximately 4 seconds/frame (full screen), or approximately 2 seconds/frame (reduced display)

(4) SLOW scan modes (Slow 3/4/5)   

For use in ordinary image observation and for fine adjustment of focus/stigma. These modes can be changed in four steps:

Slow3 : approximately 19 seconds/frame (full screen), or approximately 10 seconds/frame (reduced display)

Slow4 : approximately 38 seconds/frame (full screen), or approximately 19 seconds/frame (reduced display)

Slow5 : approximately 77 seconds/frame (full screen), or approximately 38 seconds/frame (reduced display)

(5) Reduce Area Modes (restricted field of view) (Reduce 1/2/3)   

These modes, while delivering an improvement in image quality using a scanning speed slower than the Fast scanning mode, offer a greater repeat rate through the use of a reduced observation area to yield an image quality optimal for focus/stigma adjustments. The observation area can be moved by dragging it with the mouse.

- Reduce 1 :  
This mode, at a repeat rate approximately equal to the TV scanning mode, is well-suited for FOV search and focus/stigma adjustments.
- Reduce 2 :  
At a four-fold increase in repeat rate while delivering the same image quality as Slow 3, this mode is well-suited for fine adjustment of focus/stigma.
- Reduce 3 :  
Using the same observation area as Reduce 1, this mode offers a somewhat slower scanning speed for use in low-frequency band detectors (semiconductor-type reflected electron detectors, EBIC, and other devices).

### 3.5.3 Image Brightness and Contrast Adjustment

Image brightness and contrast can be adjusted both manually and automatically.

**BC Monitor** mode is also available for manual adjustment.

A histogram of the observed image can be shown for reference of adjustment.

(1) Auto adjustment (ABCC)



Click the **ABCC** button on the **Control panel** or select the **ABCC** command from the **Operate** menu to start the auto-adjustment.

If the results of the ABCC are not adequate, you can change the reference brightness and contrast on the **Image** tab in the **Setup** dialog window.



**Fig. 3-50 ABCC(SE) Block**

**NOTICE:** In addition to secondary-electron images, for backscatter electron (BSE) images, too, an ABCC auto-set level adjustment function is provided in the **Image** tab of the **Setup** dialog box. If any other image signal is selected, the ABCC is disabled.

In the **Dual Screen** mode, the ABCC works on the image selected with the **Image Adj.** selection button located in the center of the Control Panel.



**Fig. 3-51 Image Adj. Menu**

(2) Manual adjustment using the mouse on the GUI

Change the mouse operation to **Focus, Stigma Correction, and Contrast Adjustment**, and move the mouse cursor to the upper right area of the image being observed. This will change the shape of the cursor to a B/C icon . By dragging the left button, you can adjust the brightness; by dragging the right button, you can adjust the contrast. Dragging to the right increases the brightness and contrast; dragging to the left reduces them.

The sensitivity of mouse operation can be adjusted by using the **Mouse Op.** tab in the **Optional Setup** dialog box. Refer to < 3.9.14 >.

Checking  the **Show Scrollbar** box on the **Operation Panel - Utility** tab displays the scrollbar  (Brightness) ,  (Contrast) . These items can also be adjusted with the bar.

(3) Operation Panel

Use the BRIGHTNESS and CONTRAST knobs on the Operation Panel. In the **Dual screen** mode, the operating the knob works on the image that is selected by the **Image Adj.** selection button located in the center of the Control Panel.

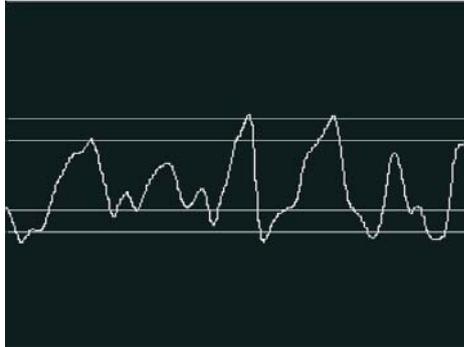
By using the BC monitor mode, you can accurately adjust by monitoring the location and the amplitude of signal waveforms. Refer to < 2.2.3 >.

## (4) BC Monitor mode

A waveform and reference lines are displayed for monitoring contrast (amplitude of the waveform) and brightness (vertical level of the waveform).

To start **BC Monitor** mode, click the **Monitor**  button twice on the **Control panel** or select the **BC Monitor** command from the **Operate** menu.

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.

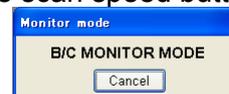


**Fig. 3-52 BC monitor**

Alternatively, by selecting **BC Monitor** from the **Operate** menu, you can select the BC monitor mode.

To close the BC monitor mode, either click any of the scan speed buttons or click the

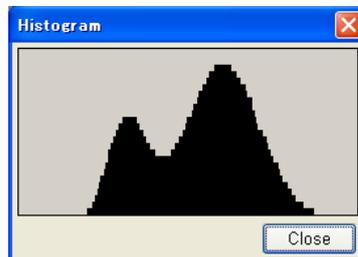
**Cancel** button in the BC Monitor Mode On message



## (5) Histogram display

A histogram of present observing image can be shown.

To show histogram, select **Show Histogram** from **Image** menu. The system calculates and displays a histogram of the image being displayed.



**Fig. 3-53 Histogram**

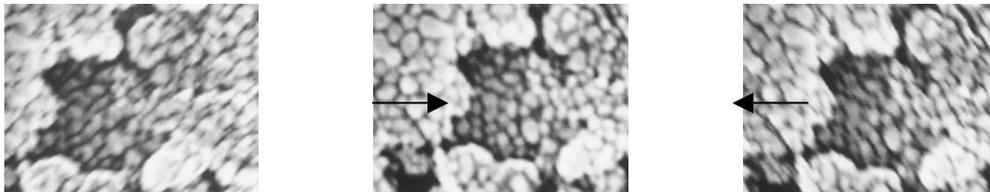


### 3.5.4 Focus and Astigmatism Correction

Focus and astigmatism correction can be done manually and automatically.

Focus Monitor mode is available for manual focusing.

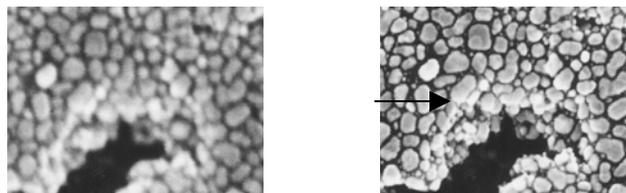
- (1) General method for focusing and astigmatism correction  
Focusing and astigmatism corrections are related to each other and need to be repeated alternately. Use the following process to perform adjustments.
  - (a) Focus the image. When there is no astigmatism, the sharpest image is obtained at 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.



Uniformly focused

**Fig. 3-54 Adjusting the Focus**

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



**Fig. 3-55 Adjusting the Stigma Aberration**

- (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:

- (a) Reduce probe current.
- (b) 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 Focusing

Auto-focusing is executed when the AFC  button on the Control Panel is clicked or **Auto Focus** is selected from the **Operate** menu.

Auto-focusing provides a Coarse mode and a Fine mode, which are automatically selected based on a specific magnification that is set.

The Coarse mode is executed when the magnification is 5,000x or less. The Coarse mode searches the entire working distance range covered by the operation mode that is set; it automatically adjusts so that even in a condition in which images are not visible at all, they can be visible to some extent. Compared with the Fine mode, the Coarse mode takes more time and delivers less precision.

The Fine mode is executed at magnifications higher than 5,000x. With a narrower search range, it adjusts the focus from a condition in which images are visible to some extent.

If the WD of a specimen is known to some extent, specify a working distance value in the WD display window of the **OPE CONDITION** block of the Operation Panel, set a magnification greater than 5,000x, and then use the Fine mode. In this manner, focusing adjustments can be performed quickly.

The precision of auto-focusing is affected by the surface structure of the specimen. If the specimen surface contains few micro-structures, the contrast is low, or the specimen is susceptible to electrostatic charge, auto-focusing does not perform properly.

## (3) Manual focus adjustment

Manual focusing operations can be performed by either using the Focus knob on the Operation Panel or mouse operation on the image.

- (a) Operation Panel  
Perform adjustments using the focusing knobs FOCUS COARSE or FINE.
- (b) Mouse operation

Switch the mouse operation to **Focus, stigma correction, and contrast adjustment**, and move the mouse cursor to the lower half of the image being observed. This changes the shape of the cursor to the Focus icon . Drag the right button for coarse adjustment, and the left button for Fine adjustment. Dragging to the right reduces the focal distance, and dragging it to the left increases it.

By checking  the **Show Scrollbar** box of the **Utility** tab on the Operation Panel, you can display the scroll bars  (Coarse)  (Fine) . You can also perform adjustments by manipulating the scrollbars.

The Focus Monitor allows you to monitor the focusing condition in terms of waveforms.

The sensitivity of mouse operation can be adjusted by using the **Mouse Op.** tab in the **Optional Setup** dialog box. Refer to < 3.9.14 >

(4) Auto Stigma function

Select the **Auto Stigma** command from **Operate** menu to start Auto Stigma function. 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.

(5) Manual astigmatism correction

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

(a) Knob operation

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

(b) Mouse operation

Switch the mouse operation to **Focus, stigma correction, and contrast adjustment**, and move the mouse cursor to the upper left area of the image being observed. This changes the shape of the cursor to a Stigma icon.

Drag the left button to adjust X, and the right button to adjust Y. Repeat the X, Y adjustments and the focusing adjustments until an appropriate image is produced.

Checking  the **Show Scrollbar** box on the **Utility** tab on the Operation Panel displays the scroll bars  (X) ,  (Y) . You can also perform adjustments by manipulating the scrollbars.

The sensitivity of mouse operation can be adjusted by using the **Mouse Op.** tab in the **Optional Setup** dialog box.

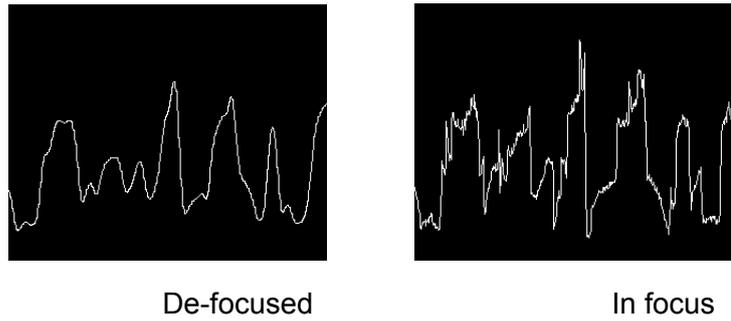
Refer to <3.9.14 >.

**NOTICE:** If image moves with astigmatism correction, carry out Stigma Alignment.

(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 **Monitor** button  on the **Control panel** and focus the image so that the waveform shows sharp peaks.



**Fig. 3-56 Focus Monitor**

The sensitivity of the focus knob and mouse operation will be equal to the low-magnification mode (1,000x) so that the variable focusing range can be searched with a small number of operations.

To close the Focus Monitor mode, either click one of the scan speed buttons or click the

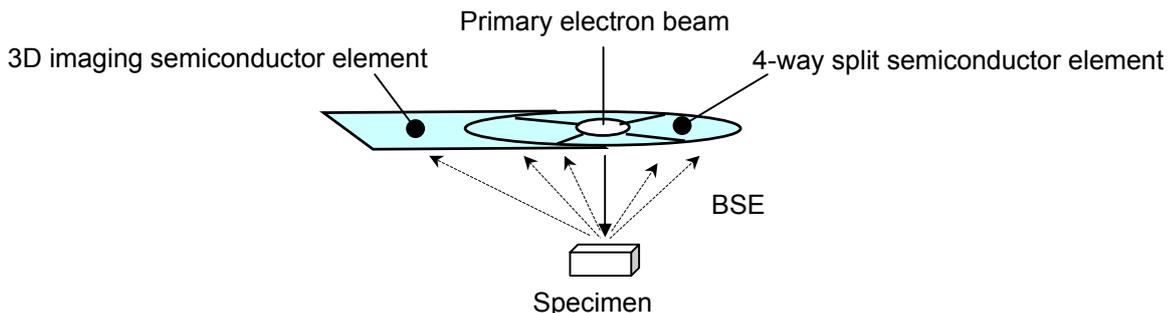
**Cancel** button in the **Focus Monitor mode on** message



### 3.5.5 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, topology, and 3D modes.



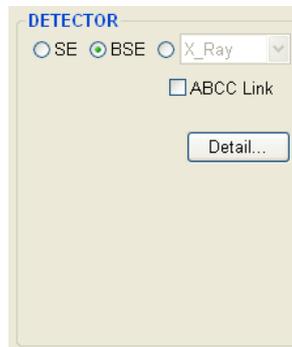
**Fig. 3-57 Signal Detection by Backscattered Electron Detector**

**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:

- ① 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 3.2.3 Adjustment of Specimen Height
- ② The specimen height should be set accurately by using the supplied height gauge.  
See 3.5.6.4 Setting Specimen Size and Detectors in Use

## (1) Setting the backscattered electron detector (BSE)

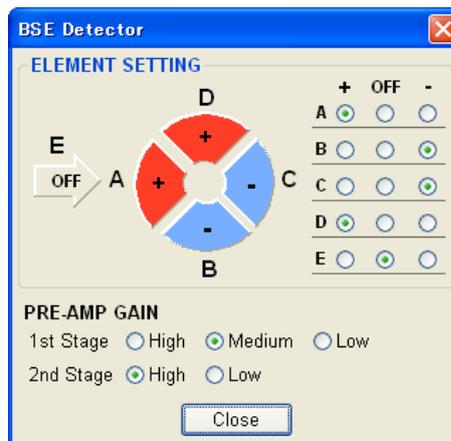
Selecting the BSE option in the DETECTOR block produces a BSE image. This menu can be used to set the type of BSE signal, composition, topology or 3D, and the amount of gains to be produced.



**Fig. 3-58 DETECTOR Block**

## (2) Detailed settings of the BSE

For detailed detector sensor settings, press the Detail button in the DETECTOR block to bring up a BSE dialog, which allows you to turn individual sensor signals on and off and select signal polarity reversal/non-reversal.



**Fig. 3-59 BSE Detector Dialog**

The picture of elements shows the orientation looking down from the top.

When polarity of opposed elements (A and C, B and D) are set to same, topographic information is eliminated and compositional contrast is dominant.

To observe compositional contrast image, set all of four (A to D) elements to same polarity. When these are set to +, area of high backscattering efficiency will be observed as brighter area.

If polarity of opposed elements are set inversely each other, compositional information is eliminated and topographic contrast image will be observed.

The E element is placed at off-axis position. It can be used to add topographic contrast to observed image. It is better to be set off to obtain pure compositional images.

### (3) Detector orientation on observing images

The SEM image is displayed so as it is identical to specimen direction looking from the direction of specimen exchange chamber, when raster rotation is off.

In the other hand, the BSE detector is inserted from -25 degree upper-left direction compared with the image direction.

### (4) Gain selection

BSE image contrast is adjustable with mouse operation on the image and also with manual operation panel.

Additionally, there placed two set of gain setting on the BSE Detector dialog window to support wide range of BSE signal amount.

Use these gain setting as follows.

#### (4a)Pre-amplifier 1st stage gain

The 1st stage gain setting is for the signal path before signal offset is adjusted.

Use Medium under normal conditions.

When image contrast is too low, set to High.

When image contrast is too high, set to Low.

In case where signal offset is very large compared with relatively low contrast, image may be shown as if it is saturated. In such a case, set the 1st stage gain to Low, and set the 2nd stage gain to high.

#### (4b)2nd stage

The 2nd stage gain setting is for the signal path after signal offset is adjusted.

Use High under normal conditions. Set to Low when image contrast is too high.

### (5) Brightness and Contrast adjustment

Continuous contrast and brightness adjustment can be carried out using mouse operation on the image and manual operation panel.

These are similar as adjustment for secondary electron images.

Brightness adjustment using mouse dragging on image is set rather slower than that for secondary electron image, as the necessary range of adjustment is wider.

It is recommended to use scrollbar above image area for coarse, and mouse dragging for fine adjustment.

## Notices on operation

1. Generally amount of backscattered electron is smaller than secondary electron. It is prominent under low acceleration voltage condition.

Additionally, detector efficiency is changed proportional to acceleration voltage.

These will result lower contrast and noisier image compared with secondary electron image.

In such a case, increase probe current and, if possible, use higher acceleration voltage.

2. If image contrast is difficult to control due to too large signal amount, try to select pre-amplifier gain, or set some of elements to off.

3. Frequency response of the BSE detector is slower than that of secondary electron detector.

TV, FAST and Slow1 scan speed is not available.

It is recommended to complete focus adjustment using SE image and then, change to BSE image.

The Dual Screen mode, possible to observe SE and BSE images simultaneously, will be effective for BSE observation.

4. BSE image will be saturated to white level during specimen exchange operation, as the detector is sensitive to visible light.

Take no thought for it. It will cause no damage to detector elements.



### 3.5.6 Operation of the Specimen Stage

The SU6600 provides a 5-axis motorized stage

#### 3.5.6.1 Coordinate Notation

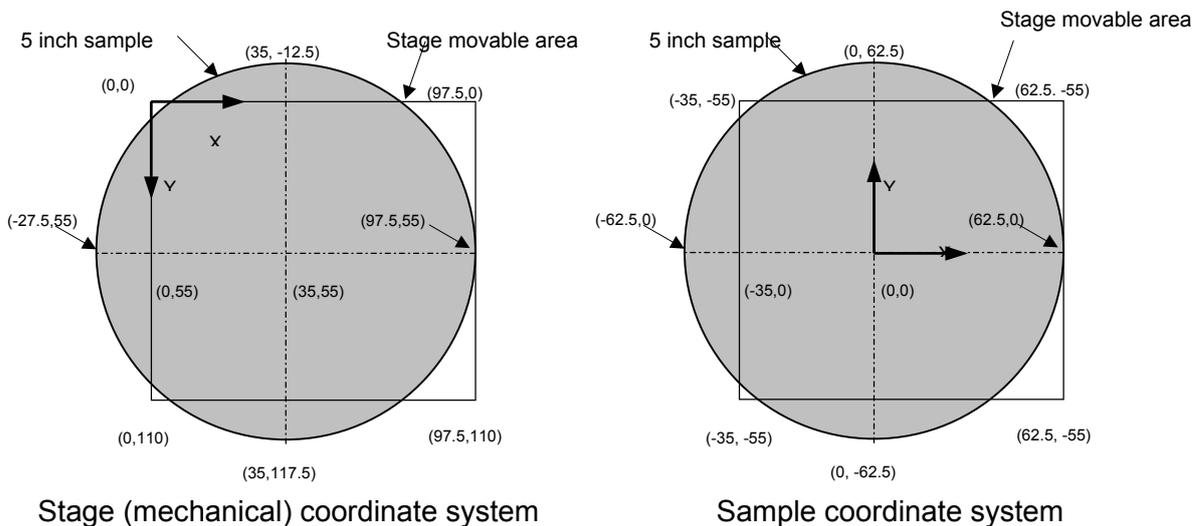
The SU6600 utilizes two coordinate notation systems, stage (mechanical) coordinate and sample coordinate. The sample coordinate system will be better for using the Rotation Assist function. The stage coordinate system is also available for users familiar with previous Hitachi SEMs using the stage coordinate 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=35,Y=55 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 (X=0, Y=0 mm) and the origin fits it.



**Fig. 3-60 Relationship Between Two Coordinate Systems**

(2) Selecting a coordinate system

Open the **Optional Setup** dialog window by selecting **Stage** command in **Optional Setup** menu.

On the **COORDINATE** area, select **Sample** or **Stage**. **OK** button will update the coordinate system.



**Fig. 3-61 Coordinate System Area**

**NOTICE:** The sample coordinate is not exactly the coordinate of the sample. It is not rotated with the sample when the latter is rotated.

**3.5.6.2 Applicable Optional Detectors and Specimen Size**

(1) Optional detectors

The following table shows the specimen chamber and detectors applicable to each port. Only one detector can be put on a port, even multiple detectors are listed. Detectors shown with bold letters are standard configuration.

Port	Applicable optional detectors	Port name of specimen chamber (view from left-behind)
A		
B		
C	EDX detector	
D	EBSP detector	
E		
F	ESED detector	
F	(PBS detector)	
F	(EDX detector)	
G	Secondary electron detector	
I	WDX detector	
I	PBS type WDX detector	
I	(ESED detector)	
K	Chamber scope	

(2) Simultaneous operation

EDX , WDX (Full focus type) and ESED detectors can be used with all other detectors. EBSP and PBS-WDX detectors can be inserted simultaneously. Other detector combinations are not allowed.

**(2) Specimen size**

The following table shows the specimen sizes available on the SU6600.

When a PBS type WDX detector is attached and a EBSP detector is inserted, some specimen sizes are not allowed.

Specimen sizes with an **x** mark are not available.

Specimen size		Optional detector in use				
		EBSP			PBS-WDX	
			Differential AP IN	BSE IN		EBSP IN
φ5mm						
φ10mm				×		
φ15mm				×		×
φ1 inch			×	×		×
φ2 inch		×	×	×		×
φ3 inch		×	×	×		×
φ4 inch		×	×	×		×
φ5 inch		×	×	×		×
φ6 inch		×	×	×		×
□4 inch	Need optional mask holder	×	×	×		×

### 3.5.6.3 Movable Range and Specimen Exchange Position

(1) Movable Range and Specimen Exchange Position

The following table shows the movable range, home position and specimen exchange position. Mechanical coordinate and specimen coordinate expression are selectable for X and Y-axes. The specimen coordinate is (0, 0) at the center of the specimen holder.

	Movable Range of Mechanical Coordinate	Movable Range of Specimen Coordinate	Home Position of Mechanical (specimen) Coordinate	Exchange Position of Mechanical (specimen) Coordinate
X	0 to 110 mm	-35 to +75 mm	35.0 mm (0 mm)	35.0 mm (0 mm)
Y	0 to 110 mm	-55 to +55 mm	55mm (0mm)	0 mm (55mm)
R	0 to 360°	0 to 360°	0°	0°
T	-5 to 70°	-5 to 70°	0°	0°
Z	4 to 40 mm	4 to 40 mm	31mm	31mm

The allowable ranges of X, Y, Z and T axes are limited for a large specimen, WDX detector installation and when optional detectors are at their operating 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 and height, and detectors being used are set correctly.

Refer to 3.5.6.15 Movable Range and Limitation by Optional Detectors for X,Y axes movable range and Z-Tilt limitation.

(2) To drive stage to specimen exchange position and home position

Use the **XC** and **HOME** button on the control panel to bring stage to specimen exchange and home position.

When stage is at exchange position, only the **HOME** button can be operated and other stage controls are not active.

If the stage position is at the specimen exchange position when starting up the SEM control program, the stage remains at the present specimen exchange position.

In this case, the **XC** button lamp on the GUI will be lit and the stage operation is restricted.

You may just start operation from specimen insertion without driving the stage.

If the stage position is not at the specimen exchange position when starting up the SEM control program, the stage will be driven to its home position.

(3) Special limitation at stage initializing

When the specimen stage control power is turned on, stage initializing will be carried out. In following case, a warning message will be shown, and counter operation is necessary.

(a) When EBSP have an insertion sensor switch and the detector is inserted

If the EBSP detector is inserted, a message requesting to retract it will be shown. Retract the detector and then, click OK on the message.

(b) When EBSP detector does not have insertion sensor

When EBSP detector is installed and have no insertion sensor switch, a warning message requesting to retract it will be shown even if it is not inserted.

Confirm position of detector and retract it if inserted and then, click OK on the message.

**NOTICE:** Except when it is unavoidable, such as when the stage becomes inoperable, the stage power switch should not be turned on and off frequently. Also, turn the stage power switch on and off by retracting all detectors and closing all windows with the exception of the Operation Panel and the SEM image display window.

(4) Replacing a specimen by pulling out the stage

In the SU6600, change specimens in principle by using the specimen exchange chamber. If specimens must be changed due to unavoidable circumstances without using the specimen exchange chamber, vent the specimen chamber to atmosphere, and pull out the stage to change specimens. For a description of how to vent the specimen chamber to the atmosphere, see section 4.1.2.

After venting the specimen chamber to the atmosphere, remove the four screws that secure the stage, pull out the stage, and insert a specimen holder from the specimen exchange chamber side. After setting a specimen, secure the stage with retaining screws, and evacuate the specimen chamber.

**⚠ CAUTION:** Fingers can be caught in the door, potentially resulting in injury.  
When mounting the stage, use caution so that fingers are not pinched.

#### 3.5.6.4 Setting Specimen Size and Detectors in Use

After setting specimen, set specimen size and optional detector to be used in the **SPECIMEN** block on the **Operation panel – Stage** tab. The control software will limit stage movement within a safe area based on information set above. If the setting is not correct, the specimen may touch to the objective lens or the detector.

- (1) Specimen size and detector setting confirmation  
Check the indication on the **SPECIMEN** block on the **Operation panel - Sage** tab.  
**Size** shows specimen size. **Height** is the difference of specimen surface height from level gauge height (-2mm to +16mm, plus when sample surface is higher than level gauge, "Standard" if equal).  
The optional detector name will be shown with orange color box if it is inserted.

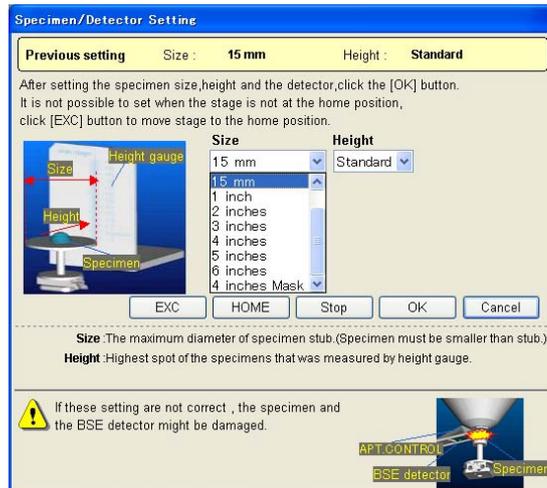


**Fig. 3-62 SPECIMEN Setting BLOCK**

When the indication does not correspond to the specimen size or detector to be used, click the **Set** button.

Detector information setting can be done at any stage position. In the other hand, specimen size setting is possible only at home position or specimen exchange position.

- (2) Setting specimen size information  
The **Set Sample Size / Detector** dialog window will be shown. (It will take few seconds until setting becomes possible after the dialog is shown)



**Fig. 3-63 Specimen/Detector Setting Window**

Select a specimen stub size in the **Size** pull-down list (5 mm to 6 inches and select a difference from the standard specimen height in the **Height** pull-down list (-2 mm to +16 mm).

There is limitation of specimen size for optional detectors.

The following message will be shown when you selected a specimen size not allowed.



**Fig. 3-64 SPECIMEN Size Message**

Select allowable size, or retract the optional detector. (Help button on the message shows table of allowable specimen size for optional detectors)

- (3) Setting optional detectors
 

On the **Set Sample Size / Detector** dialog window, name of installed optional detectors are shown at right side of **Port-A** to **Port-I** indication. These are set at installation.

There are two boxes at the right side of port indication. The right box is for user setting. Check a box before inserting an optional detector. The left box will be orange colored when a insertion sensor switch of an optional detector is sensed.

  - (a) Recommended detector setting (when sensor switch is not provided for the detector)
 

Put check to the box of the detector before inserting the detector. Do not insert it before checking the box.

After completing analysis operation, retract the detector fully and then, release the check mark of the box.

- (b) Recommended detector setting (when sensor switch is provided for the detector)  
Even in the case where the optional detector has the insertion sensor switch, it is recommended to take just same as above procedure (put check – insert, retract – release check).  
If a detector is inserted before putting check to the box, the necessary protection will taken place. However, there may be a chance of specimen-detector interference if, for example, you insert a detector faster that the stage can move.  
The left box will be orange colored when a insertion sensor switch of an optional detector is sensed.  
After completing analysis operation, retract the detector fully and then, release the check mark of the box.  
Note that software protection for the detector is released not only by retracting the detector, but also by unchecking the box.
- (c) Automatic stage evacuation  
When an optional detector is set on the **Set Sample Size / Detector** dialog window, or an insertion sensor is detected, stage will move to safe position if the present stage is not within allowable position for the detector.  
In case where an insertion sensor is detected while it is still not set on the **Set Sample Size / Detector** dialog window, buzzer will sound during evacuation motion.
- (d) When the detector to be inserted is not allowed to use  
There are two cases. One is when another detector(s) is already inserted and simultaneous operation is not allowed, another case is when size of the present observing specimen is not allowed for the detector.  
In both cases a warning message will be shown when you checked a detector on the **Set Sample Size / Detector** dialog window. Retract the other detector, or change specimen and then retry setting the detector. If you start insertion of a detector without setting it on the dialog window, the buzzer will sound and a warning message will be shown. Stop insertion, retract it, and retract the other detector, or change specimen and then retry setting the detector.



(e) Buzzer sound

The buzzer used in the above (c) and (d) cases will sound in different pattern according to the situation as follows.

- During stage movement: intermittent, like “Bu --- Bu--- Bu --- Bu --- Bu ---.”
- Warning of prohibited detector insertion: continuous, like “Bu. Bu. Bu. Bu. Bu....”

### 3.5.6.5 Various Operation Methods for Specimen Stage

The following operation methods are available.

(a) Operation on the **Stage** tab of the **Operation panel** (all 5 axes)

(b) Manual operation using trackball (X and Y)

(c) Mouse operation on the image (all 5 axes)

(d) Position memory function (X, Y and R axes)

(e) Stage history function

Memorizes a position where capturing or photographing was performed, or manually registered and displays a map of the above points. Returning the stage to a memorized position is also possible.

(f) Image Navigation function

Goes to an assigned position on a captured image or imported external image.

The figure below illustrates the Operation Panel **Stage** tab.

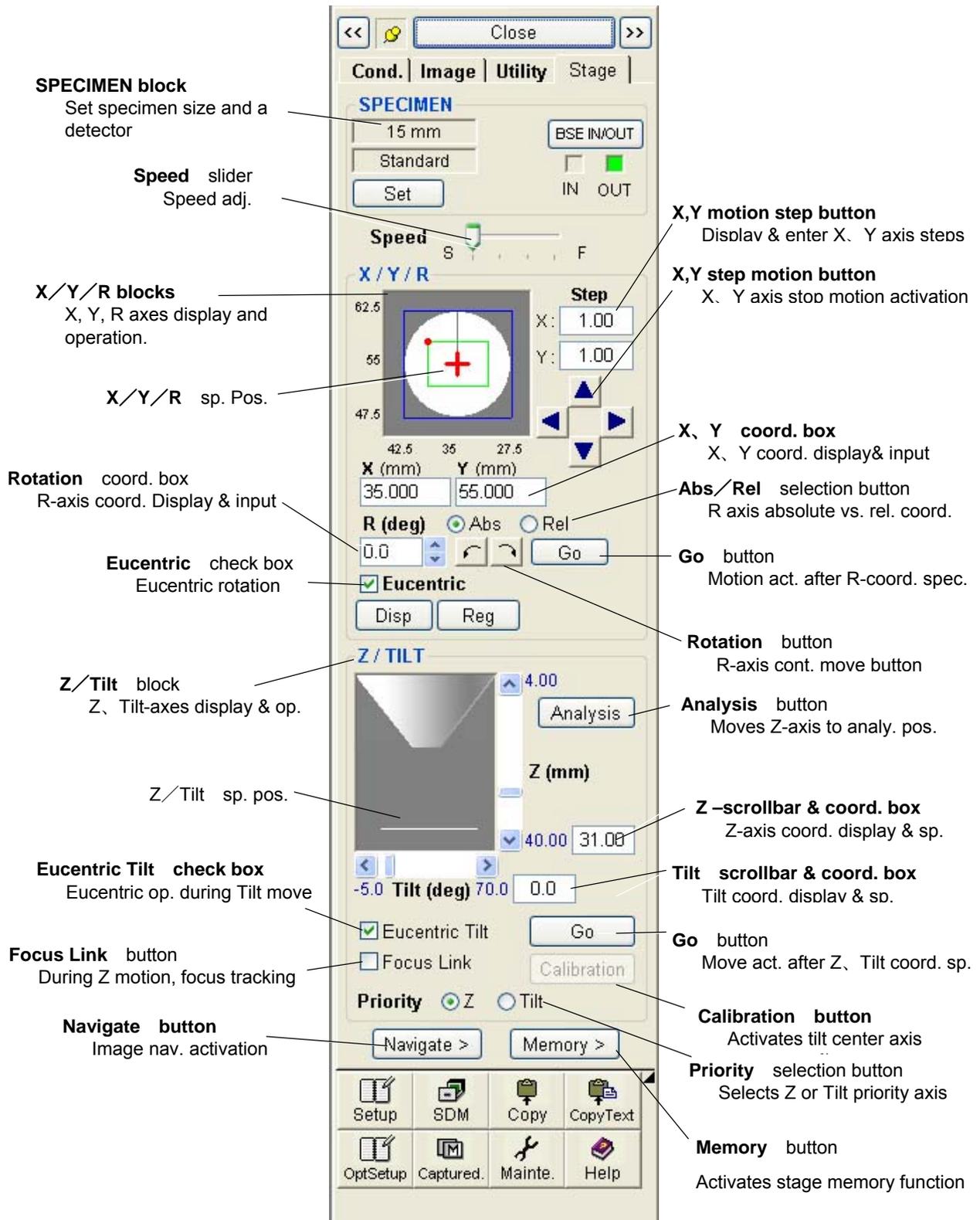
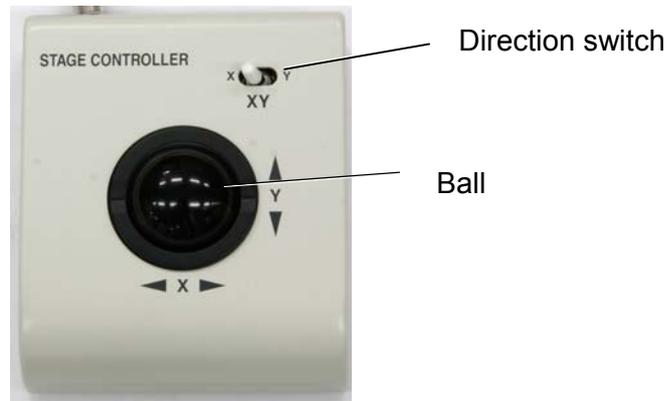


Fig. 3-65 Stage Operation Panel

### 3.5.6.6 X, Y, R Axis Operation

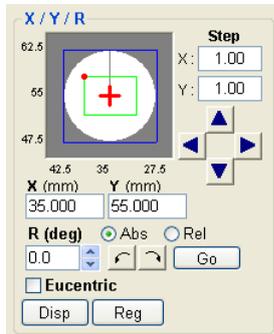
- (1) Manual operation using trackball  
Stage moves in the direction of trackball rotation.



**Fig. 3-66 Trackball**

- The displacement of the stage relative to the amount of rotation of the ball varies in tandem with the magnification rate for the image: the lower the magnification rate, the larger the amount of movement.  
To move the stage over a long distance, it is useful to lower the magnification.
- The displacement of the stage relative to the amount of rotation of the ball can also be varied in 4 steps by setting the **Speed** slider on the **Stage** tab of the Operation Panel.
- Normally, use the SW at XY (the mid-point). The stage will move in the direction in which the ball rotates.
- If the ball is rotated by setting the trackball SW in either direction and the ball is rotated, the stage moves only in the direction in which the SW selects.
- The direction of rotation of the ball and the direction in which the image moves can also be reversed by checking the **Trackball/Joystick** check box in the **Reverse** mode of the **Stage** tab of the **Optional Setup** dialog box.
- In terms of miscellaneous items, for a description of custom settings on the stage, see 3.9.14.

## (2) Entering Absolute or Relative Coordinate Value



**Fig. 3-67 X/Y/Z Block**

For X and Y-axes, enter absolute coordinates for X and Y-axes into **XY Display/Input** box and then press ENTER key.

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 359.9 for absolute and -180 to +180 for relative value.

When the **Rotation eucentric** check box is checked, X and Y axes also move so the present field of view is retained after the stage is rotated.

## (3) Continuous rotation (R axis)

The R axis is driven with the **Rotation** buttons. Press the  or  button to drive the R axis continuously or click the buttons to drive in steps.

A driving speed can be selected using the **Speed** slider in four steps.

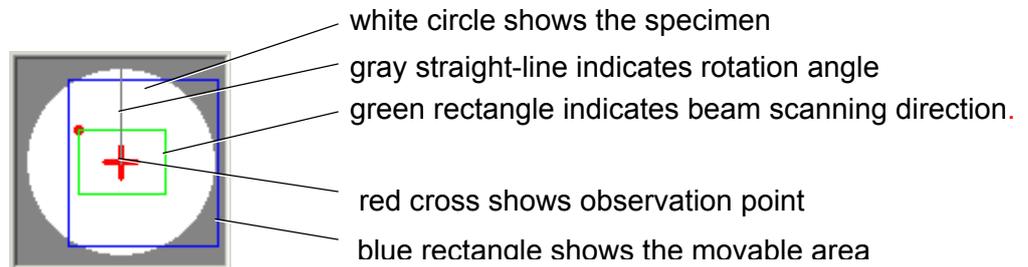
## (4) Mouse operation on the scimage

Operation of all 5 axes by using the mouse is available.

Refer to <3.5.6.8 >.

(5) Position display

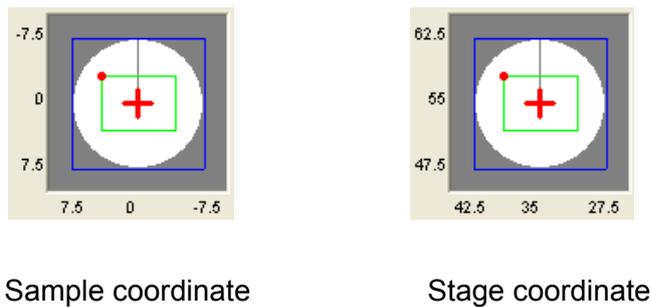
The size of the specimen, its present position, and rotation angle are displayed on the XYR position monitor area.



**Fig. 3-68 Position Display**

Following are examples using a  $\phi$  15mm sample.

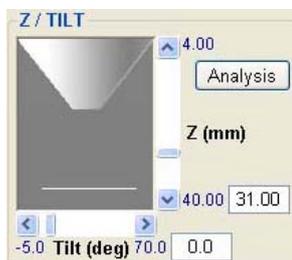
The scales at the left and bottom show the coordinate values of the beam point when the sample is at the center and moved to each end of the indicated area.



**Fig. 3-69 Differences of Values Displayed in Sample Position Monitor**

### 3.5.6.7 Z and Tilt Axis Operation

- (1) Z-Tilt operation tool  
 Z-Tilt operation block on the STAGE tab has various configurations depending on the optional detector in use.  
 The block configuration for each of optional detectors is described in chapter 3.5.6.15.
- (2) Priority of Z or Tilt axis  
 The movable range of the Z and Tilt axes is limited by all other axis conditions.  
 Maximum tilt angle is limited to 11° when the Z is 4mm, or the minimum Z is limited to 16mm when the tilt angle is 60°.  
 The **Priority** button selects which axis has priority when moving the stage (available with non-continuous movement).



**Fig. 3-70 Z/Tilt Block**

When **Priority-Z** is selected, Z can be set within a full range. If Tilt is out of its movable range, it is changed to be within the movable range automatically. When **Priority-Tilt** is selected, Tilt can be set within a full range. If Z is out of its movable range, it is changed to be within the movable range automatically.

This priority selection is available only when the **Continuous** checkbox is off.

For example when 45° tilt is necessary, first select **Tilt** with the **Priority** buttons and set Tilt scrollbar to 45. The blue indication above the Z scrollbar shows allowable range of Z axis for 45° tilt angle. Specify Z value within the range.

- NOTICE:**
- 1) When the specimen height is set higher than the standard position, tilting will change the actual specimen surface position. The allowable range of Z and Tilt are therefore recalculated after the tilt angle is specified for movement.  
 It may cause a somewhat different allowable range than has been indicated before specifying tilt angle.
  - 2) If a specimen is set at a level higher than the standard level, the priority axis cannot be set to “Tilt” because of the algorithm.  
 When setting a specimen at a level higher than the standard level, set the priority axis to Z.

- (3) Operation using the Z/Tilt block (coordinates specification) of the **Stage** tab of the Operation Panel  
When moving the stage by specifying coordinates, uncheck the **Continuous** box  . By specifying a priority axis as above, specify coordinates by using the Z and Tilt scrollbars, and then click the **Go** button.  
If a number is entered and the Enter key is pressed, the stage begins to move without waiting for a click on the **Go** button.
- (4) Operation using the Z/Tilt block (continuous motion) of the **Stage** tab of the Operation Panel  
By checking the **Continuous** box , you can move the Z and Tilt axes continuously. Operating the slider (the knob part) on the scroll bar causes a Coarse adjustment; clicking the arrows at the two ends of the scroll bar produces a Fine adjustment. Since the mechanical motion of the stage is slower than scroll bar operation, clicking the arrows is recommended.  
The following amounts of motion apply:  
Clicking the arrows: Z : 0.01 mm T : 0.1°  
Clicking the side of the slider on the bar: Z : 0.1 mm T : 1°.  
Similar operations can also be performed by using the mouse on the image, as described later.  
For continuous motion this technique, which is easier to use, should be employed.
- (5) Using the mouse on the image  
The Z/Tilt axes can be specified in terms of positions and continuous motion can be performed by operating the mouse on the image.  
For details, refer to <3.5.6.8 >.

**NOTICE:**

- An incorrect setting of specimen size, height, and the detector can potentially damage the objective lens or the specimen.
- When manipulating the Z and Tilt axes, unlock the stage. These axes cannot be operated if the stage is locked.
- The **Go** button should not be pressed when the stage is moving, as pressing the **Go** button can potentially disable the **! Stop** button. Similarly, the power switch for the stage should not be turned off when the stage is moving.

### 3.5.6.8 Mouse Operation of Stage on the Scanning Image

The mouse operation tools on the scanning image, for image adjustment (focus, stigma, contrast) and for stage operation, alternate by clicking the S button of the mouse. These tools also can be selected with **Mouse Operation** command on the popup menu.

The following tools are shown for stage operation. Operation mode without T, Z tools is also available.

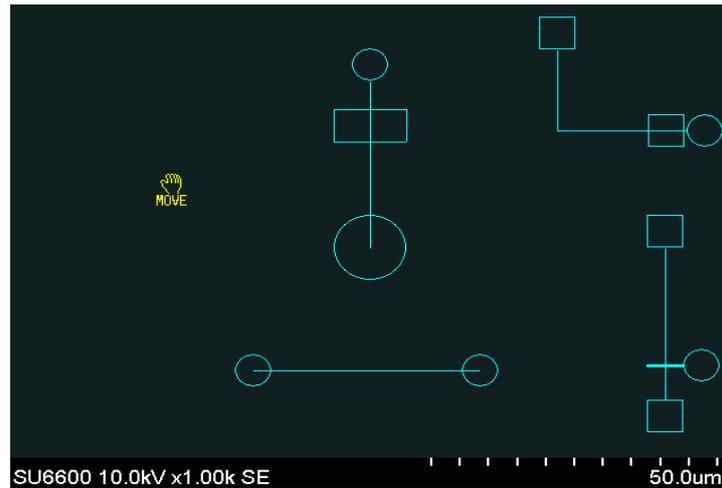


Fig. 3-71 Image Shifty/Stage Move Tools

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

Move the mouse pointer to the circle at the center. It changes to an XY mark . Press the left button down and move the mouse in the direction you wish to move the image. The 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.

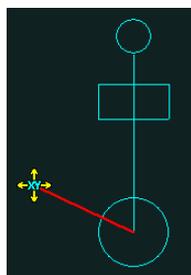
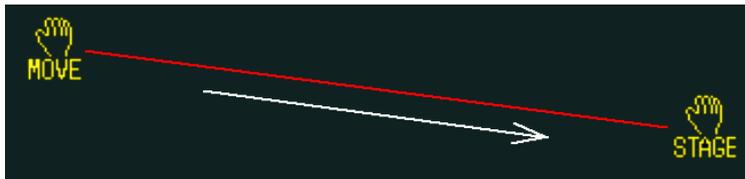


Fig. 3-72 Continuous Motion of XY



- (2) Manipulating the X- and Y-axes (moving a specified point to a specified spot)

In a location other than on the tool mentioned above, the mouse pointer appears as a MOVE mark . Holding down the left button of the mouse on the image changes the mouse pointer to a STAGE mark . In this condition, move the mouse to the destination of motion, and release the mouse button, which causes the stage to move. The path through which the stage moves is indicated as a red straight line.

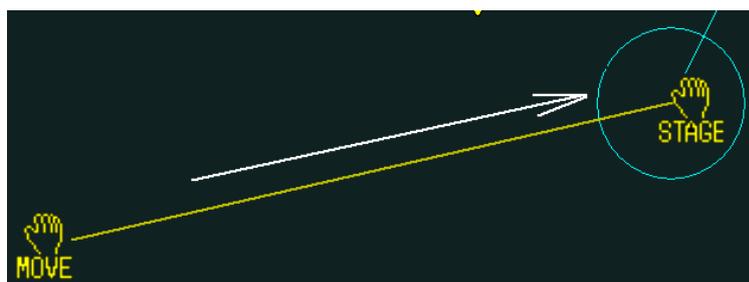


**Fig. 3-73 Motion by XY Specification**

- (3) Manipulating the X- and Y-axes (RISM function – Moving a specified point to the center of the image (1))

To increase the magnification rate after determining the field of view to be enlarged, you need to bring the FOV to the center of the image.

In the above operation (2), bringing the destination of motion to near the center of the image causes the straight line indicating the motion path to turn yellow and be fixed in the center of the image. Releasing the mouse button at this point causes the stage to move so that the FOV in the position in which the button is held down is brought to the center of the image. In this operation, the image shift (a function that moves the FOV of observation by shifting the electron beam position) operates in combination with the mechanical motion of the stage. The stage will not move if the distance of motion is small enough so that motion can be performed solely on the basis of an image shift.



**Fig. 3-74 RISM Function**

**NOTICE:** If the distance is such that the image cannot be moved on the basis of an image shift, the function returns the image shift to the mid-point, and makes up the difference by mechanically moving the stage. For this reason, in high-magnification areas, the destination of motion sometimes fails to be brought to the center of the image due to error inherent in the mechanical motion of the stage.

- (4) Manipulating the X- and Y-axes (RISM function – Moving a specified point to the center of the image (2))

In the operation above (3), the mouse is moved with the mouse button held down. When the mouse is clicked (pressing and releasing it immediately) in the FOV position to be moved to the center, the stage moves so that that position is brought to the center of the image.

The image shift is not used in this function. For this reason, at high magnification rates, the precision by which the position moves to the center is reduced due to error inherent in the mechanical motion of the stage. However, in contrast to the notes given in **NOTICE** above, no unexpected error occurs commensurate with a reduction in precision due to image shift.

- (5) Image shift motion

Image shift refers to a function that moves the FOV of observation by shifting the electron beam position.

In operation (2) or (3) above, holding the right button down instead of the left button on the mouse changes the mouse pointer to a BEAM mark ; when the button is released, the stage does not move, but the image is moved by image shift.

Because the amount of displacement due to image shift is not large, this technique should be used at high magnification rates. If the allowable range of image shift is exceeded, the image will not move. (As a general rule, stage operations should be performed on the GUI, and image shifting by using knobs on the Operation Panel.)

**NOTICE:** The current position relative to the entire range of motion by image shift can be monitored on the BEAM display unit on the Control Panel. If the yellow cross-bar mark reaches an edge, the image cannot be moved any further. In this case, clicking the **Reset** button resets the current position to the mid-point of the allowable range of motion.

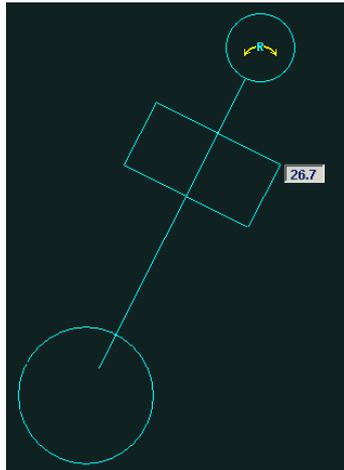
(6) R axis operation to a specified angle

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 rotate 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.



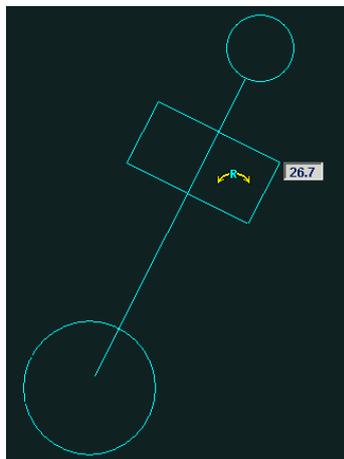
**Fig. 3-75 R-axis Moving Tool (angle specification)**

(7) R axis continuous driving

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

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.

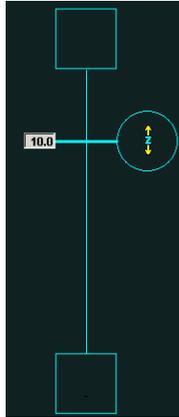
The eucentric rotation function is not effective for this operation.



**Fig. 3-76 R-axis Moving Tool (continuous move)**

## (8) Z-axis operation to a specified coordinate

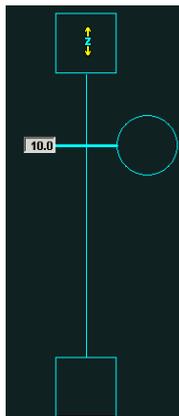
On the circle of the Z-axis tool, the mouse pointer will be changed as shown below. Press down the left button and move the mouse up or downward while holding down the button. The circle moves following the mouse and the Z-axis value is shown in the indicator box. Then release the button. The stage will go to the Z position specified in the indicator box. The control of Z is limited to a range allowable for the present Tilt angle



**Fig. 3-77 Z-axis Moving Tool (coordinates specification)**

## (9) Z axis continuous driving

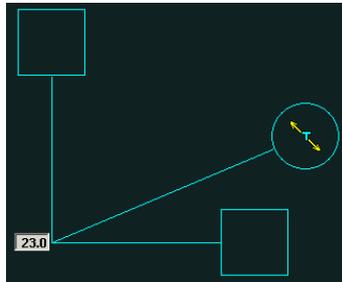
On the rectangles at the top and bottom of Z-axis tool, the mouse pointer will change as shown below. Press down the left button on one of the rectangles. Stage will go up or down continuously while holding the button down. On the top rectangle, stage moves to a shorter Z, and on the bottom, to a longer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



**Fig. 3-78 Z-axis Moving Tool (continuous move)**

(10) Tilt axis operation to a specified coordinate

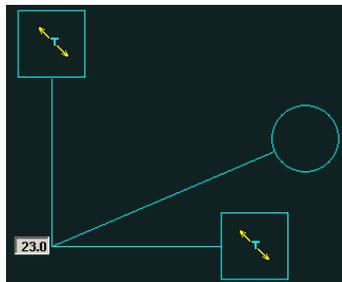
On the circle of the Tilt axis tool, the mouse pointer will change as shown below. Press down the left button and move the mouse up or downward while holding down the button. The circle moves following the mouse and the Tilt axis value is shown in the indicator box. Then release the button. Stage will 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.



**Fig. 3-79 Tilt-axis Moving Tool(coordinates specification)**

(11) Tilt axis continuous driving

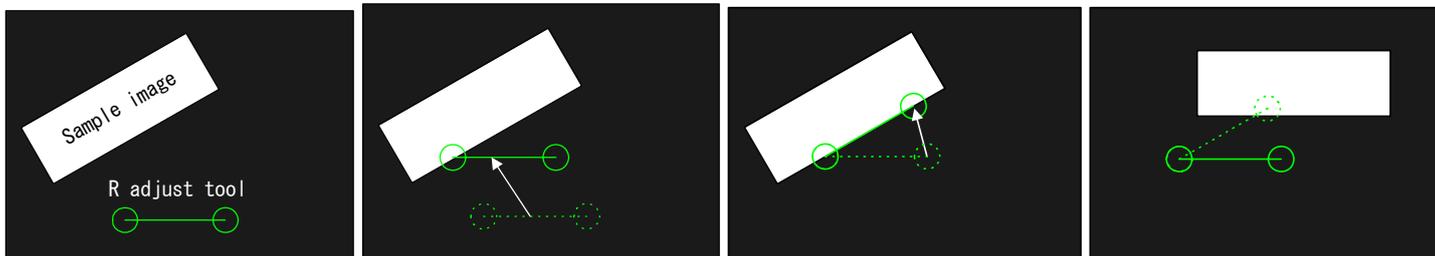
On the rectangles at the top and bottom of Tilt axis tool, the mouse pointer will be changed as shown below. Press down the left button on one of the rectangles. Tilt axis will move continuously while holding the button down. On the top rectangle, tilt angle is increased and on the bottom, decreased. Tilting will stop when it reaches the end of the allowable range calculated using the present Z angle.



**Fig. 3-80 Z-axis Moving Tool (continuous move)**

(12) Rotation adjust tool

The rotation adjust tool is convenient for adjusting a line in image to horizontal.



**Fig. 3-81 Rotation Adjust Tool**

Move the mouse at about the center of the tool.

Mouse pointer will be changed to an array mark . Press down the left button and move the tool to touch the inclined line to be rotated to horizontal.

Press down the left button in the circle of the other end and move the tool to the line.

Release the mouse button. The R axis will rotate and the line is rotated to horizontal.

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

**REFERENCE:** Using the right button instead of the left button drives raster rotation with the same method of operation. It is necessary to turn the raster rotation to on to operate raster rotation.

(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. 3-82 Movable Tools**

Press down the left button and move tools while holding down the button.

### 3.5.6.9 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. The coordinates of all 5 axes are memorized.

All axes are retrieved when the **Include TZ** checkbox is checked. In the other hand, only X,Y,R axes are driven if the checkbox is not checked.

Click the **Memory** button on the **Stage** tab. The following **Position Memory** dialog window will open.



Fig. 3-83 Stage Memory Dialog

- (1) Registration of absolute stage coordinates at the present stage position  
Select a **Page** and **Number**, then click **Get Position**. The present coordinates are then indicated in the **X**, **Y** and **R** boxes. Input any comments in the **Comment** box, and click **Save**.
- (2) Registration of absolute stage coordinates by direct input  
Select a **Page** and **Number**, 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 **Save**.
- (3) Registration of relative stage coordinates using the present stage positions
  - (a) Select page **Rel** and **Number**.
  - (b) Move the stage (using RISM) to the first position and click **Get Relative-1**.
  - (c) Move the stage to the second position and click **Get Relative-2**.  
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 **Save**.

- (4) Registration of relative stage coordinates by direct input
  - (a) Select page **Rel** and **Number**.
  - (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 **Save**.
- (5) Moving the stage to a memorized position
 

To move the stage to a memorized position, select a **Page** and **Number**, and click **Go**. The **Next** button moves the stage to the coordinate of the next number.
- (6) Moving the stage by relative movement
 

To move the stage by a relative movement from the present position, select a page **Rel** and click **Go**.
- (7) Clearing of registered data
 

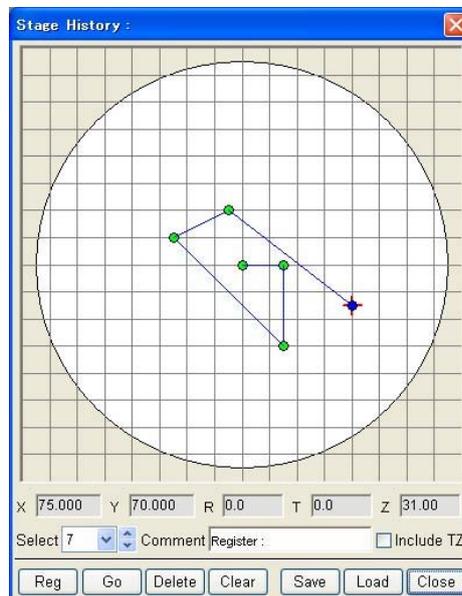
Select a **Page** and **Number**, and click **Clear**.

### 3.5.6.10 Stage History Function

Displays present position and registered positions on the specimen diagram with trajectory lines showing the order of registration.

Retrieving stage coordinates of a registered position is also possible.

Click the **Disp** button in the **XYR** block on the **Stage** tab. The **Stage History** dialog window will open.



**Fig. 3-84 History Display Dialog**



- (1) **Display**  
The white circle represents specimen size. The red cross indicates beam point. The green points are registered points, and the blue point is the selected point. Lines connecting registered points show the stage trajectory.
  - (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 dialog window or in the **XYR** block on the **Stage** tab registers the 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 **Go** button to go to the position representing the selected point.  
All 5 axes are retrieved when the **Include TZ** checkbox is checked. On the other hand, only X,Y,R axes are driven if the checkbox is not checked.
- NOTICE:** The stage may move to slightly different X,Y coordinate if driven excluding T,Z axes to a position with a tilt angle different from the angle of the registered coordinates. It is because a calculation is included to compensate the mechanical T axis Y displacement.
- (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 dialog window for saving will open. Specify a folder and file name and then, click **Save**. The extension of history files is "ssh".  
To read saved data, click the **Load** button and specify a file name in the opening dialog window. The saved data contains the information on specimen size and data loading is possible when the present specimen size setting is the same as that of the data to be read.  
If the data loaded is that of the presently observed specimen or of a specimen having the same layout, the data is effective for retrieving a once-observed field of view.

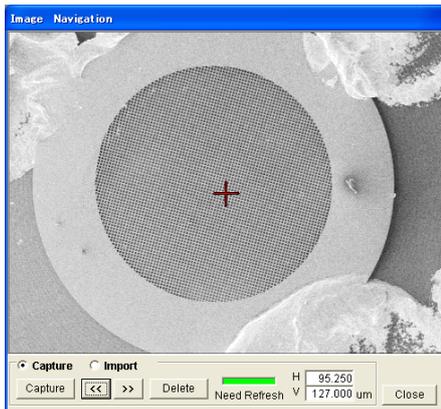
**REFERENCE:** The Undo function for stage position is prohibited when stopped during driving to exchange or home position. It is because of a technical reason. Instead of Undo in such a case, the stage position just before going to exchange or home position will be automatically registered to Stage History. When you need to retrieve a previous observed position, once going to home position, open **Stage History** dialog window and select newest position number (the comment will be EXC Posi. or Home) and then, click **GO** button.

### 3.5.6.11 Image Navigation

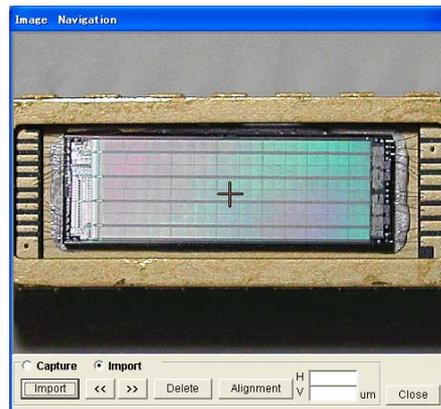
The Image Navigation function drives the stage to a position pointed out on navigation images. Captured SEM images of low magnification and also imported externally created images, such as optical microscope images or drawings, are available as navigation images.

The **Navigation** button on the **Stage** tab opens **Image Navigation** dialog window.

SEM image



Imported image



**Fig. 3-85 Image Navigation Window**

(1) Starting the image navigation  
Clicking the **Navigation** button on the **Stage** tab in the Operation Panel opens the **Navigation** window.

(2) Saving a SEM image  
In the SEM image **Capture / Import** selection, select the SEM image **Capture** option.  
In the **Navigation** window, clicking the **Capture** button displays the image being observed in the **Navigation** window. A maximum of 10 images can be saved by changing the FOV (stage position) or magnification setting.

**NOTICE:** The saving of a captured image is enabled if the current observation magnification rate is 5,000x or less. At any higher magnification setting, the system issues a message and cancels the save process.

- When any of the following operations are performed, any save image is nullified, and a **Need Refresh** display window flashes in red:
  - (a) Moving the R, T, and Z-axes of the stage (changing the rater rotation angle does not)
  - (b) Changing the accelerating voltage

(3) Navigation on the SEM image  
On the Navigation image, the mouse pointer appears as a white cross mark. Place the cross mark in the position to be enlarged, and click the left button on the mouse. The stage will move so that the clicked point is brought to the center of the image. The red cross mark indicates the current observation position.

If multiple images are saved, the   buttons can be used to select images one by one.

(4) Saving an imported image  
Images and graphics that are used as imported images must be in the correct one-to-one correspondence with specimens (with the correct aspect ratio, with the up/down and right/left orientation not reversed). Acceptable file formats are bitmap (BMP), JPEG (JPG), and Tiff (TIF). Also, as much as possible, ensure that the orientation of the image, when viewed from the specimen exchange chamber, is the same as the orientation of the specimen.

Alignment operation is also necessary to ensure that the image coincides with the location of the specimen. This requires two points on the image (on both the image and specimen, use structures that are easily distinguishable). Select two points so that they are situated across the center of the image, either vertically or horizontally.

To load an imported image, select **Import** in the **Capture/Import** selection, and click the **Import** button.

When the file selection dialog box is displayed, load a file by specifying its file name.

- (5) Alignment operation on an imported image and a specimen
  - (a) Pick two points on the navigation image that are identifiable and can also be distinguished on the SEM image.  
First, move the stage, while observing the SEM image, so that the first-point position is brought to the center of the image.
  - (b) In the **Navigation** window, click the **Alignment** button.



**Fig. 3-86 Alignment Block**

When a message "Move a marker structure to the center of the screen, and click the 1st button. Then, click the position on the Navigation image that corresponds to the center of the screen" appears, click the OK button to close the message, adjust the position of the SEM image, and click the 1st button.



**Fig. 3-87 1st Setting**

- (c) In the next step, click a location on the navigation image that corresponds to the SEM image. When a message “Move a marker structure to the center of the screen, and click the 2nd button. Then, click the position on the Navigation image that corresponds to the center of the screen” appears, click the **OK** button to close the message, move the stage, search for a second alignment point, and move it to the center of the image.
- (d) After that, click the 2nd button, and then click a spot on the navigation image that corresponds to the SEM image. Upon completion of the alignment process, the 2nd button disappears, and the **Alignment** button re-appears.



**Fig. 3-88 2nd Setting**

**NOTICE:** Pick two alignment points on the Navigation image that are located across the center, either vertically or horizontally. When the alignment operation is commenced, a cross marker is displayed on the Navigation image. In the four partitioned areas, select one alignment point per area.

- The correspondence breaks down when the R, T, or Z-axis of the stage is moved or the accelerating voltage is changed, in which case an alignment operation should be performed again (the raster rotation remains in effect even when the angle is changed).

- (6) Navigation on an imported image  
After the alignment operation, as in the case of the Capture image in Step (3) above, place the white cross cursor in the position to be observed, and click the left button on the mouse.
- (7) Combined use of import and capture images  
Effective (with a **Need Refresh** window in green) SEM images and aligned import images can be switched over at any time for use in navigation operations.
- (8) Deleting a Navigation image  
Clicking the **Delete** button deletes the image currently displayed as a Navigation image.

### 3.5.6.12 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. XY axes are driven to the calculated point together with the rotation axis.

In addition, the tilt eucentric function drives XY axes together with the tilt axis so that the previous viewing point will be kept after tilting.

To improve the accuracy of the functions, calibration of the following correction factors are provided.

- (a) Measure and correct the deviation between rotation center axis and beam position.
- (b) Measure and correct the deviation between tilt center axis and beam position.
- (c) Measure the specimen height error and compensate the rotation center and the tilt center axes.

The above (a) and (b) are basically dependent on the assembly of the instrument.

These are measured and corrected once in the beginning (before delivery of the instrument).

But since the beam position may shift when adjusting the electron beam axis, this measurement tool is provided to enable measurement and correction at any time.

On the other hand, the specimen height error (the above (c)) will change whenever specimens are exchanged. It should be compensated at each specimen exchange to get the best accuracy.

It is not necessary when you use the eucentric rotation function with no tilt condition.

- (1) Specifying eucentric or non-eucentric rotation or tilt  
 Check the **Eucentric** check box in the **XYR** block to enable the eucentric rotation.  
 It is active when rotating R axis by specifying the angle value. It is not active when rotating the R axis using continuous rotation.  
 Check the **Eucentric Tilt** check box in the **Z/Tilt** block to enable eucentric tilt.  
 It is active when tilting the specimen by specifying the angle value. It is not active when using continuous tilting.
- (2) Calibration  
 The following calibration commands are provided.
  - (a) Measure and correct the deviation between rotation center axis and beam position.
  - (b) Measure and correct the deviation between tilt center axis and beam position.
  - (c) Measure and correct the deviation between rotation center axis and beam position caused by changing Z-axis position.
  - (d) Measure the specimen height error and compensate the rotation center and the tilt center axes.

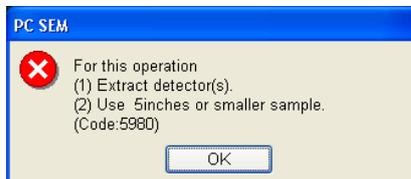
The above (a) to (c) are basically dependent on the assembly of the instrument. These are measured and corrected once in the beginning (before delivery of the instrument). But since the beam position may shift when adjusting the electron beam axis, this measurement tool is provided to enable measurement and correction at any time.

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.

It is not necessary when you use the eucentric rotation function with no tilt condition. To carry out the calibrations, use a flat sample and set the specimen height as close to the standard height as possible.

**CAUTION:** The R, Z and T axes of the stage are driven automatically in this series of operations. So before starting operation, check the following points.

1. **Rotation Center:**  
A mask specimen holder cannot be used.
2. **Tilt Center:**  
The BSE detector must be pulled out.
3. **Z Axis Comp.:**  
Both EDX and BSE detectors must be pulled out, and a mask specimen holder cannot be used.
4. **Tilt Center** started by **Calibration** button on the STAGE tab:  
BSE detectors must be pulled out.  
When the presence/absence of these detectors is set correctly at **SPECIMEN** block, a warning message



**Fig. 3-89 Warning Message**

will appear if an optional detector is still inserted, and the operation will be disabled. Note that if these settings are not made, protection will not be provided and the specimen and/or detectors may be damaged.

(3) Stage tilt calibration – Calibration is necessary for each specimen exchange. When the 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, set WD at 12 mm or more, tilt at 0° and R at 0°, then search for a structure of interest near the specimen center.
- (b) Click the **Calibration** button in the **Z/Tilt** area on the **Z/Tilt** block, then the **Stage Tilt Calibration** dialog window will appear.

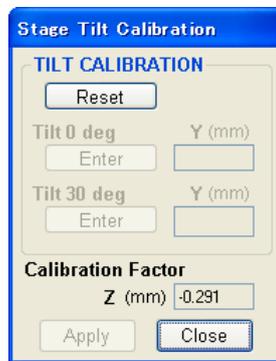


Fig. 3-90 Center of Tilt Calibration Dialog

(c) Click the **Reset** button. The method message will appear.

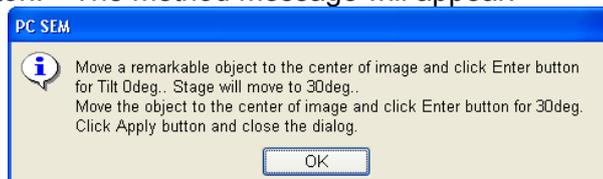


Fig. 3-91 Confirming the Operation Method Message

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 30°. Again bring the structure of interest to the image center, and click **Enter** button of Tilt 30 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 necessary when accuracy degraded  
Carry out the following three calibrations when accuracy of eucentricity is degraded.

(a) Rotation center

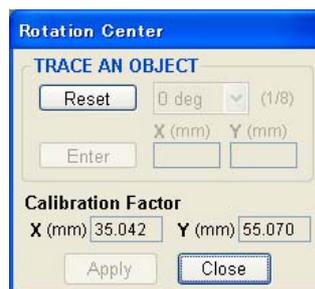
It measures the deviation of the rotation center from the beam point.

- 1) Insert a specimen, set WD at 12 mm or more, 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.



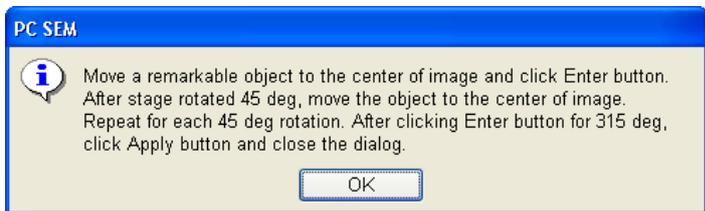
**Fig. 3-92 Center of Rotation Calibration Dialog setting**

The **Stage Offset Adjust** dialog window will open



**Fig. 3-93 Center of Rotation Calibration Dialog**

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



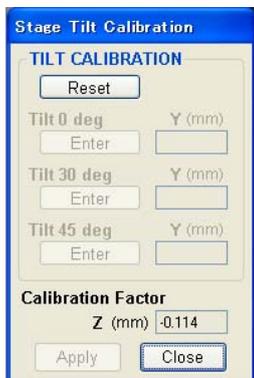
**Fig. 3-94 Confirming the Operation Method Message**

- 4) Bring the structure of interest to the image center, and click **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 **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 35 ± 1 mm and 55 ± 1 mm. After clicking the Apply button, click **Close** button to close the window.

(b) Stage tilt calibration

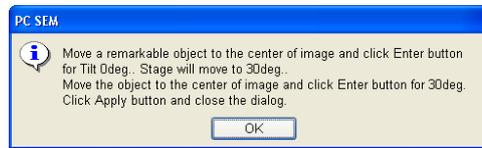
It measures the deviation of the tilt center from the beam point.

- 1) Insert a specimen, set the WD to 30 mm, tilt at 0° and R at 0°, then search for a structure of interest near the specimen center.
- 2) Select Stage Calibration – Tilt center command in the Option menu. The Stage Tilt Calibration dialog window will open.



**Fig. 3-95 Center of Tilt Calibration Dialog**

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



**Fig. 3-96 Confirming the Operation Method Message**

As described in the message, bring the point of interest to the image center at a magnification of about 500 $\times$ , then click **Enter** button of Tilt 0 $^{\circ}$ .

- 4) The stage will be driven to a tilt angle of 30 $^{\circ}$ . Bring the point of interest to the image center and click **Enter** button of Tilt 30 $^{\circ}$ .
- 5) The stage will be driven to a tilt angle of 45 $^{\circ}$ . Again bring the point of interest to the image center and click **Enter** button of Tilt 45 $^{\circ}$ .  
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 the **Close** button to close the window.

(c) Z-axis compensation

It measures the shift of the stage caused by changing Z-axis position.

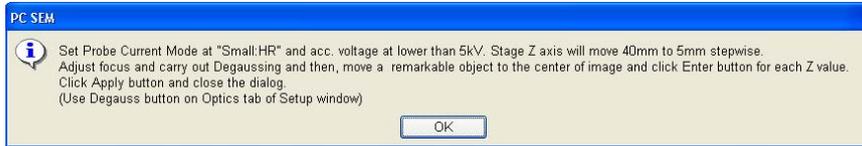
- 1) Insert a specimen, set the WD to 31 mm, tilt at 0 $^{\circ}$  and R at 0 $^{\circ}$ . Set the accelerating voltage to 5 kV or less, **Probe current** mode to **Normal** and **Focus mode** to **UHR**. Then search for a structure of interest near the specimen center.
- 2) Select **Stage Calibration – Z Axis Comp** command in the **Option** menu. The **Z Axis Compensation Calibration** dialog window will open.



**Fig. 3-97 Z-axis Calibration Dialog**

3) Click the **Reset** button.

The following message indicating steps of operation will be shown.



**Fig. 3-98 Confirming the Operation Method Message**

Upon closing the message, the Z-axis will be driven to 31 mm. Carry out focusing and set magnification to about 500 $\times$ , then bring the point of interest to the image center and click **Enter** button.

- 4) The Z-axis of stage will be driven to 40 mm. Carry out focusing again, bring the point of interest to the image center and click **Enter**.
- 5) At each click of **Enter**, the Z-axis will be driven to 40 mm, 30 mm, 20 mm, 15 mm, 12 mm, 8 mm, 5 mm. Bring the point of interest to the image center each time and then click **Enter**. After clicking **Enter** at 5 mm, click **Apply** and then click **Close** to close the window.

### 3.5.6.13 Stage Lock

For high magnification work, the Stage Lock function is recommended for better mechanical stability. The Z and T axes are locked or released by clicking **Lock/Release** button on the control panel. When the box is red the stage is in a locked condition.



**Fig. 3-99 Stage Lock Button**

Z and T axis operation is disengaged while the stage is locked.

### 3.5.5.14 Stopping Stage and Returning to Previous Stage Position

To stop the stage movement while it is running, use the **!STOP** button on the **Control panel**.

Do not repeat clicking the button. It may cause irregular movement.

To return to a previous position after moving stage using a coordinate specifying operation, use **Undo – Stage Drive** menu. It is effective for only one previous position.

Note that when you stop stage motion with the **!Stop** button while the stage is on the way to exchange position, only the **HOME** or **EXC** button can be operated and the **Undo** is not effective. In that case, you can use the Stage History Function where the stage position just before starting to home or exchange position is automatically memorized.

Refer to <3.5.6.10 >.

### 3.5.6.15 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 or using optional detectors. Stage motion is limited to inside of the movable range automatically by the computer. The limit value is calculated using the size and detector information set on the **Set Sample Size/Detector** dialog window.  
For small size specimens, X and Y limitation is specified so the movable range covers just the size of specimen.  
For large size specimen, the movable range is limited to within a safe area.  
When optional detectors are inserted to their operating position, the safe area will be limited to a narrower range.
  
- (2) Movable range  
The stage X, Y movable range, Z-Tilt operation tool and Z-Tilt movable range limitation for each optional detectors and specimen sizes are described from chapter 3.5.6.15.1.  
When either the Z or Tilt scrollbar in the Z-Tilt operation block is set to a specified value, the movable range of the other axis is calculated and shown beside the scrollbar in blue letters.  
Set another axis value within the shown range.

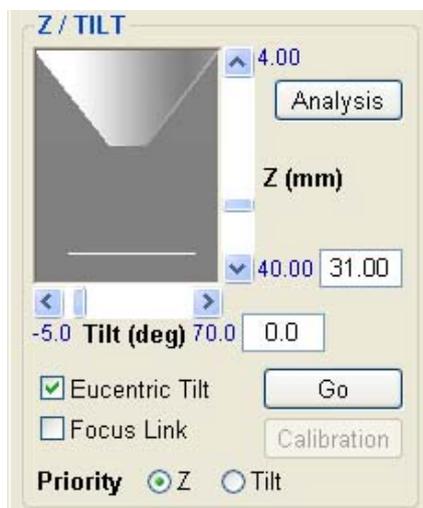
- (3) Limitation and movement when an optional detector is inserted  
Refer to chapter 3.5.6.15 for the stage movable range limitations when using optional detectors. When an optional detector is set by putting a checkmark on the **Set Sample Size/Detector** dialog window, a warning message will be shown and the stage will move automatically to safe position, if the present position is out of the movable range for the detector. If the sensor switch is detected before setting the detector on the **Set Sample Size/Detector** dialog window, stage movement as above is carried out and the buzzer sounds. In such a case, stop detector insertion and wait until the buzzer stops sounding. Stage movable range limitation for detectors not described in chapter 3.5.6.15.1 to 3.5.6.15.5 is as follows.

- (a) EDX detector  
No limitation required

**CAUTION:** Set the specimen height using the level gauge so the top of the specimen surface fits to the gauge.  
If this is impossible, set the difference of specimen and level gauge height in the Height box on the Set Sample Size/Detector dialog window. Stage protection calculation will be carried out using that value.

### 3.5.6.15.1 Stage Movable Range when No Optional Detector is Used

(1) Z-Tilt operation tool (Standard operation tool)



**Fig. 3-100 Z/Tilt Block**

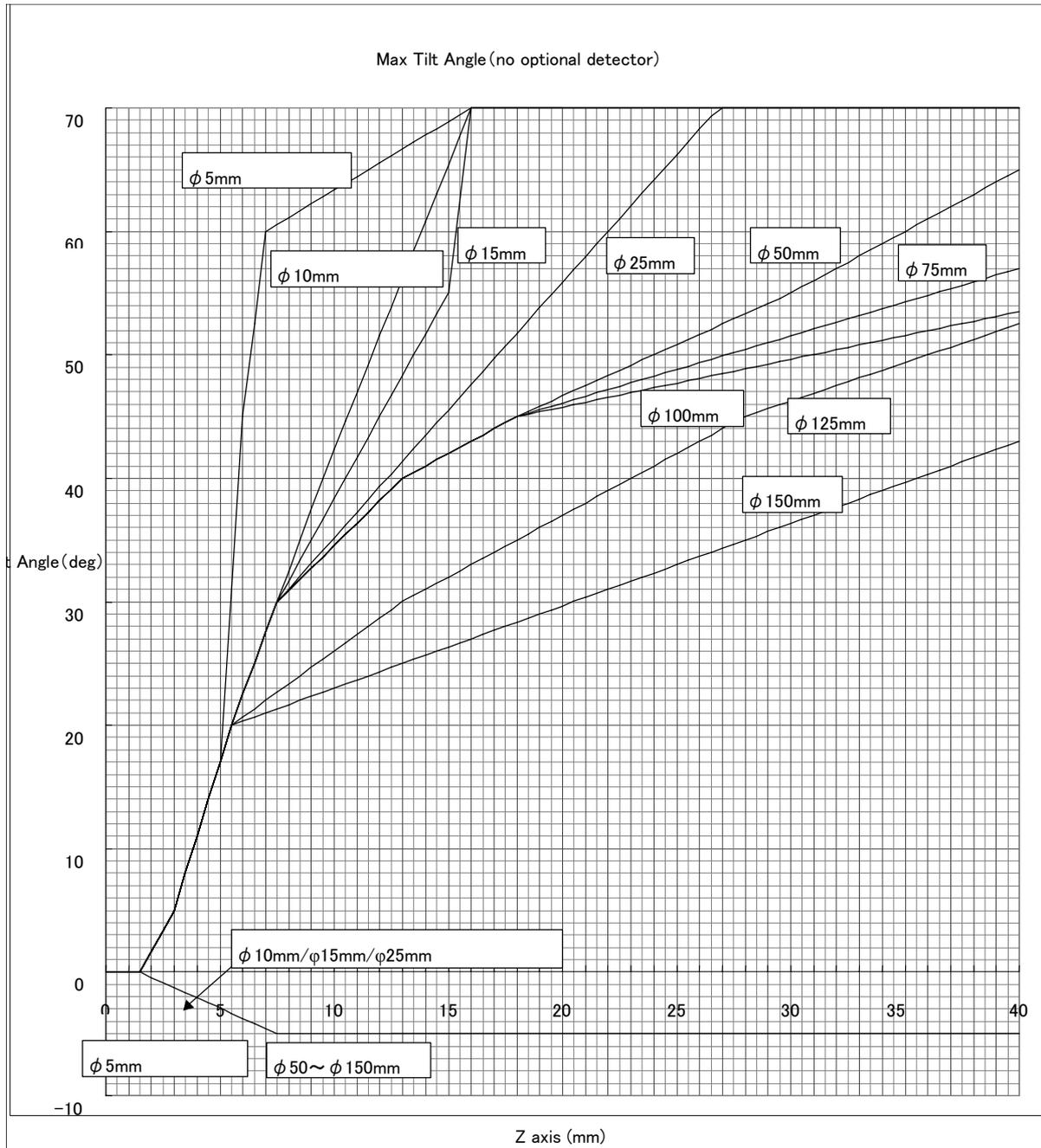
(2) X and Y axes movable range

Specimen size	WDX not installed		WDX installed	
	X movable range	Y movable range	X movable range	Y movable range
φ5mm	32.5~37.5	52.5~57.5	Same as in the left	
φ10mm	30~40	50~60		
φ15mm	27.5~42.5	47.5~62.5		
φ25mm	22.5~47.5	42.5~67.5		
φ50mm	10~60	30~80		
φ75mm	0~72.5	17.5~92.5	10~72.5	17.5~92.5
φ100mm	0~85	5~110	12~85	5~88
φ125mm	0~97.5	0~110	25~97.5	0~85
φ150mm	2~110	0~97	30~110	0~60
□100mm	0~107	0~110	30~107	0~110



- (3) Z and Tilt axes movable range  
 Maximum Tilt angle for Z value is as follows (in case when Sample Height=Standard).

Z axis range	4.0mm~40.0mm
Tilt axis range	-5~+70°



**Fig. 3-101 Tiltable Angles with respect to Z-axis Position**

### 3.5.6.15.2 Stage Movable Range when Semiconductor-BSE Detector is Used

(1) Z-Tilt operation tool (Standard operation tool)

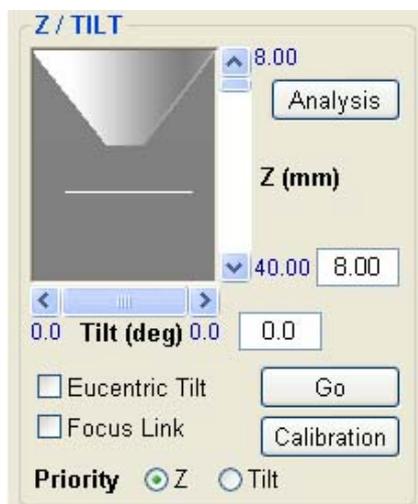


Fig. 3-102 Z/Tilt Block

(2) X and Y axes movable range

Specimen size	WDX not installed		WDX installed	
	X movable range	Y movable range	X movable range	Y movable range
φ5mm	32.5~37.5	52.5~57.5	Same as in the left	
φ10mm	30~40	50~60		
φ15mm	27.5~42.5	47.5~62.5		
φ25mm	22.5~47.5	42.5~67.5		
φ50mm	10~60	30~80		
φ75mm	0~72.5	17.5~92.5	10~72.5	17.5~92.5
φ100mm	0~85	5~110	12~85	5~88
φ125mm	0~97.5	0~110	25~97.5	0~85
φ150mm	2~110	0~97	30~110	0~60
□100mm	0~107	0~110	30~107	0~110

- (3) Z and Tilt axes movable range  
 Maximum Tilt angle for Z value is as follows (in the case when Sample Height=Standard).

Z axis range	8.0mm~40.0mm
Tilt axis range	-5~+70°

### 3.5.6.15.3 Stage Movable Range when PBS-WDX Detector is Used

- (1) Z-Tilt operation tool (Standard operation tool)  
 Minimum Z axis value is changed by specimen size setting as;
- φ5mm:  $4.0\text{mm} \leq Z \leq 40\text{mm}$
  - φ10mm:  $5.0\text{mm} \leq Z \leq 40\text{mm}$
  - φ15mm and larger specimen:  $14\text{mm} \leq Z \leq 40\text{mm}$

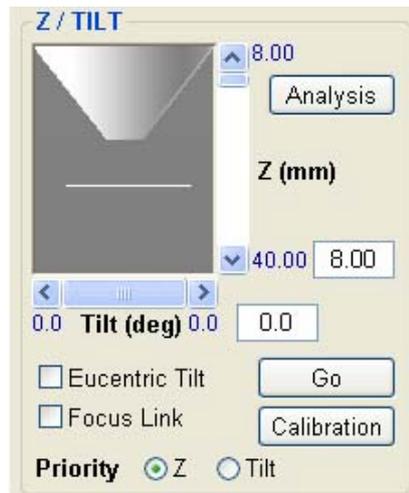


Fig. 3-103 Z/Tilt Block

## (2) X and Y axes movable range

Specimen size	WDX not installed		WDX installed	
	X movable range	Y movable range	X movable range	Y movable range
φ5mm	32.5~37.5	52.5~57.5	Same as in the left	
φ10mm	30~40	50~60		
φ15mm	27.5~42.5	47.5~62.5		
φ25mm	22.5~47.5	42.5~67.5		
φ50mm	10~60	30~80		
φ75mm	0~72.5	17.5~92.5	10~72.5	17.5~92.5
φ100mm	0~85	5~110	12~85	5~88
φ125mm	0~97.5	0~110	25~97.5	0~85
φ150mm	2~110	0~97	30~110	0~ <del>75</del> 60
□100mm	0~107	0~110	30~107	0~110

## (3) Z and Tilt axes movable range

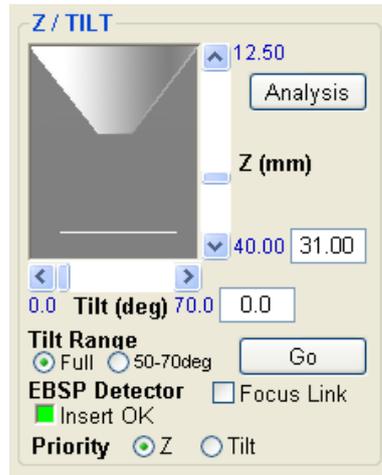
Maximum Tilt angle for Z value is as follows (in the case when Sample Height=Standard).

Z axis range	4.0mm(φ5mm), 5.0mm(φ10mm), 14.0mm(φ15mm or over)
Tilt axis range	-5~+70°

### 3.5.6.15.4 Stage Movable Range when EBSD Detector is Used

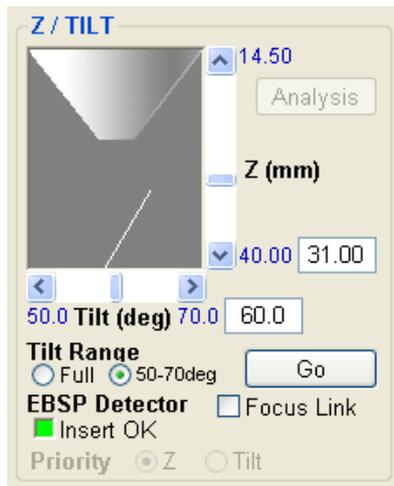
**NOTICE:** Following is value for HKL detector. A different value will be specified for other detectors.

- (1) Z-Tilt operation tool  
Two operation modes, one is including a 0 degree tilt angle, and the other is a limiting tilt angle from 50 to 70 degree, are provided.  
The reason for dividing the operation mode is that the stage mechanical parts (not the specimen) may interfere with the EBSD detector near the 0 degree tilt angle.
  - (a) Tilt Range=Full  
This mode includes 0 degree tilt angle.



**Fig. 3-104 Z/Tilt Block**

- (b) Tilt Range=50-70 deg



**Fig. 3-105 Z/Tilt Block**

**Tilt Range:** Full or 50-70deg is selectable. Full includes the 0 degree tilt angle and the X,Y movable range is narrower than 50-70 deg mode.  
50-70 deg allows a little wider X,Y movable range. A tilt angle less than 50 degree is not allowed.

**Insert OK/Do not Insert** indication: Do not insert the EBSP detector when the indication is “**Do not Insert**” and the box is orange. You may insert the EBSP detector when displaying “Insert OK” and the box is green.

(2) X and Y axes movable range

The X,Y movable range is different in the two Tilt Range modes. (\* marks show values different in the two modes)

Tilt Range=Full

Specimen size	Tilt Range=Full	
	X movable range	Y movable range
φ5mm	32.5-37.5	52.5-57.5
φ10mm	30~40	50~60
φ15mm	27.5-42.5	49-62.5
φ25mm	*27.5-47.5	*54-59

Tilt Range=50-70 deg

Specimen size	Tilt Range=50-70 deg		Tilt Range=50-70 deg With differential aperture	
	X movable range	Y movable range	X movable range	Y movable range
φ5mm	32.5-37.5	52.5-57.5	32.5-37.5	52.5-57.5
φ10mm	30~40	50~60	30~40	50~60
φ15mm	27.5-42.5	49-62.5	27.5-42.5	49-59.5
φ25mm	*22.5-47.5	*54-67.5	-	-

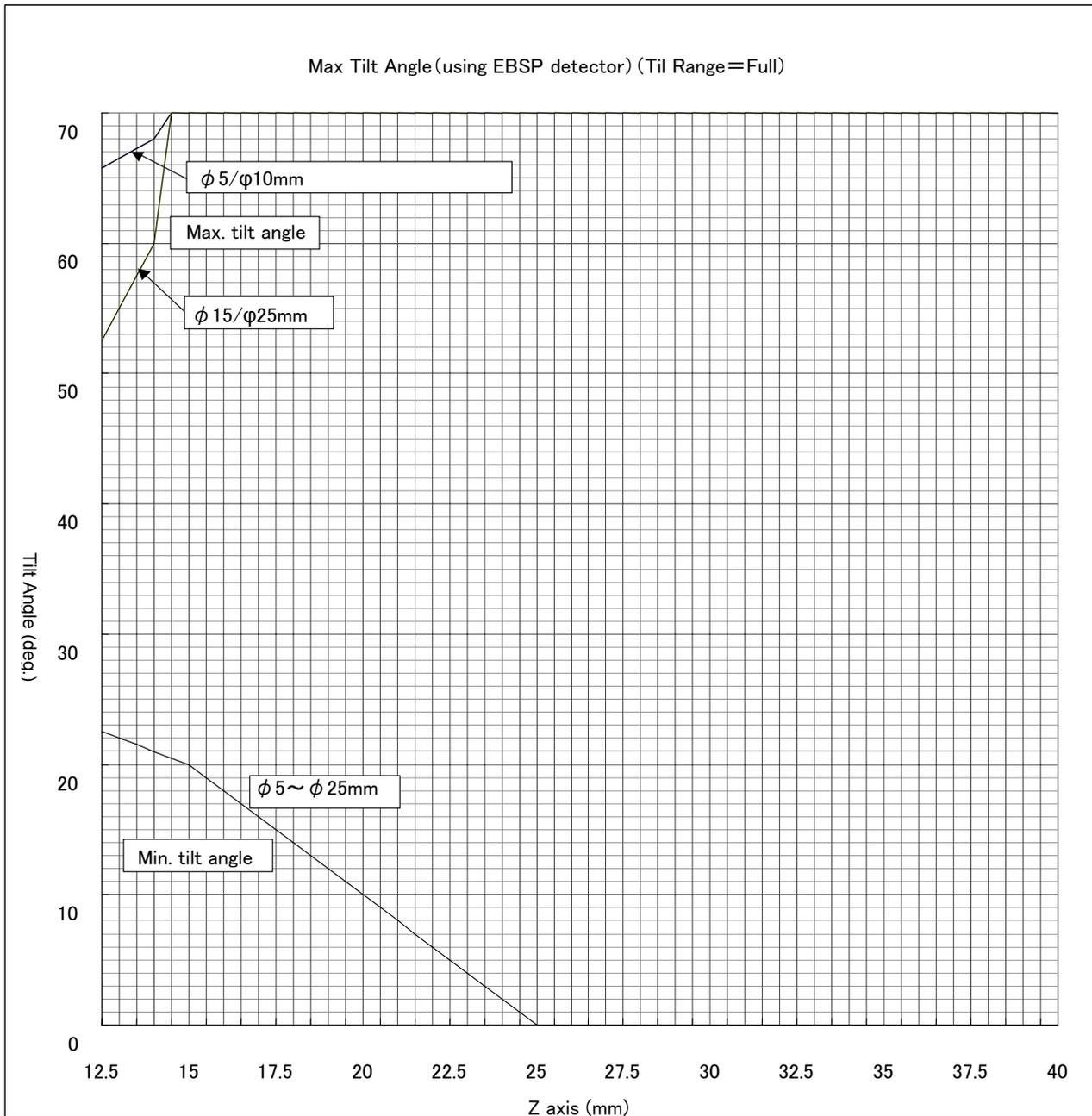
When the differential aperture is inserted, the specimen size that is larger than φ25mm cannot be used. In this case, the specimen size of φ25mm or less is usable.

When the BSE detector is inserted, the specimen size of φ5mm is usable.

Also, the specimen size of φ10mm or less is usable when the PBS-type WDX detector is inserted.

(3) Z and Tilt axes movable range (Tilt Range = Full)

The maximum tilt angle for a Z value is as follows (in the case when Sample Height=Standard). Note that there is a minimum tilt angle limitation. 0 degree tilt angle is not allowed when the Z axis is less than 25mm. Negative tilt angle is not allowed.



**Fig. 3-106 Tiltable Angles with respect to Z-axis Position**

(4) Z and Tilt axes movable range (Tilt Range = 50-70 deg)

Z axis movable range is within 14.5 to 40mm and Tilt axis within 50 to 7 degree. Tilt angle range is not changed by Z axis value.



### 3.5.6.16 Protection to Prevent Specimen Exchange Rod Insertion at other than Specimen Exchange Position

If the specimen exchange rod is inserted while stage is highly tilted, there may be trouble that internal wiring cables get stuck on the top of specimen exchange rod.

To prevent this trouble, a protection to prohibit the gate valve of specimen exchange chamber opening when the stage is away from specimen exchange position is available.

Because in some cases, we need to open the gate valve to look into the specimen chamber, for example to check sample position against objective lens, this protection is set or released by users.

(1) Protection

When the **EXC** button is clicked to move stage to exchange position, the **OPEN** switch on the exchange chamber is set inactive. When the **HOME** button is clicked to move stage away from exchange position, the **OPEN** switch is disabled.

When the **OPEN** switch is depressed while disabled, a buzzer sounds three times and the gate valve is not opened.

(2) Protection effective range

This protection is active from starting up to closing of the SEM operation program.

When display the power is off or the SEM operation program is closed, the gate valve can be opened at any stage position, despite of enable/disable setting.

(3) Setting enable/disable of the protection

This protection is set to disabled as default. It is to prevent present Hitachi SEM user's confusion.

If a user wishes to use this protection, open **Optional Setup** dialog window from **Option – Optional Setup** menu.

Put a checkmark to **Allow Gate Valve Open only at Exchange Position** checkbox to enable the protection and then click **OK**.



**Fig. 3-107 LOCK SPECIMEN EXCHANGE VALVE Block**

The checkbox setting will be saved independently for each login user.

(4) Recommended usage of the protection

It is recommended to set it enable usually, and each time you need to open the gate valve at out of specimen exchange position, uncheck the above mentioned checkbox.

If you depress the **OPEN** switch when the protection is enabled, the buzzer will sound three times to inform you to move stage to exchange position.

Note that this protection is disabled as a default setting. Each login user needs to set it to be enabled to utilize the protection.

## 3.6 Saving and Recording Images

### 3.6.1 Saving and Recording Images

It is possible to save images as an image file on the hard disk (HD), magnetic optic disk (MO), floppy disk (FD), and to output as a hard copy using a printer, or video printer.

- (1) Saving images  
Available commands for saving images include Direct Save, which saves the current image; **Direct Save**, which captures and displays the image; **Capture Image Save**, which saves an image shown in the window; and **Quick Save**, which automatically saves an image under a specified name. These commands can also be used to save images processed in the SEM Data Manager.
- (2) Printing images  
Printing of images using Windows-supported printers is available.
- (3) Copying images to other application software  
The scanning Image can be copied to the Windows-clipboard. You can use the image in other application software by simply pasting it.  
When the optional PCI image database software is installed, images are transferred directly to it without saving images.
- (4) Add-on information  
This function allows you to save overlay information, entered on the auto data display and with the data entry function, together with the image. When an image is saved or copied to another application, observation conditions are attached as a text file, which can be viewed when using image data.  
The Measurement Function Option allows you to write any text onto an image, and save and output it in addition to measurement results (measurement data and the cursor).

**NOTICE:** For storing images, we suggest the use of external storage devices, as the storage capacity of a PC hard drive is generally not large enough for images. Also, external storage devices are recommended for data backup.

### 3.6.2 Preparing Images for Recording

Frozen images are available for output by this function.

- (1) Freezing an image  
In the following cases, the image stops scanning and goes into the frozen state:
  - 1) Using **Run/Freeze** button  
The scanning image will be frozen. When the 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 screen mode.
  - 2) Capturing an image  
Depending on the particular scanning speed used, the image is frozen after Fast scanning integration or after single-frame slow scanning. The resolution of the image will be equal to a selected capture resolution (640×480, 1280×960, 2560×1920, or 5120×3840).
  
- (2) The source of image to output  
Several commands or buttons are placed in multiple areas. The image sources for the commands are as follows.
  - 1) When you use menu commands, or buttons on the control panel, the scanning image will be used as the image source. The resolution of the output will be equal to the resolution that is in effect when the current image is frozen.
  - 2) When you use buttons on the **Captured Image** window, the selected image on the window is used as the image source. The resolution of the output will be equal to the capture resolution.
  
- (3) Embedding text and graphics written on the image
  - 1) Auto Data Display  
When the **Embed Into Image** box in the **Auto Data Display** area on the **Setup** dialog window - **Record** tab has been checked, the auto data display is embedded into the image data when the image is saved. Such data applies to both of the above image sources.
  - 2) Data Entry  
When recording scanning images, graphics and text written using the Data Entry function are recorded as they are shown on the scanning image.  
When an image in the **Captured Image** window is output or saved, any characters or graphics drawn at the time of capture are embedded. Whether an auto data display and data entry are to be embedded in the captured image is specified in the **Embed into Image** check box of the **Captured Image** window.  
Refer to <3.9.8 >.
  - 3) Measurement data  
The measurement function option allows you to write, save, and output any text by using the data entry function, in addition to measurement results (measurement value and cursor). Such text is output as it is displayed on the image being observed.

### 3.6.3 Image Capture

Image Capture memorizes images using specified scanning mode and specified resolution. Two methods, multi frame integration using FAST (TV) scanning speed and single frame slow scanning are available. Up to 16 images can be recorded.

Fast (TV) scan integration is effective for specimens susceptible to charge-up. Slow scan is advantageous in order to obtain high-resolution images. When a capture is started with TV or FAST scanning speed, frame integration is performed.

Single frame slow scanning is performed when a capture is started with slow (1~5) scanning or reduced area scanning.

To select conditions for image capture, use the following steps.

- (1) Capture Resolution  
Clicking the Capture Setting button (▲) located in the upper right area of the Capture button on the Control Panel brings up a capture setting list, as shown in the figure below. Select the desired resolution from the list. The selected resolution is displayed on the Capture button.

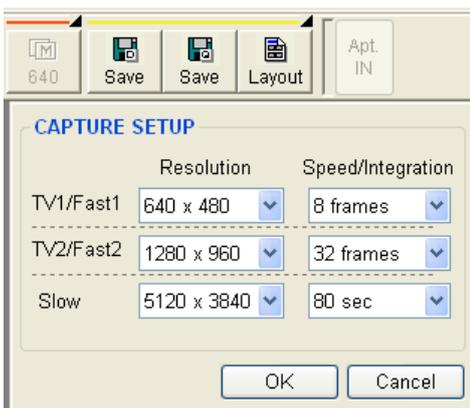


Fig. 3-108 CAPTURE SETUP Block

- 640×480 pixel:  
Advantageous for small image sizes and faster acquisition times.
- 1280×960 pixel:  
Adequate image quality with reasonable acquisition times. Recommended for normal operation.
- 2560×1920 pixel:  
Fine quality image. The large image size results in a long acquisition, storage and processing time.
- 5120×3840 pixel:  
Effective for relatively low magnification and samples containing very fine structure.

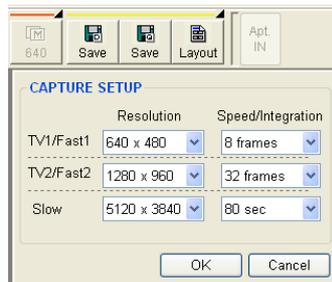
Please be aware that the processing speed declines when the file size approaches 20 M bytes. Also, some of the functions, including the measurement function and image processing by the SEM Data Manager, do not operate when image capturing is being executed.

**NOTICE:** With regard to operations performed after the execution of a capture, the following restrictions are provided depending on the file size to prevent excessively long processing time. In any case, when an attempt is made to execute a restricted function, the function is canceled by displaying a message:

- CD Measurement function works on 2560 × 1920 pixel or smaller images.
- Color mixing on SEM Data Manager works on 2560 × 1920 pixel or smaller images.
- Pseudo Coloring on SEM Data Manager works for 2560 × 1920 pixel or smaller images.

## (2) Capture Speed/Number of Fast (TV) Frame Integrations

Right-clicking the Capture Setting button (▲) located in the upper right area of the Capture button on the Control Panel brings up a capture setting list.



**Fig. 3-109 CAPTURE SETUP Block**

- **Fast 1 / Fast 2:**  
For Fast (TV) scan capture, specify the number of integration frames (8 to 1024 frames). The larger the number, the better image quality at the expense of an increased processing time. Under conditions such as a high magnification or when a specimen that easily charges up is used, image sharpness can decline due to factors such as an image drift during the integration process.
- **Slow:**  
Select a scanning speed (20 to 320 s) for Slow Scan Capture (if capturing cannot be performed at a specified time, depending on the particular display mode employed, the capturing is executed at a speed closest to the specified speed).  
When capturing is performed at any speed between Slow 1 and Slow 5, the resulting capturing speed will be equal to the value set in this parameter.

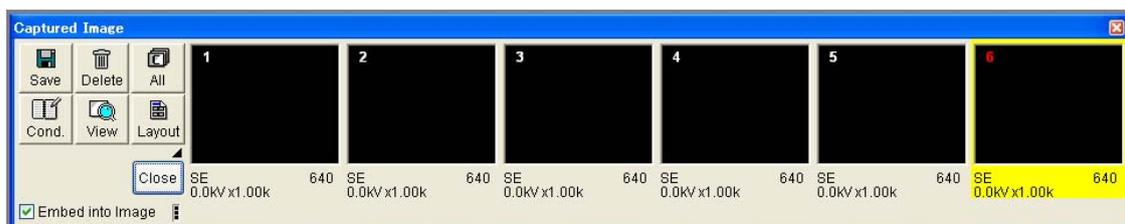
(3) Image Capture

To start an Image Capture, click the **Capture**  button on the **Control panel**.

When the scanning speed is set to **FAST**, frame integration is performed. When the scanning speed is set at **SLOW1** to **SLOW5** or **RED**, a single frame slow scan is performed. Image capture can be started either in RUN or FROZEN status.

(4) Display of the 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. 3-110 Captured ImageWindow**

The **Captured Image** window opens by  button on the tool button area of the **Operation panel**, **Captured Image** command in the **Window** menu and the shortcut **Ctrl - L** at any time. Refer to <2.3.10 >.

### 3.6.4 Saving a Scanning Image (Direct Save) and [Quick Save]

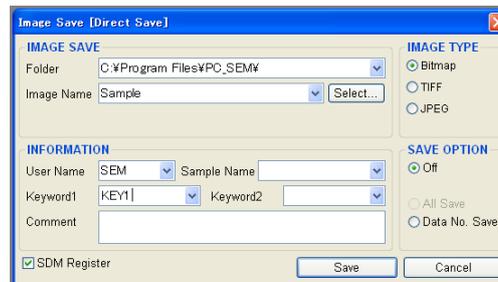
The scanning image, simply frozen or captured, can be saved.

Resolution of saved image is  $1280 \times 960$  or  $640 \times 480$  (in the **Full** display mode, the image is saved in  $1280 \times 960$  pixels; in the **Small** display mode, in  $640 \times 480$  pixels) depending on present screen mode when saved just after freezing the image. When saved after capturing, the resolution follows capture resolution.

Graphics and text written using the Data Entry function and CD measurement function are put on saved images when saved while they are shown on the image.

Any measurement value and text under the measurement function option are also similarly embedded and saved.

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



**Fig. 3-111 Image Save Window**

- (1) Select an image format in the **Image Type** area.

Bmp: Windows bitmap file

tif: TIFF file

jpg: JPEG file (The compression ratio is approximately 1/3 to 1/4. A low compression ratio is used to avoid any image degradation.)

- (2) Set **Save Option** if necessary.

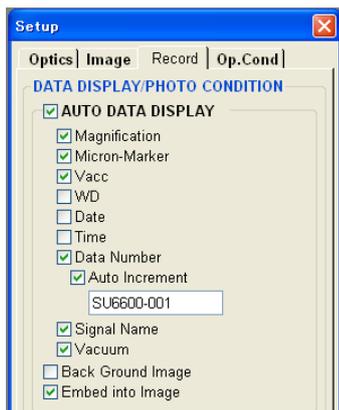
- **All Save:**

Effective when opened from the **Captured Image** window. Saves all images selected in the **Captured Image** window at one time. File names {Input File name} + \_m01, \_m02, are automatically generated.

- **Data No. Save:**

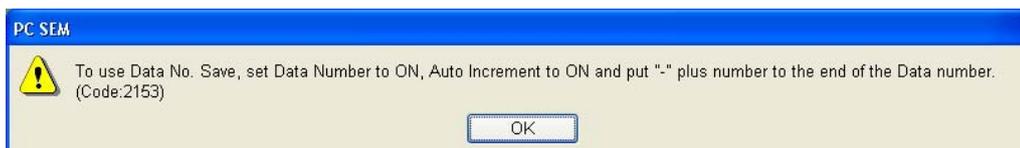
Puts a data number which is specified in the **Auto Data Display** setting at the end of the file name when saving images. **Auto Increment** is set for the **Data Number**.

To enable this save option, **Data Number** and **Auto Increment** must be checked in the auto data display settings, and the last characters in a data number must be “-” + “numeric”. (In the example in the figure below, the characters “-001” are appended to “SU6600”). In this example, the file names will be **SU6600\_i001.tif, SU6600\_i002.tif . . . .**



**Fig. 3-112 Setup Window Record Tab**

The data No. is automatically incremented when an image capture is performed; it is not incremented when a RUN-Freeze is performed on an image. Therefore, this feature is useful when an image is captured multiple times and the results are to be saved as a group. The PC SEM message appears if this condition is not satisfied when the **Data No. Save** option is checked:



**Fig. 3-113 Data No.Save Message**

If settings are re-specified to inhibit the above auto-increment after the **Data No. Save** option is enabled, the system saves the image without a data No. (using a specified file name only). If an attempt is made to save multiple images as a group, to prevent the second and subsequent file names from being identical, a confirmation message asking whether the file can be saved on an overwrite basis appears. If this is the case, cancel the image save function, cancel the **Data No. Save** option, and save images one by one. Also, since a data No. is attached to any captured image at the time of capture execution, set the Auto increment option before executing the capture function.



(3) Input **INFORMATION**.

The data entered here is saved in a text file together with the image, and used as ancillary data in a database in the SEM Data Manager.

- **User Name:**

This mandatory information is used for retrieval purposes in the SEM Data Manager. Select a user name by clicking the  button. You can also enter a new user name.

- **Samplename, Keyword:**

Either enter a new keyword or select from a list of previously saved keywords. These items, while not being required, can be used as image retrieval keywords and can be a powerful retrieval tool.

## (4) Select options.

- **SDM Register:**

Check this item when using the SEM Data Manager. The item is automatically registered when the data is saved. Uncheck this item when Quartz-PCI is used as a data base and it does not need to be registered in the SEM Data Manager.

## (5) Specify folder and file name.

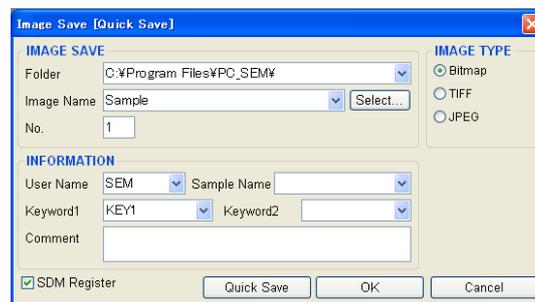
The  button beside the Folder and Image Name input box to open a list of recently used names. You can select one of them and modify it. The **Select** button opens a **Image Save** dialog window. You can select or create a folder and file name in it.

After that, click the **Save** button to save (the maximum allowable file name, in alphanumeric and single-byte characters, including the characters that are automatically assigned in the Save option, is 251 characters).

Quick Save is another function that saves images being observed.

Quick Save allows you to save an image captured according to Section 3.6.3, *Image capture*, under a previously assigned file name.

To execute Quick Save, run **Quick Save** from the **File** menu. A **Save Image** window opens, as illustrated in the figure below:



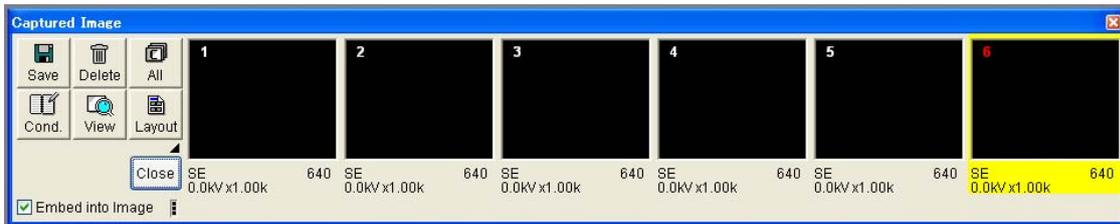
**Fig. 3-114 Image Save[Quick Save] Window**

Enter the **IMAGE TYPE, INFORMATION, SDM Register** and a destination folder and the file name. Quick Save provides a No. below the file name. When Quick Save is executed, the image is saved with a name constructed by appending a **\_qXX** to the file name, where **XX** corresponds with the No. No. is a single-digit number from 1 through 99. Executing Quick Save increments the No. by 1. When the value of No. reaches 99, a message prompting for a file name change appears.

Setting the Quick Save option allows you to save an image using the **Save**  button on the Control Panel by bypassing the Quick Save window.

### 3.6.5 Saving Captured Images

- (1) Captured images can be selected in the **Captured Image** window. To save captured images, select an image by clicking a thumbnail or multiple images by clicking thumbnails and pressing the **Ctrl** key. The **Save** button opens the **Save Image** dialog window. The procedure is the same as above. Additionally the **All Save** option is available. The selected images are identified with yellow bordering. The text “Saved” shows already saved images.



**Fig. 3-115 Captured Image Window**

- (2) The **Save**  button opens the **Save Image** dialog window. For this operation, see the preceding section 3.6.4. The Thumbnail for a saved image contains the characters **Save**.

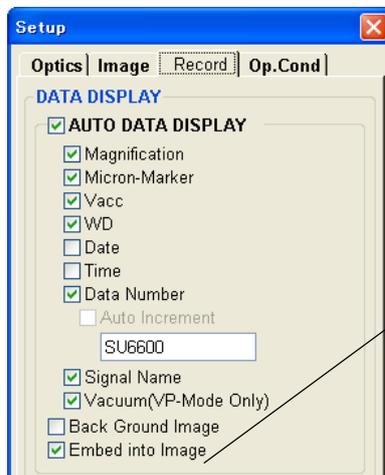
### 3.6.6 Recording Data Display with Images

Text and graphics drawn using Auto Data Display and Data Entry function are embedded into image data as follows.

#### 3.6.6.1 Image Recording Using Menu Commands or Buttons on the Control Panel

When images displayed on the scanning image screen are saved (direct save/quick save), 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** checkbox on **Record** tab of **Setup** dialog window is checked. If the checkbox 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.



**NOTICE:**  
The check box shall be checked to record Auto Data Display with images.

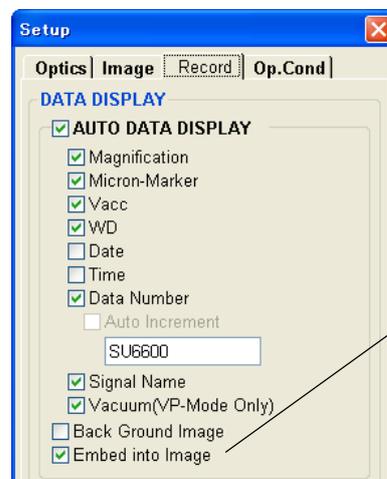
**Fig. 3-116 Setup Window Record Tab**

### 3.6.6.2 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.

When an image is saved, printed, or subjected to a PCI transfer by using a command button on the **Captured Image** window, "items drawn at the time of image capture" stored in memory at the time of capture execution are embedded.

- (1) The Data Entry can be added or edited while the captured image remains on the image window (before switching to RUN or carrying out the next capture).  
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 the RUN operation.
- (2) If additional data is entered or data is changed during the capture process when the image is being displayed (when the CAP {number} is displayed in yellow in the upper left edge of the image), and if such data is saved (Direct Save), printed, or subjected to a PCI transfer from the menu or the Control Panel, the addition data is added as data on the captured image.
- (3) When the **Embed into Image** checkbox on the **Record** tab of **Setup** dialog window is checked, the 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 the command buttons on the **Captured Image** window. If the checkbox is not checked, Auto Data Display text is not memorized even if it is shown on the image.
- (4) Even when Auto Data Display text and entry data is shown on the image at the timing of capturing, only the image is recorded without entry data if the **Embed into Image** checkbox on the **Captured Image** window is not checked.  
Keep the box checked to record Auto Data Display text and entry data with images.



**NOTICE:**

If the checkbox is not checked, only the images are recorded.

**Fig. 3-117 Setup Window Record Tab**

### 3.6.6.3 To Record Captured Images without Embedding Text or Graphic Data

When the **Embed into Image** checkbox 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.

If the data displayed is to be saved with the image, leave this check box ON (checked).

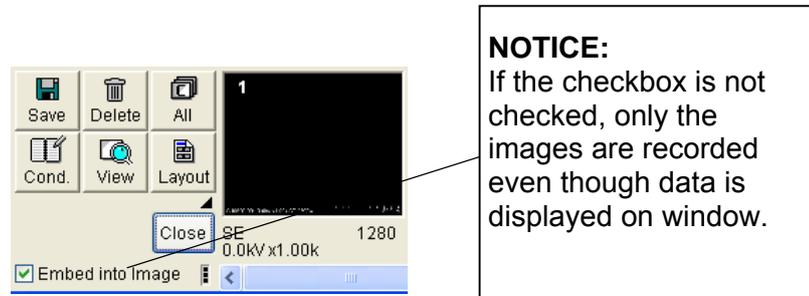


Fig. 3-118 Captured Image window

## 3.7 Using SEM Data Manager

Saved images can be managed by using SEM Data Manager functions. For details and the operation of SEM Data Manager functions, see 3.12.

## 3.8 At the End of Daily Use

Take out specimen, shutdown Windows and turn display power off at the end of operation. The electron gun shall be kept in an emission active status. The vacuum EVAC system will remain working.

### 3.8.1 Turning Accelerating Voltage Off

- (1) Close open dialog windows. Save data if necessary.
- (2) Click the HV **OFF** button  on the **Control panel**.

### 3.8.2 Moving to the Specimen Exchange Position

Move the specimen stage to the specimen exchange position.

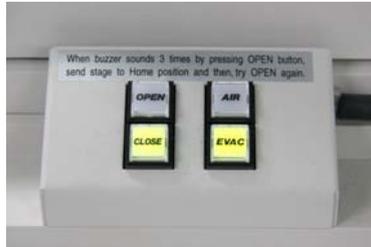
Release the stage lock.

Click the **EXC** button on the **Control panel**. Wait until the indicator for the button changes to green.

### 3.8.3 Taking Out a Specimen

Remove the specimen from the specimen chamber according to the following procedures:

- (1) Press the **OPEN** button on the specimen exchange chamber. The exchange chamber will be evacuated and then the gate valve will open.



**Fig. 3-119 Specimen Exchange Chamber Operation Panel**

- (2) Turn the knob of the specimen exchange rod clockwise so the **Unlock** mark faces upwards.



**Fig. 3-120 Specimen Exchange Rod**

- (3) Insert the rod straight and insert the two spring pins at the end of the rod into holes of the specimen holder. If the rod is inserted completely as in the following picture, the spring pins are plugged in normally.



**Fig. 3-121 Specimen Exchange Chamber Operation**

- (4) Turn the knob counterclockwise so the **Lock** mark faces upwards to hook the specimen holder.



**Fig. 3-122 Specimen Exchange Rod**

- (5) Pull out the specimen exchange rod, and lock it.
- (6) Press the **AIR** button on the specimen exchange chamber. The gate valve is closed and air is introduced into the specimen exchange chamber. The buzzer will sound after the completion of venting.
- (7) Open the exchange chamber door.

**CAUTION:**

- Do not hold the specimen exchange rod when opening and closing the specimen exchange chamber. The rod may bend and disable specimen exchange.
- Wear gloves when handling the specimen holder.

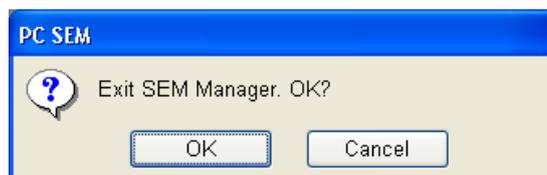
- (8) Turn the knob clockwise and remove the specimen holder from the rod.
- (9) Close the exchange chamber door and press the **EVAC** button.

**REFERENCE:** When the operation is terminated by leaving the stage in the specimen exchange position, when the system is started next time, the system starts up without initializing the stage. In this manner, a specimen can be loaded immediately.

### 3.8.4 Closing Windows and Shutting off the Display Power

At the end of daily use, shut down the display power after closing Windows.

- (1) Click  on the title bar or select the **Exit** command in the **File** menu.



**Fig. 3-123 Exit SEM Manager Window**

Click the **OK** button. The SU6600 SEM main window will close.  
If the processing is not complete, perform it as necessary.

- If captured images remain unsaved, a warning message will be shown. Click Yes if saving is necessary and then close the message dialog window.
- If accelerating voltage is still applied, a message asking to shut the accelerating voltage off or not is shown. OK will shut the accelerating voltage off and continue closing the SEM main window.

**NOTICE:** Do not shut Windows down before the closing message disappears.  
If necessary data backup is terminated before completion, incorrect operation may occur at the next start up.

- (2) On the Windows task bar, click the **Start** button and select **Shut Down**.



**Fig. 3-124 Windows Taskbar**

- (3) In the **Shut Down** dialog window, select **Shut down the computer** and click **Yes**.
- (4) Wait until the message “It’s now safe to turn off your computer” is displayed, or the power of PC is shut down automatically.
- (5) Turn the **DISPLAY** switch (on the front of the display console unit) to **O**.

**NOTICE:** 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 DISPLAY 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.

**NOTICE:** Keep the GUN high voltage power supply unit power switch ON.



## 3.9 Using Other Functions

While the descriptions given above are concerned the basic operation of the SEM, the SU-6600 provides a wide variety of features, which should be utilized as appropriate.

### 3.9.1 Screen Mode

Screen modes, **Full**, **Dual** or **Small** are selectable with the **SCREEN MODE** block of the operation panel.



Fig. 3-125 SCREEN MODE Block

#### (1) Full screen mode

A scanning image is displayed at the full desktop size. The image resolution is 1280 × 960 pixels. It is recommended to use this mode for normal operation.

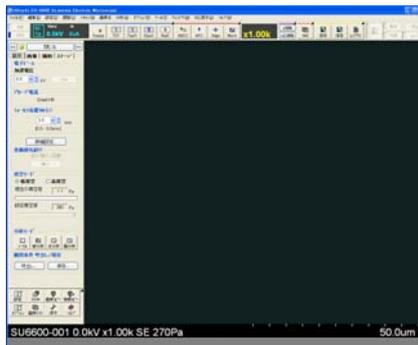
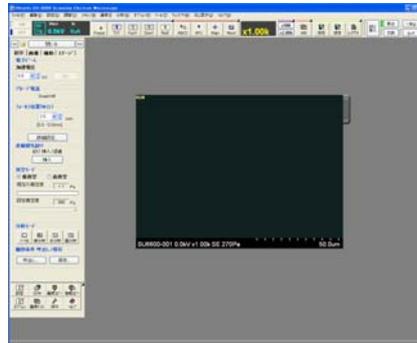


Fig. 3-126 Full Screen Mode

- Large image provides an easy to operate condition. The magnification of the displayed image is about 2.5 times the indication that is calculated for 4 × 5 inch (127 mm×95 mm) photograph size.
- The scan speed is somewhat slower compared with **Small screen** mode. If the scanning image is noisy or you need a faster refresh rate, try using **Small screen** mode.
- When TV (1 or 2) scan is selected or in alignment mode, the image size is reduced to half, to obtain true TV rate scanning speed.

(2) **Small screen mode**

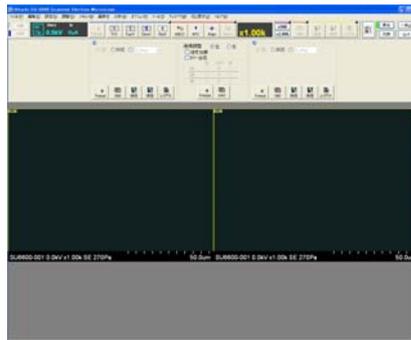
Scanning image size is reduced to half. The image resolution is  $640 \times 480$  pixels. Faster scanning rate compared with Full screen mode may result in better image quality in some cases (against noise). The magnification of the displayed image is about 1.2 times the indication.



**Fig. 3-127 Small Screen Mode**

(3) **Dual screen mode**

Two  $640 \times 480$  pixel images are shown simultaneously. They can display different signals or the same signal. In this mode, color mixing is available, and analysis modes (line, spot and area analysis) and split screen/dual mag modes are inactive.



**Fig. 3-128 Dual Screen Mode**

The following are functions are different from Full or Small screen mode.

- Signal selection

The **Dual** display mode permits the assignment of different signals to the left and right screens (screens A and B). Such assignments can be specified in the upper part of the image display.



**Fig. 3-129 Signal Selection Control**

- Run/Freeze operation

Use the  buttons located in the left and right frames at the top of the image to toggle between Run/Freeze independently for screens A and B. To toggle between Run/Freeze simultaneously for both screens A and B, use the  button in the center.

- Capturing images

To capture an image in one of the screens, click the  button located at the top of the image to be captured. To capture the images on both Screens A and B, click the  button in the center.

- Image recording

Use the buttons located at the top of each image to select Direct Save, Quick Save, Layout Print, and PCI transfer operations.

The buttons that are displayed are the same as the image recording buttons on the Control Panel.

- The capture resolution 2560×1920 and 5120 × 3840 are not available.

- To assign ABCC, Operation Panel brightness, and Contrast knobs, use the left and right selection buttons for image adjustment. These buttons are applicable to a specified image signal.



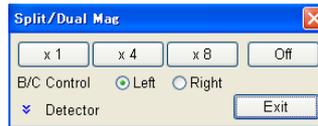
**Fig. 3-130 Image Adj. Button**

- If the scanning speed is RED (1/2/3), Focus Monitor, BC Monitor Mode, or Alignment Mode, an image is displayed only on the right or left screen. To which screen it is displayed can be specified by using the Left/Right selection buttons in the **Image Adj.** block above.

### 3.9.2 Split Screen and Dual Mag Mode

**Split screen** mode displays two images in the viewing area, and allows display of images having different signals and at different magnifications. This mode is available in **Full** and **Small** screen modes.

Selecting **Split DM Mode** - enlarged magnification from the **Scan** menu splits the image into two parts, right and left, and brings up a **Split/Dual Mag** controller. The numbers  $\times 1$ ,  $\times 4$ , and  $\times 8$  represent the magnification rates for the right images.



**Fig. 3-131 Split/Dual Mag Controller**

(1) Split Screen Mode

Clicking the  $\times 1$  button allows you to display dissimilar signal images on the right and left screens at the same magnification rate. By selecting an input signal in this state, you can display different signal images on the right and left screens.

To select an input signal, use the **Detector** button to display the settings unit, where an input signal can be specified.



**Fig. 3-132 Enlarged Display of Detector Settings**

(2) Dual Mag Mode

Clicking either the  $\times 4$  or  $\times 8$  button enlarges a part of the left screen by a factor of 4 or 8, and displays it on the right screen. The area to be enlarged is displayed in a box in the left image, and the area to be enlarged can be specified by dragging and moving the box.

**NOTICE:** Using a scan mode other than the scanning speed (Slow 3/4/5) in the Dual Mag Mode can in some cases produce distortion in the right enlarged image, due to the inductive nature of the operation coil when the left and right images are scanned alternately. Since this problem does not occur in the Scan Mode (Slow 3/4/5), images should be captured using the Scan Mode (Slow 3/4/5).

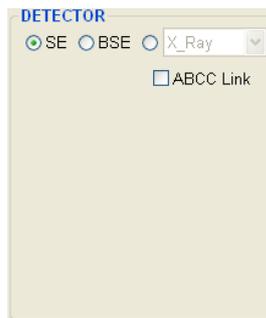
### 3.9.3 Signal Selection and Color Mixing

The SU6600 has three external signal channels for optional signal detectors and one X-ray signal (for X-ray mapping, line analysis) 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, you can display two images with two different signals simultaneously. Also color mixing, which combines two signals with different colors available.

To select a signal;

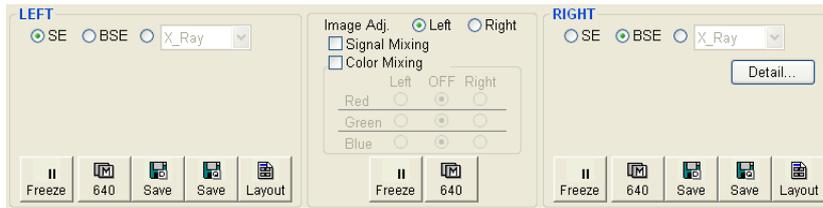
- (1) **Full screen and Small screen mode**  
Use the **SIGNAL SELECT** block of the operation panel.  
Only the left side selection box is effective.



**Fig. 3-133 DETECTOR Block**

The signal for line profile in the Line Analysis mode is selected independently of the signal for the image. Use the **LINE PROFILE SIGNAL** block in the **Setup** dialog window - **Image** tab.

(2) **Dual screen display mode**



**Fig. 3-134 Enhanced Control Panel for Dual Mode**

Use the **Signal Select** block of the operation panel. The left side selection box is for the left side (A screen) image, and the right side box for the right side (B screen) image. The **Brightness** and **Contrast** knobs on the manual operation panel are applied to the signal selected with the **Signal A/B** selection buttons.

(3) **Signal Mixing** (available in dual screen display mode)

This function can add and display the signals assigned to the right and left screens, provided that the mode is **Dual** display mode.

First, bring up the **Dual** display mode, assign different signals to the right and left screens, and then observe.

Place a check mark on the signal mixing option in the image adjustment box. The function displays an image with both selected signals added on Screen B (right image).

The example below shows an SE (secondary electron) image on Screen A (left) and an SE (secondary electron) and BSE (backscattered electron) image added together on Screen B (right).



**Fig. 3-135 Signal Mixing Control**

- Contrast and Brightness adjustment by mouse operation on the scanning image is applied to the original signals, not to the mixed signal.
- To turn off mixing (neither is an add image), remove the check mark.

(4) **Color Mixing** mode (available in dual screen display mode)

The **Color Mixing** mode is a function that displays a color composite image. Each of three colors (Red, Green and Blue) is assigned to two images selected for A (Left) and B (Right) screens, and displayed as a color composite image. The color composite image is displayed on the B (right) screen.

Bring up the **Dual** display mode, assign different signals to the right and left screens, and then observe.

On the Operation Panel and in the **Color Mixing** block (normally located on the **Utility** tab), check  the **Color Mixing** box. Click the colors to be assigned to A and B to assign colors to the respective signals. On a color not to be assigned, click **Off**. The figure below shows an example where colors are mixed between the blue signal assigned to Screen B, and the yellow signal (a mixed color of red and green) signal assigned to Screen B, and the results are displayed on Screen B.



**Fig. 3-136 Color Mixing Control**

Unchecking  the **Color Mixing** box resets the display to the normal monochrome display. Although color-mixed images cannot be photographed, they can be saved. To save colored images, select **B** and then carry out capture. Use the **Save** button on the **Captured Image** window. Also the **Save** button on the control panel or **File - Direct Save** menu saves the presently observed color image.

**NOTICE:** Both A and B screen images are refreshed by capturing due to the limitation of the processing.

### 3.9.4 X-ray Analysis Mode

This is an operating mode for Line and Spot analyses.

Specify this mode, which is disabled in the **Dual** display mode, in the **SCAN MODE** block of the Operation Panel.



Fig. 3-137 SCAN MODE Block

- (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** 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** button is clicked, the scanning image is frozen and a waveform, which is a profile of the signal intensity of the line, is shown on the image. The electron beam line-scans the position of the horizontal cursor. In this condition, the position of analysis can also be changed. The speed of line scanning can be changed by using the Scan Speed button. Fast 1 / Fast 2 changes the speed to fast signal speeds for secondary and backscattered electrons. Slow 1 - Slow 4 set slow speeds for X-ray signals.

Whether a line profile is to be displayed by superposing it on an image or only waveforms are to be displayed by erasing the image can be specified by using the **Background** option in the **LINE PROFILE SIGNAL** block on the **Image** tab in the **Setup** dialog box.

**Image** displays an image; **Black** displays a line profile only.



Fig. 3-138 LINE PROFILE SIGNAL Block



The **Run/Freeze** button changes run and stop alternately.

In the freeze state, the line profile is displayed clearly.

For recording a line profile, the following procedures are recommended in order to ensure consistency between the image and the line profile and to prevent line-like contamination due to the line scanning:

- 1) Observe an image in **Position Set** mode at **Slow2** or slower scanning speeds.  
Click the **Line** 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.
- 3) Save the image.  
The signal for line profile can be selected independent of the signal for image.  
For example, you can observe or record 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** dialog window - **Image** tab.

(3) **Spot Analysis** mode 

Stops the scanning and places the electron beam at a specified point on the image.  
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 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 the 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 

When the **Spot Analysis** button is clicked in **Position Set** mode, the scanning image is frozen and the electron beam is positioned at the cross point of the cursor.

You can make analysis of this point.

The cursor can also be moved in this mode with the same operation as above.

(4) **Area Analysis mode** 

Scans the electron beam in a selected frame on the image. 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  (change the size in horizontal direction),  (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 Analysis** button is clicked in **Position Set** mode, the scanning image is frozen and the electron beam is scanned in the box area (the cursor is changed to a straight-line box). The analysis position can also be changed in this condition.

### 3.9.5 Signal Processing

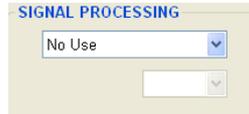
Processing of the image signal is available on a live image.

For SE signal, digital processing, spatial filtering, contrast conversion can be applied.

In addition, analog signal processing is available for an optional detector signal (BSE etc.).

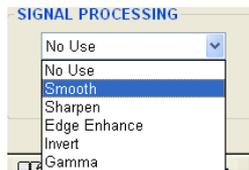
(1) Digital signal processing

Use **SIGNAL PROCESSING** block on the operation panel to apply digital signal processing.



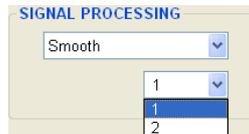
**Fig. 3-139 SIGNAL PROCESSING Block**

Click  button and select the processing on the pull-down list that appears.



**Fig. 3-140 Signal Processing List**

In the selection box below, select a level (in numerical value) of change if the level of processing can be varied in several steps:



**Fig. 3-141 Signal Processing Depth list**

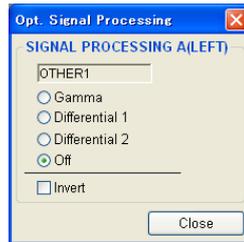
The following processing is available.

- (a) **Smooth** (1/2): Two-dimensional smoothing including the surrounding pixels.  
Reduces snow noise. It is effective especially at high magnification, where originally the 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 a stronger effect than the above Sharpen.
- (d) **Invert**: Invert the contrast.
- (e) **Gamma** ( $-5 \sim 0 \sim +5$ ): A plus value of Gamma suppresses the white contrast and enhances the dark part. A minus value increases contrast.

**NOTICE:**

- This processing is performed on the part of the image that is displayed on the monitor.
- If the processing is switched by using Slow Scan, the scanning returns to the starting point before resuming.

- (2) Analog signal processing for optional detector signal  
To use analog signal processing, click the **Option Signal** button in the **DETECTOR** block on the **Operation panel**. The **Signal Processing** dialog window will open.



**Fig. 3-142 Opt. Signal Processing Window**

- (a) **Gamma:** Gamma Control  
Gamma correction suppresses excessive contrast, maintaining the contrast of the average brightness of the image.
- (b) **Differential:** Differential Image  
Differentiates the image signal in the horizontal direction (bypass filtering) in a technique that highlights the outline of the image. The **Differential 1** option creates a stronger emphasis effect. Results vary with scanning speeds because it applies to differentiation time domain.
- (c) **Invert:** Invert contrast.
- (d) **Off:** Turns off the processing.

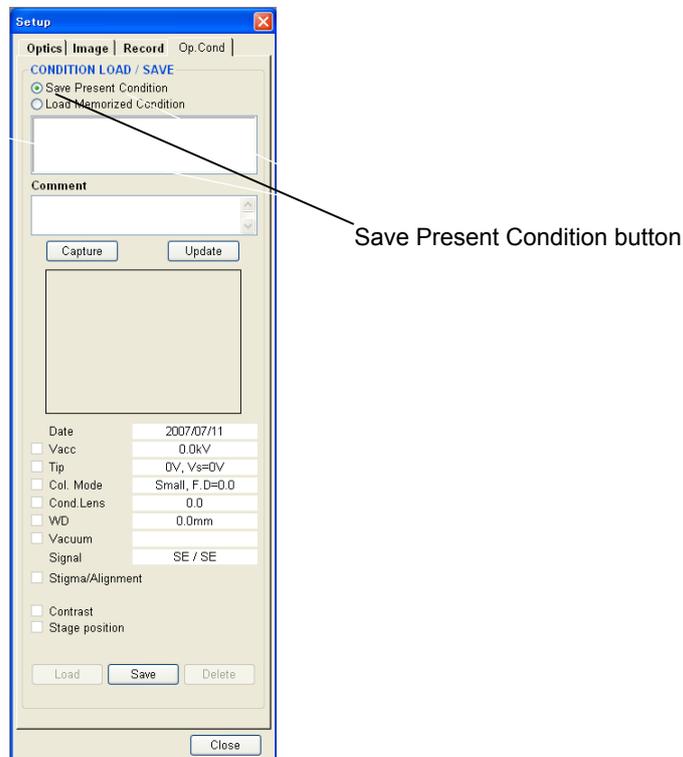
### 3.9.6 Operating Condition Memory

The operating condition memory allows you to save settings for the electron optical system and load and restore them.

By performing axial alignment on the electron optical system under certain conditions and saving the results, you can reproduce the same settings.

- (1) Saving Present Operating Conditions  
Use the following steps to save the present operating conditions.

- (a) Open the **Setup** dialog window  
Select **Condition Save** from the **Operate** menu, or click the **Setup** button of the **Operation panel** and select **Op.Cond** tab.  
Select **Save Present Condition** on it.



**Fig. 3-143 Op. Cond Tab (Save)**

- (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.

**NOTICE:** The memorized condition data remains until the **Update** button is clicked, even when loading a 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.

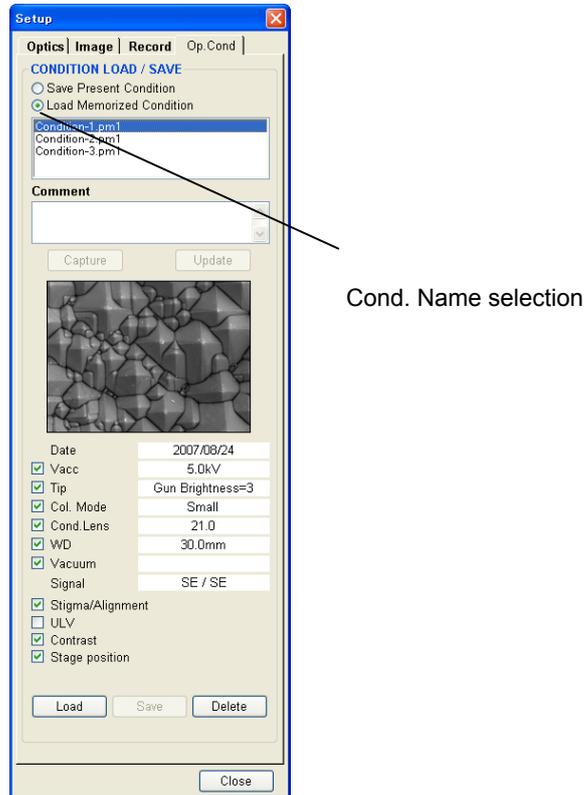
(d) Saving condition data  
Click the **Save** button. The **Condition Save** dialog window will open. Input a comment, specify a **Condition Name** and then click the **Save** button.



**Fig. 3-144 Condition Save Dialog**

- (2) Loading and re-storing of Operating Conditions  
Use the following steps to load and restore the operating conditions.

- (a) Open the **Setup** dialog window  
Select **Condition Load** from the **Setup** menu, or click the **Setup** button on the **Operation panel** and select **Op.Cond** tab. Select **Load Memorized Condition** on it.



**Fig. 3-145 Op. Cond Tab (Call)**

- (b) Select a condition name  
Memorized condition names are listed. Select a name by clicking it.  
Use sample picture and comment for reference of selection.
- (c) Select items to be set  
The items beginning with **Vacc** and below represent the recorded observation conditions. Of these conditions, check the items to be restored on the system, and uncheck those items that are not needed.
- (d) Setup  
Click the **Load** button. The memorized data is retrieved and the electron optical column is restored. If the **Stigma / Alignment** is checked, a message will appear for confirmation. These have possibly changed if the loaded condition was saved long before. The reason is that in some cases it is advantageous to use the latest state that is stored in memory by the learning function.

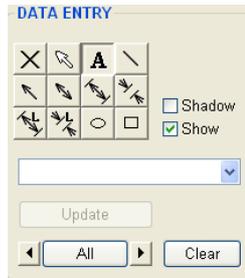
- (3) Deleting an observation condition  
Select a condition name in the same manner as above, and click the **Delete** button.

### 3.9.7 Pseudo Color Display

Use the **SEM Data Manager** for pseudo color imaging.  
Refer to < 3.12.3.7 >.

### 3.9.8 Data Entry Function

Use the **DATA ENTRY** block on the **Operation panel** for drawing graphics and text on the scanning image display.



**Fig. 3-146 DATA ENTRY Block**

- (1) Function of tool buttons



**Stop data entry:** Stops data entry. Tool buttons are disabled.  
Drawn data remains on the image.



**Edit text:** Selecting the Edit button changes mouse pointer to hand mark. Click the text to be edited. The text is changed to black background form. You can edit the text. The Enter key completes editing. The text is shown in red color and you can move its position by dragging it with the mouse.



-  **Text input:** Writes text on the image. After selecting the button, click on the image. The text input area black stripe is shown on the image. Input text using the keyboard and complete with the Enter key. The text is shown in red color and you can move its position by dragging it with the mouse. Text fonts can be selected by selecting **Optional Setup - General** from the **Option** menu and in the **DATA ENTRY/MEASUREMENT** area on the **General** tab of the **Optional Setup** dialog box. Entering text in Japanese requires the selection of a Japanese font. If a character is entered in the text box, the character is input when an input position on the image is clicked.
-  **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 point and then release the mouse button.
-  **Arrow:** Draws a single-head arrow mark on the image.
-  **Double head arrow:** Draws a double-head arrow mark on the image.
-  **Inner dimension mark:** Draws an inner dimension arrow mark on the image. The numerical value (size) will not be written.
-  **Outer dimension mark:** Draws an outer dimension mark on the image. The numerical value (size) will not be written.
-  **Inner dimension mark with measurement:** Draws an inner dimension marks with the measurement on the image. The numerical value (size) will be written. The minimum unit of display, however, is 0.5 $\mu$ m if the optional Measurement function is not installed.
-  **Outer dimension mark with measurement:** Draws an outer dimension mark with the measurement on the image. The numerical value (size) will be written. The minimum unit of display, however, is 0.5 $\mu$ m if the optional Measurement function is not installed.
-  **Circle:** Draws a circle or oval shape on the image. Click this button and press the left mouse button to create a starting point on the image.
-  **Rectangle:** Draws a rectangle on the image. Click this button and press the left mouse button to create a starting point on the image.

In the above operation, while each button is depressed, you can repeat the drawings.

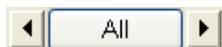
**Shadow** check box: When the **Shadow** box is checked, text and graphics are drawn with a shadow.

**Text box:** If you enter 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 text are memorized and can be selected with the  button. Use the function when you repeat writing the same or similar text.

**Show** check box: Shows (checked) or hides (unchecked) text and graphics.

**Update** button: The entry data is memorized at the moment of image capture for the image. After that, entered data can be saved together with the image. If data is to be added and changed after the execution of capture, the data attached to the captured image can be updated by subsequently clicking the button. Updating is available, however, only when capture is executed and the image is being displayed. Input data cannot be updated if the image is updated by performing a RUN. (After saving, data can be added by using the Data Entry function of SEM Data Manager).

**NOTICE:** The current input data or data displayed at the time of image capture is saved as is. If the data is not to be recorded by attaching it to the image, erase the display itself using the **Show** check box. (Even if the display is erased, the input data remains intact; therefore, the previous input data can still be displayed by re-displaying it.)



**Select** buttons:

  button selects graphics or text on the image in order. (The selected text is displayed with the characters in red and the background in black.) A selected graphic is indicated with the gray color and a surrounding dotted line box. They can be moved and re-positioned by mouse dragging. A selected text can be edited by double-clicking on it.



**All** button selects all graphics and text.



**Clear** button: Clears selected graphics or text.

(2) Entry data and show / hide drawn data

When the 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.

The characters or graphics that are drawn remain as is.

To hide the display by leaving the input data intact (as internal data), uncheck the **Show** check box.

(3) Editing text

To edit already written text, select the **Edit text** button. 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 entered data

 or  button selects graphics or text on the image in order. A selected text is indicated with red color and black background. A selected graphics is indicated with gray color and a surrounding dotted line box. 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 extended and editing becomes possible.

The **Clear** button  erases the selected data. To erase all, select all data by clicking the  button and then click the **Clear** button.

(5) Recording entry data with images

The characters and graphics drawn here can be embedded in the image and saved, printed, or transferred via the PCI.

Refer to < 3.6.6 >.

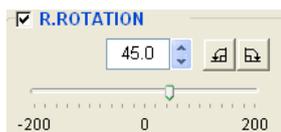
**NOTICE:**

- (1) A dimension mark with a measurement value is calculated using the present magnification value. The dimension value will be re-calculated at the following time when image magnification has been changed.
  - (a) Image is frozen
  - (b) Image capturing is carried out
- (2) In Dual Screen mode, it is possible to display two different magnification images, for example freezing an image and running another. In such a case, dimension value is correct for only one of two images.
- (3) An abnormal text character display where text is shown doubly may occur. Although this will be very rare, carry out the following operation in such a case.
  - (a) Editing the character (character edit)
  - (b) Drawing another character or graphic
- (4) When screen mode (Full / Dual / Small) is changed, all data is deleted.

### 3.9.9 Raster Rotation, and Tilt Compensation

(1) **Raster Rotation**

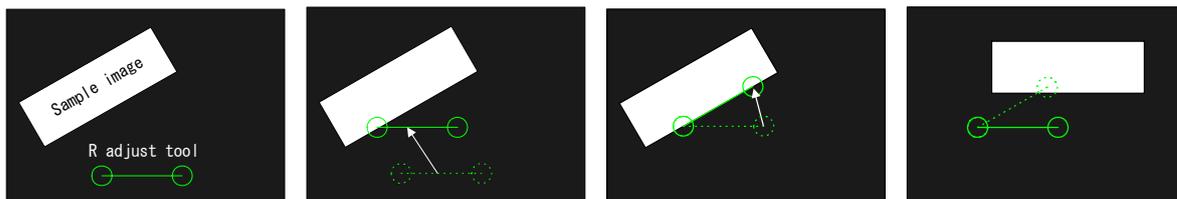
Scanning of electron beam can be rotated within a range of  $-200^{\circ}$  to  $+200^{\circ}$ , using the slider. This allows observation of an image at the best orientation. Use the **R. ROTATION** block on the **Operation panel**.



**Fig. 3-147 R.ROTATION Block**

To operate the Raster Rotation, check the **R. Rotation** box. To select a rotation angle, move the slider, or input an angle numerical value into the angle indication box.

Also mouse operation on the image can be used. Use the same operating procedure as that described in 3.5.6.8 - (12). To move the circle part with the mouse, right-click the mouse button (the left button mechanically rotates the state; the right button causes a raster rotation).



**Fig. 3-148 Rotation Tool (Rastar Rotation)**

Move the mouse at around the center of the tool, the mouse pointer will change to an array mark . Press either the left or right button and move the tool to the end to the inclined line part to be rotated to horizontal.

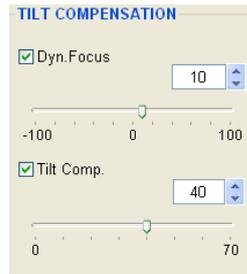
Press the right button in the circle of the other end and match the tool to the line part. Release the mouse button. The raster rotation will be driven R axis will rotate and the line part is adjusted to horizontal.

This operation is effective when raster rotation is set to on.

**REFERENCE:** Image rotation caused by the objective lens magnetic field is compensated automatically even when the above rotation angle is set to **0** or the **R. Rotation** 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** dialog window - **General** tab. For normal operation, it is strongly recommended to enable the automatic compensation function.

(2) **Tilt compensation**

When a specimen is tilted to 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 position. Also the magnification along the tilt direction is lower than that in a non-tilt direction. As a result, the image appears to be compressed in the tilt direction. The image can be corrected so the magnification is accurate in all directions by using Tilt (magnification) compensation. Use the **TILT COMPENSATION** block on the operation panel.



**Fig. 3-149 TILT COMPENSATION Block**

Use the following steps to focus the entire field.

- (a) Set the angle of raster rotation to 0. In this condition, the scanning direction of the Y-axis (vertical direction) of the electron beam coincides with the direction of the tilt of the specimen. (Since the tilt correction applies to the direction of Y-scan, the orientation of the image must match the direction of the tilt of the specimen.) The directional matching can be ensured by setting the angle of raster rotation to 0.
- (b) Dynamic focusing
  - Check  the **Dynamic Focus** box, and set the slider to the mid-point (0). Focus on the center of the image, and adjust the slider so that the entire image is in focus.
  - In another method, use the Reduce2 scanning mode. In Reduce2 scanning mode, set the scanning position in the center of the screen, and perform focusing with the slider moved all the way to the left (0), and move the scanning position to the top of the screen. Adjust the slider so that the image is in focus there.
  - Since the slider adjustment position varies with the magnification, the WD, and the accelerating voltage, re-adjust the slider adjustment position if image observation conditions are changed.

**NOTICE:**

- When the specimen tilt angle is high and the magnification is lower than 1000×, the image may have some distortion.
- At SLOW1 or TV, or FAST scanning speed, unexpected defocusing may appear in the image. It is caused by a slow response of the magnetic field of the objective lens.
- Dynamic focusing is effective for a magnification range from the lowest magnification, up to about 1000 times (the absolute value changes according to operating condition).

(c) Tilt magnification correction

When a specimen is tilted, it appears shrunk in the Y-direction. The Tilt magnification correction is a function that elongates the image in the direction of its tilt, to correct it to the same dimensions as before tilting.

- Check  the **Tilt Comp.** box. Either use the slider or enter a numeric value to match to the tilt angle of the specimen.

**NOTICE:** Tilt Compensation may result in an unnatural image when a specimen has topographic structures.

### 3.9.10 Layout Print

Scanning images or saved images can be printed using a Windows-supported printer, freely allocating images on a sheet of a specified size.

(1) Starting up

The **Report Generation** window will open by selecting **Layout Print** from the **File** menu or clicking the **Print** button  on the **Control panel** or on the **Captured Image** window.

In this case, the first image displayed in the window will be as follows:

- Starting from the menu or the Control Panel  
The scanning image is placed first (in the **Dual** display mode, the image selected in **Record (A/B)** is placed).
- Restarting with the **Report Generation** window already open  
This operation adds the image being observed.
- Starting from the **Captured Image** window  
Place the selected (yellow-rimmed) thumbnail image.  
Starting by selecting multiple items (clicking the thumbnail while holding the Ctrl key down) places multiple images that are selected.

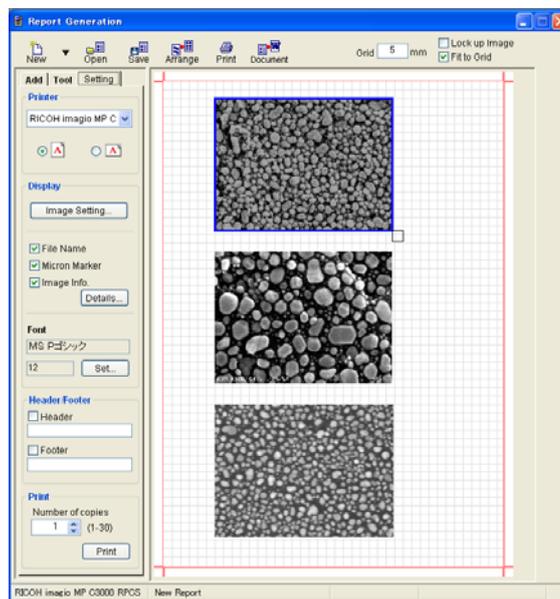
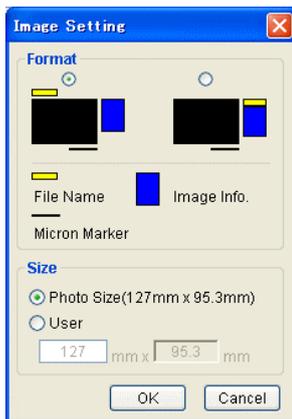


Fig. 3-150 Report Generation Window

- (2) Selecting a printer and setting paper size  
Use the **Printer** option of the **Settings** tab to select the printer to be used, and switch between portrait and landscape orientations of paper. For setting the paper size, use the appropriate Windows function.
- (3) The image size on the report sheet and position of file name indication  
To set the size of the images and position of file name indication, click the **Image Setting** button in the **Display** area. The following dialog window will open.



**Fig. 3-151 Image Setting Menu**

- **Format**  
This allows you to specify the file name for the image to be printed, and it is printed independently in the upper left part of the image or by including it in the image attribute portion.
- **Size — Photo Size (127 mm × 96.3 mm)**  
This option makes any image that is added, the same image size as Polaroid film (a size in which the magnification of the printed image is equal to the display magnification).
- **Size - User**  
By selecting **Size - User** and entering a numeric value (in mm) in the left box, you can set any image size to be printed (applicable to the size of the image to be registered in the layout after this setting).

The size setting specified here takes effect in the image to be added next or the image to be placed in the next startup process.



If an image already placed in the layout is to be rendered in the size specified here, right-click the image, and select the **Set default size** option on the popup menu that is displayed. Images can be added by using the **Add** tab.

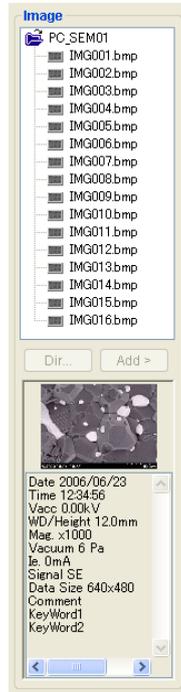


Fig. 3-152 Add Tab

(4) Modifying a layout or size

The image on the layout can be moved by dragging it with the mouse. To change an image size, select the image by clicking it, and with the mouse drag the square part located in the lower right corner of the image.

If there is more than one image, clicking the  button on the Tool Bar lines up the images with respect to the clicked position.

To adjust the layout manually, use the **Grid** or the **Fix to Grid** features to display grid lines as a frame of reference for the adjustment operation. This makes it possible to align the images with the grid lines and cause the images to line up.



Fig. 3-153 Grid Control

Checking the **Lock up Image** option disables the moving of images and comments by the mouse

and resizing of an image. In this case, an Edit Lock mark  (locked) appears in the lower right part of the menu.

(5) Displaying and writing text information

- Header and footer  
Checking the check boxes on the **Header/Footer** part on the **Setting** tab displays and prints the header and footer on the paper, respectively. The text to be included in a header or footer is entered in the respective input boxes.

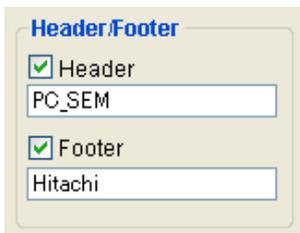


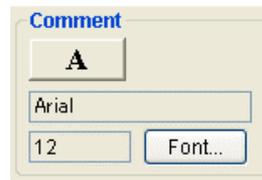
Fig. 3-154 Header/Footer Control

- File name and image information  
Checking the **File Name**, **Micron Marker**, and **Image Info** check boxes in the **Display** part of the **Setting** tab causes the respective item to be printed in the prescribed arrangement around the image.  
To change fonts for these items, click the **Set** button for **Font** under the control to bring up a font setup window, on which a font can be specified.



Fig. 3-155 Display Block

- Writing a comment



**Fig. 3-156 Comment Block**

In the **Comment** area of the **Tool** tab, click and hold down button A and click the mouse on the layout to bring up a comment input window. In this window, enter comments from the keyboard.

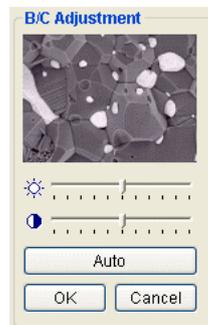
To change the comment fonts or size, click the **Font** button in the **Comment** area to show the font setup window, where a font and font size can be specified.

A comment placed on the layout can be moved by dragging it with the mouse.

To delete a comment, select it with the mouse, and press the Delete button on the keyboard.

(6) Correcting contrast

Clicking and selecting an image in the layout, displays the image in the **B/C Adjustment** preview section of the **Tool** tab.



**Fig. 3-157 B/C Adjustment Block**

The brightness and contrast of the image can be adjusted by using the Brightness and Contrast bars, respectively. Alternatively, you can click the **Auto** button to adjust the contrast so that the minimum/maximum of the image data cover the entire range of the grayscale.

On the preview image, check to see if the contrast is appropriate, and click the **OK** button. The specified correction will be reflected on the image in the layout.

(7) Printing

In the **Print** section of the **Setting** tab, specify the number of copies to be made, and click either the **Print** button or the print button  on the Tool bar to commence the printing process.

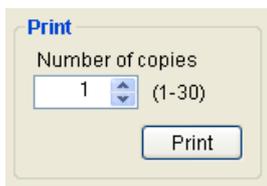


Fig. 3-158 Print Block

(8) Other auxiliary functions

These functions allow you to correct the contrast of the image in the layout, import images registered in the SEM Data Manager, save paper formats, and reading the same.

- **Batch Print**

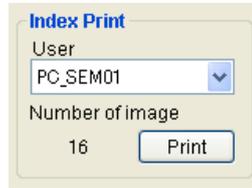


Fig. 3-159 Batch Print Block

Clicking the **Add** button allows you to specify an image file and add it to the list. Clicking **Print** causes the images on the layout added to the list to be printed. This feature can be used to print different images in the same layout.

- **Index Print**

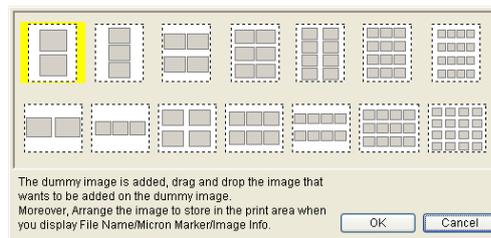
This feature prints, in reduced images, a list of images controlled by the user (the user that was created in SEM Data Manager for image control purposes) selected in **User**.



**Fig. 3-160 Index Print Block**

- **Layout Template**

To select a sheet template, click template  button. The following template selection dialog window will be shown.



**Fig. 3-161 Layout Template Menu**

Select a template by clicking it and click **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** is set to on every time the new template is selected. It is necessary to un-check it if you need to move image position.

- **Open/save a report**

A layout that has been created can be loaded or saved using the following button on the Tool bar. The Save process can also output to HTML format documents in addition to report files.

**Lock up Image** is set to on every time the report is opened. 

It is necessary to un-check it if you need to move image position.



**Fig. 3-162 Open/Save Button**

- Document output  
This feature generates a created layout in Microsoft Word. This button is displayed on the Tool bar only if Microsoft Word is installed on the PC being used. This feature is enabled in Word 2003 only.



**Fig. 3-163 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. If the Copy Image command is activated in the data entry function with text and graphics displayed, they are embedded together and copied.

To copy an image to the Windows clipboard, select the **Copy Image** command from the **Edit** menu or click the **Copy Image** button  in the tool button area on the **Operation panel**.

### 3.9.12 Copy Image Information Text (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 Text** button  in the tool button area on the **Operation panel**.

### 3.9.13 Oblique Image

An oblique image is formed from a scanning image.

To open the **Oblique** window, select the **Oblique** command from the **Analysis** menu.

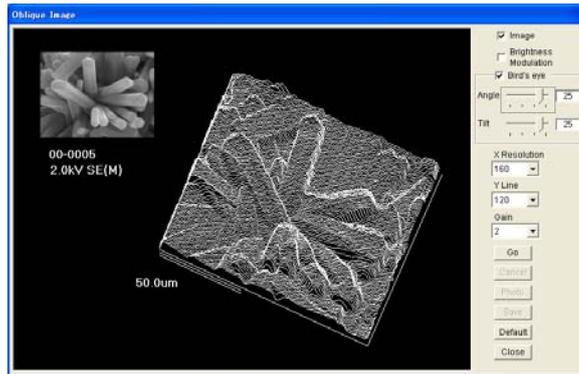


Fig. 3-164 Oblique Window

(1) Setting properties

- Check the Image box to show the reference image together with the oblique image.
- **Bird's eye** area specifies a viewing angle and tilt angle. If it is not checked, just a flat image is formed.
- **X Resolution** and **Y Line** specify the 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 the height of the modulation.

- **Brightness Modulation** modulates the brightness of each line with signal intensity. If not checked, lines are drawn with a fixed brightness. The **Default** button resets these settings to their default values.

(2) Drawing and recording oblique image

- **Go** button starts drawing the image.
- Click **Save** to save the oblique image.



### 3.9.14 Optional Setting

Operation environments are set in the **Optional Setup** dialog window.

To open the **Optional Setup** dialog window, select the **Optional Setup** command from the **Option** menu or click the **Opt Setup** button  in the tool button area of the **Operation panel**. The dialog window has 4 tabs. Each has functions as follows.

**NOTICE:** Setting on each tab is applied when the **OK** button is clicked.

(1) General Setting: **General** tab/**General** menu

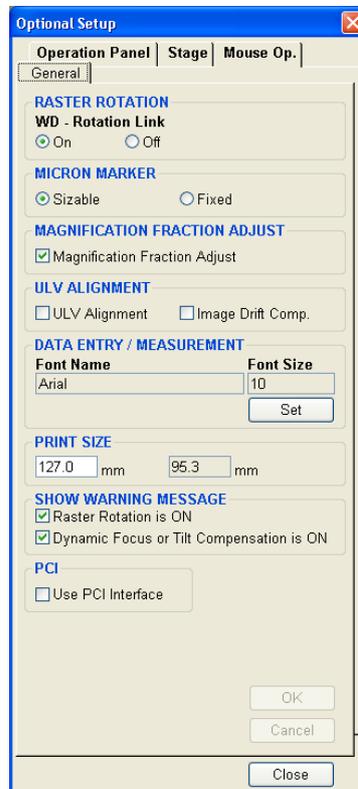


Fig. 3-165 General Tab

- **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.

- **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, and in this case, the length value indication some times has a fraction, especially when coarse focusing.

- **MAGNIFICATION FRACTION ADJUST**  
Put a check mark in this checkbox to enable the auto magnification fraction adjustment. The magnification value will have fraction by focusing operation.
- **ULV Alignment**  
Refer to < 3.4.4 >.
- **DATA ENTRY / MEASUREMENT**  
Select font and size to be used in **Data Entry** and Measurement.

**NOTICE:** A font name with a @ prefix means that the characters in that font are oriented sideways.

- **PRINT SIZE**  
Set the size of images when placed on a page using Windows application software. The setting is effective only on application programs that support the **X** and **Y-Resolution** tags of **Tiff** files or equivalent header of **DIB** files. Aldus Page Maker supports TIFF files and MS Word, and also DIB files. Many of these file types are not supported by commonly available word processing software, in which case any value specified in this section will not take effect.
- **Show Warning Message**  
Refer to < 3.9.21 >.
- **PCI**  
Turn the check mark on if the PCI (database software made by Quartz Imaging Corporation) is to be installed and used.

- (2) **Operation panel tab / Op.Panel Setting** menu  
The arrangement of control blocks to be placed on the operation panel can be customized. Refer to < 2.3.7.13 >.

(3) **Stage tab / Stage menu**

**Fig. 3-166 Stage Tab**

- MOTOR DRIVE STAGE**  
 Although the SU6600 has a motor-driven stage, if this feature is not used because of the installation of an optional stage, turn off the Motor Drive Stage function, the reason is that while the GUI normally operates under the assumption that a stage is attached, if the stage is removed, data communications with the stage fail, which prevents the GUI from operating normally. The default is “On”.
- REVERSE MODE**  
 Changes direction of image motion by mouse operation on the scanning image and by the trackball. 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.
- TRACKBALL / JOYSTICK SPEED**  
 When the box **Adjustable with Speed Slider** is checked, the stage drive speed by trackball or joystick option can be adjusted with the **Speed** slider on the **Stage** tab on the **Operation panel**.

- **COORDINATE**

This feature allows you to specify whether the stage coordinates are to be treated as a mechanical coordinate (**Stage**) or in a (**Sample**) coordinate system in which the center of a specimen is designated as (0,0).

Refer to <3.5.6.1 >.

- **LOCK SPECIMEN EXCHANGE VALVE**

It enables / disables setting the Lock Specimen Exchange Valve function. When it is enabled (put checkmark), the gate valve of specimen exchange chamber can only be opened when the stage is at the specimen exchange position.

Refer to <3.5.6.16 >.

- **STAGE HISTORY**

It enables or disables the setting for automatic registration with registered position and order on the specimen diagram. Put checkmark to [Use auto registration] to enable automatic registration. Uncheck it if you do not use the function and feel that the message shown on every specimen size changing is cumbersome.

Refer to <3.5.6.16 >.

(4) **Mouse Operation tab / Mouse Operation menu**



**Fig. 3-167 Mouse Op. Tab**

- **Selecting mouse operation sensitivity on an image**  
Set the sensitivity of mouse operation (focus, stigma, brightness and contrast adjustment) on the scanning image.  
Set the slider control at the **Slow** side for lower sensitivity or at the **Fast** side for higher sensitivity. The adjustable range is from a half to 1.5 times the default sensitivity.
- **Selecting an object of mouse operation on the image**  
On each of **Stigma**, **Brightness / Contrast**, and **Focus**, specify whether mouse operations are to be performed on the image. On each item, checking the check box allows you to perform mouse operations. With regard, to **Stigma**, you need to experience in performing adjustments. To prevent touching it inadvertently, it may be a good idea to leave it unchecked.

### 3.9.15 Password Setting

Use the **Password Setting** dialog window to set or change the login password for the current user. To open this dialog window, select the **Password Setting** command from the **Option** menu.



**Fig. 3-168 Password Setting Window**

The present login name is shown in the **User** box.

Type in the old password in **Old Password**, and a new password in **New Password** and **Confirm Password**, and 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 a **New** and **Confirm Password**, the password will be deleted.

Login names cannot be registered or deleted in this section.

These actions should be performed by the System Administrator according to 3.9.16.

### 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 "**SU6600**" is set up with no password.

Use this name for the user who is responsible for the instrument.

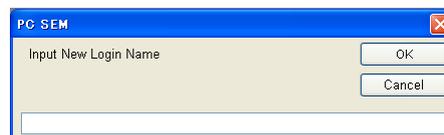
Use **Login Setting** command in the **Option** menu for setting a password for the login name "**SU6600**" and also for setting other login names and passwords. This command is available only when logged in with "**SU6600**".



**Fig. 3-169 Login Setting Window**

Use the following steps for setting password protection.

- (1) Login with the name "**SU6600**".
- (2) Open the **Login Setting** dialog window by selecting the **Login Setting** command from the **Option** menu.  
 Select "**SU6600**" in the **Login Name** list. Set a password for the name.  
 Input **Old Password**, if already set, and input the new password to **New** and **Confirm Password** boxes and then click the **Change** button.  
 If you do not disclose the password to other users, they cannot use the login name "SU6600" for the next login.  
 Because the **Login Setting** command will not open when logged in with other than "SU6600", you cannot register a new login name nor change the password for "**SU6600**".
- (3) Register login names for general users.  
 Click the **Add** button and enter a login name in the dialog window.



**Fig. 3-170 Add User Menu**

- (4) Select a name in the **Login Name** list by clicking it and set a password for the name. You can set the names and passwords of general users. (If password is not needed, this operation is not necessary) Then, they can login using it. Up to eight characters are accepted as login names and passwords. Uppercase and lowercase letters are distinguished.
  
- (5) To add a login name and password for more general users, it be carried out in the same manner as above.  
To delete a login name, select the name in the **Login Name** list by clicking it and click the **Delete** button.  
To change a password, select the name in the **Login Name** list by clicking it and enter the present password into **Old Password** and then, enter the new password twice into **New Password** and **Confirm Password** (to eliminate any password, do not enter any password).. Then, click the **Change** button.

**REFERENCE:** Customizing the Operation Panel and the Tool Bar causes the settings to be saved by login user name so that different settings can be used by different login users. Therefore, even when protection is not needed, it is convenient to register and use specific login names.

**NOTICE:** If you forget the password for “**SU6600**”, the above operation is not possible. You must call the service engineer to recover the password for the name.



### 3.9.17 ECO Mode (Power Saving Mode)

SU6600 needs to be continuously evacuated in order to keep gun emission active and maintain the gun chamber vacuum. When evacuating only the gun chamber area with the specimen chamber evacuation stopped and the display power shut off, the electric power consumption will be reduced to about 30% of that during full operation.

For example, if the system is shut down Friday evening and observation is to be commenced at 9:00 the following Monday, you can specify Monday 9:00 as an eco-mode starting time. This stops the evacuation process and automatically restarts it at 5:00 Monday (assuming that a 4-hour evacuation is required before the start of full system operation). Turn off the display unit at the start of the eco-mode, and turn it back on at 9 a.m. Monday.

Note that the power supply units for the electron gun, the ion pump for the evacuation of the electron gun, and for eco-mode control are required; therefore, power for the system should remain on continuously.

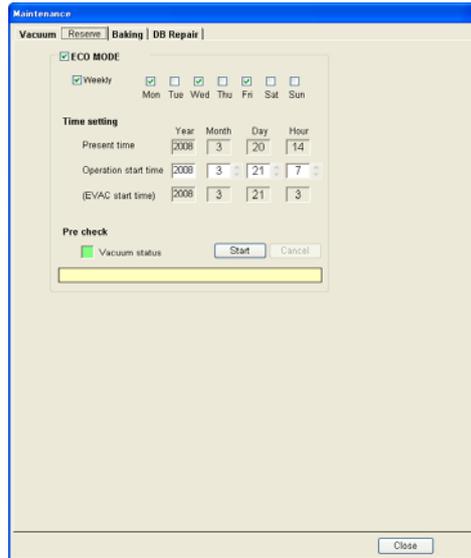
#### (1) Sequence of ECO mode

When you start the ECO mode, the specimen chamber evacuation will be halted in the following steps.

- Wait 30 minutes for the heated objective lens aperture to cool down.
- Shut down the TMP (allow about 4 minutes).
- Shut down the evacuation power, including that for rotary pump and air compressor. You may shut down the PC and turn off display power after starting the ECO mode. When the evacuation startup time (4 hours prior to the specified operation startup time) is reached, the evacuation system power will be turned on by the following procedure
- Turning on the evacuation system power, the rotary pump, and the air compressor
- Starting the TMP after rough pumping
- Finishing the evacuation of the specimen chamber

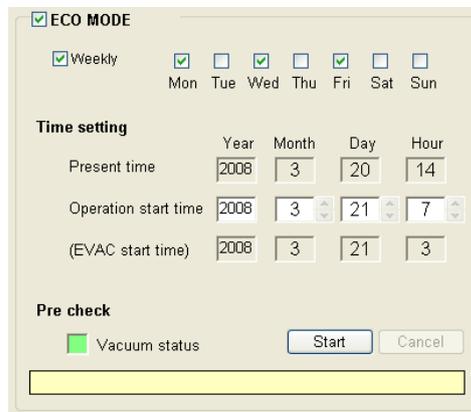
You can begin observation by starting the display and the program at a desired time.

- (2) Starting ECO mode  
Although eco-mode can be started from either the GUI or the Operation Panel for the evacuation system, Hitachi recommends starting it from the GUI for the SU6600 control program under normal condition.
  
- (3) Starting the eco-mode from the GUI  
Click the **Maintenance** button on the tool button area of the Operation panel or by **Maintenance** command in the **Help** menu, and select the **Reserve** tab.



**Fig. 3-171 Reserve Tab**

In the **ECO MODE** area, check the **ECO MODE** check box. Set date and time when you will start operation in the **Operation Start Time** boxes. **Evac Start Time** is the evacuation start time, which is 4 hours before operation start time, and is set automatically.



**Fig. 3-172 ECO MODE Block**

If ECO mode with the same starting time will be used repeatedly, **Weekly** setting is available.

Check the **Weekly** checkbox and put a check on the days of the week where you wish to use ECO mode.

In the following example, starting ECO mode will be repeated on Monday, Wednesday and Friday.

The date of **Operation Start Time** is set automatically to the next relevant day.

For example, if today (2008/03/20) is Thursday, next Friday (2008/03/21) will be set.

Note that even if you set **Weekly**, ECO mode is not started automatically.

Startup by the user is necessary each time. Automatic shutoff/activation is not used due to safety issues.

The **Pre check - Vacuum status** indicator must be green to start ECO mode.

It shows that the evacuation system is working normally and the vacuum of the specimen chamber and gun chamber is good enough.

If it is pink, ECO mode cannot be started.

After setting the **Operation Start time**, confirm it again and then click the **Start** button.

The evacuation system will start the shutdown steps mentioned above.

**“ECO”** is shown on the evacuation control panel.

To stop ECO mode and return to normal evacuation status, turn the **EVAC POWER** switch on the evacuation control panel to OFF, and after a few seconds, turn it to ON again.

### 3.9.18 Restoring DB

SU6600 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 the PC is stopped while the database file is open for accessing.

In such a case, click the **Maintenance** button in the tool button area of the **Operation panel** or by the **Maintenance** command in the **Help** menu, and select the **Restore DB** tab.



Fig. 3-173 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 the repair is finished successfully, the message **End of this procedure** will be shown.

The above database file, which is not very large, does not require optimization (although an optimization feature is provided in anticipation of a need arising in the future). Database files used on SU6600 are as follows;

- (1) Stage.mdb: Position memory data for stage control
- (2) StageCal.mdb: For saving calibration data of Stage calibration
- (3) Ras.mdb: This file, which is used for servicing the system, is written to from time to time, and the above message can be generated depending on the timing at which writing operations are performed.  
(SEM Data Manager uses image database “SDM.sdb”. Repairing tool is provided in SEM Data Manager.)

### 3.9.19 User Dependent Operation Condition Memory

The operating conditions just before shutting down the SU6600 operation program are saved and restored at the next start up. Some items are independently saved and restored by the SU6600 user login, and others are saved and restored irrespective of the user name.

The following list shows items saved individually for a user login.

Condition item	Contents
Operation panel display	The foreground tab, show or hide, left side or right side
Operation panel arrangement	Arrangement of control blocks on the operation panel, selection of tool buttons (Option Setup dialog box - Operation Panel/Tool bar, Setup tab settings)
High voltage setting	Previously used acc. voltage, emission current setting, list of recently used voltages
Electron optical system settings	Setup dialog box - electron optical system tab settings (The WD will be at the default value (31mm))
Signal selection	Setting of the <b>SIGNAL SELECT</b> block in the operation panel
Image Saving	Settings in the <b>Save Image</b> dialog window Image format, Save option, destination folder, file name etc.
Image display parameters	Settings in the <b>Setup</b> dialog window - <b>Image</b> tab
Screen mode	Full, Dual or Small screen
Scanning speed assignment	Scanning speed assignment of <b>Scan Speed</b> buttons
Record button assignment	Function assignment of <b>Record</b> buttons
Raster Rotation setting	Rotation angle and Tilting angle (Raster rotation is set to OFF at start up)
Optional setting for specimen stage	Setting of <b>Optional Setup</b> dialog window - <b>Stage</b> tab
Data Display setting	Setting of <b>Setup</b> dialog window - <b>Record</b> tab - Auto-Data Display
Optional setting for mouse operation	Setting of <b>Optional Setup</b> dialog window - <b>Mouse</b> tab
Other optional setting	Display language, $\mu$ marker mode, character font, etc. (Option Setup dialog box - General tab)
Data Entry setting	Recent entered strings, drawing option etc. (The input mode is off when the system is started)

Condition item	Contents
Color mixing setting	Color combination
Window position	Last placed position of dialog windows
Specimen stage operation	Setting of <b>Eucentric rotation and tilting</b>
Stage position memory and Stage history	Setting of <b>Include ZT</b> checkbox
ULV Alignment	Setting of on or off of ULV Alignment
Warning message	Selection of show / not show warning message

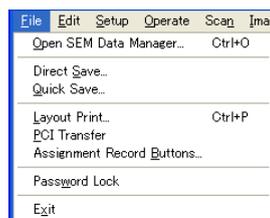
### 3.9.20 Password Locking of Windows

The locking feature of Windows is designed to prevent unintended operations when the system is left unattended, is available in Windows screen savers. However, in the case of the SU6600, such a feature can stop the scanning image drawing function (direct drawing), and the result when Windows is activated again, is that the image cannot be displayed. Therefore the feature is not used.

Instead, Windows can be locked from within the SU6600 program.

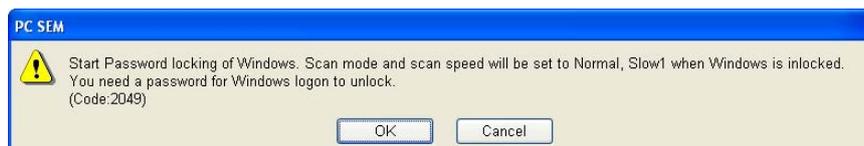
Please notice that after unlocking, the scan mode and speed will be set to normal, slow1 condition regardless of previous scan mode.

To lock Windows, select **Password Lock** from the **File** menu.



**Fig. 3-174 File Menu**

The following warning message will be shown.



**Fig. 3-175 Password Lock Confirmation Message**

**OK** button locks Windows.

Depending on network setting of the computer, the login dialog window will appear immediately, or only the Windows message (computer lock) will be shown. In the former case, enter user name and password in the login dialog window to unlock Windows.

In the later case, press Ctrl + Alt + Delete keys simultaneously to show the login dialog window and then, enter user name and password in the window.

The SU6600 GUI is restored, reset to Normal Scan, and Slow1 speed, as noted above.

**NOTICE:** Use the user name and password for logging in to Windows, not for SU6600 login. Therefore, if Windows is to be locked by password by a specific user or group, then separate Windows login names and passwords must be set in advance. In such a case, the user privilege should be set to the **Standard user** (Power User group) level. If you log in at the Limited User (Users group) level, the system is unable to write to the registry, and may not be able to run properly in some respects.

### 3.9.21 Warning Message to Avoid Operation with Improper Condition

If non-standard settings are specified during operations such as axial alignment and the system is operated without changing such settings, in some cases the system may not perform properly. To prevent a failure to reset the settings, the following warning message functions are provided:

- (1) Displays a warning message if an HV ON (including SET) operation is performed and any of the following conditions occur:
  - (a) Column condition setting
    - Cond Lens 1 check box is Off
    - Cond Lens 2 check box is Off
  - (b) Raster Rotation
    - Raster Rotation is On and not at 0 degrees.

(b) Tilt focus correction/tilt magnification correction

- Tilt focus correction ON (not depending on angle settings)

The message shows above condition individually, for example,

**Cond Lens 1 or 2 is set to OFF.**  
**Raster Rotation is ON.**  
**Dynamic Focus or Tilt Compensation is ON.**  
**Reset to default ?    [YES] [NO]**

**YES** resets the condition setting to default, **No** keeps condition settings as they are.



## (2) Selecting warning message

It is possible to select showing the above messages or not with an optional setting, because the message will be troublesome for experienced users.

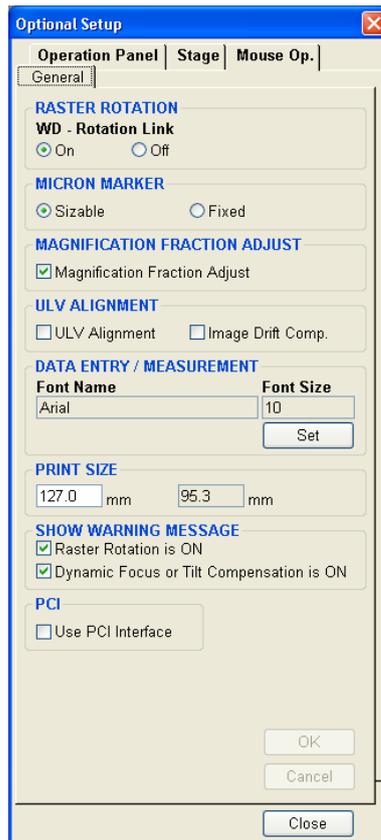
To set the selection, open **Optional setup** dialog window - **General** tab.

Put check mark in each checkbox in the **SHOW WARNING MESSAGE** area to show the message, or uncheck these to hide.

(Cond Lenses setting are warned regardless to this selection)

These checkboxes are checked as a default at the installation of new instrument, or during software upgrading.

This check / uncheck selection is saved for each user login individually.



**Fig. 3-176 General Tab**

(3) When closing the **Setup** dialog box - **Column** tab

When closing the **Setup** dialog box, the system checks Condenser Lens 1 and 2 settings, and if either one is off, it turns it on.

At the same time, the system displays the following message:

Turned on Condenser Lenses 1 and 2. OK

### 3.9.22 Cell Counting Function

The Cell Counting function is provided for traversing evenly placed structures such as memory cells. To use this function for fine structures at high magnification, close attention will be necessary.

#### 3.9.22.1 Setting to Enable the Cell Counting Function

Open Operation Panel tab of the Optional Setting dialog window from Option - Optional Setup - Op. Panel setting menu.

Put a check in Cell Counting, and also to Show Scrollbar / Area Marker.

#### 3.9.22.2 Cell Count Function

The following Cell Counting tool is placed on the Operation panel.

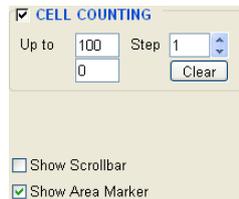


Fig. 3-177 CELL COUNTING Block

- (1) "Cell Counting" checkbox  
Put check in the box to enable cell counting function.
- (2) "Up to" box and "Step" box  
Set count value in the "Up to" box.  
(For example, type in "100" to move a memory cell by 100 pitches.)  
The count value in the box below "Up to" box will be increased by the number set in the "Step" box for every stage operation.  
(For example, if **Unit** = 2, each stage operation increments the numeric value by 2.)
- (3) Clear button  
"Clear" button resets the count value to zero.
- (4) "Show Area Marker" checkbox  
It is recommended to put check in the "Show Area Marker".

**REFERENCE:** The maximum count value is 9998. When you set 9999, the count up message will not be shown. Use it to utilize the stage operation, regardless of cell counting.

### 3.9.22.3 Stage Mouse Operation on Image for Cell Counting

When the “Cell Counting” checkbox is checked, the function of stage mouse operation is changed as follows.

- (1) When stage operation is selected (with S button of mouse), the tools for XY operation, and T,Z operation are not shown. Also, the mouse pointer is changed to cross mark ().
- (2) When the mouse pointer is the above cross mark, simply clicking on image drives stage so that the image click point will move to the center of image area. In this operation, the electronic image shift is not driven. The stoge only moves mechanically.
- (3) If the mouse is clicked with Shit key pressed down, only X or Y axis is driven. The axis to be driven is selected by the distance from the click point to the horizontal or vertical line of the area marker. If the click point is nearest to the horizontal line, the X axis will be driven.

### 3.9.22.4 General Recommendation for Using Cell Count Function

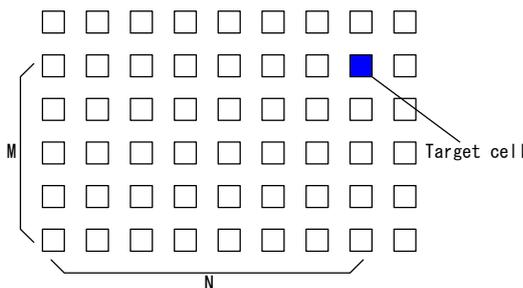
Generally, the cell count function will be used for driving finer pitches than a few micron - which is smaller than the stage mechanical accuracy. Close attention will be necessary in such a case.

- (1) It is recommended to drive only one of X or Y axis at one operation. When the stage drive direction is reversed, the stage will not move correctly in the following operation, because of mechanical backlash. Even if it can be compensated with attentive operation, controlling backlash in both the X and Y direction will be difficult. To keep single axis operation,
  - (a) Set raster rotation off. When raster rotation is used, the stage drive direction is compensated automatically to match the image move direction to the operation direction.
  - (b) For the same purpose, open “General” tab of the “Optional Setting” dialog window from “Option - Optional Setup - General” menu and set “Raster Rotation - WD - Rotation link” to off.
- (2) Adjust the sample direction using the stage rotation, so the cell direction to be traced is matched to the stage X or Y single axis movement. For this adjustment, it is recommended to use the trackball while pressing the lower button (to drive X only) or Upper button (Y only).

- (3) Start tracing after compensating backlash.  
Perform this operation by removing (Compensate) the stage backlash (when the direction is reversed, the stage sometimes fails to move for a while. That amount is roughly equal to the amount of backlash). Without backlash removal, the stage may fail to move to the extent it must move in the motion start operation.
- (4) Do not use electrical image shift.
- (5) Compensate the stage inaccuracy with continuous operation.  
The stage movement may be not accurate for a small amount of movement distance. Compensate distance error at the next operation, so that the average will be kept at the desired step distance.

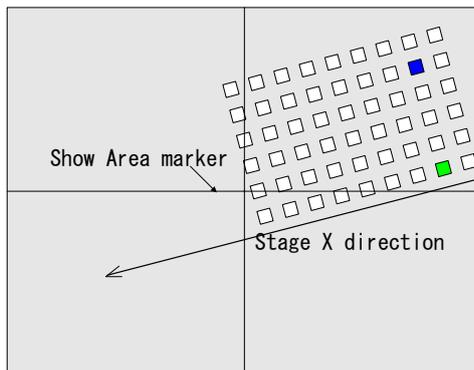
### 3.9.22.5 Example of Cell Counting Operation

Suppose that cells are placed as shown below.



**Fig. 3-178 Example of Cell Counting Operation**

- (1) Set the conditions referring to above 3.9.22.4.
- (2) Adjust sample direction.  
Move the stage in the X direction with the trackball and adjust the R axis, so that the direction of the image movement matches the cell arrangement direction.  
Do not use raster rotation for this operation.



**Fig. 3-179 Adjust sample direction**

(3) Backlash canceling

Place the end of the cell block at 20 to 30 micron from the image center.

Set Cell Counting ON and select mouse stage operation (set the mouse pointer as a cross mark).

Place the mouse pointer on the end of cell block and click mouse while pressing the Shift key. If the clicked point is nearer to horizontal area marker line, the stage will move in the X direction. If it is nearer to the vertical line, it will move in the Y direction. Usually the end of the cell block will not reach the image center due to stage backlash.

The following image shows an example where stage was moved in the X direction.

Next click the end of cell block again. Stage will move in the Y direction.

Repeat the above operation until the end cell is moved to the center of the image. If it went past the image center, repeat from the beginning.

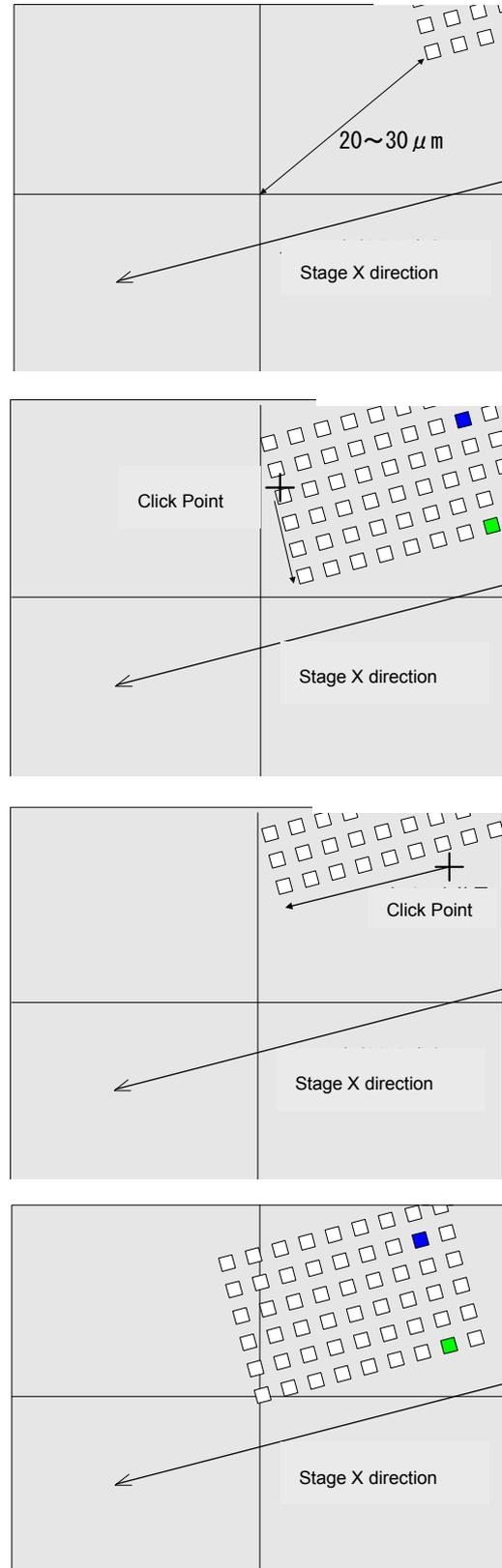


Fig. 3-180 Backlach canceling

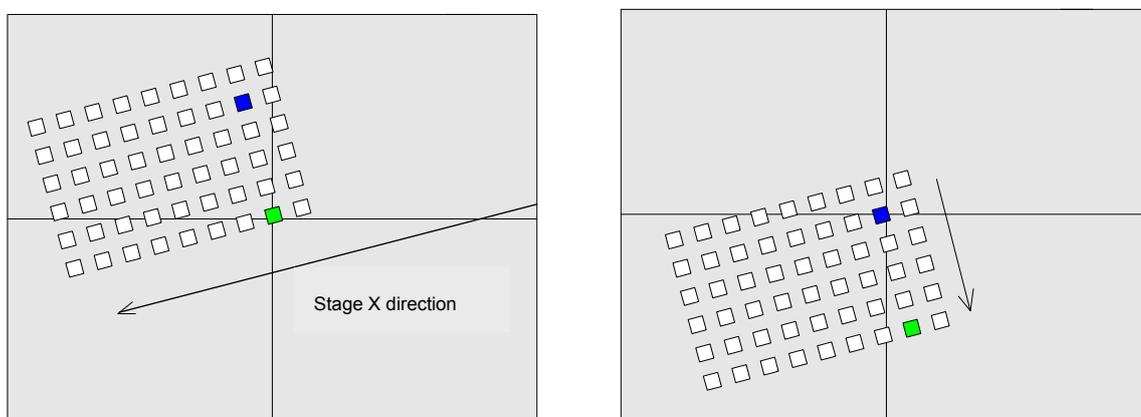
(4) Setting of the “Up to” counter and tracing

Enter the “N-1” (horizontal counting value) in the “Up to” box, set 1 in the “Step” box and reset counter to zero with the Clear button.

Click the horizontal second cell pressing Shift key. Repeat it until counter reaches “N-1” and the end message is shown. The horizontal number N cell will reach the image center. With this operation, if the sample direction is near the diagonal line, click points near the horizontal area marker line instead of the center of the cells, to keep the X axis stage position. Then, enter the “M-1” (Y direction count value) in the “Up to” box and click the Clear button.

Click the vertical second cell while pressing Shift key. Repeat it until the counter reaches “M-1” and the end message is shown. The target cell will come close to the image center.

In the above operation, the cell may not be placed just at the image center, especially in the case where the step pitch is small. In that case, compensate the error with the following operation.



**Fig. 3-181 Setting of the Up to counter and tracing**

(5) At the end of cell counting operation

Please be sure to turn the “Cell Counting” check box off after finishing the operation. If it is left on, the stage mouse operation remains in a different mode from normal operation.

### 3.9.23 Downloading Stage Control Program

Upgrading the specimen stage control program can be carried out by the user. However, it shall be operated only by manufacturer's or service engineer's request. To start the stage program download, select **Stage Program Download** from **Option** menu. The following message will appear.

The stage control program is updated. Carry out the stage update by manufacturer's or service engineer's request. Follow to the **Procedure for SU6600 program update** attached to the program CD-ROM.

**NOTICE:** (1) Terminate other programs before starting stage update.  
 (2) Aborting stage update is not possible.  
 (3) Do not shut STAGE power switch off before completion of update procedure.

Click **OK** to continue.

First the stage status is checked. If stage is not working correctly, the following message will be shown and program downloading will be canceled by pressing OK button.

Stage power is not ON, or stage is not working correctly. If stage power is OFF, turn it ON. If it is ON, turn to OFF and then, turn it ON again. Wait about 1 minute and start **Stage program download** again.

When stage is working correctly, the **Stage program download** dialog window will appear.



**Fig. 3-182 Stage program download Dialog**

Click the **Write** button. The following message will appear.

Insert the SU6600 Setup CD-ROM into the CD-ROM drive. Wait until the drive lamp stops blinking, click OK button. Down loading will take about 10 minutes.

Set the CD-ROM and click **OK**.

Program downloading will start. The following messages are shown in the message area of the above dialog window.

**Writing**

Shown during program writing.

**Error {No.}**

Shown when an error occurs. Write down the error number, and contact the service engineer.

**Writing Completion**

Indicates that downloading completed successfully.

After completing downloading, close the dialog window and take out the CD-ROM.

Turn the stage power off once, and turn it on again to enable the new program.



### 3.10 Determinant Conditions for Image Quality

Reference conditions for improving image quality are described below.

#### 3.10.1 Accelerating Voltage and Image Quality

In common applications, the resolution of secondary electron images increases with an increase in accelerating voltage, for example. On the contrary, the depth of the electron beam probing into the specimen becomes larger, and increases the amount of internal information observed, which may cause a relative decrease in specimen surface contrast, i.e., a translucent surface appearance.

For observation of a non conductive specimen without coating with metal vapor deposition, it is advantageous to use a low accelerating voltage. In contrast, for X-ray analysis, a high accelerating voltage is required to provide a sufficient excitation energy level of characteristic X-ray radiation.

In consideration of the above, select a proper accelerating voltage according to the kind of specimen and the purpose of observation.

Accelerating Voltage (kV)	1 2 3			10 15 20 25				30		
	Low	High	Topmost surface information	Large	Small	Easy	Small	Large	Large	Small
Resolution	←									→
Secondary electron signal level	←									→
Surface information	←									→
Adverse effect of contamination *1	←									→
Degree of charge buildup *2	←									→
Observation without pretreatment of metal vapor deposition *2	←									→
Specimen damage *2	←									→
Adverse effect of stray magnetic field	←									→
X-ray analysis										
Transmission electron image										

\*1: At a low accelerating voltage, the topmost surface information is observed.

Therefore, if the specimen surface to be observed is contaminated, its image is affected significantly.

\*2: These conditions vary depending on the kind of specimen and its preparation.

### 3.10.2 Condenser Current and Image Quality

Probe current adjustment can be made by changing the first condenser lens setting. Set the first condenser lens by referring to the table shown below.

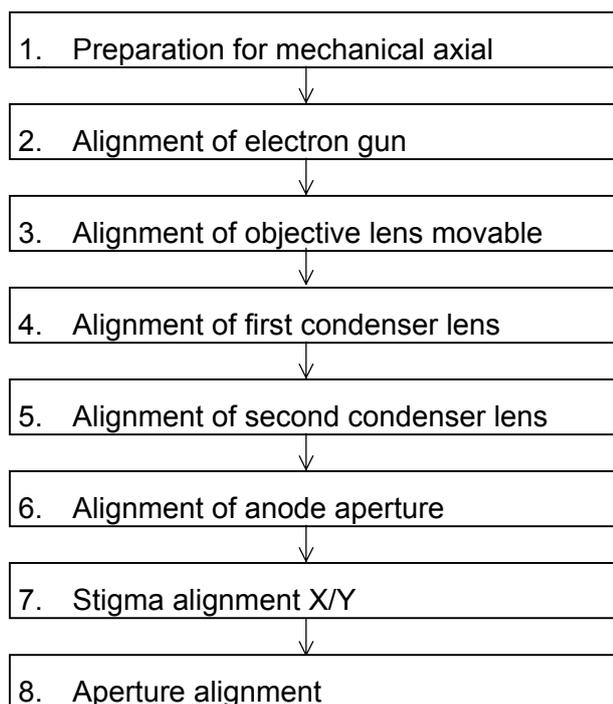
Probe Current Mode (Cond. Lens 1)	
Specimen irradiation current (A)	Large  Small
Resolution	Low  High
Secondary electron signal level	High  Low
Degree of image graininess	Small  Large
Degree of charge buildup *1	Large  Small

\*1: In observation of a non-conductive specimen

For the electron optics condition setting (condenser current and image quality), refer to <3.4.32>.

## 3.11 Axial Alignment

In normal operation, it is not required to carry out mechanical axial alignment of the electron gun and the first and second condenser lenses. If the desired image quality cannot be obtained by performing electronic alignment, conduct mechanical axial alignment as instructed below.



**NOTICE:** Before proceeding to mechanical axial alignment, wait for at least two hours after starting the heating of the objective lens aperture. If mechanical axial alignment is attempted immediately after the heating of the objective lens aperture, the thermal expansion of the aperture will cause a misalignment in the adjusted alignment condition.

### 3.11.1 Preparation for Mechanical Axis Alignment

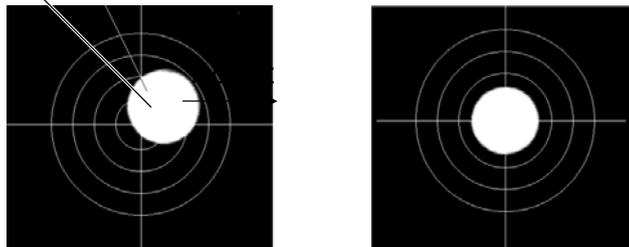
Prior to mechanical axial alignment, take the following preparatory steps.

- (1) Retract the objective lens differential vacuum aperture.
- (2) Load a sample in to the specimen chamber.  
Refer to <3.2>.
- (3) Set the accelerating voltage to 1.0 kV.
- (4) Select a minimum level of magnification.
- (5) On the operation panel, select SSignal in the **SIGNAL SELECT** block.
- (6) Open the **Setup** dialog window, and select the **Optic** tab, set the probe current mode to Small:HR.
- (7) Uncheck the check boxes of **Cond Lens 1** and **Cond Lens 2** to turn them off.
- (8) Set the working distance to 15 mm, and also set the Z axis of the specimen stage to 15 mm.
- (9) Set the anode aperture and the objective lens movable aperture to the "O" (out position).
- (10) On the control panel, click the Align button  to open the **Alignment** window. In this window, click the **Reset All** button.

### 3.11.2 Alignment of Electron Gun

- (1) In the **Alignment** window, click the **Beam Align** button to start the beam alignment mode. The concentric-circles marker and the beam circle image appear on the screen. Adjust the contrast if the beam circle image is too light or dark.

Beam circle image



**Fig. 3-183 Beam Alignment Image**

**NOTICE:** Beam alignment is a function that mechanically aligns the center of the differential vacuum aperture that is inserted into the electron optical system. The circular image displayed during this process reflects the shape of the electron beam on the differential vacuum aperture in the second intermediate chamber. A differential vacuum aperture is also provided between the electron gun and the differential vacuum aperture in the second intermediate chamber. It is difficult to completely align these optical elements with the center of the optical axis, with the result that the beam on the aperture assumes an elliptic profile, producing an elliptic image during beam alignment. However, if the beam circle becomes round when inserting the anode aperture or the objective movable aperture, the ultimate SEM resolution will not be affected.

- (2) Using the axis adjusting knobs of the electron gun, bring the center of the beam circle to the center of the screen.



**Fig. 3-184 GUN Adjusting**

**NOTICE:** While conducting the above step, check the degree of vacuum of the electron gun **IP1**. If it decreases, turn off the accelerating voltage and then move the axis adjusting knobs repeatedly (for releasing residual gas from movable parts).  
When the degree of vacuum does not decrease anymore, wait until the vacuum level indication of **IP1** is restored to normal. Then, try axial alignment of the electron gun again.

### 3.11.3 Alignment of Objective Lens Movable Aperture

- (1) With the beam alignment mode ON, select hole 3 on the objective lens movable aperture plate. Indicated below is the correspondence between the hole numbers and diameters:
- Bore 1: 200  $\mu\text{m}$  in diameter  
 Bore 2: 100  $\mu\text{m}$  in diameter  
 Bore 3: 50  $\mu\text{m}$  in diameter  
 Bore 4: 30  $\mu\text{m}$  in diameter
- (2) Since the circular spot image becomes darker, adjust the contrast.
- (3) Using the fine control knobs X and Y of the objective lens movable aperture, align the center of the beam circle with that of the screen.



**Fig. 3-185 Objective Lens Aperture Adjusting**

### 3.11.4 Alignment of First Condenser Lens

- (1) With the beam alignment mode ON (in the state that the circular spot image is displayed), open the **Setup** dialog window and select the **Column** tab for electron optics setting. On the **Column** tab page, turn on the check box of **Cond Lens 1** and select **Small:HR "21"** for the condenser lens 1.
- (2) The beam circle will then become brighter. Adjust the brightness and contrast if necessary.
- (3) Using the axis adjusting knobs of the first condenser lens, align the center of the beam circle to that of the screen.



Fig. 3-186 First Condenser Lens Adjusting

### 3.11.5 Alignment of Second Condenser Lens

- (1) In the **Alignment** window, click the **Off** button to turn off the beam alignment mode.
- (2) Open the **Setup** dialog window, and select the **Column** tab for electron optics setting. On the **Column** tab page, turn on the check box of **Cond Lens 2**.
- (3) Adjust the image brightness (the ABCC function is available), and adjust the focus at a magnification of approx. 2,000× in the High Mag mode. Select any feature point of interest on the specimen, and move the stage so that its image will be located at the center of the screen.
- (4) On the **Column** tab page of the **Setup** dialog window, click the **Degauss** button. Then, adjust the focus again.
- (5) In the **Alignment** window, click the **Aperture Align** button to start aperture alignment mode. Using the axis adjusting knobs of the second condenser lens, adjust so as to minimize the wobbling of the image.

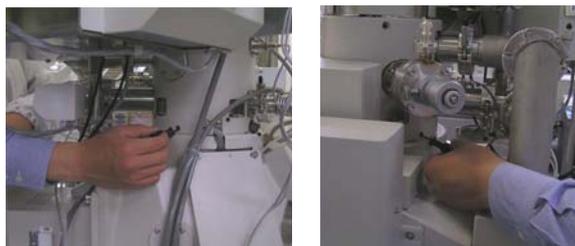


Fig. 3-187 Second Condenser Lens Adjusting

- (6) After completion of the above adjustment, click the **Off** button in the **Alignment** window to turn off the aperture alignment mode.

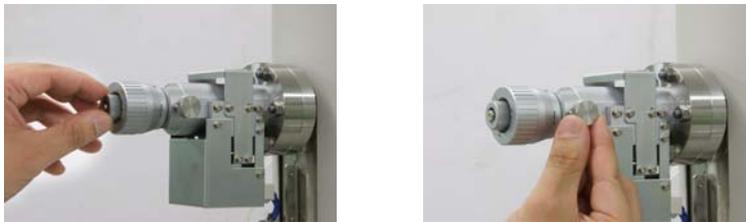
### 3.11.6 Alignment of Anode Aperture

- (1) In the **Alignment** window, click the **Beam Align** button to start beam alignment mode. Adjust the brightness and contrast if necessary.
- (2) Select "4" for the anode aperture.



**Fig. 3-188 Anode Aperture Setting**

- (3) Adjust the contrast if necessary. Using the fine control knobs X and Y of the anode aperture, bring the center of the beam circle to the center of the screen.



**Fig. 3-189 Anode Aperture Adjusting**

### 3.11.7 Stigma Alignment (electromagnetic alignment)

Carry out stigma alignment for the purpose of preventing an image shift during astigmatism correction. This alignment is also required for ensuring accurate operation of the auto stigma function.

- (1) Select a magnification of approx. 5,000 $\times$  to 10,000 $\times$ , and bring any feature point of interest on the specimen to the vicinity of the center of the screen.
- (2) Carry out focus and stigma adjustments.
- (3) In the **Alignment** window, click the **Stigma Align X** button. The image will then wobble at a certain frequency.

- (4) Adjust so as to minimize the wobbling of the image by turning the STIGMA/ ALIGNMENT knob on the operation panel or by moving the mouse with its left button held down on the alignment control area in the **Alignment** window.
- (5) In the **Alignment** window, click the **Stigma Align Y** button. The image will then wobble at a certain frequency again.  
Minimize the wobbling of the image by turning the STIGMA/ALIGNMENT knob on the operation panel or by moving the mouse with its left button held down on the alignment control area in the **Alignment** window.
- (6) On completion of the above adjustment, click the **Off** button.

**NOTICE:** In the stigma alignment, image wobbling may not completely be eliminated. It is advisable to select a magnification lower than 50,000× for minimizing the degree of image wobbling.

### 3.11.8 Aperture Alignment (electromagnetic alignment)

Without changing the magnification that has been selected in the above adjustment, click the **Aperture Align** button in the **Alignment** window.

Make adjustment so as to minimize the wobbling of the image by turning the STIGMA/ ALIGNMENT knob on the operation panel or by moving the mouse with its left button held down on the alignment control area in the **Alignment** window.

Refer to <3.4.4>.

This completes the mechanical axial alignment.

**NOTICE:**

1. After changing the accelerating voltage setting, be sure to carry out electromagnetic alignment. For the procedure regarding electromagnetic alignment, refer to <3.4.4>.
2. It is recommended to use an accelerating voltage of 1.0 kV for adjustment since this accelerating voltage level is suitable for mechanical axial alignment.  
If the accelerating voltage used has a fixed range, that accelerating voltage can be used to perform mechanical axial alignment.



## 3.12 Using SEM Data Manager

The 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 in the 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.

To display the SEM Data Manager, either select **Open SEM Data Manager** from the **File** menu or click the SDM  in the Tool button area of the Operation Panel.

### 3.12.1 Precaution on SEM Data Manager

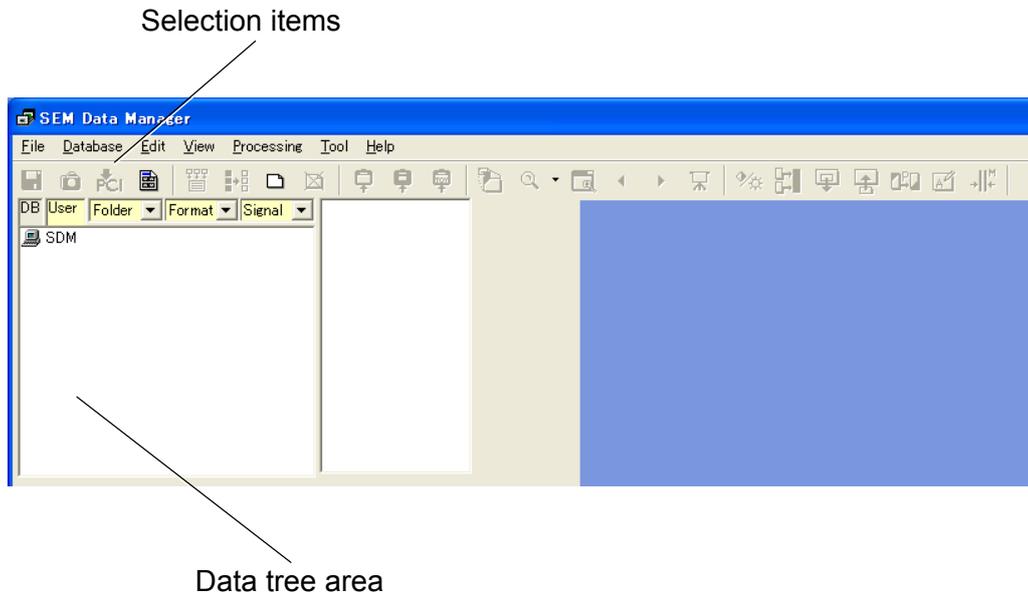
- (1) Available image formats are 8-bit gray scale BMP, TIFF and JPEG. It is possible to register images of 24-bit file, which are converted into 8 bit gray scale images when image modifications (i.e. Data Entry, Image Processing etc.) have been performed.
- (2) Use the Batch Process function to delete 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}.txt 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.
  - CD Measurement function works on 2560 × 1920 pixels or smaller images.
  - Color mixing works for 1280 × 960 and 640 × 480 pixels images.
  - Pseudo Coloring works for 2560 × 1920 pixels or smaller images.

- (6) Opening of image files, image processing or other operations in the SEM Data Manager requires large PC processing. If SEM operation, such as image capturing is carried out while the above processing is running, it may cause some incorrect results. For example, image capturing while slide show is running sometimes results incorrect captured data. Avoid SEM operation while such an operation in the SEM Data Manager is running. Also opening or operating SEM Data Manager while image capturing, saving in SEM is not recommended for the same reason.

### 3.12.2 Functions

#### 3.12.2.1 Image Database

The top part of SEM Data Manager window when opened is as follows.



**Fig. 3-190 SEM Data Manager Window**

## (1) Opening a database

The Database name (SDM) 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 – Image format – date of image creation.

## (2) Database fields

The following fields are created for each registered image data.

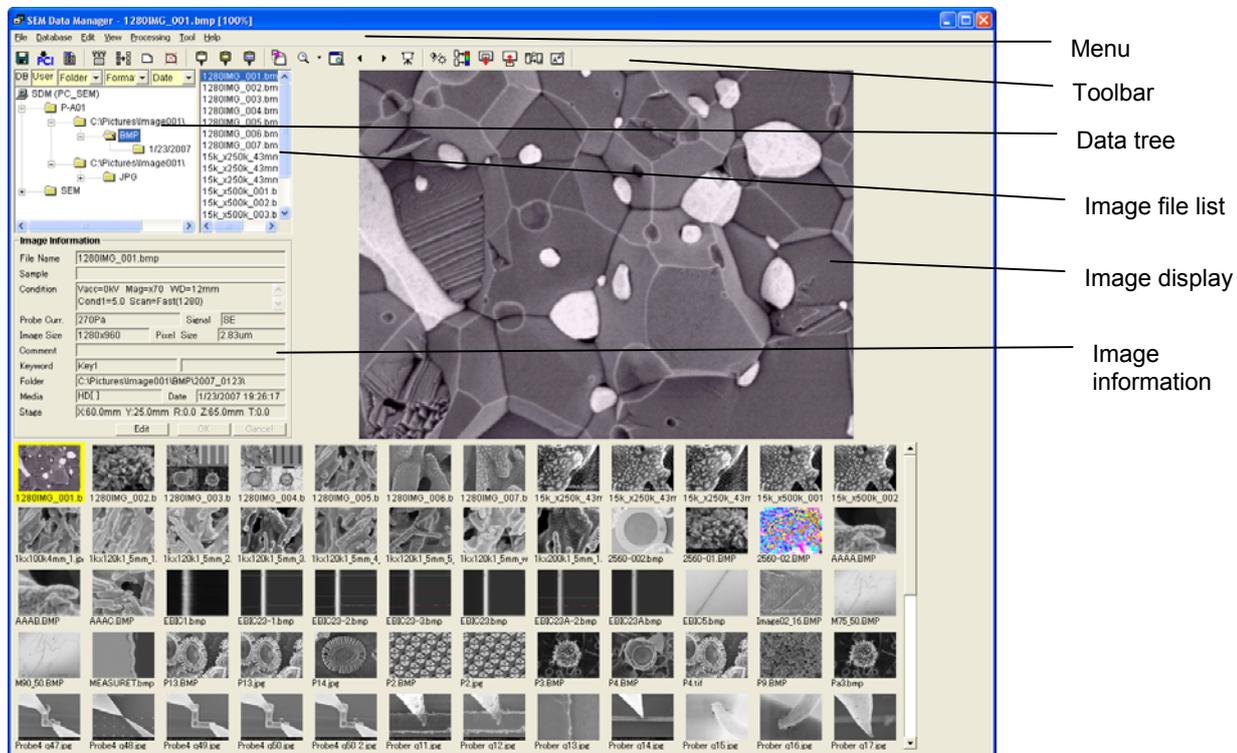
- User : Create a user name on the SEM Data Manager. It may also be created when saving images.
- Folder and Media: Directory in which images are saved, and the type (Media) of the storage device.
- Image format : BMP, JPEG or TIFF
- Date : Date of creation or modification
- Sample, Keywords : Applied 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

### 3.12.2.2 Menu and Tool Buttons

The following picture shows an example where image is open.



**Fig. 3-191 SEM Data Manager Window**

Functions of Menu commands are as follows. Corresponding tool buttons are shown in parentheses.

#### (1) File menu

- **Save as** (  )  
Save the image in the display area.
- **Reload**  
Load and display the original image. Use to recover after processing etc..
- **PCI Transfer** (  )  
Transfers the image in the display area to PCI together with the information text file. It is available only when PCI software is built in.

- **Remove List**  
Remove the image from the database. Image file is not erased.
- **Delete**  
Delete the image. Image file is erased.
- **Rename**  
Rename the image file.
- **Layout Print** (  )  
The **Report Generation** window opens for printing images.
- **Exit**  
Close SEM Data Manager.

(2) **Database** menu

- **Add from file** (  )  
Register image files specifying file name.
- **Batch Process** (  )  
Apply file operation (copy, move, delete, etc.) to multiple selected images.
- **Make new User** (  )  
Create new user name.
- **Delete User** (  )  
Delete the presently selected user name. All images included in the user must be removed before deleting a user.

(3) **Edit** menu

- **Copy** (  )  
Copy the image to Windows clipboard.
- **Copy Small Size** (  )  
Copy the image to Windows clipboard. The size of image is reduced to 640 × 480 pixels.
- **Copy Info** (  )  
Copy the image information text file to the Windows clipboard.
- **Image Editor**  
Open an image editing application program, which has been associated with the image format.

(4) **View** menu

- **Image Maximize** (  )  
Display the image in full desktop view. Menu and tool buttons are available on the maximized window.
- **Zoom** (  )  
Enable or disable image enlargement by clicking on the image. Mouse pointer is the  mark when it is enabled.
- **Show thumbnail**  
Show or hide thumbnail display.
- **Viewer Open** (  )  
Open a viewer window and display the image. The window remains even when SEM Data Manager is closed.
- **Next Image** (  ) / **Previous Image** (  )  
Open the image listed at next or previous position in the image file list.
- **Slide Show** (  )  
Open the **Slide Show** tool.
- **Refresh** (F5 key)  
Reload an image or refresh the thumbnail display.

## (5) Processing menu

- Contrast Conversion—Conversion (  )  
Open the Contrast Conversion dialog window. Adjusting the contrast and pseudo-color conversion are available in it.
- Contrast Conversion—Auto Adjust  
Execute automatic contrast enhancement.
- Contrast Conversion—Gamma—1.2/1.5/2.0  
Execute gamma adjustment.
- Color Mixing (  )  
Open Color Mixing dialog window. Create a color composite image using two selected images.
- Area Copy (  )  
Copy a specified rectangular area of the image in the display area.
- Area Paste (  )  
Paste an image copied using above Area Copy command to the image in the display area.
- Image Processing—Processing (  )  
Open the Image Processing dialog window. Several processing functions including spatial filtering are available.
- Image Processing—Noise Reduction through Flip Vertical  
Execute the image processing function.
- Image Processing—Cancel  
Cancel the results of image processing and load the original image.
- Data Entry (  )  
Draw shapes and characters on the image.
- CD Measurement (  )  
Open CD Measurement dialog window (optional function).

## (6) Tool menu

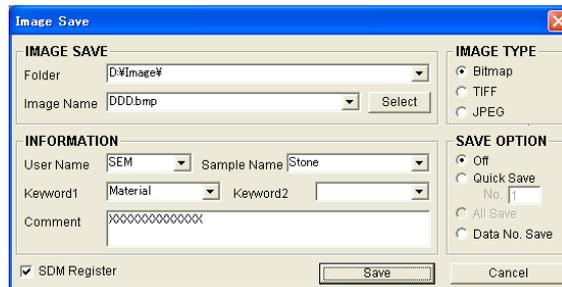
- Options  
Open the Options dialog window. Used for setting size of the thumbnail, character font and others.
- Database Utility  
Repair or optimize database files

### 3.12.3 Operation

#### 3.12.3.1 Registering Images in the SEM Data Manager Database

(1) Saving SEM images

The figure below shows the **Save Image** dialog box that allows you to save images on the SU6600 SEM on a “save as” basis.



**Fig. 3-192 Image Save Window**

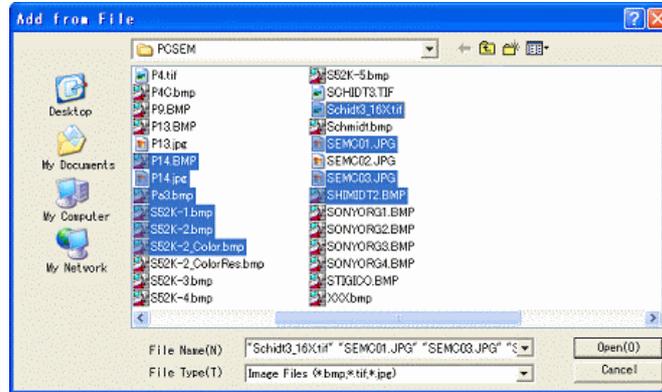
The **SDM Register** option must be checked.

Parameters for image registration are in the **INFORMATION** area.

- **User Name**  
You can select a **User name** already registered by opening the list with the  button, or input a new user name.
- **Sample Name**  
Input a 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.
- **Keyword1 and 2**  
Input keywords for selecting images.
- **Comment**  
Input a comment.



- (2) Registering images stored on disks  
 To register previously saved images to the SEM Data Manager database, use **Add from File** command in the **Database** menu or the **Add from File** button  on the tool bar. The following **Add from File** dialog window will open.



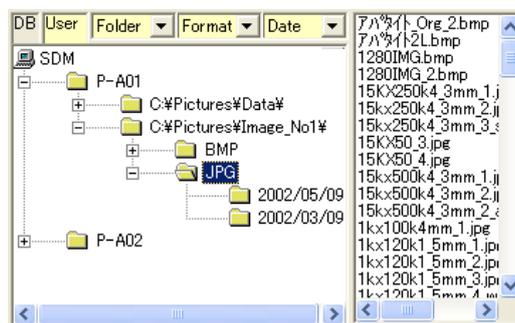
**Fig. 3-193 Add Form File Window**

Select a folder and image files and then click **Open** button. Multiple file selection using Shift or Ctrl key is available.

**NOTICE:** When copying image files using Windows tools such as File Manager, copy text files having the name "{Image file name}.txt" together with image files. The text files include image information and are used for registering images in the SEM Data Manager database.

### 3.12.3.2 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. 3-194 Data Tree Window**

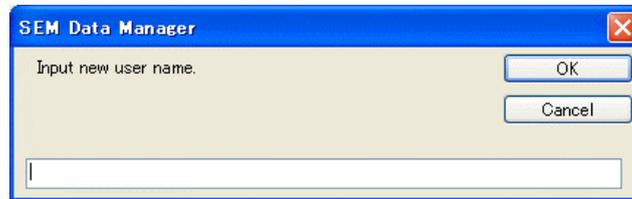
The above example has two User names (P-A01 and P-A02) and data tree is opened in the order of Folder - Image format – stored date.

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 the **Make New User** command in **Database** menu or **Make New User**  button on the tool bar.



**Fig. 3-195 New User Window**

Input a user name and click **OK**. A user ID can also be created when saving an image on the SEM. Refer to <3.12.3.1 >.

### 3.12.3.3 Image Display

Click on a thumbnail or a file name in the image file list to select an image. The selected image will open in the image display area. The selected image is shown with a yellow border on thumbnail area.

To display the image on the full desktop, double-click on the image or use the **Image Maximize** command in the **View** menu or click the **Image Maximize**  button on the tool bar.

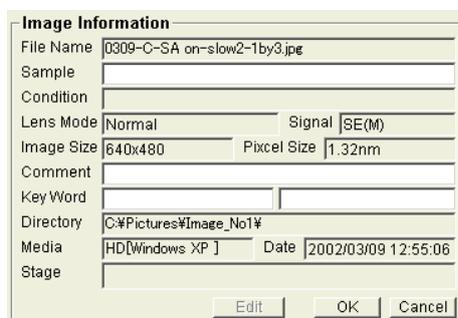
Use the same operations to return the image display to original size.

To zoom up or down the 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 clicking on the image magnifies and right clicking 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 the default pointer.

### 3.12.3.4 Image Information

Information on the presently selected image is shown in the image information area.



The screenshot shows a dialog box titled "Image Information" with the following fields and values:

Field	Value
File Name	0309-C-SA on-slow2-1by3.jpg
Sample	
Condition	
Lens Mode	Normal
Signal	SE(M)
Image Size	640x480
Pixel Size	1.32nm
Comment	
Key Word	
Directory	C:\Pictures\Image_No1*
Media	HD[Windows XP ]
Date	2002/03/09 12:55:06
Stage	

At the bottom of the dialog box are three buttons: "Edit", "OK", and "Cancel".

**Fig. 3-196 Image Information Window**

You can edit **Sample**, **Comment**, and **Keywords**. Click **Edit** button to edit the above items. Input each item and click **OK**.

### 3.12.3.5 Viewer Display

To display the presently selected image in a viewer window, use **Viewer Open** command in the **View** menu or **Viewer**  button. The **Viewer** is an independent window and remains after terminating the SEM Data Manager. It is intended for use as a reference image for observing images with the SEM. To close the **Viewer window**, click the  button on the title bar.

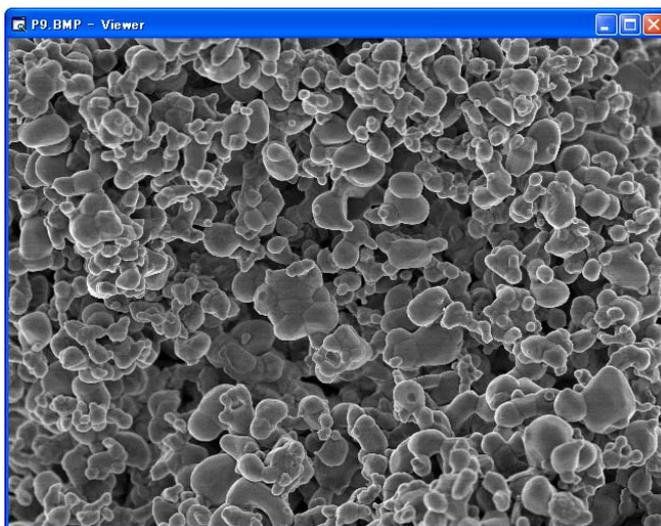


Fig. 3-197 Viewer Display Window

### 3.12.3.6 Data Entry

Use Data Entry function for drawing shapes and writing text on the image. The **Data Entry** toolbox will open with the **Data Entry** command in the **Processing** menu or **Data Entry**  button.

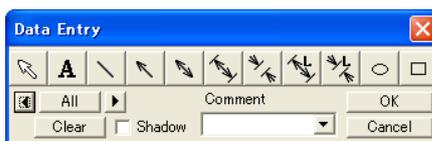


Fig. 3-198 Data Entry Window

- (1) Function of tool buttons  
Function of tool buttons in the **Data Entry** toolbox is similar to the function the on SEM.



#### **Edit text**

Edit already written text.  
 Selecting the **Edit** button changes mouse pointer  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.

### **Text input**

Write text on the image.

After selecting the button, click on the image. The black line text input area is shown on the image. Input text using the keyboard and terminate with the 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 text are memorized and can be selected with the  button. Use the function when you repeat writing the same or similar text.

To set the font and size, use **DATA ENTRY/MEASUREMENT** block in the **Optional Setup** dialog window – **General** tab.

### **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.

### **Arrow**

Draw single-head arrow mark on the image.

### **Double head arrow**

Draw double-head arrow mark on the image.

### **Inner dimension mark**

Draw inner dimension arrow mark on the image.

### **Outer dimension mark**

Draw outer dimension mark on the image.

### **Inner dimension mark with measurement**

Draw inner dimension mark with measurement on the image.

### **Outer dimension mark with measurement**

Draw outer dimension mark with measurement on the image.

### **Circle**

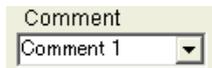
Draw circles or oval shapes on the image. Click this button and press the left button of the mouse to create a starting point on the image. Draw a shape by moving the mouse and then releasing the mouse button. While this button is depressed, you can repeat drawing of a shape.

### **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.



check box  
When the **Shadow** box is checked, text and graphics are drawn with shadow.



**Comment** box  
If you enter 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 text are memorized and can be selected with the button. Use the function when you repeat writing the same or similar text.



**Select** buttons  
 or button selects graphics or text on the image in order. A selected graphic 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.  
 button selects all graphics and text.



**Clear** button  
Clear selected graphics or text.

(2) Writing text and graphics  
Click a tool button and draw graphics or write text.

(3) Editing text

To edit already written text, select the **Edit** text tool.

Selecting the button changes mouse point 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 a 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 button and then click the **Clear** button.

(5) Saving image with entry data

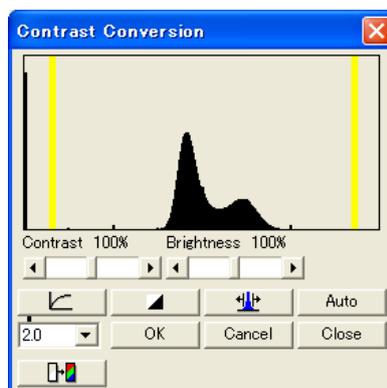
Click **OK** to fix entry data. Use **Save as** command in the **File** menu or **Save** button on the tool bar.

The save dialog 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.

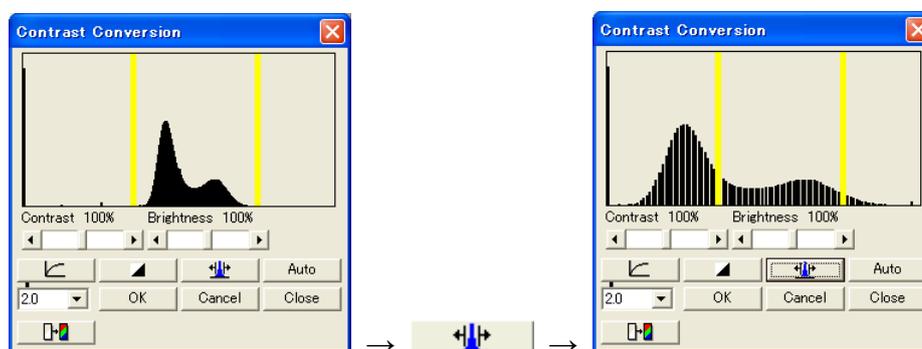
### 3.12.3.7 Contrast Conversion

Gray scale conversions and pseudo-coloring are available. To apply conversions to the image, open the **Contrast Conversion** dialog window by clicking the **Contrast Conversion** button  on the tool bar or use **Contrast Conversion - Conversion** command in **Processing** menu.



**Fig. 3-199 Contrast Conversion Window**

- (1) Manual adjustment of contrast and brightness  
Use **Contrast** and **Brightness** scroll bars. 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.

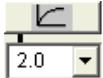


**Fig. 3-200 Brightness/Contrast Conversion**

(4) Contrast inversion

The **Negative**  button inverses black and white.

(5) Gamma correction



A Gamma value of larger than 1 enhances dark areas and suppresses bright areas. A value smaller than 1 suppresses dark areas and enhances bright areas. 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 and returns to original contrast.

**Close** button closes the dialog window. If it is clicked before clicking **OK**, the conversion result is canceled.

(7) Pseudo color conversion

**Pseudo color**  button expands the dialog window for pseudo color setting.

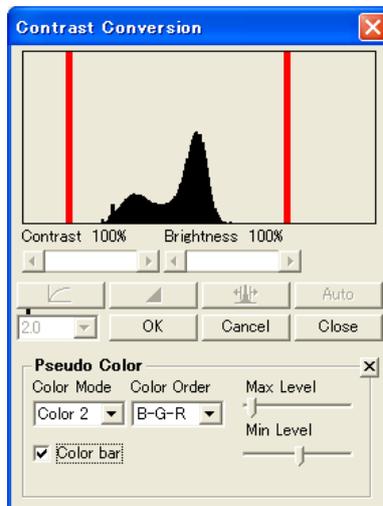


Fig. 3-201 Pseudo-Color Contrast Adjustment Window



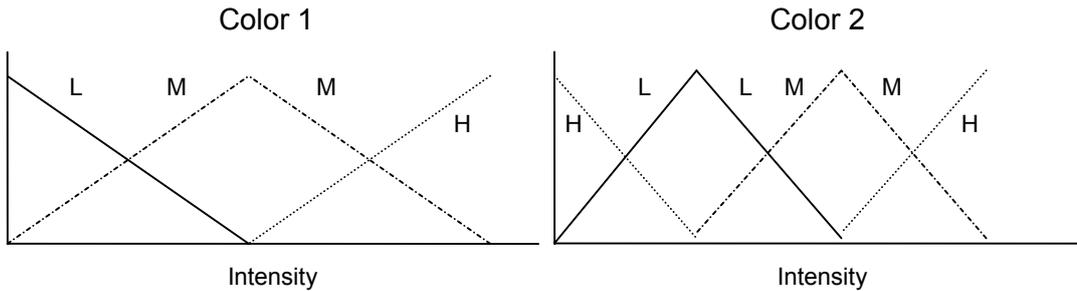
Set following parameters.

(a) Color Mode and Color Order

- Off : No coloring
- Color1 or Color2

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. 3-202 Signal/Color Intensity**

For example when Color Order is set to B-G-R and Color Mode to Color1, L, M and H represent B, G and R color and results in a pseudo color image where original dark area is blue and bright area is red.

- Slice 4/8/16  
Slices full grayscale range to 4, 8 or 16 levels and specifies colors for each separated level.

(b) Max and Min Level

Adjust minimum and maximum of gray scale range to be converted to color image.

(c) Color bar

The color bar shows relation of colors to original brightness level when checked.

### 3.12.3.8 Image Processing

Digital image processing for noise reduction, increase of sharpness and detail enhancement is available. Open the **Image Processing** tool window by **Image Processing – Processing** command in **Processing** menu or **Processing**  button on the tool bar.

The following tool window will open.

**OK** applies processing result to the image data, **Cancel** recovers the original image and **Close** terminates the window.



**Fig. 3-203 Image Processing Window**

- (1) **Noise Red. (Median)**  
Applies 3 × 3 pixel median filter. It is effective for reducing noise.
- (2) **Soften**  
Applies 2 × 2 pixel averaging. It is effective for reducing noise.
- (3) **Soften More**  
Applies 3 × 3 pixel 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.

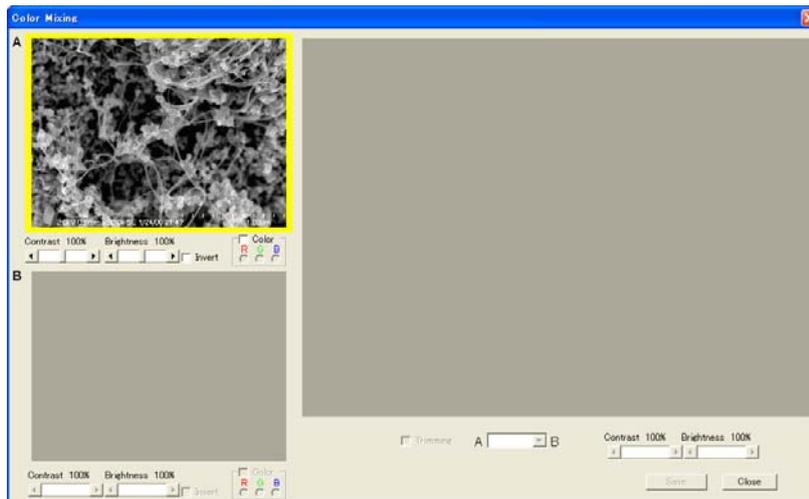
- (9) **Emboss**  
Emboss effect.
- (10) **Highlight FLT**  
Highlight filter emphasizes details and reduces shadowing of the image.
- (11) **Highlight FLT More**
- (12) **Rotate 90 deg**  
Rotates the image by 90° clockwise.
- (13) **Flip Vertical**  
Inverts top and bottom of the image.
- (14) **Flip Horizontal**  
Reverses the left and right of the image.

### 3.12.3.9 Color Mixing

Creates a color composite image using two original images.

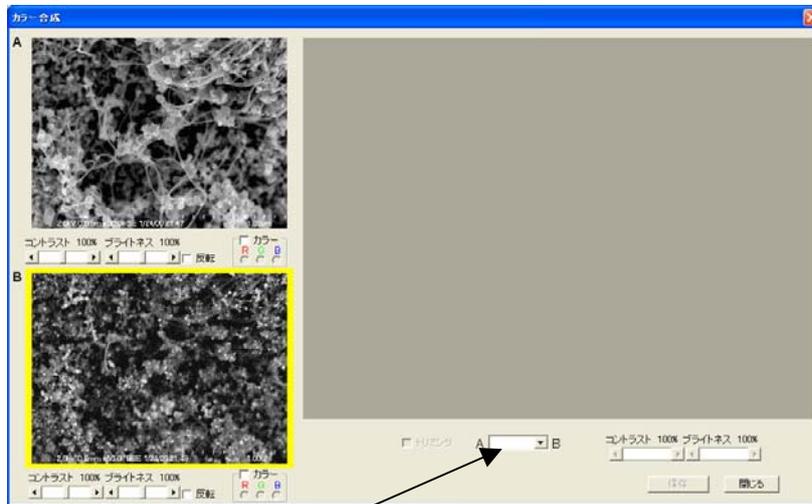
It is applicable for color composition of two different signal images, or stereo imaging using colored glasses. Positional alignment of two original images is possible.

- (1) Color mixing operation  
Select one of two original images to be mixed and open the **Color mixing** dialog window by **Color Mixing** command in **Processing menu** or **Color Mixing**  button. The selected image is shown in the source image area A.



**Fig. 3-204 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.



Mixing selection box

**Fig. 3-205 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.

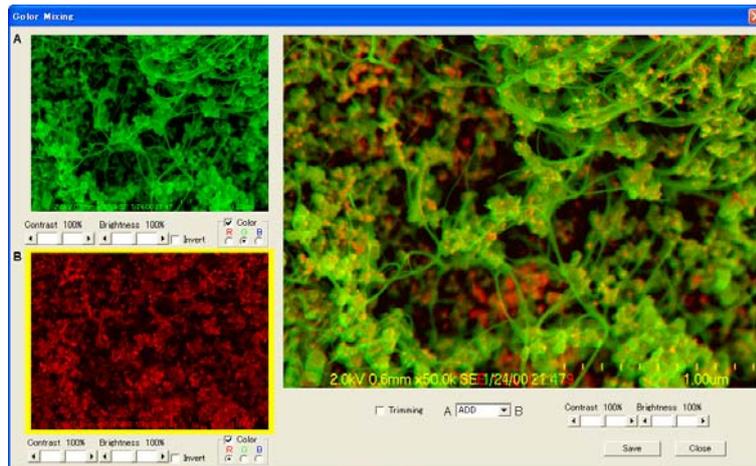
**AVG:** Average of A and B source images is used. Use this when one or both of source images are monochrome.

**MAX:** Compare the intensity of each pixel of source A and B images and use the 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 A from B source images.

**DIXDST:** Divide A from B source images



**Fig. 3-206 Color Mixing Result Display Window**

- (2) Contrast adjustment  
Use scrollbars to adjust the contrast and brightness of the 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 the source images. The cursor on the B image is movable with the 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 **Save** button. Specify file name on the opening save dialog window.

**NOTICE:**

- The composite image is saved with 24 bit RGB format. It has a file size 3 times larger than the 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.

### 3.12.3.10 Printing Images

Use the **Layout Print** command in the **File** menu or the **Layout Print**  button on the tool bar. The **Report Generation** window will open with the presently selected image in the layout sheet. Double-click a thumbnail image to add it to the layout sheet. Refer to <3.9.10 >.

### 3.12.3.11 Image File Operation

**NOTICE:** Use the functions provided in the SEM Data Manager to delete or move images to other directories, in order to keep information in the database of SEM Data Manager. Using the 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, the 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 the **Image Save**  button on the tool bar or **Save as** command in the **File** menu. **Image save** dialog window will open with the present image name as the default file name. Just click the **Save** button to overwrite, or input a new file name and click the **Save** button to save as a new file.

(2) Removing an image from database

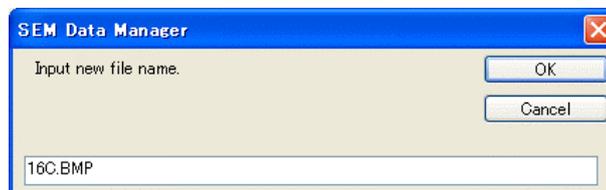
Use the **Remove List** command in **File** menu. The presently selected image is removed from the database. This command is executed without showing a confirmation message. The image file itself is not deleted.

(3) Deletion of an image

Use the **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.

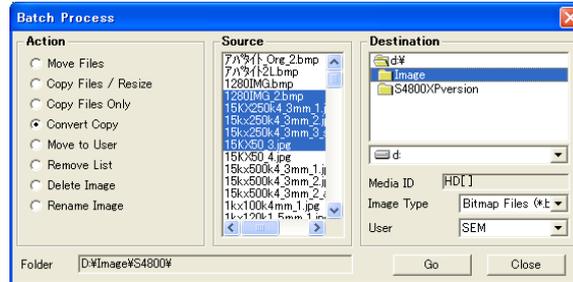


**Fig. 3-207 Rename File Window**

### 3.12.3.12 Batch Operation of Image Files

Two or more image files can be operated at once.

Use **Batch Process** command in the **Database** menu or the **Batch Process**  button on the tool bar. The **Batch Process** dialog window will open.



**Fig. 3-208 Batch Processing Window**

#### (1) Action buttons

- **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.
- **Copy Files/Resize:**  
Copies images files selected from the Source list to other folders specified in the Destination area.
- **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.
- **Convert/Copy:**  
Converts the image format of files selected from the Source list and then copies to other folders specified in the Destination area.
- **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.
- **Remove List:**  
Image files selected from the Source list are removed from the present User database. Image files are not deleted.
- **Delete Image:**  
Deletes image files selected from the Source list and removes them from the present User database. Image files are deleted.
- **Rename Image:**  
Renames an image file selected from the Source list.

(2) Source list

Image files included in the presently open folder are listed here. Files can be selected from this list for one of the aforementioned actions. Multiple selections using the Shift or Ctrl key is supported.

For multiple file selection,

- 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 highlighted.
- Click the first selected file and then click the last selected file while holding down the Shift key.
- Click selected files while holding down the Ctrl key.

(3) Destination

This is enabled when **Move Files**, **Copy Files**, **Copy Files Only** or **Convert/Copy** actions are selected. Select a target folder. The Media ID indicates the volume label of the selected drive.

**REFERENCE:** 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 pop-up menu. You can check or set a volume label in the Information tab.

(4) Format 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**, **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.



### 3.12.3.13 Slide Show

Use the **Slide Show** controller for viewing images at continuous slides.

To open the **Slide Show** controller, use **Slide Show** command in the **View** menu or the **Slide Show** button on the tool bar.

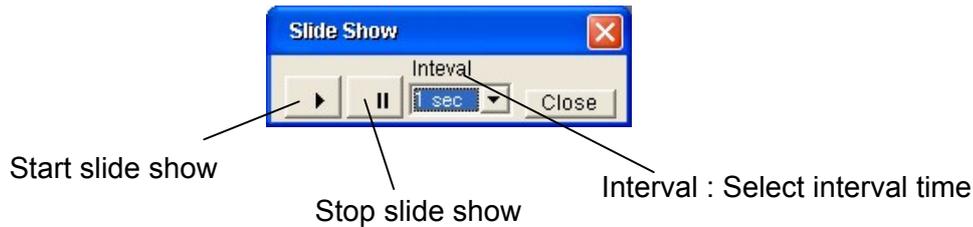


Fig. 3-209 Slide Show Window

### 3.12.3.14 Optional Setting

**Tool** menu – **Options** command opens the **Options** dialog window.

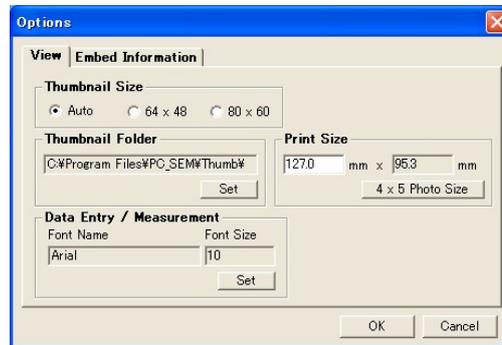


Fig. 3-210 Option Window Display Tab

#### ~~View tab~~

#### (1) Thumbnail Size

- **Auto:**  
Thumbnail size is selected automatically according to desktop size.  
When opened on 1280 × 1024 pixel desktop, thumbnail size is set to 80 × 60 pixels.  
If the desktop size is 1024 × 768, it is set to 64 × 48 pixels.
- **64×48 or 80×60:**  
Thumbnail size is set according to the selection. This setting is provided in order to reduce the thumbnail size to avoid the problem of too few a frames if the SEM Data Manager is used on another PC at a 1024 × 768 desktop size. When SEM Data Manager is launched within the SU6600 control program (at 1280 × 1024 pixels), a recommended setting is either Auto or 80 × 60.

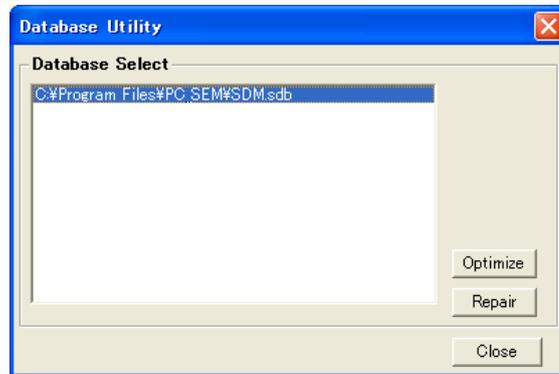
- (2) **Thumbnail Directory**  
The default directory of thumbnail images is “C:¥Windows¥Temp”. It can be set here at any directory. If the thumbnail directory is changed, all of existing image thumbnails are re-created in the new directory when the images are opened. It is recommended not to change the thumbnail directory frequently.
  
- (3) **Data Entry/Measurement**  
Use for selection of font type and size for Data Entry function and CD Measurement function.  
Embed Information tab
  
- (4) **Print Size**  
Set the image size when pasted in 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 BMP format images.

**Embed Information tab**

Refer to <3.12.3.16 >.

### 3.12.3.15 Optimizing and Repairing Database File

Use the **Database Utility** command in **Tool** menu. The following dialog window will open.



**Fig. 3-211 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.

### 3.12.3.16 Embedding Auto Data Display Information Into Images

After saving an image without auto data display, the display information can be embedded using following procedure.

- (1) Selecting information to be embedded  
Open Options dialog window – Embed Information tab with Tool – Options menu.

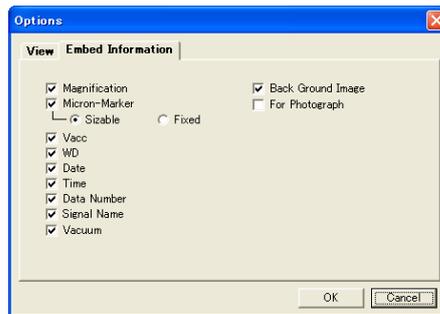


Fig. 3-212 Option Window Embed Information Tab

Put check marks next to data items you want to embed into images. Micron marker is selectable from two format, variable length (marker length value is adjusted so as it does not have fraction) or fixed length.

- (2) Executing information embedding  
Select Embed Information command from Processing – Image Processing menu to embed information data into present observing image.

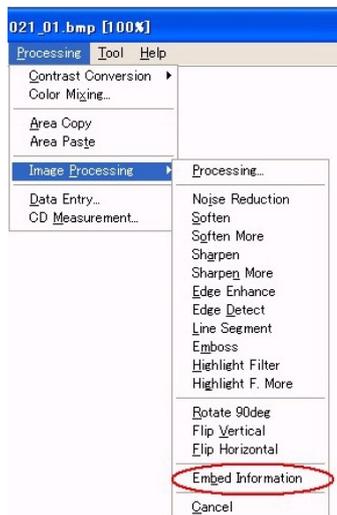


Fig. 3-213 Processing Menu

If the observed 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, does not exist in the same folder as the image file, the command will be canceled showing an error message “An information as SEM-image is missing. You can not process this image”.

## 4. MAINTENANCE

### 4.1 Maintenance of Electron Optical Column

#### 4.1.1 Maintaining Vacuum of Electron Gun and Intermediate Chamber

The electron gun shall be continuously evacuated.

Keep the ion pump power supply ON even when the SEM is not operated.

If the ion pump vacuum decreases to the following values, perform gun baking.

Refer to <4.9 >.

**IP1 :  $2 \times 10^{-7}$  Pa**

**IP2 :  $1 \times 10^{-5}$  Pa**

#### 4.1.2 Replacement and Cleaning of Objective Lens Aperture

Contamination of the objective lens aperture plate may cause an increase of astigmatism or poor resolution especially at low accelerating voltage.

To replace or clean the aperture plate, use the following steps.

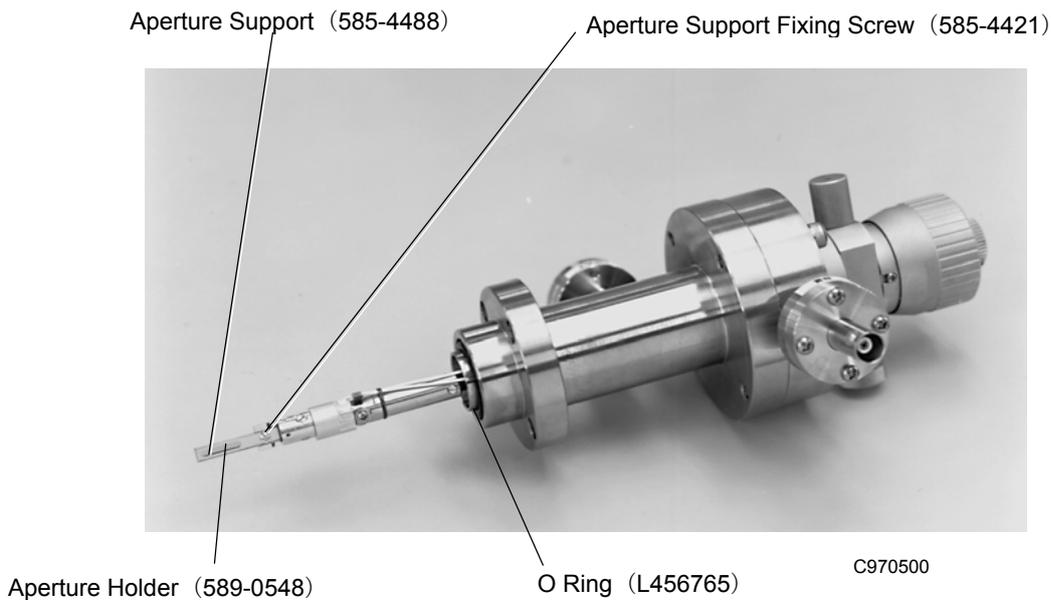
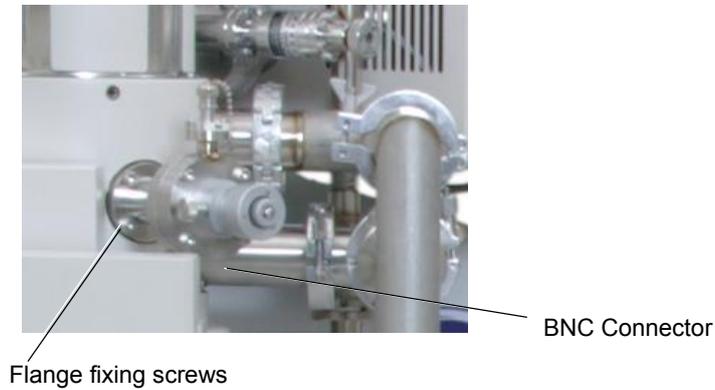
If you use a low accelerating voltage and high magnification condition, coating with Pt-Pd or Au-Pd after cleaning the aperture plate may result in a better image.

- (1) Turn off high voltage. (If the electron gun is already active, it is not required to perform the shutdown procedure.)
- (2) Press down the **S. C AIR** switch on the evacuation control panel for 3 seconds or longer. The lamp of the switch will begin blinking to indicate the start of the venting sequence. If the aperture heater has been ON, a 30-minute waiting time for cooling down begins. During the cooling period, the numeric/character display on the panel indicates **APXX** (**XX** is the remaining wait time in minutes). After the cooling time has passed, TMP will be shut down and venting will begin. It will take about 7 to 10 minutes.



**NOTICE:** Wear gloves for the following steps. Do not touch parts inside the vacuum area with bare hands directly.

- (3) Place aluminum foil of about 20 × 20 cm on a table.  
All parts to be removed in the following steps should be placed on the foil.
- (4) Disconnect the BNC type connector from the objective lens aperture unit. Remove four screws holding the flange of the unit. Pull out the unit straight while holding the flange.



**Fig. 4-1 Objective Lens Aperture Unit**

- (5) Remove the aperture support fixing screw with a small screwdriver (the second smallest one of the attached screwdriver set). With tweezers, remove the aperture support.
- (6) Remove the objective aperture plate with tweezers.  
To use the plate again, clean it by heating in a vacuum evaporator. Refer to <4.1.3 Cleaning of Aperture Plates>.
- (7) Clean the aperture support and aperture holder by means of polishing paste, absorbent cotton (wound on a bamboo stick) and acetone. Cleaning should be done meticulously.

- (8) Mount an aperture plate, new or cleaned one, on the aperture holder.  
Replace the aperture supports on the aperture holder and slightly tighten the aperture support fixing screw.  
Confirm that the aperture plate is appropriately mounted. Tighten the aperture support fixing screw. Also make sure the aperture plate is retained fully by the aperture support.
  
- (9) Insert the objective lens aperture unit straight into the specimen chamber.  
Be careful not to insert it upside down. Attach it with four screws.
  
- (10) Connect the BNC type connector removed in above step (4).
  
- (11) Press the **S.C EVAC** switch on the evacuation control panel.  
The lamp of the switch will begin blinking to indicate the start of the specimen chamber evacuation sequence. It will take about 30 minutes to complete evacuation.  
Before applying an accelerating voltage, be sure to wait for at least one hour.



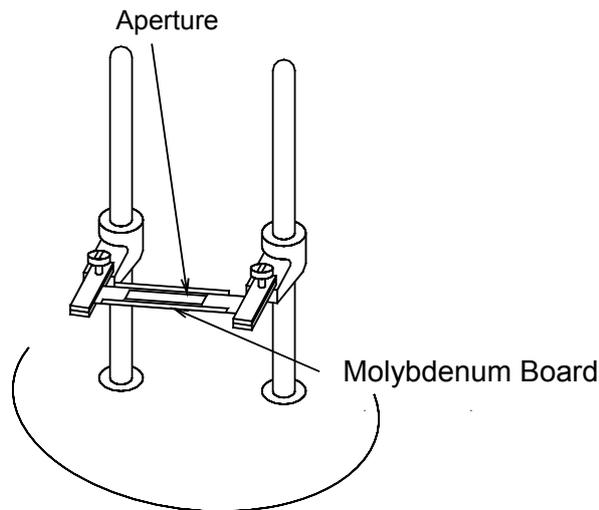
- (12) Turn the **APT HEAT** switch to **DEGAS**. Heating will start upon completion evacuation. After a lapse of about one hour, select the **AUTO** position.

### 4.1.3 Cleaning of Aperture Plates

- (1) Use a 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. 4-2.)
- (3) Evacuate the vacuum evaporator to (Vacuum  $P < 5 \times 10^{-3}$  Pa) . Heat the molybdenum board. Continue applying heater current until the molybdenum board glows. Do not apply too much heater current, otherwise the molybdenum board may be melted.
- (4) After completion of heating the molybdenum board, wait about 5 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. Apply heater current. Heat the molybdenum board up to a glowing point and then stop heating. Be careful not to heat for a long time.
- (7) After completion of heating, wait for 10 to 15 minutes and introduce air into the vacuum evaporator. Then remove the aperture plate with tweezers.

**NOTICE:** Do not touch the aperture plate directly with bare hands.

- (8) To further improve image quality at low accelerating voltages, coat both sides of the aperture plate with platinum-palladium (Pt-Pd) to a thickness of 10 to 20 nm using an ion coater after heating the aperture plate.



**Fig. 4-2 Baking of Aperture Plate**



## 4.2 Maintenance of Oil Rotary Pump

The time point of inspection cannot be uniformly determined because operating conditions of vacuum pumps differ. To minimize trouble and maximize service life, conduct periodic inspections (at least once every six months) according to the operating conditions.

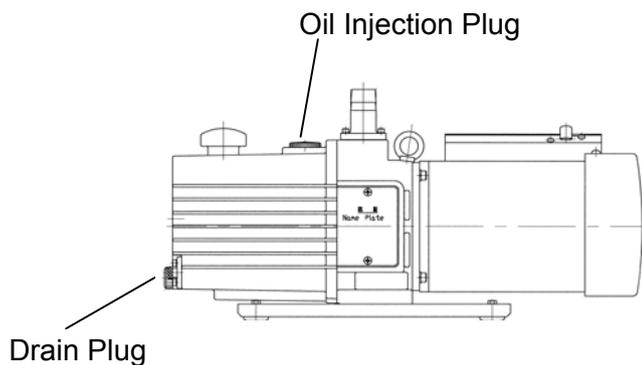
**⚠ CAUTION:** The surface of the rotary pump reaches a temperature of about 70 °C while the pump is operating. Touching it could result in a serious burn. Do not touch the rotary pump when it is running or immediately after it is turned off.

**⚠ CAUTION:** The rotary pump is a heavy object, weighing approximately 30 kg. If it must be lifted for oil change, either two persons must lift it or use hauling equipment. Any relocation of the rotary pump or the weight is performed by the Service Department; it should not be performed by customer personnel.

### 4.2.1 Oil Replacement

The conditions of the pump oil exert a significant influence on the ultimate vacuum level and the service life of pump. For enabling the pump to provide adequate performance, check the level and contamination of oil through the oil gauge window as frequently as possible. Under normal operating conditions, oil should be replaced with new one every 6 months, though the recommended period of oil change differs according to actual operating conditions.

- (1) Discharge of Oil
  - (a) Remove the oil injection plug.
  - (b) Turn the drain valve to discharge oil from inside the box.

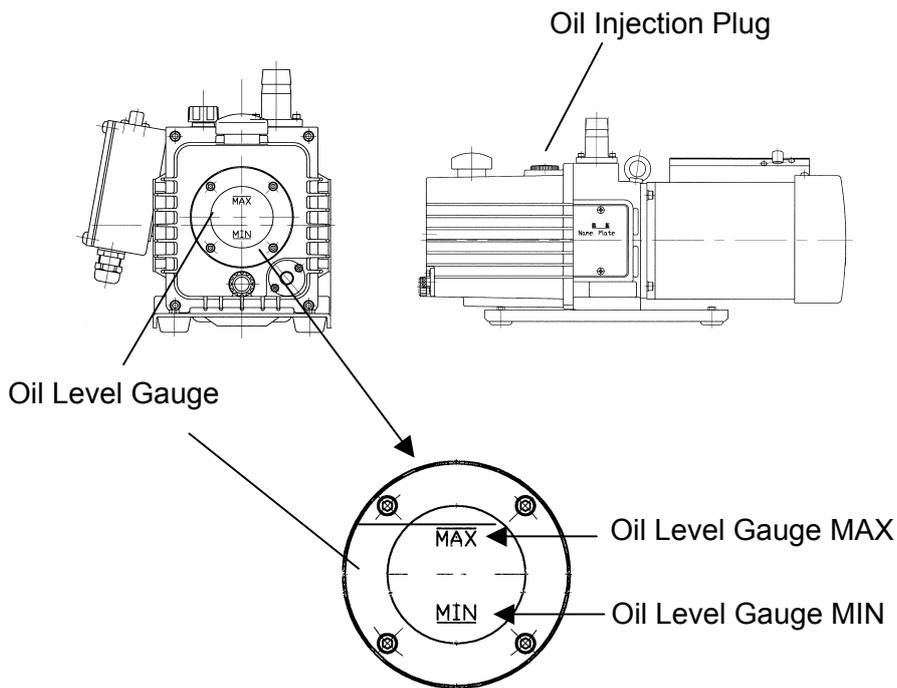


**NOTICE:** For fastening the drain plug, screw it in correctly by hand, and then tighten lightly with a spanner or the like.

(2) How to Inject Oil

Inject oil through the oil injection port so that oil level reaches within the range of MIN and MAX of the oil gauge.

**NOTICE:** If the oil level is below the MIN level, pump performance may be degraded or oil may be deteriorated earlier than usual. Conversely, if the amount of oil is excessive, oil may be blown out. Hence, the proper level of oil should be maintained.



(3) The oil used in this pump is **NEOVAC MR-100** (supplied by Muramatsu Sekiyu).

**CAUTION:** The rotary pump, which is a finite-life item, should be replaced every five years.

## 4.2.2 Replacement of Oil Mist Trap

The oil mist trap (L) is a disposable type. If oil splashes or oil fumes from the oil mist trap, replace the trap with a new one.

## 4.2.3 Troubleshooting

Symptom	Cause	Countermeasure
Pump does not rotate at all. The breaker switches off immediately. When turning on the switch, pump buzzes and does not start.	Power failure or voltage drop below 90 V.	Check the power supply.
	Oil is highly viscous because the ambient temperature is low (below 9 °C).	Close the suction port and turn the switch on and off repeatedly to repeat slight rotation or warm the pump externally.
Vacuum degree cannot be enhanced.	Air is leaking due to defective vacuum piping.	Check for a leak and repair as required.
	The inside of vacuum pipe is contaminated.	Degas the pipe.
	Pipe is too thin or too long.	Maximize the inner diameter of pipe and minimize its length.
	Oil is deteriorated.	Replace oil.
Loud noise is emitted.	Oil is inadequate.	Add oil.
	Air is leaking through the roughing pipe.	Repair the leaky point.
	* Abnormal sound may occur for approx. 5 to 6 seconds at start of evacuation, but this does not indicate a fault.	
Oil is leaking.	Oil is leaking through the drain valve.	Make sure the drain valve is closed. If oil leaks although the valve is closed, replacement with a new valve is required.
	Oil is leaking through the drain plug.	Retighten the plug. If oil still leaks, replace the drain packing.
	Oil splashes through the exhaust port.	Adjust oil level or replace the oil mist trap (element).
Pump vibrates abnormally.	Oil is highly viscous due to low ambient temperature (below 9 °C).	Warm the pump externally.

**NOTICE:** If the trouble cannot be remedied by the above procedures, contact your dealer, because overhaul, cleaning or repair may be required at the specified service shop.

## 4.3 Maintenance of Air Compressor

### 4.3.1 Checkup and Maintenance

Check the following items regularly.

Before checkup/maintenance, be sure to turn the main switch off.

Check Item	Procedure	Service Cycle			
		Every day	Every 250 h (1 month)	Every 3,000 h (1 year)	Every 6,000 h (2 years)
Discharge of drain	Loosen the drain cock of air tank to discharge drain.	○			
Activation of control devices (pressure gauge, pressure switch and safety valve)	Check the working pressure and activated function.	○			
Abnormal vibration and abnormal sound		○			
Loose bolts, nuts and screws	If loose, retighten them.		○		
Contamination and clogging of strainer/filter	Blow air to remove clogged substance.		○	○	○
Leakage through air valve *				○	●
Piston ring *				○	●
Rider ring *				○	●
Bearing*	Ball bearing			○	●
	Needle roller bearing			○	●

**⚠ CAUTION:** To avoid potential damage due to corrosion, the compressor should be drained every day.

**⚠ CAUTION:** The air compressor should be drained gradually by slowly loosening the drain cocks. The inside of tank is at a high pressure, and moisture may spray out by abrupt cock operation to cause a danger. To unplug the drain, slowly turn the drain while avoiding standing directly in front of it.

- NOTICE:**
- The mark “○” indicates the time period after start of operation or replacement of the part. The mark “●” shows the time point for part replacement.
  - The above table shows the standard inspection cycle. The inspection cycle changes slightly with the operating conditions (temperature, humidity, etc.). If the operating conditions are severe, shorten the inspection cycle.
  - For inspection and maintenance of the asterisked items, ask your dealer or nearby service agent.
  - Caution on long shutdown  
If the air compressor is not intended to be used for a long time, idle it for 30 minutes or longer once a month in order to prevent the service life of grease from being shortened due to humidity.

### 4.3.2 Troubleshooting of Air Compressor

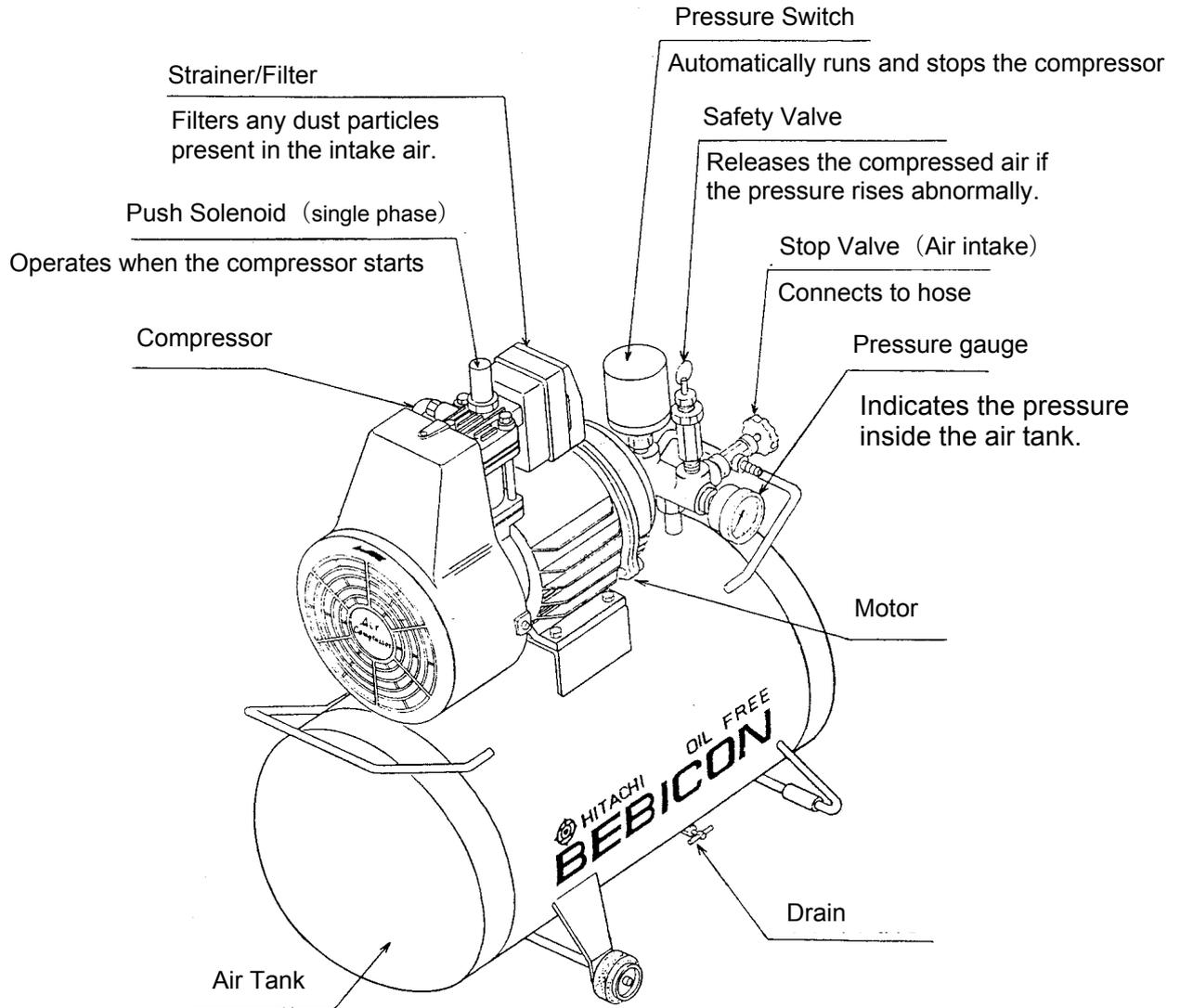
If the air compressor becomes faulty, reference should be made to the following table.

Symptom	Probable Cause	Remedy
Air compressor rotates.		
Pressure does not rise at all or rises very slowly.	Drain or stop valve leaks.	Retighten. If the valve still leaks, replace with a new one.
	Packing, screw or seal is defective.	Retighten or replace the packing with a new one.
	Safety valve leaks.	Replace with a new one.
	Clogged strainer/filter.	Clean or replace with a new one.
	Piston ring has worn.	Clean or replace with a new one.
	Starting unloader is faulty.	Ask service agent for repair.
	Pressure gauge reading is improper.	Replace with a new one.
Maximum pressure limit is exceeded.	Pressure switch is faulty.	Adjust or replace with a new one.
	Pressure gauge reading is improper.	Replace with a new one.
Abnormal sound has been emitted.	Push solenoid is faulty.	Ask service agent for repair.
	Piston hits air valve.	Ask service agent for repair.
	Bearing is defective.	Ask service agent for repair.
	Rider ring has worn.	Replace with a new one.
	Installation is inappropriate.	Install on level floor.
Motor overheats.	Sliding part has scorched.	Ask service agent for repair.
	Motor is abnormal.	Ask service agent for repair.
Air compressor does not rotate.		
Motor does not whirl.	Pressure switch is faulty.	Replace with a new one.
	Protector is actuated.	Stop operation, and then restart.
Motor whirs.	Voltage has dropped.	Replace wires with the specified ones.
	Air valve leaks.	Replace with a new one.
	Starting unloader is faulty.	Ask service agent for repair.

- When asking the service agent for repair, please notify them of the following.

1. Model code    2. Symptom of trouble    3. Location of installation site

### 4.3.3 Location and Functions of Major Components



## 4.4 Troubleshooting

### 4.4.1 When Evacuation System does not Work

If the evacuation system does not work or the evacuation sequence does not proceed, check the following items from the Evacuation Operation Panel:

- (1) Is an error message shown?  
If an error message (e.g. E-10) is shown in the (Display/Operation area) of the evacuation control panel, refer to <2.1.6 Evacuation control panel > to find the cause of the error and take a countermeasure for it.
- (2) Check the **TMP** lamps on the evacuation control panel. Both **NORMAL** and **TMP POWER** lamp shall be lit in normal evacuation condition. The **TMP POWER** lamp will be lit about 10 minutes after starting evacuation. The **NORMAL** lamp will be lit after about 10 more minutes.

### 4.4.2 When Specimen Exchange Chamber Vacuum is not Good

If the EVAC switch indicator above the specimen exchange chamber keeps blinking 10 minutes after the start of the evacuation after replacing the specimen, or if the OPEN switch indicator keeps blinking and the gate valve fails to open 10 minutes after the OPEN switch is pressed in order to open the gate valve, the buzzer sounds, and Error E 25 is displayed. If this problem occurs, check the items listed below. (If the specimen is wet and therefore needs more evacuation time, then allow more time. Buzzer and error indication can be stopped by STOP button. When vacuum reaches the specified value, evacuation sequence will continue to the next step).

- (1) Introduce air into the specimen exchange chamber by the **AIR** button. Clean and grease up the O-ring seal of the chamber. Then start evacuation again.
- (2) Check if your specimen has dried. If the specimen is not dry, outgas from the specimen may cause a longer evacuation time.
- (3) Check oil level of rotary pumps. If the level is not normal, add or exchange oil of rotary pumps referring to instruction manual.

 **CAUTION:** The surface of the oil rotary pump reaches a temperature of about 70 °C during operation of the pump. Touching it could result in a serious burn.

 **CAUTION:** Before proceeding to maintenance of the oil rotary pump, wait for a while until it becomes sufficiently cool. If the oil pump is forced to stop due to occurrence of an abnormality, it will remain extremely hot for a certain period of time. To prevent burns, never touch the oil rotary pump immediately after it is forced to stop.

### 4.4.3 When Specimen Chamber Vacuum is not Good

When evacuation of the specimen chamber is started with the SC EVAC switch, the TMP POWER and NORMAL lamps are lit. Then, even after a lapse of more than one hour, there may occur a trouble that the HV applicable state (HV indicator blinks in yellow and the ON button is enabled) is not indicated on the SEM control GUI. Or, at the time of specimen exchange, the HV applicable state may not be indicated even after a lapse of ten minutes following the closure of the gate valve. On occurrence of such a problematic condition, check the following items.

- (1) Check specimen chamber vacuum. It shall be better than  $2 \times 10^{-3}$  Pa to apply HV. Note that in a period of 15 minutes after **TMP NORMAL** lamp is lit, HV cannot be applied.
- (2) If you have attached some unit, e.g. objective lens aperture unit, after cleaning, 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.
- (3) Check if your specimen has dried. If the specimen is not dry, outgas from the specimen may cause a longer evacuation time.
- (4) If you do not find any failure mentioned above, contact a service engineer.

### 4.4.4 When Electron Gun Vacuum Level is Less Than Specified Value

If the electron gun vacuum level (IP1/IP2 indication on the evacuation control panel) is less than the specified value (shown below), carry out the baking of the electron gun. Refer to <4.9>.

**IP 1:  $2 \times 10^{-7}$  Pa**

**IP 2:  $1 \times 10^{-5}$  Pa**

If these are not improved by gun baking, contact a service engineer.

#### **WARNING:**

- Voltages up to 100 V AC and 30 kV DC are used in this instrument. Touching the interior could cause an electric shock.
- Never remove the covers of main unit, control unit or power unit and touch internal parts or circuits while power is connected to the instrument. There is a danger of fatal or serious injury due to electric shock.
- Do not detach the covers of the instrument.  
(Removing the cover from the equipment shuts off power.)



#### 4.4.5 Emission Current is not Set at Normal Range

At the time of accelerating voltage application, the error message “*The electron gun has been shut down due to too low a degree of vacuum*” may come up. This means that the electron gun power source has been turned off. In this case, check the vacuum levels of IP-1 and IP-2. In a situation where air is introduced once into the specimen chamber and its re-evacuation is performed, the above phenomenon may occur at the time an accelerating voltage is initially applied. In this case, if the degree of vacuum is normal or if recovery from a poor vacuum condition has been made in a short time, there is a possibility that the cause of the phenomenon may be gas emission from the O ring at the opening time of the electron gun isolation valve. If it is judged that the cause is the gas emission from the O ring, take the opening-closing step for the electron gun isolation valve and then proceed to activating the electron gun.

For details of the operational procedure, refer to <2.3.22>.

#### 4.4.6 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) Check that the specimen is set properly (the specimen is not left at the exchange position), the accelerating voltage and emission current are normal, the secondary electron signal is selected for imaging, and the first condenser lens set value is too large.  
Refer to <3.3.4 >. Setting of Accelerating Voltage and Emission Current  
Refer to <3.10.2 >. Condenser Current and Image Quality
- (2) Set contrast at maximum.
- (3) Open the **Alignment** dialog window and start **Beam Alignment** mode. If a circular image appears off the center of screen, carry out beam alignment again.  
If a circular image does not appear in step (3) above, try setting the anode aperture and objective lens aperture at “0”. If a circular image now appears, carry out mechanical axis alignment.  
Refer to <3.4.3>.  
If you cannot fix the trouble by checking above, contact a service engineer.

#### 4.4.7 When Image is Very Noisy

The following three kinds of noise conditions may occur in imaging:

- (1) Snowy noise on the entire area of a specimen image  
This noise condition is mainly attributable to density fluctuations (statistical error variations) in emission of the primary, secondary or backscattered electrons. Snowy noise could occur if the probe current is too small, if the efficiency of secondary or backscattered electron emission from the specimen is too low, or if the electron detection efficiency of the detector concerned is too low. In case of significant snowy noise, check the items mentioned below.

- (a) The first condenser lens set value may be too large. In case of 26 or more, select a value lower than 21.  
Refer to <3.10.2>.
  - (b) If conspicuous noise appears at the TV or FAST scanning speed, open the Image tab page of the Setup dialog window and check the setting of FAST SCAN AVERAGING. If a value of 1 or 2 is set at FAST SCAN AVERAGING, try increasing it. It is recommended to select 4 for TV1, 8 for TV2, 2 for FAST1, and 4 for FAST2.
  - (c) Conspicuous noise will also occur in case of too high contrast. Decrease the contrast of the image concerned while increasing the brightness accordingly.
  - (d) Open the Alignment dialog window, and select the **Beam Alignment** mode. If the beam spot (circular image) is off the center of the screen, carry out alignment again.
- (2) Lateral-streak noise or tailing-dot noise may appear if the probe current or the scintillator of the secondary electron detector is unstable. If this kind of noise is conspicuous, check the following items.
- (a) To check the detector, use BSE and SE detectors to compare images. Insert a BSE detector, and at a 15-mm working distance, change the detector settings on the **DETECTOR** part of the Operation Panel between SE and BSE. If noise is noticeable in the SE setting, it is an indication of a bad scintillator in the SE detector. In this case, contact a service engineer.
- (3) Random noise may appear due to a partial charge buildup on the specimen under observation. In this case, observe another region of the specimen or the surface area of the specimen stub. If noise disappears, the cause of the random noise may be a charge buildup on the specimen. Select observation conditions that are less likely to cause a charge buildup (e.g., use a low accelerating voltage, or decrease the amount of probe current). It is also advisable to make proper specimen pretreatment for prevention of a charge buildup.

#### 4.4.8 When You cannot Correct Astigmatism

If astigmatism cannot be eliminated even at the maximum level of correction, check the following items.

- (1) If the image position shifts unintentionally at the time of focus adjustment, select the Alignment mode and adjust the setting of Aperture Align.
- (2) Select another opening on the objective lens movable aperture plate. If the degree of astigmatism decreases, the objective lens movable aperture plate may be contaminated. Use an opening that allows elimination of astigmatism, or carry out the cleaning of the objective lens movable aperture plate.  
Refer to <4.1.3>.
- (3) If it is difficult to perform astigmatism correction due to a shift of the image position, select the Alignment mode and adjust the setting of Stigma Align X/Y.  
If astigmatism correction cannot be made as desired even by taking the procedures mentioned above, contact a service engineer.  
Refer to <3.4.4>.

#### 4.4.9 When Auto Focus or Auto Stigma does not Work Satisfactorily

- (1) Select the Alignment mode, and by carrying out the Aperture Align function and the Stigma Align X/Y function, check whether the image wobbles or not.  
If it wobbles, adjust the settings of Aperture Align and Stigma Align X/Y.
- (2) Check if the observed specimen has a fine surface structure.  
If it does not, please use manual focus and manual astigmatism correction.
- (3) If abnormal contrast occurs due to a charge buildup, a desirable result of observation may not be obtained.  
Refer to <3.4.4>.

#### 4.4.10 When SU6600 Control Program does not Start up

When the progress bar on the login dialog window does not progress to the end, or the login dialog window disappears before completing start up, check the following.

- (1) Check if the evacuation system is running.
- (2) An interlock switch is mounted at the edge of electron gun HV cable. This is a safety switch that shuts off the high-voltage power supply before the cable is disconnected if an attempt is made by mistake to remove the cable with the high-voltage power supply for the electron gun still on. For safety assurance, the high-voltage power supply for the electron gun is completely shut off. Therefore, the system cannot start properly unless the switch is ON. The switch is set ON automatically when the HV cable and safety cover are attached correctly.

#### 4.4.11 When PC has Hung Up

On occurrence of a hang-up in software operation, exit Windows and shut down the PC. Then, restart the PC again. You may quit only the program that has frozen and then restart it again. However, since there is a possibility that the cause of the hang-up is not cleared, it is advisable to perform the shutdown procedure for the PC.

Before proceeding to the shutdown procedure, be sure to check whether any applications other than the SEM control program are open or not. If so, save data as required, and then quit each of the open applications.

- (1) Click the Start button on the Taskbar of the Windows, and select the Shut Down item to bring up the Shut Down Windows dialog box. In this dialog box, turn on the radio button of “Shut down the computer?”, and click the Yes button. If the above step cannot be taken, press the Alt, Ctrl, and Delete keys simultaneously on the keyboard. The Windows Task Manager dialog box shown below will be presented. On the Shut Down menu of this dialog box, select the item “Shut down power to the computer”.



- (2) Wait until the following message appears; “You may shut down power to the computer”. (The PC will be powered off automatically in some setting conditions.)  
If the PC cannot be shut down at this step, hold down the POWER switch of the PC for a while. Even if the POWER switch of the PC is held down for a period of 20 seconds or longer, the PC may not be powered off occasionally.  
In this case, make sure that the hard disk access lamp is off, and then turn off power to the display monitor as instructed below.  
(If the hard disk access lamp is on, wait until it goes off.)
- (3) Turn off the DISPLAY switch located on the top of the right sleeve of the display monitor (turn the DISPLAY switch to position 0.)

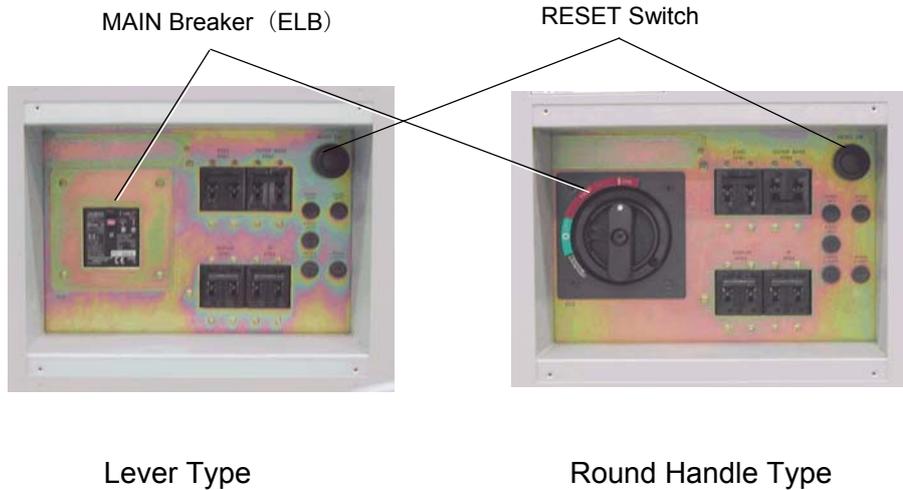
- (4) Wait for about one minutes, and then turn on the DISPLAY switch of the display monitor (turn it to position 1).  
(If the power-on automatic start function of the PC is ineffective, turn on power to the PC manually.)  
If the Windows OS has not been shut down normally in the previous session, the following message may appear at the restart of the PC:  
“Checking file system on C: To skip disk checking, press any key with 10 seconds.”  
If no key is pressed on occurrence of this message, the ScanDisk utility program is carried out automatically. At the end of execution of the ScanDisk utility program, the Windows OS may boot up in the safe mode. In this case, select Start – Shut Down, and restart the PC.
- (5) Log in to Windows to start SU6600.  
Refer to < 3.1.2 >. Startup of Display
- (6) If the program hangs up and the SU6600 control program fails to close properly, it is possible that the condition that existed prior to program closing cannot be reproduced (in which case, the condition that existed two session ago is resumed).

#### **4.4.12 When Error Messages are Shown**

Messages shown on the window 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 Operation at the time of Power Failure or Shutting down

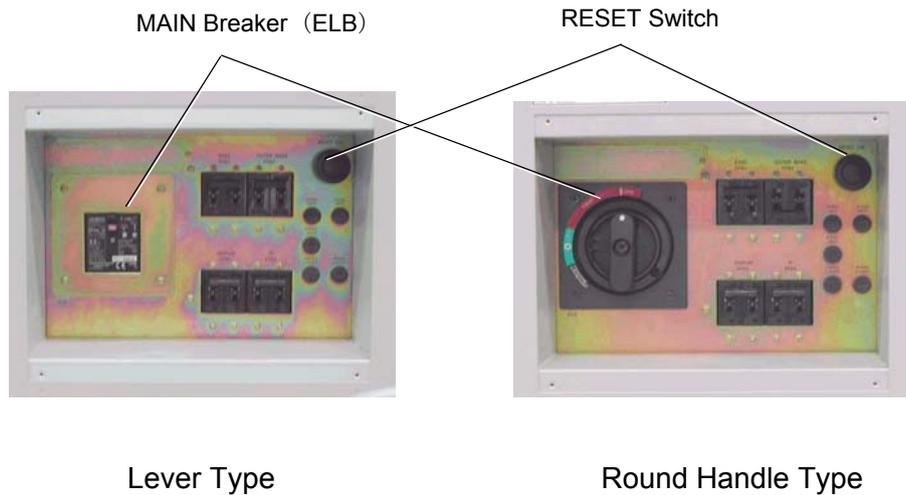
- (1) Turn off accelerating voltage, and shut down the electron gun.
- (2) Take the ordinary shutdown procedure (remove the sample - shut down PC - turn off **DISPLAY** power switch). Then, switch off the HV unit of electron gun.
- (3) Stop of the Evacuation System  
On the evacuation control panel, turn the **EVAC POWER** switch to **O** (OFF).
- (4) After 30 minutes of cooling time for the objective lens aperture heater and 5 minutes of TMP power down, the evacuation system stops. **POFF** will be shown on the evacuation control panel.
- (5) Turn **IP1** and **IP2** switches on the evacuation control panel to **OFF**.  
At the back of the display unit, turn off **IP**, **EVAC**, **DISPLAY** and **OUTER BAKE** breakers. And then, turn the **MAIN** breaker to off. If the **MAIN** breaker is a straight lever type, set it down. If it is a round handle type, turn it counterclockwise fully.



- (6) Turn off the power breaker in the power distribution panel

## 4.6 Operation when Power was Shut Down by Power Line Failure

- (1) Turn on the power breaker in the power distribution panel.
- (2) At the back of the display unit, turn the **MAIN** breaker to ON and press the **RESET** switch. The sound of relay operation will be emitted from inside of the unit.



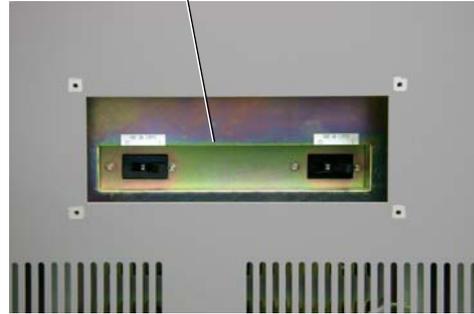
**NOTICE:** If the breakers mentioned in step (5) of Section 4.5 have not been turned off after occurrence of a power failure, it is not allowed to turn power on again. Before taking this step (2), be sure to turn off all the breakers as instructed.

- (3) Turn **IP**, **EVAC**, **DISPLAY** breakers to ON. (Keep the **OUTER BAKE** breaker off. Turn it ON when conducting gun baking.)
- (4) Turn **IP1** and **IP2** switches on the evacuation control panel to ON. Lamps in the **RESET** switches of each pump will be lit. If lamps are not lit, press **RESET** switch (IP RESET 1~2). If the lamp is once lit and goes out soon, over current protection for the ion pump power supply may have been activated. Repeat pressing **RESET** switch at about 10 second intervals. If the lamp is not lit at all, protection breakers may be tripped by rash current. If the indicator fails to turn on when the Reset switch is pressed, inspect the breaker. If the breaker has tripped, turn it on. The breaker is located on the left side of the main unit base. Operate it by removing the cover as illustrated in the figure below. (The cover can be removed without compromising safety since there are not hazardous internal voltages.)

Breaker Cover



IP Protection Breaker



- (5) On the evacuation control panel, turn the EVAC POWER switch to position 1 (ON). The specimen chamber evacuation sequence will then start up. On completion of this sequence, the S.C EVAC switch lamp is lit on the evacuation control panel. Turn on the objective aperture heating switch (APT HEAT) if it is off.
- (6) For ion pump vacuum recovery, usually from half a day to one full day is necessary. (It is shorter when power is down for only a short period.) Check ion pump vacuum after waiting above time. If it is lower than the following value, gun-baking operation is necessary. For the baking procedure, refer to <4.9>.
- IP1:  $2 \times 10^{-7}$  Pa**
- IP2:  $1 \times 10^{-5}$  Pa**
- (7) When the vacuum level of the ion pump has been restored to normal, turn on the power switch of the electron gun HV unit. Then, turn on the display monitor. When activating the electron gun, refer to <3.1.4>.



## 4.7 Gun Baking Operation

**NOTICE:** It will take about half a day to make the electron gun available again after the start of gun baking. Note also that gradual variations in emission current may occur continuously for a few days. Before proceeding to gun baking operation, it is recommended that the customer consult with qualified service personnel about whether or not to carry out gun baking.

**CAUTION:** A service engineer or a person who has been trained by Hitachi High-Technologies Corporation or its service representatives must carry out gun baking operation.

**CAUTION:** To avoid damaging the table, with the table falling and causing injury, do not get on the table or sit on it. The load bearing capacity of the table is 200N.

Use the following steps for gun baking operation.

After completion of gun baking, a period of at least six hours will be required for its cooling.

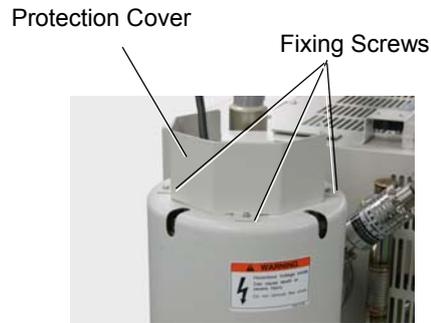
(1) Turn HV to OFF. Then, shut down the electron gun.

**CAUTION:** Confirm that each of the FL and HV lamp on the right side ion pump cover is extinguished. If it still is lit, don't proceed to the next step.



**WARNING:** The magnetic field from the ion pump (10 mT around the ion pump, and approximately 1 mT outside of it) can potentially damage a pacemaker. Any person wearing a pacemaker should stay at least 0.6 m from the ion pump.

- (2) Remove three fixing screws and then the protection cover.  
(A protection is provided so that gun HV is forcibly turned off when the cover is removed.)



- (3) Loosen four setscrews on the flange of the cable head (it is not required to remove these setscrews completely), and then disconnect the electron gun HV cable.



**⚠ WARNING:** Before removing the HV cable, perform the shutdown procedure, and verify that the two indicators (FL and HV) on the ion pump cover have turned off.

- (4) Insert the HV cable into the HV cable holder provided at the back side of HV power supply.  
(A protection is provided so that baking will not start if the cable is not placed in the holder.)



- (5) Remove one screw (remaining one screw after remove the cable cover) at the top of the column cover and remove the cover.



- (6) In order for the hand not to touch the heater of the electron gun directly, the baking protector should be installed in the electron gun, (if not, baking is impossible for protection)



**NOTICE:** Confirm that heater lead wire does not touch the heater directly.

**⚠ CAUTION:** The electron gun and ion pumps are heated at about 250 °C in order to keep the electron gun in a high vacuum. Never touch these parts.

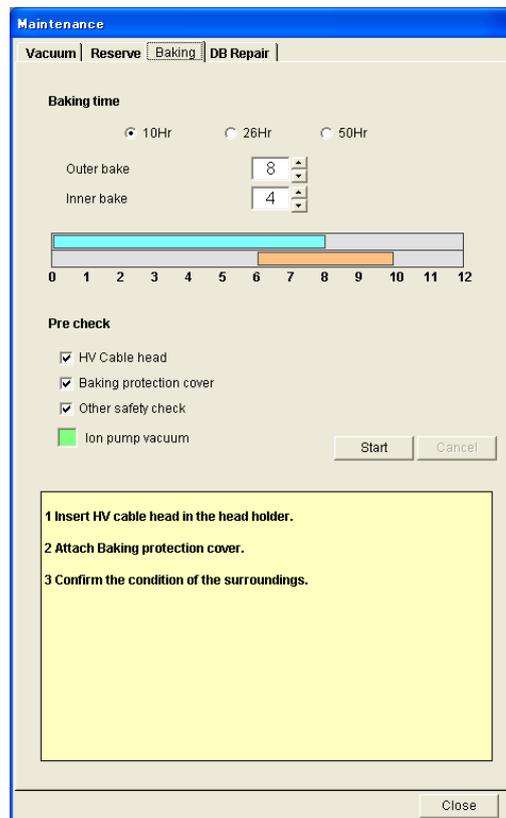
**⚠ CAUTION:** Since the cover is hot during baking or cooling, do not touch it.

- (7) Turn ON the OUTER BAKE breaker  
Turn ON the OUTER BAKE breaker at the back of the display unit.



- (8) Starting gun baking (From the SU6600 control program)

You can start gun baking from the SU6600 control program or from the evacuation control panel. To start from the SU6600 control program, select the **Maintenance** command in the **Help** menu. The **Maintenance** dialog window will open.



Select a **Baking time** (10Hr, 26Hr or 50Hr). A time period of outer baking (the entire electron gun is heated) and a time period of inner baking (only the anode electrode and its vicinity are heated) are automatically assigned so that the sum of these time periods will be equal to a baking time selected as instructed above.

Although the outer and inner bake times can be set freely by up/down button beside the time indication boxes, usually use 10 hr setting. In this case, separate time values need not be set.

**Pre check** items are provided for confirmation. Confirm that the HV cable is placed in the cable holder, the baking protection cover is attached and other surrounding conditions are safe. Put check marks at each item if there is no problem.

The **Ion Pump Vacuum** display is automatically read when the Dialog is opened. If no problems are detected, the display turns green. If these four conditions are met, click the **Start** button.

On the display area of the evacuation control panel, the indication “b-hh” (“hh” represents a period of remaining time in hours. Since a truncated form with “minutes” rounded down is used, “b-09” is indicated immediately in the case of starting from “10 hours”.) will be shown. It indicates that gun baking has started normally. After this appeared, click the Close button in the Maintenance dialog window.

It is recommended to close the program and shut down PC and display power after that.

- (9) Starting gun baking (From the evacuation control panel)
- Press the **MODE** switch so the **BAKE** of status indicator lamps blinks. Indication display will be changed by the **SELECT** switch in the order of 10.00 → 26.00 → 50.00 → Ou.00 → In.00. The former three are for 10, 26 or 50 hrs. of total baking time. The indication of Ou.00 is the outer bake time, UP or DOWN switch increases or decreases the outer bake time. Each press of the UP switch increases a value of outer bake time in increments of 01 (i.e., Ou.01, Ou.02 and so on).
- For inner bake time setting, the indication “In.00” is given.
- In common practice, carry out baking with the time setting of 10.00.
- After completion of the time setting, check that the HV cable is securely connected to the receptacle on the rear of the electron gun HV power unit and that the baking protection cover is attached properly.
- Check also that there is no hazardous potential in surrounding conditions.
- After ensuring safety in gun baking operation, press the START switch with the status indicator lamp BAKE blinking.
- Thus, the gun baking operation can be started. Then, check that “b-hh” is indicated on the evacuation control panel.
- “hh” represents a period of remaining time in hours.
- Since a truncated form with “minutes” rounded down is used, “b-09” is indicated immediately in the case of starting from “10 hours”.)
- If it is attempted to start gun baking under the condition that the baking is not permitted, an error is indicated on the evacuation control panel.
- Refer to the table shown below on occurrence of an error indication on the evacuation control panel.

Error No.	Description	Countermeasure
E31	Baking has been started without setting the cable head to the specified safe position.	Check the above step (4).
E32	Baking has been started without attaching the baking protection cover.	Check the above step (9). Attach the baking protection cover properly.
E34	Baking has been started without turning on the IP1.	Baking is not enabled unless both the IP1 and IP2 are turned on.
E35	Decrease in degree of vacuum in IP1 during baking	This condition may occur in a certain period of time after the start of baking. If the vacuum level of the IP1 decreases below the specified lower limit due to excessive gas emission caused by overheating, the heating operation is suspended until the IP1 reaches the normal vacuum range. The indication E35 is given during this time period of suspension. Just wait for a certain period of time.
E36	Improper setting time for baking	This error indicated under the following conditions: Inner bake time > Outer bake time + 2 hours Outer bake time < 2 hours

Pressing the STOP switch can clear any of these error indications. When the STOP switch is pressed, the baking operation is canceled. After taking a proper countermeasure against the error condition concerned, make the bake time setting again and then press the START switch.

- (10) After gun baking is finished, turn OFF the OUTER BAKE breaker, which you turned ON at above mentioned (7).

**⚠ CAUTION:** Be sure to keep the OUTER breaker at OFF except during gun baking to avoid unexpected gun heating by any fault of baking controller.

After gun baking is finished, wait about 6 hours for cooling.  
Remove the baking protection cover and baking heaters. Attach the electron gun cover.  
Take the above steps (5) to (10) in reverse order.

**⚠ CAUTION:** It will take about 6 hours for cooling down to nearly room temperature after gun baking is finished.  
Until the cooling time elapses, the electron gun and ion pumps are still hot.

- (12) Remove the baking protection cover that has been attached in the above step (6).
- (13) Attach the electron gun cover that has been removed in the above step (5) (secure the screw that has been removed).
- (14) Check that the electron gun HV cable and its connector on the electron gun are free from dust and contamination. Then, insert the HV cable into the connector, and secure the cable by tightening the four screws on its head flange part.  
Then, attach the cable cover and secure it with the three screws.
- (15) Start of electron gun  
To start the electron gun, refer to <3.1.4>.

**NOTICE:** After baking, it may take a few days until the emission current becomes stable at a certain level. Note also that the same value of emission current as that used before baking is not always given after baking.

## 4.8 Caution on Maintenance

- (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.

## 5. REPLACEMENT PARTS

### 5.1 Consumables and Spare Parts

#### 5.1.1 Consumables

The items shown in Table 5-1 should always be on hand for normal operation.

**Table 5-1 Consumables**

Part No.	Part Name	Use	Remarks
G370009	Conductive paint	For protection against charge up	30 g
G370250	Metal polishing paste	For cleaning parts	50 g
G743002	Bamboo stick	For cleaning parts	10 pcs
S370061	Absorbent cotton	For cleaning parts	
S370057	Gauze	For cleaning parts	
S269003	Aluminum foil	For cleaning parts	
539-2132	Vacuum grease	For vacuum seal (sliding part)	
585-4267	Vacuum grease (in tube)	For vacuum seal (stationary part)	50 g
539-0938	Objective lens aperture plate	(0.03, 0.05, 0.1, 0.2 mm dia.)	Baked and coated in pretreatment
539-1724	Objective lens aperture plate	(0.03, 0.05, 0.1, 0.2 mm dia.)	
57E-3610	Objective lens fixing aperture plate	0.3mm dia	
—	Acetone	For cleaning	
533-1337	Molybdenum board	For baking aperture plate	
S263001	Polyethylene gloves	For handling vacuum parts	
L474074	AIR filter	Valve open and close	
45891500	Cooling water filter	OBJ Cooling	
566-4916	Molybdenum electron grease	For stage(moving part)	37.5 g
G469018	Fomblin grease	For stage(moving part)	Y-VAC40/11



### 5.1.2 Replacement Parts

Table 5-2 shows a list of parts having a useful lifetime. These parts must be replaced periodically as specified for ensuring safety in operation and maintaining the performance of the instrument.

Refer replacement servicing to qualified service personnel.

For ordering a replacement technical service, contact the nearest service office or agent authorized by Hitachi High-Technologies Corporation.

**Table 5-2 Replacement Parts**

Part No.	Part Name	Use	Frequency of Replacement
J386012	Photomultiplier R268	Secondary electron detector	5 years
539-0940	SE tip	Electron gun	1 year
539-1561	Pulse motor (X, Y)	Motor stage	4 years
539-1562	Pulse motor (T, Z)	Motor stage	4 years
539-1563	Mini motor R	Motor stage	2 years
539-1398	Encoder R	Motor stage	3 years
589-3565	Scintillator	For SE detector	3 years
G469023	RP oil (MR-100)	For rotary pump (4 L)	0.5 years
539-1991	Oil mist trap	For rotary pump	0.5 years
K433004	Pirani gauge bulb	Evacuation system	3 years
K439000	Penning gauge	Evacuation system	5 years
—	Rubber tube for evacuation	Evacuation system	5 years
—	Vinyl tube	Evacuation system	3 years
—	PC monitor	PC	5 years
—	Hard disk	PC	3 years
—	Keyboard	PC	3 years
—	Mouse	OC	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
733-3822	Rotary Pump	Evacuation system	5 years

**NOTICE:** The frequency of replacement indicated above does not represent a guaranteed period. Each period shown in the column "Frequency of replacement" is a recommended interval (reference value) calculated on the basis of eight-hour operation per day. Predetermine each interval of replacement in accordance with the actual operating schedule at each site.

### 5.1.3 Spare Parts

The items shown in Table 5-3 must be prepared for long-term operation.

Select a proper quantity in consideration of the application of each part.

**Table 5-3 Spare Parts (Provisional, pending due to fuse change)**

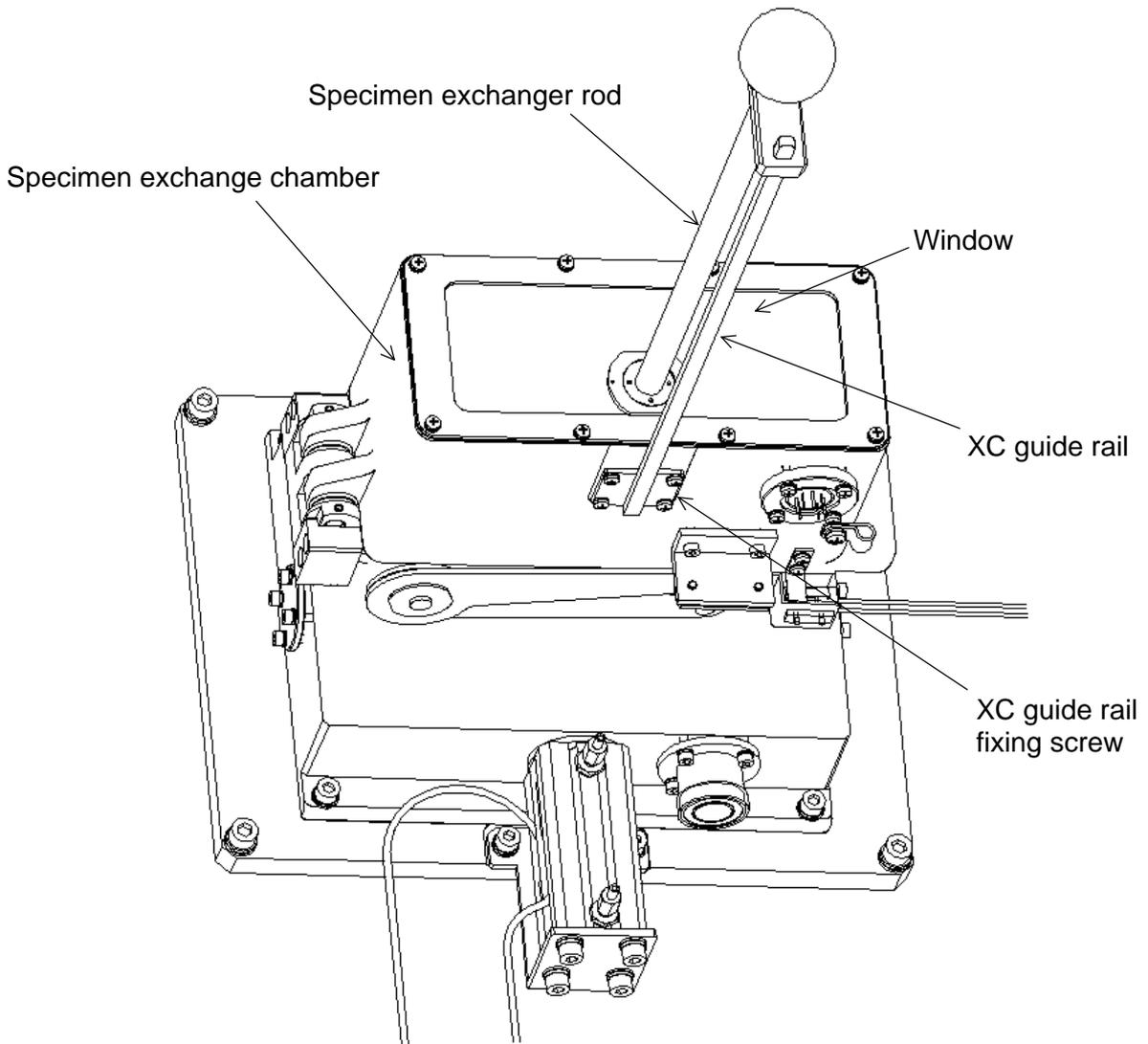
Part No.	Part Name	Location	Q'ty Used
J821153	Fuse LM03		5
J821154	Fuse LM05		9
J821155	Fuse LM10		8
J821157	Fuse LM20		17
J821158	Fuse LM32		10
J821159	Fuse LM50		2
J821361	Micro fuse SVM16		5
J821362	Micro fuse SVM20		6
J821363	Micro fuse SVM32		5
J821364	Micro fuse SVM50		7
J821335	Time lag fuse 2A		5
J821336	Time lag fuse 3.15A		14
J821348	Time lag fuse 4A		6
J821777	Time lag fuse ST4 5A		6
J821394	Time lag fuse ET 5A		1
J821167	Fuse HM 20		1
J821519	Alarm fuse PL 4150		1
J821595	Fuse PL475H	Used in MFG. No. 03-xx or later	1
J821596	Alarm fuse P4100H	Used in MFG. No. 03-xx or later	1
535-1255	Specimen stub	15 mm in diameter	
535-1256	Specimen stub	26 mm in diameter	
433-3702	Specimen stub	15 mm in diameter	
433-3703	Specimen stub	26 mm in diameter	
535-1254	Specimen stub	38 mm in diameter	
L456765	O-ring seal AS568-116FPM	Objective lens aperture unit	
57E-3523	Packing 3 (O-ring)	Specimen exchange chamber gate valve	

## 6. ACCESSORY OPERATION

### 6.1 Procedure for Installing Guide Rail for Specimen Exchange Chamber (for personnel in charge of installation)

Described below is the procedure required when installing the Model SU6600 main unit. Only the personnel in charge of installation is allowed to implement this procedure.

- (1) Explanation of Part  
This part, or guide rail is necessary for using the specimen exchange chamber of SU6600.
- (2) How to Mount the Guide Rail
  - (a) Remove the XC guide rail fixing screws from the specimen exchange chamber (SEC).
  - (b) Pass the XC guide rail through the rectangular hole as shown below.
  - (c) Mount the guide rail with the screws which were removed in (a).



## Declaration of the EC directive for CE Marking in the EU

The instrument requires the following conditions to conform with the LVD directive and EMC directive of EU.

(1) Use of power supply with the below specifications

Power voltage: 200–240V  $\pm$  10%

Frequency: 50/60 Hz

Capacity: 4kVA

Grounding resistance of less than 100  $\Omega$

(2) Use of the below parts that conform to the EU directives

- Step-down Transformer  
(Isolation transformer from 200V–240V to 100V)
- Oil Rotary Pump or Scroll Pump
- Compressor
- Monitor

**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**  
**Type: SU6600**

to which this declaration relates is in conformity with the following standards  
or other normative documents:

**EMC Directive 89/336/EEC,**  
**EN61326: 1997 +A1+A2+A3**  
**Low Voltage Directive 2006/95/EC,**  
**EN61010-1: 2001**

CE Marking is affixed in 2008.

Authorized representative in EU:

**Name: Hitachi High-Technologies Europe GmbH**  
**Address: Europark Fichtenhain A12, 47807 Krefeld,**  
**F. R. Germany**

**Place: Japan**  
**Date: Feb.22, 2008**

  
**Yuuki Nonaka**  
**Senior Engineer**  
**Quality Assurance Dept.**

# APPENDIX: MESSAGE LIST

The following is a list of error or warning messages and countermeasures for them.

(As for errors shown on the evacuation control panel, refer to <2.1.9 >.

Messages simply for instruction or for confirmation are not listed.

Codes with \*mark are shown as “error code”

Code	Message Text	Explanation and Countermeasure
*1301	Repair unsuccessful.	Failed to repair or optimize database file. If the database is available for optimization, please use it. If you tried and failed to repair database when the code 2014 error appeared, contact the 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.	SU6600 uses this login name. Use other names.
2005	Entered parameter is invalid. Adjust the parameter so as to satisfy the following equation. [Measurement Point - 1]x[Multi Pitch] + [Measurement Pitch]x[Summing Line] <= 480	In Measurement option, specified value exceeds allowable range, Re-input following the message.
2007	Invalid login name	Use a login name already registered. 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 not a setup file for PC-SEM. The setup value 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.	This message appears in SEM Data Manager and other programs if data, saved in a database format, cannot be handled normally when an attempt is made to save or read the associated database file. If the message appears when SEM Data Manager is being used or when an image is being saved, try a recovery procedure by using the database recovery tool available in the SEM Data Manager option menu, or in other programs, in SU6600 Help Menu – Save.
2016	Specified file not moved because source and destination folders are 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	{ Entered File name } is already exist.	This message will be shown if the input User name (or login name) is already used when creating a user of SEM data manager, or in the login setup window. Specify another name.
2031	Use this feature at a magnification lower than x5,000.	This message will be shown when trying to register an image of image navigation feature at a higher magnification than x5,000. Please register an image at x5,000 or less.

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 the service engineer.
2033	Rotate R axis after adjusting the X/Y axis to the HOME position.	When observing 4 inches mask sample with WDX installed, X/Y axis can rotate only at the Home position. Move X/Y axis to the home position and rotate them.
2034	Rotate R-axis with 90 degree pitches.	the rotation angle is limited to only 90 deg steps with the above condition.
*2035	Failed in the capture.	Image capturing failed. If the error is repeated, contact the service engineer.
2036	Image Processing is not applied for the selected Capture resolution.	Image Processing function on the operation panel is applicable to 2560 × 1920 pixels or smaller capture size.
*2040	This is not 8 bits image file.	This message appears depending upon the specific nature of processing performed when an attempt is made to handle a non-SU6600 image by saving it in SEM Data Manager. The processing cannot be performed on the specified file.
*2041	The size of image exceeds the maximum resolution 2560 × 1920.	Some commands in the SEM Data Manager limits the available image size depending on the procedure.
2042	Image size is not available except 640 × 480, 1280 × 960, 2560 × 1920.	
2044	Over 2560 × 1920 image size is not available.	
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.	
2050	After Password lock is released, click OK button. Scan mode and scan speed will be set to Normal, Slow1.	This message is shown when password locking is released. The scanning setting will be forced to change.
*2060	Insufficient memory space in a temporary drive. At least 400 MB free area is necessary for PC-SEM startup.	These messages will be shown when available space 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 20 MB free area is necessary for executing this process.	
*2062	Insufficient memory space in a temporary drive. At least 10 MB free area is necessary for executing this process.	
*2063	Insufficient memory space in a temporary drive. At least 1 MB free area is necessary for executing this process.	
2065	Free space in temporary drive is 30 MB or less. System may become unstable. Please quit PC-SEM program and free up the disk space.	

<b>Code</b>	<b>Message Text</b>	<b>Explanation and Countermeasure</b>
2070	For correct operation of the PC-SEM, set the Display properties at 1280 × 1024 pixels for the desktop area, 24 Bit colors for the color palette and 60 Hz or 70 Hz for the refresh rate.	This message will be shown when the desktop is not set as shown in the message. Cancel the SU6600 Login dialog and make setting as requested. Then, restart computer.
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 too many characters for comment.
2107	Please input comment.	[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 extension. Example: If the folder in which the file is to be saved is C:¥ImageFile¥ (13 bytes), the maximum allowable file name is 242 bytes (or 238 bytes, exclusive of the 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.	Delete User is effective only when the user's image list is empty in SEM data manager. Re-execute the command by deleting the list by using the [Remove List] or [Delete Image] command.
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.



Code	Message Text	Explanation and Countermeasure
2140	Invalid file name.	The file name possibly includes characters not allowed ( / : ; , * ? " < >   ).
2141	File name is too long. Up to 255 characters (half space) are acceptable for a file name including folder name.	Use file name shorter than 255 characters including folder name and extension. (half space). Example: If the folder in which the file is to be saved is C:¥ImageFile¥ (13 bytes), the maximum allowable file name is 242 characters (or 238 characters, exclusive of the extension) in single-bytes.
2142	Invalid User name.	The User name possibly includes characters not allowed ( / : ; , * ? " < >   ).
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.
*2150	The maximum number which the user name can be registered is over.	Delete user names not necessary.
2151	Invalid file name.	The file name possibly includes characters not allowed ( / : ; , * ? " < >   ).
2152	File name is too long. Up to 200 characters (half space) are acceptable for a file name.	Use file name shorter than 200 characters (half space) including folder name and extension when saving observation condition.
2153	To use Data No. Save, set Data Number to ON, Auto Increment to ON and put "-" "+" "number" at the end of the Data number.	Setting described on the message is necessary to carry out Data number save. Perform 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 of system administrator is not allowed to delete.
2210	Capacity of floppy disk in not enough.	These are the error occurred when saving an image in a FD. Check the disk, available space, and write-protect.
2211	The FD is Write-protected.	
2212	There is not floppy disk.	
*2213	Cannot save the file in FD.	
3000	Original Image can not be recovered. OK?	The original image will be lost by the operation you are going to execute.
3901	Can input by half space (numerical value) bytes.	You entered too long a login name or password. Please input within the number of a ( ) .

<b>Code</b>	<b>Message Text</b>	<b>Explanation and Countermeasure</b>
4500	Input value or measured value is not correct.	This message will be shown when ratio of correct value and measured value in the calibration operation is out of range.
4501	Present magnification has a fraction. Focus adjustment will cause magnification fraction. Set magnification once and then, carry out calibration measurement.	Magnification changes stepwise by magnification operation and also being corrected continuously by focus change. Measurement will only work with the step-set magnification value. (This is to use calibration result correctly), thus, this message appears after a magnification operation if the magnification is a fractional number after the focusing is changed. Re-execute the command by manipulating the magnification.
4502	Please execute calibration.	This message will be shown when you click the Apply button before performing a Calibration by Measurement (option) – [Calibration].
4503	Please input caption.	Input Caption before applying calibration or measurement parameters by measurement feature (option).
4504	Invalid caption.	The caption possibly includes characters not allowed ( / : ; , * ? “ < >   ).
4505	Caption is too long.	Use Caption shorter than 16 characters (half space).
4510	The number of measurement point on an image exceeds the maximum.	Number of measurement point on an image is limited.
4511	Calibration of another direction not completed.	This message will be shown when you click [Apply] button without completing calibration by Measurement (option) – [Calibration].
4512	Remove the check mark of “Multiple”.	Calibration operation by Measurement (option) – [Calibration] is not allowed in multiple measurement mode.
*4520	An information as SEM-image is missing. You can not measure of this image.	The image under measurement lacks image information (magnification, etc). This error may occur for images registered using [Add from File] command if the image information files have not been copied in the same folder as the images.
4867	Operation start time is not correct.	Please check the setting of the start time in ECO-mode.
4868	Set operation start day for less than 31 days from today.	The start time of ECO-mode setting shall be within 31 days from today.
4869	Set operation start time five hours later from present.	The start time of ECO-mode setting shall be at least 5 hours after present time.
4881	Insert HV cable head in the head holder.	Check if the HV cable head is set correctly to the holder, and put a check mark.
4882	Attach Baking protection cover.	Check if the baking cover is attached correctly, and put a check mark.
4883	Confirm the condition of the surroundings.	Check if there are any problems around for baking, and put a check mark.
4884	A vacuum degree of an electron gun is not enough.	Vacuum of electron gun is not good enough. Baking is not started.
4887	Vacuum status is abnormal.	When Evacuation system is not working properly, or vacuum is not good enough, ECO-mode will not start.
4889	Baking is on-going now. Cannot change to ECO-mode.	ECO-mode can not be set during a baking.
4896	To cancel ECO mode, once turn the EVAC POWER switch to OFF and then, turn it to ON immediately.	Once ECO-mode is started, cannot cancel by command operation. To cancel ECO mode, turn the EVAC POWER switch to OFF once and then, turn it to ON immediately.

Code	Message Text	Explanation and Countermeasure
*5000	X-axis parameter error (Max) please check sample size.	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.	
*5002	Y-axis parameter error (Max) please check sample size.	
*5003	Y-axis parameter error (Min) please check sample size.	
*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. If these errors occur again, contact the 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 about five minutes. If the message is still shown 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 appears when the stage is driven by specifying coordinates when the stage is being driven from the trackball or the joystick. Re-execute the command by suspending the trackball operation.
5040	Cannot execute while initializing X axis	Initialization of each axis in progress. Wait until initialization ends.
5041	Cannot execute while initializing Y axis	
5042	Cannot execute while initializing Z axis	
5043	Cannot execute while initializing T axis	
5044	Cannot execute while initializing R axis	
5045	Cannot execute while initializing differential vacuum aperture	Initialization of differential vacuum aperture is in progress. Wait until initialization ends.
5046	Cannot execute while initializing semi-conductor BSE detector.	Initialization of semi-conductor BSE detector is in progress. Wait until initialization ends.
*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)	

<b>Code</b>	<b>Message Text</b>	<b>Explanation and Countermeasure</b>
*5204	Specimen exchange position error (R axis) (Permissive value: 0.5deg)	This message will be shown when the stage can not be set at the home position correctly. If it happens frequently, contact the service engineer.
*5369	Time out error (R axis)	This message will be shown when the operation does not end within specified time period. If the message is shown frequently, contact the service engineer.
*5984	Stage movement was stopped by opening Specimen exchange valve and inserting specimen exchange rod. Pull off specimen exchange rod and try to drive stage if necessary.	Stage will stop movement when the gate valve between specimen chamber and specimen exchange chamber is open and the specimen exchange rod is inserted. It is to avoid damage to stage or rod by interference. Pull out the rod fully and retry operation.
5985	Set Z axis so as 45 deg. or more tilt is possible.	This calibration operation tilts stage to 45 deg. Set Z axis where 45 deg. or more tilting angle is allowed.
5986	Extract TE detector for the calibration.	This calibration operation sets Z axis to 20 mm. Extract TE detector.
5987	Set Z axis so as 30 deg. or more tilt is possible.	This calibration operation tilts stage to 30 deg. Set Z axis where 30 deg. or more tilting angle is allowed.
5988	Extract all detector(s) for the calibration.	Extract optional detector(s) for the calibration.
5989	Set specimen height error within -0.5 mm to +0.5 mm to keep calibration accuracy.	Set specimen height error within -0.5 mm to +0.5 mm to keep calibration accuracy.
5993	For this operation (1) Extract optional detector(s). (2) Use 5 inches or smaller sample.	For this operation (1) Extract optional detector(s). (2) Use 5-inch or smaller sample.
5994	The X and Y axis for the rotation angle is out of movable range.	The resulting X or Y axis position for eucentric rotation is out of the movable range of X or Y axis. The stage will not move.
*5998	No effective data.	No effective data in the present page.
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 (vertical direction) can not be used.
6000	Too near to stage limit. Set 1 mm or more.	The alignment position is too near the stage limit. Set 1 mm or more away from the limit.
6001	No data of 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 same rotation angle.

Code	Message Text	Explanation and Countermeasure
*7200	Abnormal temperature rise occurred in the power supply. Shut down the PC and turn the [DISPLAY] switch off. Restart the microscope after about half an hour. When this message is shown again, contact service engineer.	This message will be shown when temperature of high power electric circuitry exceeds specified value. Turn the EO control switch off. Wait for about 30 min. Then turn the switch on and start operation. If the message is shown frequently, contact the service engineer.
*7201	Objective lens cooling water failure or Objective lens coil Overheat. Check cooling water flow on the evacuation system. Wait until temperature recovers.	This message will be shown when objective lens cooling water stops or flows at less than necessary flow rate, or when temperature of the objective lens coil exceeds specified value. Check cooling water and, if it is the reason of the error, adjust water flow and leave the message until the error recovers. If the water flow is normal, click OK, shut the PC down and turn the display power switch off. Wait for about one hour. Then turn the switch on and start operation. If the message is shown frequently, contact the service engineer.
7202	Temperature has recovered	This message will be shown when the message code 7200 or 7201 has been shown and the temperature has recovered to normal value. You may continue operation. If message code 7200 or 7201 is shown frequently, contact the service engineer.

<b>Code</b>	<b>Message Text</b>	<b>Explanation and Countermeasure</b>
*7300	Failed to open gun isolation valve (V1). Check evacuation system.	This message will be shown when the gun isolation valve (V1) did not open by HV ON operation. Turn HV OFF and then HV ON again. If the error is repeated, contact the service engineer.
*7301	Failed to close gun isolation valve (V1). Check evacuation system.	This message will be shown when the gun isolation valve (V1) did not close by HV OFF operation. Turn HV ON and then HV OFF again. If the error is repeated, contact the service engineer.
*7302	High voltage power supply is not working. Shut the PC-SEM down and turn DISPLAY switch at OFF. Then, check that the HV cable is correctly put to the electron gun.	High voltage power supply is not working. Turn power switch on. If it is already on, check that the gun high voltage cable and the safety cover are attached correctly. An interlock switch is built in at the end of the cable and if the switch is not turned on by correct setting of the cover, input power of the HV power supply is shut off and this error will happen. Check that the setting is proper, then re-start it.
*7303	High voltage power supply is not working. Check that the HV cable is correctly put to the electron gun.	
*7304	Evacuation system is not working. Check power switch.	The program will not start up if the evacuation system is not working. Check that the EVAC power switch is on and the evacuation system is working normally.
7310	You selected the inapplicable specimen size for present used detector. Pull out the detector, or use applicable size of specimen.	Pull out the detector, or use applicable size of specimen.
7311	Detectors you checked are not allowed to use simultaneously. Set detectors again referring detectors combination table.	Use detectors with allowable combination.
7312	Detectors you checked is not allowed to use with the present using specimen size. Abandon to use the detector, or exchange specimen to allowable size before using the detector.	Pull out the detector, or use applicable size of specimen.
7313	Present position is out of movable T or Z range of Tilt 50 - 70deg mode. Move T or Z to within allowable range.	Click OK. Stage will move T or Z to 50 - 70deg allowable position.
7314	Present position is out of movable XY range of Tilt-Full mode. Move XY to within allowable range.	Click OK. Stage will move X or Y to allowable position for Tilt-Full mode.
7315	Specimen size 25mm or smaller can be used with EBSP detector. Confirm the present specimen size. If it is larger than 25mm, abandon to insert EBSP detector and click Cancel button. If it is 25mm or smaller, click OK button. Stage will move to safety position. After "EBSP Detector" indicator changed to "Insert OK", you may insert EBSP detector.	Check the present specimen size. It must be 25mm (one inch) or smaller. If it is, click OK. If not, click Cancel and pull out EBSP detector. Insert an EBSP detector after an EBSP detector indicator changes to green.

<b>Code</b>	<b>Message Text</b>	<b>Explanation and Countermeasure</b>
7316	The detector(s) you tried to insert are not allowed to use simultaneously with the previously inserted detector. Set detectors again referring detectors combination table.	Pull out the detector you tried to insert. Check allowable detector combination.
7317	The detector you tried to insert is not allowed to use with the present specimen size. Abandon to use the detector, or exchange specimen to allowable size before using the detector.	Pull out the detector you tried to insert. Check allowable detector-specimen size combination.
7318	Stage is moving to safety position. Stop detector insertion during buzzer is sounding. Continue to insert a detector after buzzer stops sounding.	Wait until buzzer stops sounding. After that you can insert the detector.
7319	Stage Initialization aborted to prevent interference with EBSP detector. Retract EBSP detector and then, click [OK] button.	Stage will not do initialization if EBSP detector is inserted. Click OK after retracting the detector.
7320	Stage Initialization aborted to prevent interference with CL detector. If the present specimen size is 4 inches (100mm) diameter or smaller, click [4 inches (100mm) or smaller specimen] button. Stage initialization will be continued. If the present specimen size is 5 inches diameter or larger, retract CL detector and then, click [OK] button.	Check the present specimen size. If it is 4 inches (100mm) diameter or smaller, click [4 inches (100mm) or smaller specimen]. If not, retract CL detector and click OK.
7321	Stage Initialization aborted to prevent interference with EBSP and / or CL detector. Retract both EBSP and CL detectors and then, click [OK] button.	Retract both EBSP and CL detectors and then, click [OK] button.
7322	Stage Initialization aborted to prevent possible interference with EBSP detector. If EBSP detector is inserted, retract it and then, click [OK] button.	Check if EBSP detector is inserted. If it is, retract it. Confirm EBSP is fully retracted and click OK.
7323	Stage Initialization aborted to prevent possible interference with CL detector. If CL detector is inserted, retract CL detector and then, click [OK] button. If CL detector is not inserted, just click [OK] button.	Check if CL detector is inserted. If it is, retract it. Confirm CL is fully retracted and click OK.
7324	Stage Initialization aborted to prevent possible interference with EBSP and/or CL detector. Retract both EBSP and CL detectors and then, click [OK] button.	Check if EBSP or CL detector is inserted. If it is, retract both. Confirm both EBSP and CL detector are fully retracted and click OK.
7325	Confirm that EBSP detector is retracted completely and then, click [OK] button.	Check if EBSP detector is inserted. If it is, retract it. Confirm EBSP is fully retracted and click OK.

Code	Message Text	Explanation and Countermeasure
7326	Confirm that CL detector is retracted completely. Then, click [OK] button.	Check if CL detector is inserted. If it is, retract it. Confirm CL is fully retracted and click OK.
7327	Confirm that both EBSP and CL detectors are retracted completely and then, click [OK] button.	Check if EBSP or CL detector is inserted. If it is, retract both. Confirm both EBSP and CL detector are fully retracted and click OK.
7328	Rotate R axis after adjusting the X/Y/Z/T axis to the HOME position.	When 5 inches mask sample is used and WDX is installed, rotation is possible to be operated X/Y/Z/T axes at home position.
7329	The detector you tried to insert is not allowed to use with the present specimen height. Abandon to use the detector, or change specimen height that can be used before using the detector.	Stop detector insertion and re-adjust specimen at standard height.
7330	Stage stopped by detector insertion during EXC operation. Only HOME or EXC operation possible.	Stage stopped by detector insertion while moving to EXC position. Only HOME or EXC operation possible.
7331	Stage stopped by detector insertion during HOME operation. Only HOME operation possible.	Stage stopped by detector insertion while moving to Home position. Only HOME or EXC operation possible.
7332	Stage is moving to safety position. Begin detector insertion after stage stops its motion.	Wait until stage stops moving. Then start detector insertion.
*7340	Electron Gun was shut down due to hardware error.	Electron Gun was shut down due to some error in high voltage supply unit. Contact a service engineer.
*7341	Electron Gun was shut down due to gun chamber vacuum error.	If it happened just by the first HV-ON operation after the specimen chamber was at atmospheric pressure, repeat open-close of gun isolation valve ten times referring 2.3.22 of instruction manual. Then carry out gun starting up. If it happens again, contact a service engineer.
*7342	Electron Gun was shut down due to emission or filament over current error.	In almost case it happens by emission over current. Try gun starting up. If the result is not normal, contact a service engineer.
*7343	HV forced OFF due to specimen chamber vacuum error or exchange chamber operation. (HV part safety interlock actuation will also show this message.)	Try to apply HV after specimen chamber vacuum recovered. This HV shut off will occur also when you operated exchange chamber air or gate valve open, or the interlock switch at deceleration voltage connector at the side of specimen stage is released. Specimen chamber vacuum degrading may occur when Liq-N2 in the cold trap is emptied and absorbed gas is released. If the shutting down occurs without above considerable reason, contact a service engineer.
*7350	There is an adverse effect in the longevity etc. of the chip if the current value is improper. Please choose whether to use this value temporarily or to apply every time from now on.	This message is shown when you change the filament current value at gun starting up. Do not change filament current value by your own decision. It can be done only by instruction by service engineer.
7360	A differential vacuum aperture unit is not attached. Click the (Apt.In) button to insert a differential vacuum aperture unit.	This message appears if the differential vacuum aperture unit is not inserted when the mode is changed to the low-vacuum mode. Operate the system by inserting the differential vacuum aperture unit.



7361	The differential vacuum aperture unit cannot be removed when the low-vacuum mode is on or when the mode is being changed to it.	This message appears when an attempt is made to remove the differential vacuum aperture unit when the low-vacuum mode is on or when the mode is being changed to it. Remove the differential vacuum aperture by verifying that the high-vacuum mode is on.
7362	This is a differential vacuum aperture unit / semiconductor BSE detector operation error. Initialize the system.	This message appears if an error occurs when the differential vacuum aperture unit or the semiconductor BSE detector is operated.
7363	If the error recurs during initialization following an error, contact a service engineer.	This message appears if an error occurs when the differential vacuum aperture unit or the semiconductor BSE detector is operated. Contact a service engineer.