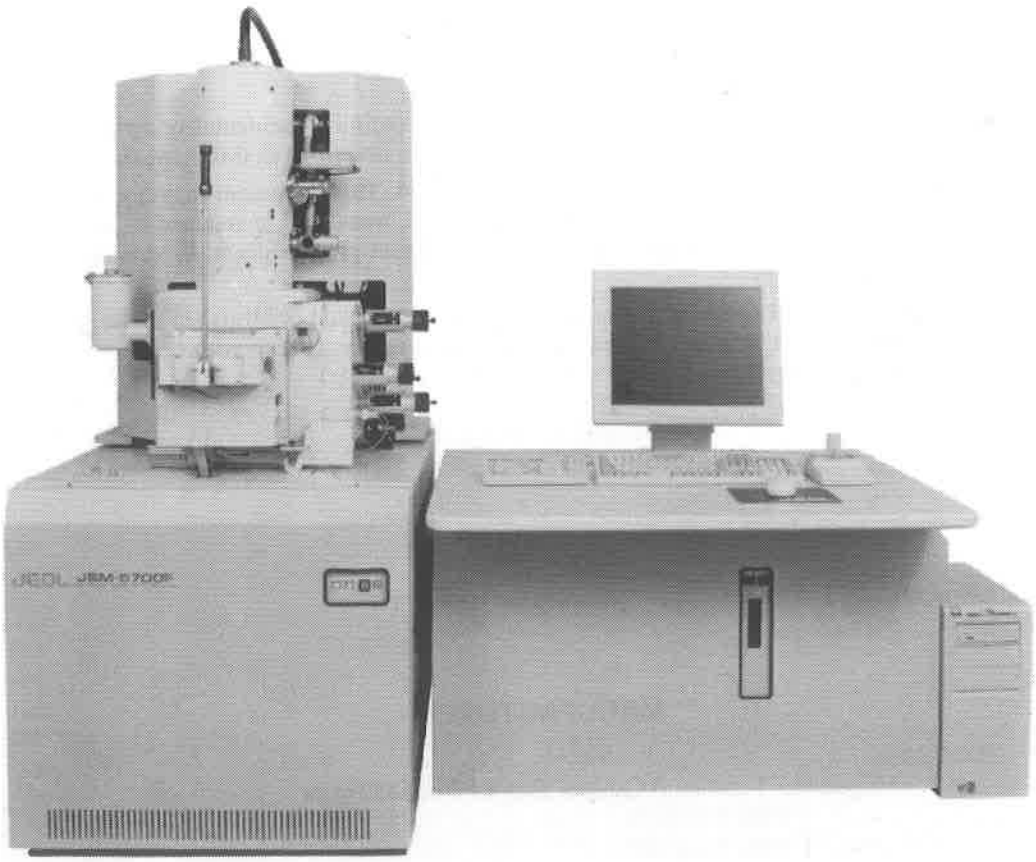
JSM-6700F

FIELD EMISSION SCANNING ELECTRON MICROSCOPE



NOTICE

- This instrument generates, uses, and can radiate radio-frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to the environment, especially radio communications.
- This instrument must not be modified, and products other than those manufactured by JEOL Ltd. must not be attached to this instrument, without prior written permission. If any such modification or attachment is made, all the stipulated warranties and services contracted by JEOL Ltd. or its affiliated company will be void.
- Replacement parts for maintenance of the instrument performance are available for seven years from the date of installation. Thereafter, some of those parts may be available for a certain period of time, and in this case, an extra service charge may be applied for servicing with those parts. Please contact your local service office for detail.
- The information in this manual, which is based on specifications believed correct at the time of publication, is subject to change without notice due to improvements made in the instrument.
- In order to assist us in preparing future documentation, please advise your nearest JEOL service office if you find any errors in this manual.
  Kindly note that while the instrument can be used in combination with various attachments to serve a number of purposes, this special feature of the instrument is only briefly described in this manual, which chiefly provides information on basic operations.
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MANUFACTURER

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Note: For servicing or inquires, please contact your service office.

CONTENTS

SAFETY PRECAUTIONS

For the proper use of the instrument, be sure to read the following safety precautions prior to starting operation or maintenance. They contain important information related to safety. Contact your JEOL service office whenever you are unclear about an operation or maintenance. Please keep the operation manual close at hand so that you can consult it whenever necessary.

The safety definitions and their meanings used in our company's operation manuals are as follows:

⚠ **WARNING:** A potentially hazardous situation which, if not avoided, will result in death or serious injury.

⚠ **CAUTION:** A potentially hazardous situation which, if not avoided, may result in minor injury or material damage.

Do not touch the parts labeled with the following signs:
Examples:

We request that you use the instrument in a proper manner and in the scope of the purposes and usage described in the brochures and operation manuals. Never make modifications such as removing protective parts, exchanging component parts and unlocking safety measures.

⚠ WARNINGS

■ General warnings

- Do not unlock or remove any covered parts, modify or remove component parts, or dismantle these parts in any way other than their intended use, due to a risk of thermal, electrical or emissive hazards taking place.
- Never remove the grounding wire or connect it to any other location than that specified, due to a risk of electric shock.
- When moving the instrument is required, various hazards are expected. Confirm the specifications and installation requirements for the instrument, check the state of the new installation site and consult your local service center.
- When performing maintenance, checks, or routine operations, never stand on the operation console table, a stool or the instrument frame.

- There are potential hazards, concerning the high voltage and magnetic field, which may take place while a service engineer is disassembling or repairing the instrument for maintenance. Keep well away from the instrument on such occasions.

■ Warnings when replacing the oil diffusion pump heater

- When replacing electrical parts such as the oil diffusion pump heater by removing the side panels of the operation and display system console, power supply unit, or SIP/BAKEOUT power supply unit, be sure to stop the instrument, as there is a risk of electric shock due to the high voltage.
- Be sure not to touch the boiler and cover of the oil diffusion pump immediately after its heater has broken, as these parts are very hot and burns can occur.
  To return the heated parts to room temperature, keep cooling water flowing for 30 minutes or more.

■ Warnings when using a nitrogen gas cylinder

- Dry nitrogen gas is supplied at high pressure in a compressed gas cylinder and must be handled with care.
  Prior to use, ensure that:
  - there is no furnace or heating appliance near the gas cylinder
  - there is no electric wiring near the gas cylinder
  - the gas cylinder is installed on a special stand or secured to a wall with chains
  - the temperature in the area where the gas cylinder is installed does not exceed 40℃
- Never apply any mechanical shock to the gas cylinder during operation. A cylinder valve open/close handle used for opening and closing the gas cylinder should be provided on the top of the gas cylinder to minimize hazards in an emergency.
- Normally, an expiration date is indicated on compressed gas cylinders. Check this and use a gas cylinder that has passed pressure-withstanding tests.
- Do not stand in front of the pressure gauge when adjusting or reading the pressure. Be sure to operate the pressure control wheel from an off-centered position to avoid possible injury from a potential pressure gauge break or a pressure valve break.
- When handling high pressure gases such as nitrogen gas in an enclosed room, regardless of the amount, be sure to open the windows and doors to ventilate the room.
  Although nitrogen gas is inactive and generally harmless, leakage of a large amount of the gas may lower oxygen concentrations in a room, and suffocation can result.

⚠ CAUTIONS

■ General cautions

- If anything abnormal occurs with the instrument, immediately stop operation. To stop the instrument, follow the instructions in Subsection 5.1.4 "Action to Take in an Emergency", then contact your local service center.
- If a power failure occurs, the instrument will automatically stop operation. When restarting the instrument after a long power failure (4 hours or more), contact your local service center. If a water failure occurs, the high voltage and lens power supplies are shut down automatically. When the water supply resumes, restart the instrument.
- When installing the specimen holder or inserting the objective lens aperture, take care not to get your fingers caught in the space between the specimen exchange chamber and the specimen exchange rod, and the space between the selecting knobs.
- Since the microscope column is placed on the frame via the anti-vibration mount, the microscope column will sway a little even when you operate the knobs. Take care not to get your fingers caught in any space that results from this sway.
- An instrument that has been installed properly will usually not vibrate or give off annoying noises. Should this occur, stop the instrument immediately and contact your local service center.

■ Cautions concerning the oil rotary pumps

- Be sure not to remove the rubber hose from the oil rotary pump during operation.
  If you do so, the oil in the oil diffusion pump will flow back to the microscope column, causing serious damage to the instrument.
- Do not let the oil level of the oil rotary pump fall below the lower limit even though the pump can operate down to this limit. If the pump is left with only a small quantity of oil, hard-to-repair problems can occur.

■ Cautions when disassembling the microscope column for cleaning

- When it becomes necessary to perform maintenance that requires disassembling and cleaning the microscope column or replacing parts other than those specified in Chapter 7 "MAINTENANCE", consult your local service center.
- When you clean microscope column components, use as a cleaning agent a nonflammable highly volatile highly efficient solvent that is free from impurities and is not harmful to the human body. Be sure to use the solvent in a location free from combustible material and sources of

ignition and with open windows or proper ventilation, regardless of the quantity.

- When you use the cleaning agent, be sure to wear protective gloves that are resistant to the solvent.

■ Cautions concerning optional attachments

- Liquid nitrogen trap:
  When replenishing the liquid nitrogen vessel with liquid nitrogen, take care that liquid nitrogen does not overflow the vessel or splash on the peripheral areas.
- Large specimen exchange airlock:
  When opening or closing the specimen exchange chamber valves, take care not to get your fingers caught in the spaces between knobs.
- Specimen heating holder:
  In use, the specimen heating holder reaches temperatures of up to 110℃. Since the tip of the heating holder is kept at the same high temperatures, take care not to touch it with bare hands.
- Cryo system:
  Since in use, the tip of the specimen cooling holder is kept in the cryogenic state with the liquid nitrogen, take care not to touch it with bare hands.
- Backup power supply for ion sputter pump:
  There is a risk of electric shock when the UPS-401 backup power supply is used. Take care not to touch this power supply. It is maintained only by JEOL service personnel.
- Energy dispersive X-ray analyzer:
  1) Do not install or remove the energy dispersive X-ray analyzer on or from your instrument by yourself. If such a necessity arises, contact your local service center.
  2) Use a stable and safe stool when replenishing the liquid nitrogen tank with liquid nitrogen. Take particular care not to be splashed with liquid nitrogen during replenishment.
  3) Take care not to touch the analyzer drive motor shaft during measurement.
  4) The analyzer window uses a beryllium thin film for light element detection. Beryllium is harmful to the human body, so take particular care when handling the analyzer.

1

GENERAL

The JSM-6700F is a high-resolution and easy-to-operate scanning electron microscope, which employs a field-emission gun for the electron source and state-of-the-art computer technology for the image-display system.

A combination of a conical field emission gun and semi-inlens objective lens results in a high-resolution image; a 1280×1024 pixel high-definition display system enables a fine flicker-free image even in slow-scan conditions and makes it possible to operate the SEM in a lighted room; and mouse/panel/keyboard operation with on–screen menu bar and condition-setting windows offers easy and smooth operations in all stages from condition setting to image observation.

Employing the Windows NT operating system provides high networking performance as well as easy and smooth operations in all stages from condition setting to image observation and filing with the JEOL-specific graphic user interface.

The JSM-6700F is a super intelligent PC-SEM that can flexibly cope with the development of the computer technology.

When the electron probe illuminates the specimen, secondary electrons, backscattered electrons, transmitted electrons, characteristic X-rays, and so forth are emitted from the specimen surface as shown in Fig. 1.1. In order to detect these as signals or for other research purposes, the JSM-6700F can accommodate a variety of optional attachments. By effectively combining these attachments, you can fully expand the scope of application of this instrument, allowing multiple information to be drawn out of the surfaces of the specimen.

For example, if equipped with an energy dispersive spectrometer (EDS), the instrument can also be used as an electron-probe microanalyzer, allowing accurate, efficient and non-destructive element analysis or element distribution observation of micro-areas on the specimen surfaces or cross-sections. This capability is very useful in the fields of materials science such as metals, minerals, semiconductors, and new materials, as well as biology and industrial research.

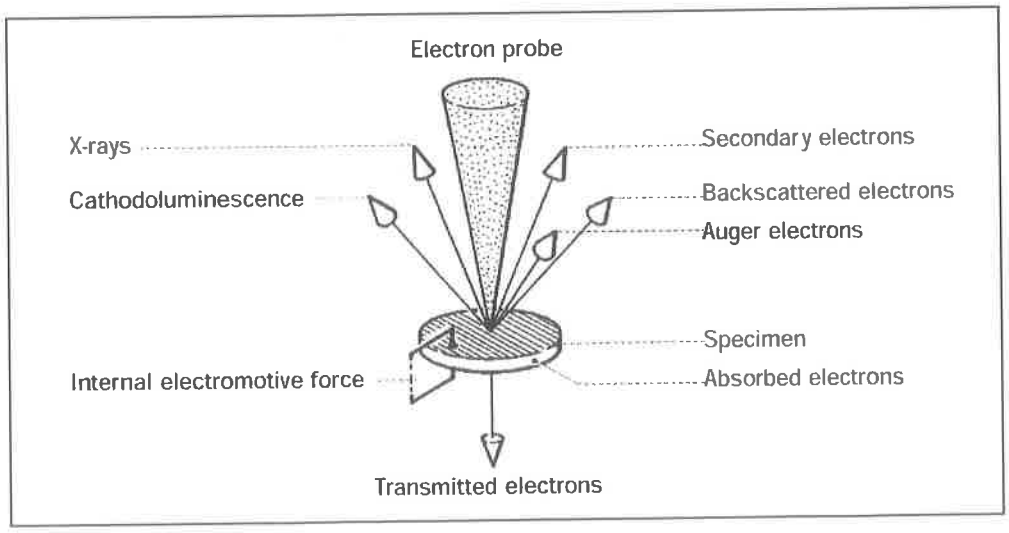


Fig. 1.1 Signals from specimens

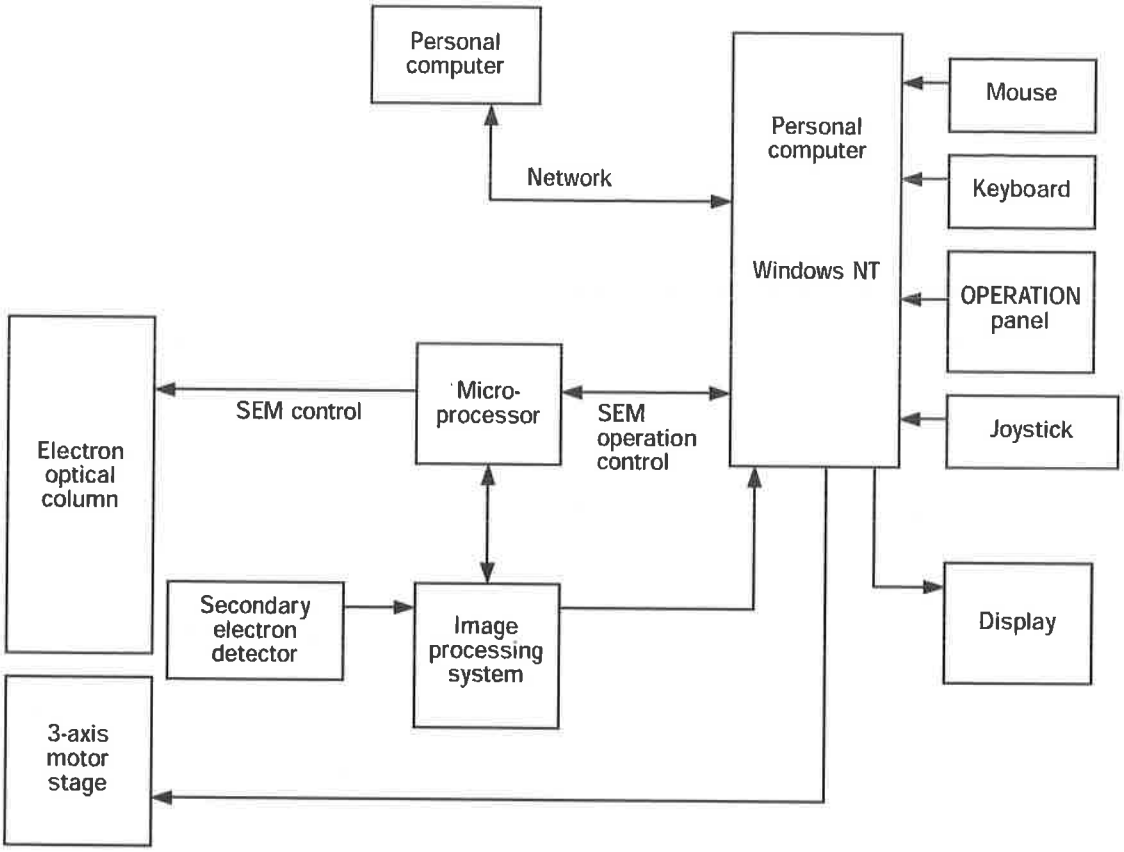


Fig. 1.2 Outline of operation system

■ Principle of Field Emission

Thermoelectrons are emitted from the surfaces of metals, oxides, and borides when they are heated to a high temperature. Conventional thermionic electron guns make use of this thermionic emission. On the other hand, a field emission takes place on the surface of a sharp-pointed emitter made of metals, oxides or carbides when a strong electric field is present at the surface. Field emission electron guns make use of this field emission.

Many field emission guns are now used as electron sources in electron microscopes because of their high brightness. Special precautions, however, are required when handling a field emission gun since it is highly sensitive to the condition of the emitter surface.

For a field emission gun, a voltage of several thousand volts is applied between the extraction electrode and the cathode, which has a sharp-pointed tungsten metal tip. Since the tip has a curvature radius of about 100 nm, a strong electric field of about 10^7 V/cm is usually created at the cathode tip and electrons are emitted from the tip by the tunnel effect. The amount of electrons emitted greatly depends on the work function of the cathode surface. When gas molecules are adsorbed on the cathode surface, the amount of electrons emitted changes with the work function. The cathode surface becomes rough due to ion bombardment, and finally the cathode becomes ruined. Therefore, the electron gun (especially the vicinity of the cathode) must be placed under clean, ultrahigh vacuum conditions in order to obtain a stable electron emission for a long time.

Fig. 1.3 shows a schematic diagram of the JSM-6700F electron gun. We call the cathode the emitter, the electrode for extracting electrons the extraction electrode and the electrode for determining the final energy of the emitted electrons the anode.

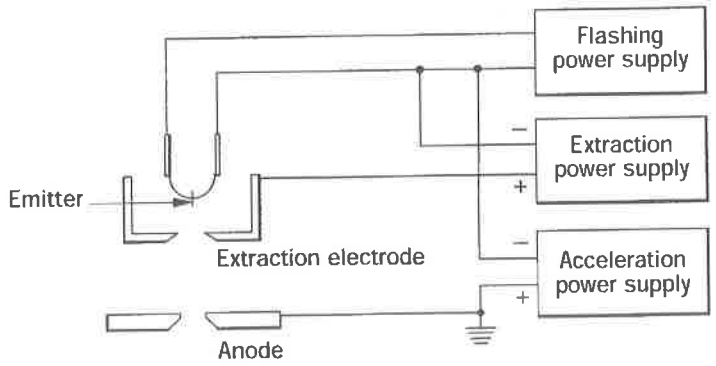


Fig. 1.3 Field emission electron gun

Fig. 1.4 shows the change in emission current with time. First, electrons are emitted from a clean emitter tip under a constant extraction voltage condition. Later, molecular adsorption changes the amount of the electrons and finally ruins the tip. A small amount of residual gas molecules, even under an ultrahigh vacuum of 10^{-8} Pa, is adsorbed on the emitter surface, causing the work function of the emitter surface to be changed. Therefore, the emission current initially decreases and the amount fluctuates slightly due to gas molecule migration. Once the emitter surface has been totally covered with gas molecules, the fluctuation of emission ceases and a comparatively stable emission is obtained.

Since the emission current becomes low in the stable range, it is necessary to increase it by raising the extraction voltage. As the field emission continues, the emission current becomes unstable and increases because the emitter surface is roughened by bombardment of ionized gas molecules. Consequently, the emission current increases abruptly and finally ruins the emitter. It is therefore necessary, before the emitter is ruined, to clean and smooth the rough emitter surface by periodically heating the emitter for a short time. This procedure is called "flashing".

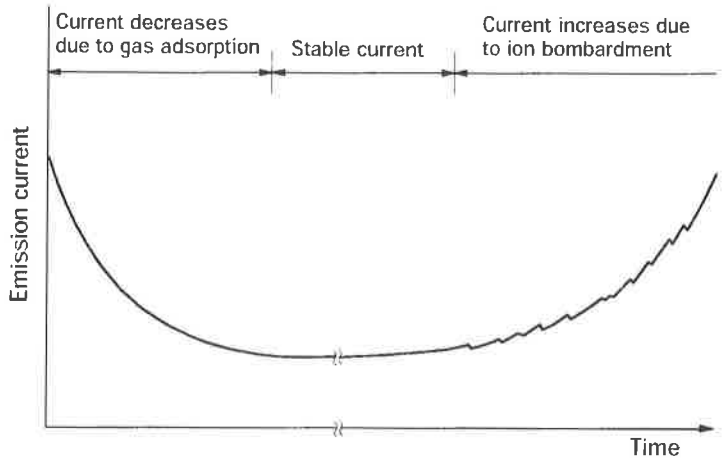


Fig. 1.4 Change in emission current

2

COMPOSITION AND CONSTRUCTION

2.1 COMPOSITION

The JSM-6700F basic unit is composed of an electron optical system (column, vacuum system and main console), an operation and display system (personal computer, PC control interface, optional 3 axis motor stage controller, image processing system, OPERATION panel, keyboard, mouse, main power supply and SIP/BAKEOUT power supply, observation display) and an oil rotary pump.

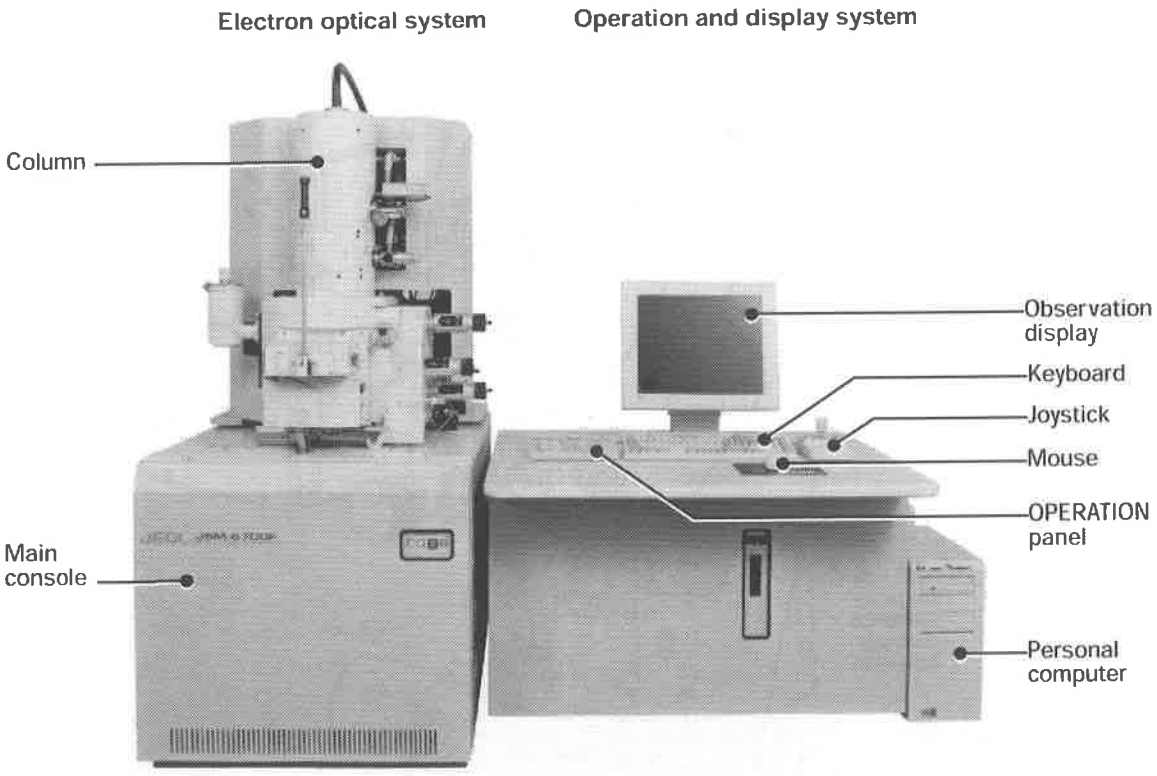


Fig. 2.1 External view of JSM-6700F

2.2 COLUMN

The principal sections of the electron optical system column are shown in Fig. 2.2.

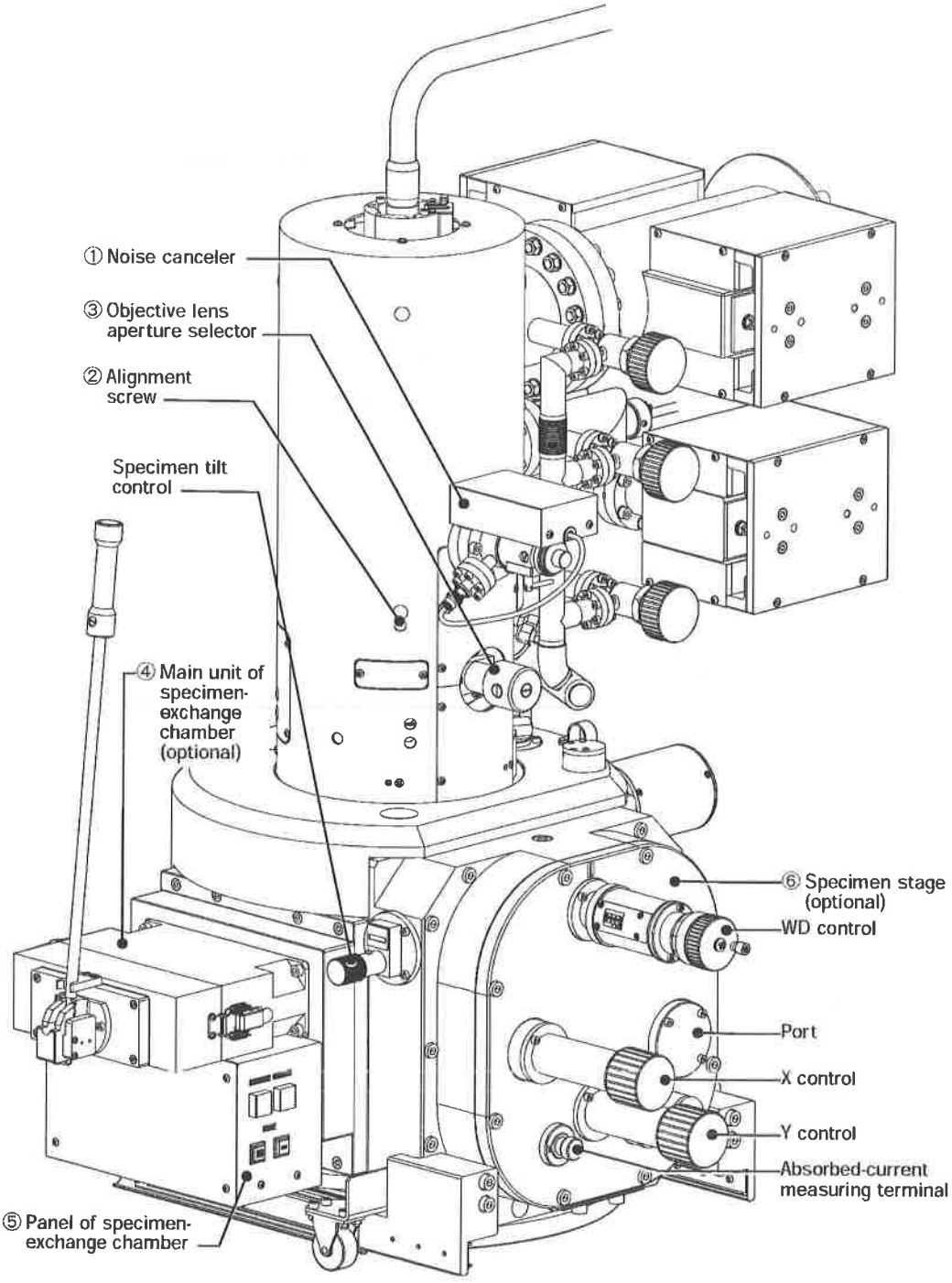


Fig. 2.2 General view of column

2.3 OPERATION AND DISPLAY SYSTEM

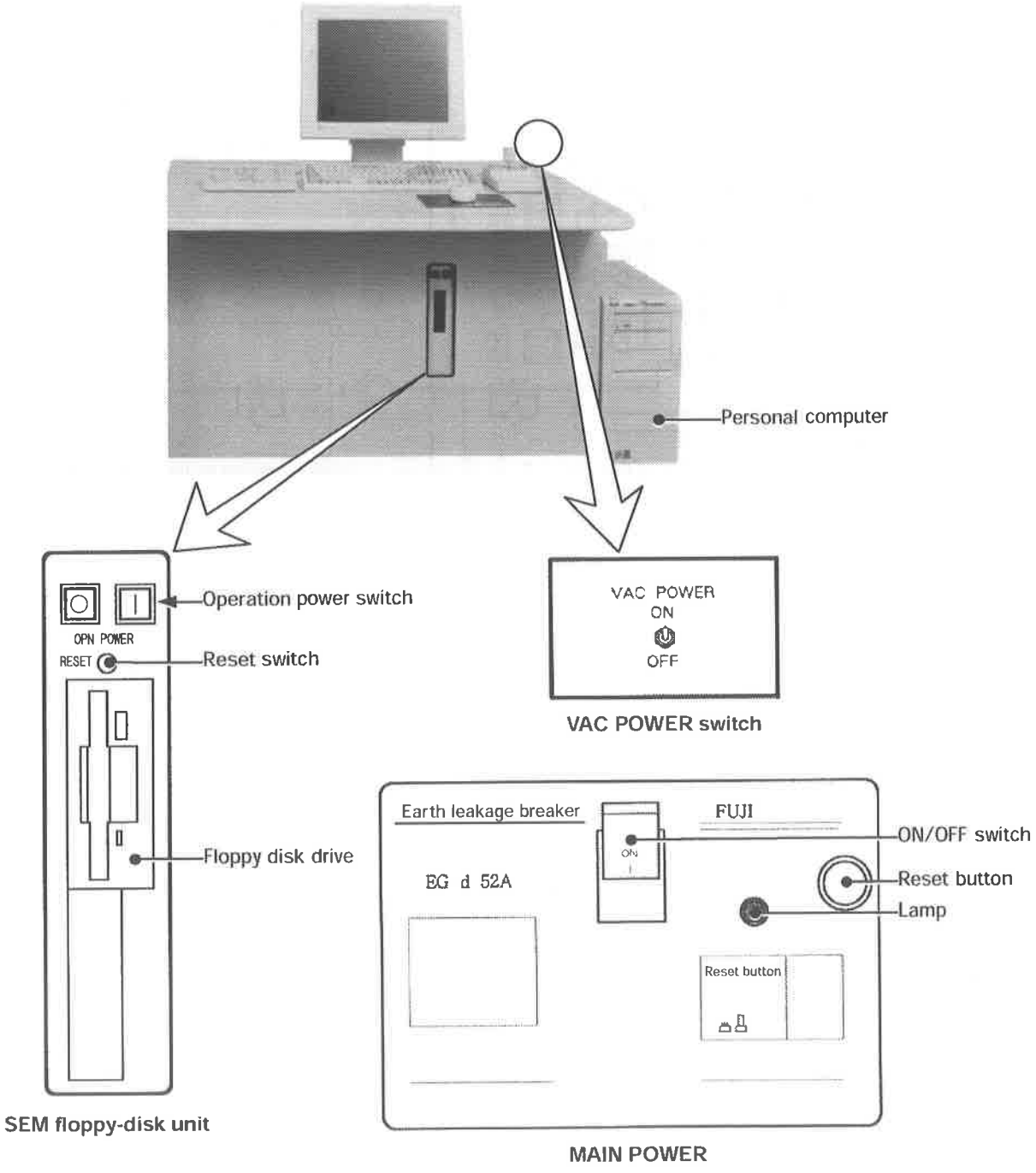


Fig. 2.3

2.4 SYSTEM DIAGRAMS

The vacuum and compressed gas systems are shown in the following schematic diagrams.

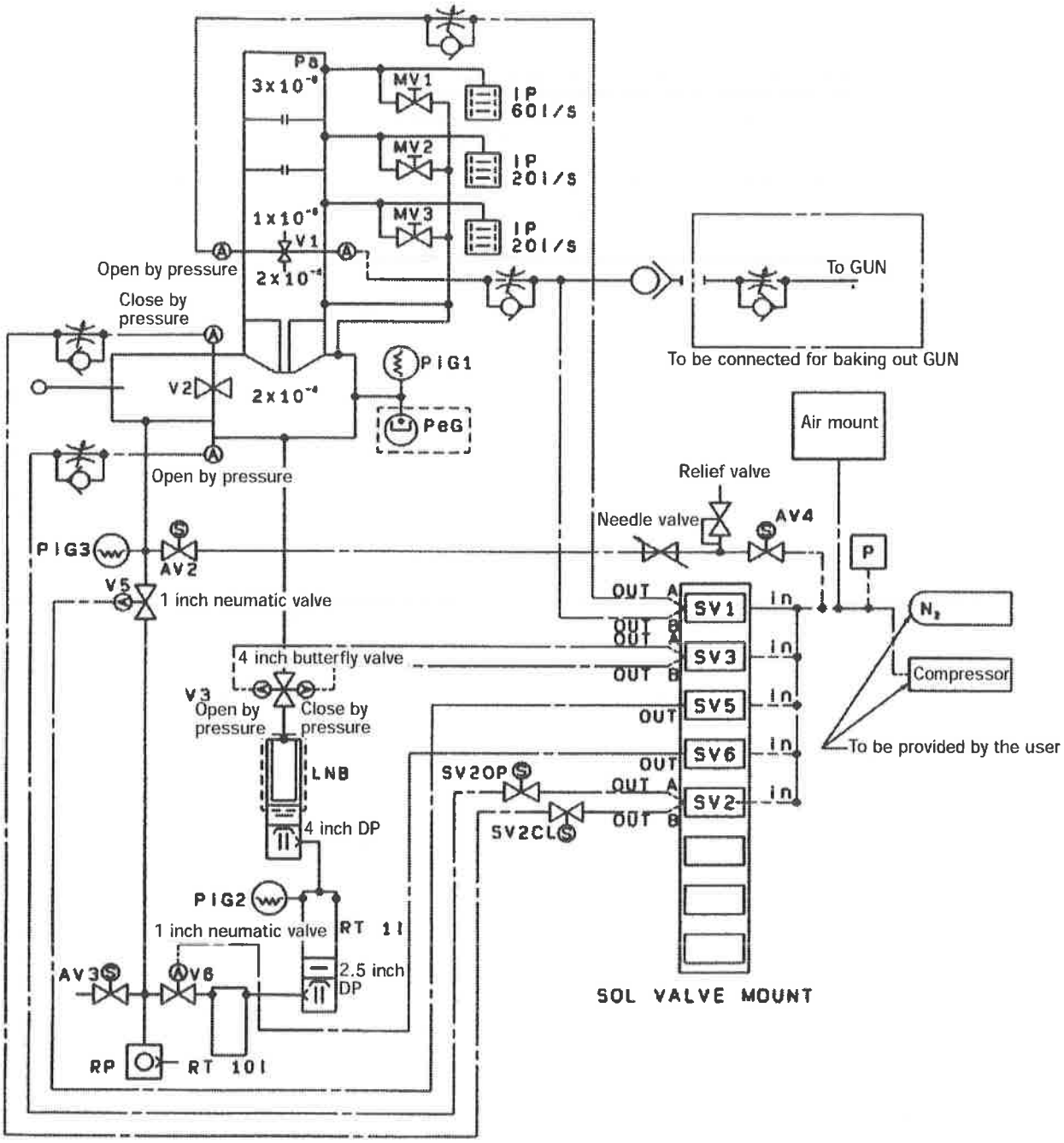


Fig. 2.4 Vacuum and compressed gas systems

Table 2.1 Opening/closing the vacuum valves

○: Open Blank: Closed

Valves and pumps	V1	V2	V3	V5	V6	AV2	AV3	AV4	MV1	MV2	MV3
Shutdown							○				
Oil diffusion pump					○						
Gun rough pumping		○		○					○	○	○
Gun fine pumping		○	○		○				○	○	○
Specimen chamber rough pumping		○		○							
Specimen chamber fine pumping		○	○		○						
During observation	○	○	○		○						
Specimen chamber venting		○			○	○		○			
During bakeout (SIP evacuation)		○	○		○						
Specimen exchange chamber rough pumping			○	○							
Specimen unloading and loading		○	○		○						
Specimen exchange chamber venting			○		○	○		○			

*1. The electron gun chamber isolation valve, V1, is opened by pressing the Accelerating Voltage On/Off button HT.

2. Never open the manual valves, MV1, MV2 and MV3. They are used only when replacing the emitter. If you need to replace the emitter, contact your local JEOL service center.

3. If the specimen chamber is vented, the Accelerating Voltage On/Off button HT changes its color from black to blue two hours or more after start of re-evacuation.

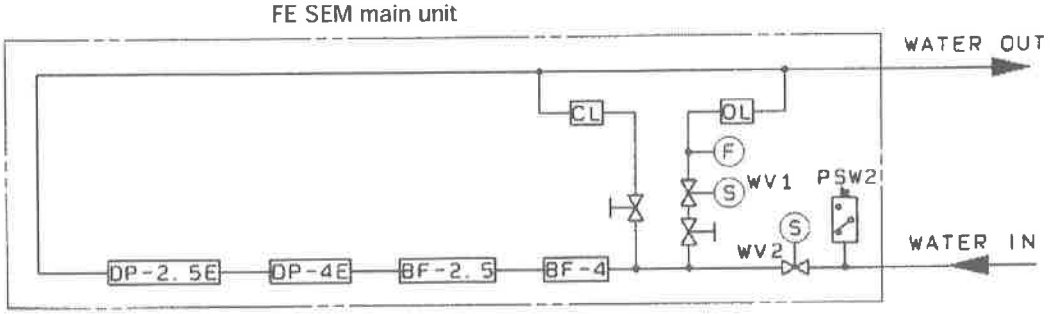


Fig. 2.5 Cooling water system

2.5 GENERAL SYSTEM DIAGRAM

Primary electron beams generated from the electron gun are scanned on the specimen surface by the deflector. Secondary electrons and backscattered electrons emitted from the specimen are detected as electrical signals by the secondary electron detector (SED: scintillator/photomultiplier) and an optional retractable backscattered electron detector (BED: two-segment semiconductor type), respectively. These electrical signals are fed into the respective video amplifiers via the preamplifiers.

The video signals amplified by the video amplifiers are fed to the image processing system via the image selector (IMS) and displayed as two-dimensional intensity distribution images (secondary electron image, backscattered electron image or absorbed electron image). Incidentally, in the backscattered electron image mode, two types of images are available, a topographic image and a compositional image.

The video signals fed from the IMS are integrated, image-processed and displayed on a 1,280 × 1,024 pixel display as a two-dimensional high-quality dynamic image.

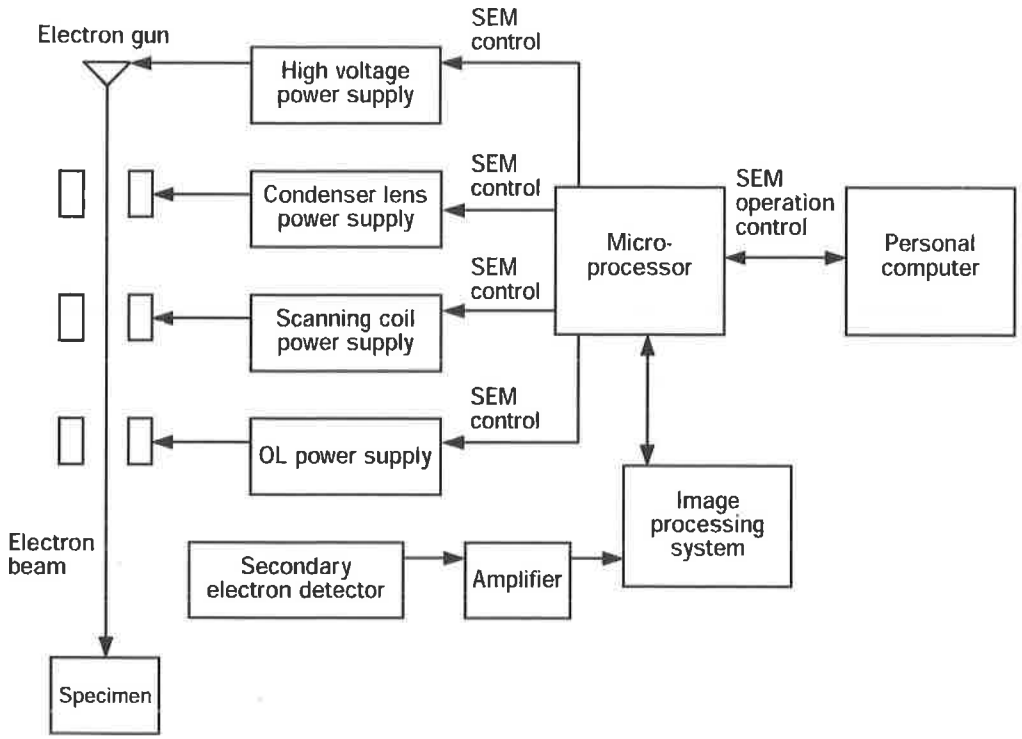


Fig. 2.6 General system diagram

2.6 ACCESSORIES

- Noise canceler aperture
- Objective lens aperture
- Scintillator
- Specimen holders
  - 12.5 mm (dia.) × 10 mm (hgt.) specimen holder (height adjustable)
  - 26 mm (dia.) × 10 mm (hgt.) specimen holder (height adjustable)
- Specimen stubs
  - 12.5 mm (dia.) × 5 mm (hgt.)
  - 12.5 mm (dia.) × 10 mm (hgt.)
- Vacuum grease

Note: These accessories are subject to change without notice.

3

DESCRIPTION OF EACH UNIT

This chapter briefly describes the functions and uses of the knobs, switches and other operating controls that have a direct bearing on operation.
The numbers ① to ⑥ here are linked to Fig. 2.2 General view of column.

3.1 COLUMN

① Noise canceler

Used for noise reduction in scanning images at each scanning speed.
Never tamper with the centering lever and centering screw since these are factory-adjusted and are to be used by a service engineer.

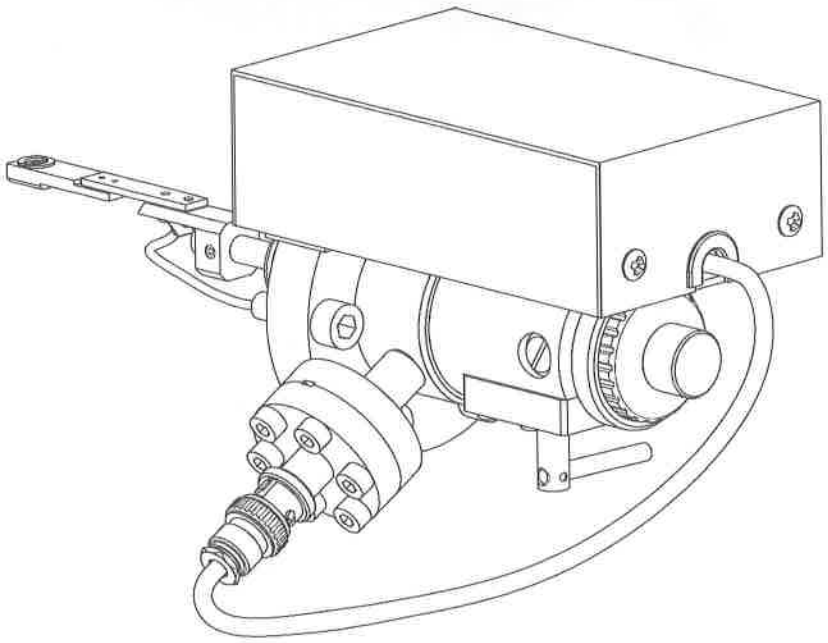


Fig. 3.1 Noise canceler

② Alignment screws

The alignment screws are factory-adjusted, and all these screws are tightened.
Never unfasten any of them since trouble may result if they are unfastened.

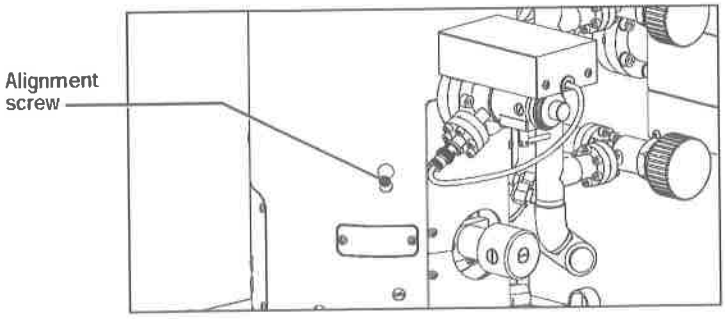


Fig. 3.2 Alignment screws

③ Objective lens aperture selector

The objective lens aperture has been set to the number 4 on the scale at the time of installation.

Never use the objective lens aperture selector since trouble may result if it is used.

If the alignment is required, perform it on the screen of the display.

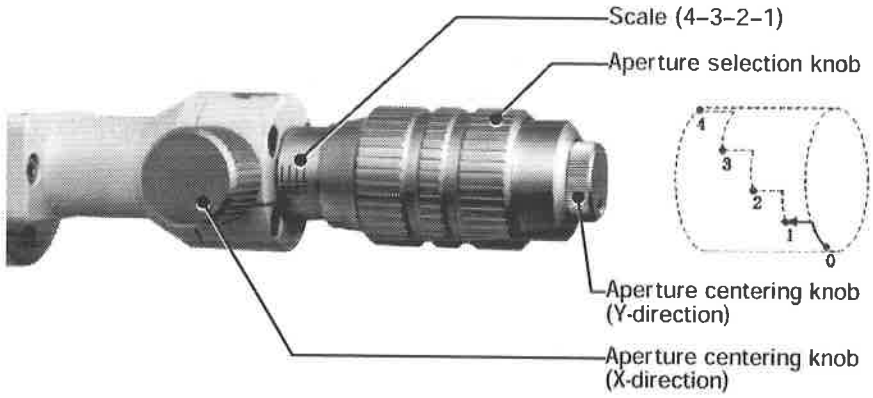


Fig. 3.3 Objective lens aperture selector

Table 3.1 Selection of objective lens apertures

Scale	Aperture diameter (μm)	Probe current indication coefficient	Purpose of use
4	30	Approx. 1	Used for all the image observations
3	50	Approx. 2	Not to be used for observation
2	70	Approx. 5	Not to be used for observation
1	110	Approx. 10	Not to be used for observation
0	1,000	—	Used for alignment by the service engineer

④ Main unit of the specimen-exchange chamber

Locking hook: Used for locking the lid of the specimen-exchange chamber.

Specimen-exchange rod: Used for inserting and withdrawing the specimen holder.

Specimen-holder chuck device: Used for chucking the specimen holder in the specimen-exchange chamber when mounting it on the specimen stage, and for chucking the specimen holder on the specimen stage when returning it to the specimen-exchange chamber.

⑤ Panel of the specimen-exchange chamber

VENT button lamp: The lamp is out when the specimen-exchange chamber is under high vacuum.
The lamp blinks during venting of dry nitrogen gas into the specimen-exchange chamber to bring it to atmospheric pressure.
The lamp is on when the specimen-exchange chamber is at atmospheric pressure.

EVAC button lamp: The lamp is off when the specimen-exchange chamber is at atmospheric pressure. The lamp blinks during evacuation of the specimen-exchange chamber to bring it to high vacuum.

EXCH POSN indication lamp: The lamp lights up when the specimen stage is in the specimen-exchange position.

HLDR indication lamp: The lamp lights up when the specimen holder is mounted on the specimen stage.

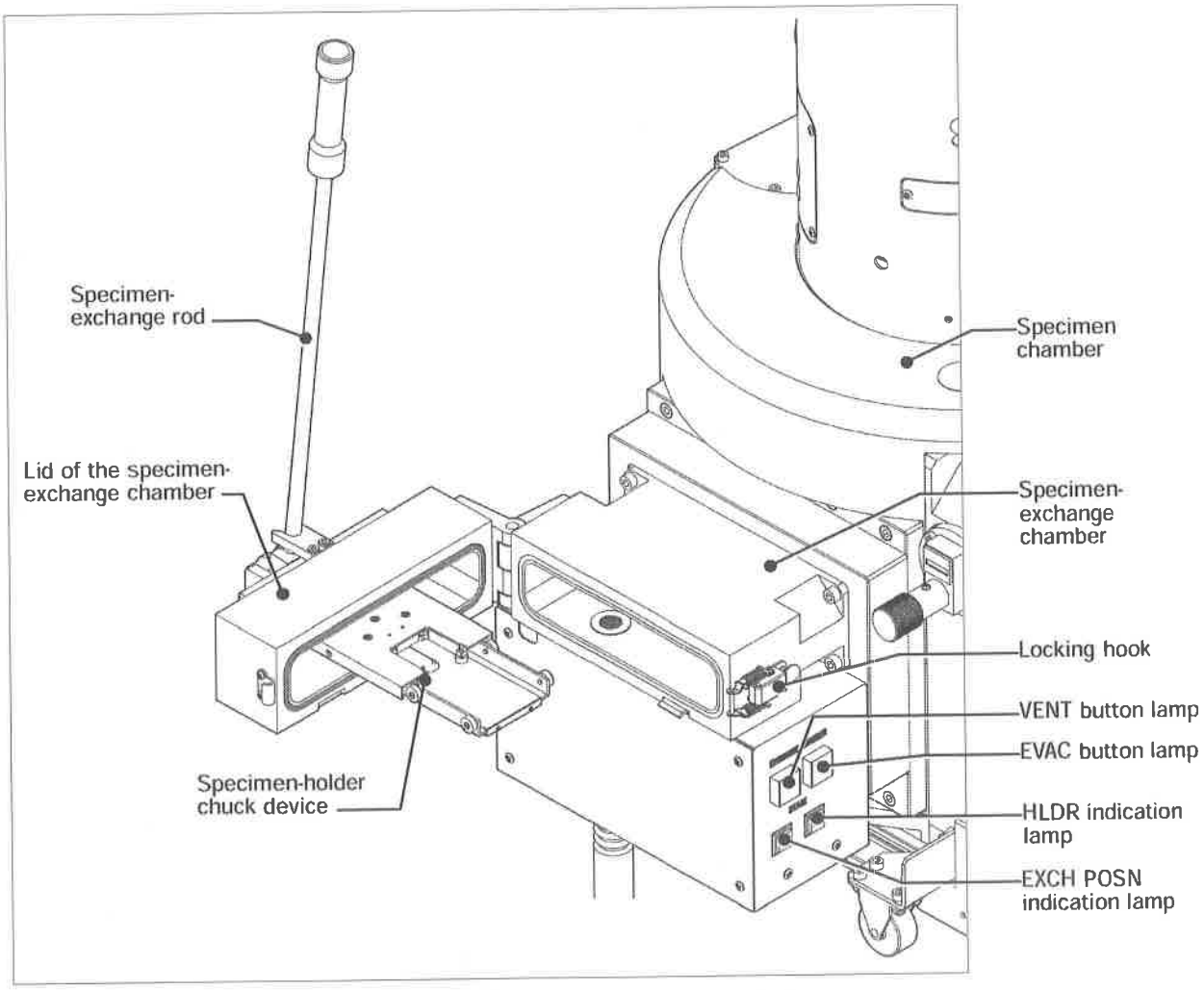


Fig. 3.4 Specimen-exchange airlock Type 1

⑥ Specimen stage

X control: Moves the specimen stage in the X-direction.

Y control: Moves the specimen stage in the Y-direction.

WD control: Moves the specimen stage in the Z-direction.

Tilt control: Tilts the specimen stage.

Port: Used for attachments.

Absorbed-current measuring terminal: Used for measuring absorbed current using a connector.

The X control and Y control are components of the 3-axis motor stage controller, SM-31350.

Turn the knobs of the X, Y, WD and Tilt controls to move the specimen stage.
For the range of specimen movement, refer to Table 3.2 below.

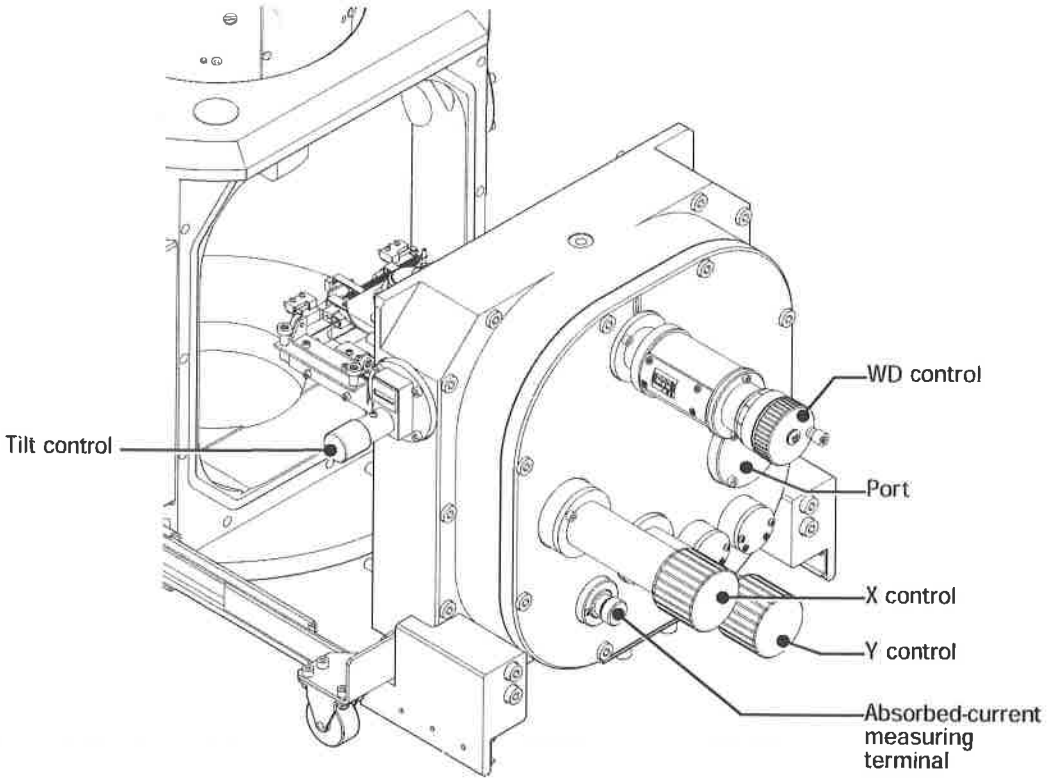


Fig. 3.5 Specimen stage TYPE 1

Table 3.2 Range of specimen movement (■)

Specimen exchange		X: 35 mm, Y: 25 mm, WD: 8 mm Tilt: 0° (000), Rotation: 0° (000)											
Specimen holders		26 mm diameter						12.5 mm diameter					
Tilt range −5° to 60°	60°						■	60°					■
	55°						■	55°					■
	50°						■	50°					■
	45°						■	45°					■
	40°					■	■	40°					■
	35°					■	■	35°					■
	30°					■	■	30°				■	■
	25°				■	■	■	25°				■	■
	20°				■	■	■	20°			■	■	■
	15°			■	■	■	■	15°		■	■	■	■
	10°			■	■	■	■	10°		■	■	■	■
	5°		■	■	■	■	■	5°		■	■	■	■
	0°	■	■	■	■	■	■	0°	■	■	■	■	■
	−5°			■	■	■	■	−5°		■	■	■	■
Working distance (WD)		1.5	3	6	8	15	25	WD	1.5	3	6	8	15	25
Shift range	X	22 to 48 mm						28.5 to 41.5 mm					
	Y	12 to 38 mm						18.5 to 31.5 mm					

3.2 VACUUM CONTROL PANEL

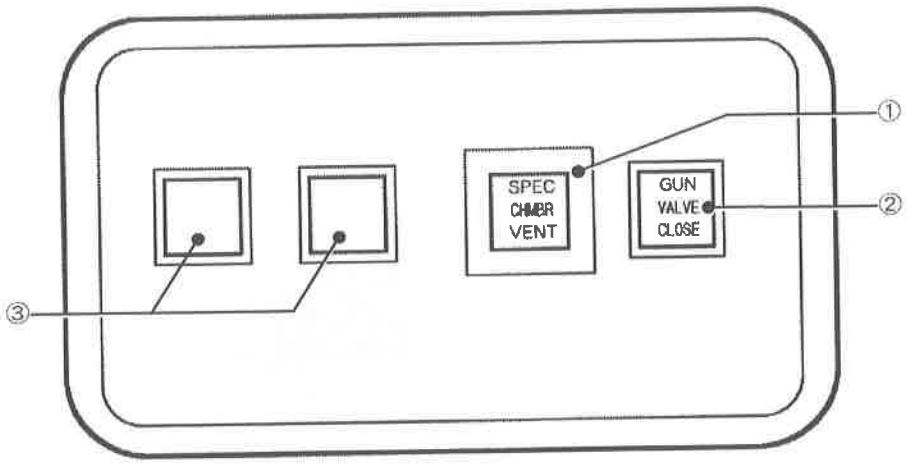


Fig. 3.6 VACUUM CONTROL panel

① SPEC CHMBR VENT button

Temporarily vents the specimen chamber (including the objective lens) (VENT) or re-evacuates it.

- When the button is pressed in for venting (▬), the button lamp brightens, and nitrogen gas enters the specimen chamber.
- When the button is pressed once again, it returns to its initial position (■), the button lamp dims and the specimen chamber is automatically re-evacuated.

To evacuate the chamber to the vacuum level for accelerating voltage application, wait two hours or more until the Accelerating Voltage On/Off button HT changes its color from black to blue.

- This button is mainly used in the following cases:*
- Mounting attachments on the specimen chamber
- Replacing the objective lens aperture, or cleaning its holder
- Cleaning the liner tube of the condenser lens and exchanging the emitter
- Installing an optional probe current detector

② GUN VALVE CLOSE button

This button is exclusively used for maintenance. Pressing the button forcibly closes the electron gun chamber isolation valve V1.

③ Spare buttons

Not used.

* When you need to have one of these operations performed, contact your local JEOL service center.

3.3 OPERATION SYSTEM

3.3.1 Observation Display

The optional observation display is used as a monitor for observing images and selecting a variety of functions.

⇒ For further details, refer to the instruction manual of the display.

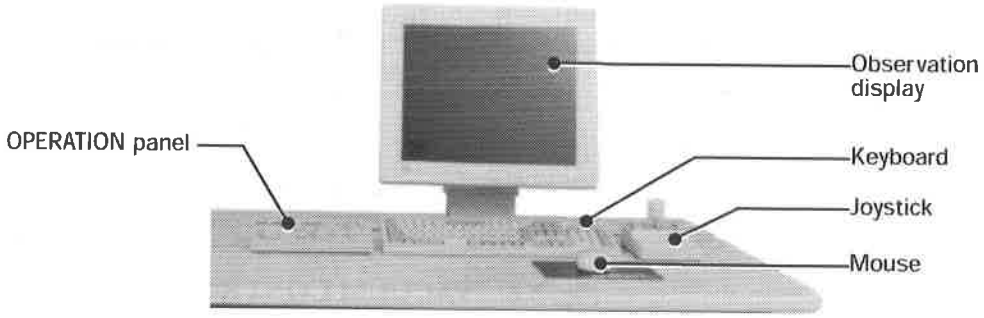


Fig. 3.7 Operation system

3.3.2 OPERATION Panel

The OPERATION panel contains knobs and push buttons used to perform adjustments during an observation or measurement. You can use it to change the settings according to the observation conditions and operation conditions. You can also perform the same settings and operations from the Setup menu.

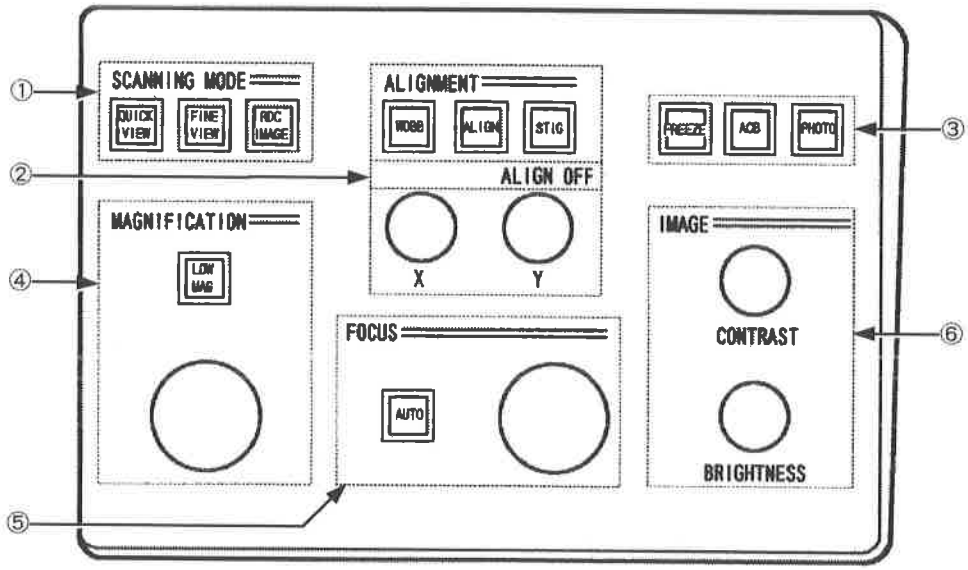


Fig. 3.8 OPERATION panel

① SCANNING MODE

- QUICK VIEW button
  Sets one of two high scanning speeds. Each time you press the button, you select one of the two high scanning speeds.
- FINE VIEW button
  Sets one of two slow scanning speeds. Each time you press the button, you select one of the two slow scanning speeds.
- RDC IMAGE button
  Pressing this button lights the lamp and reduces the scanning image on the observation screen to one quarter.

② ALIGNMENT

- WOBB button
  Used for the axis alignment of the electron optical system (OL Aperture, Stigma Center X and Stigma Center Y).
  When you press the WOBB button that periodically changes the OL exciting current, the button blinks, and the Alignment window appears on the observation screen. Pressing the WOBB button once again dims the button lamp and cancels the WOBB mode.
  When the Stig Center X or Stig Center Y in the Alignment window is selected, pressing the WOBB button blinks the button lamp and the excitation current of the OL stigmator is changed periodically.

Fig. 3.9 Alignment window

- ALIGN button
  Pressing the ALIGN button lights the button lamp and opens the Alignment window. Each time you press the ALIGN button, the item to be adjusted changes sequentially, enabling you to select any desired item for adjustment. You can also select any item by clicking on it directly.

Adjustment item	Functions of the X and Y knobs
Gun Alignment	Gun alignment X and Y
OL Aperture	Electromagnetic alignment for OL aperture X and Y
Stig Center X	Axis alignment of OL stigmator (X)
Stig Center Y	Axis alignment of OL stigmator (Y)

- STIG button (ALIGN OFF)
  Activates the astigmatism correction mode for OL, and lights the button lamp. If you press the STIG button when the Alignment window is opened, the Alignment window will close.
- X and Y knobs
  Used for astigmatism correction or for axis alignment of the electron optical system. When the STIG button is pressed they are used as the stigmator, and when the ALIGN button is pressed they are used as the control knobs for the selected item.

③ FREEZE/ACB/PHOTO buttons

- FREEZE button
  Pressing the FREEZE button lights the button lamp and freezes* the displayed image according to the predetermined FREEZE setting.
  To set up FREEZE, click **Setup—Operation** on the menu. Pressing the FREEZE button once again dims the button lamp and deselects the freeze state.
  Instant Freeze: Pressing the FREEZE button freezes the image instantly.
  Freeze Frame: After the FREEZE button is pressed, the image that is being scanned is frozen as soon as it has been completely acquired.
  Integration: After the FREEZE button is pressed, the image is frozen as soon as it has been accumulated the number of times specified in advance.
  ⇒ For details, refer to Sect. 4.8.2d Freeze of this instruction manual.
- ACB button
  When this button is pressed, the button lamp blinks, and the image is set to the contrast and brightness specified in advance. For details of the BRIGHTNESS and CONTRAST settings, refer to Sect. 4.8.2h Contrast/Brightness (ACB) of this instruction manual.
- PHOTO button
  Pressing this button lights the button lamp and starts photography. Once photography is completed, the lamp dims and the photography mode is canceled.
  ⇒ For details, refer to Sect. 4.8.2a Photo and Printer of this instruction manual.

④ MAGNIFICATION

- LOW MAG button
  Pressing this button lights the button lamp and sets the magnification to **LM** mode (the lowest magnification range). Pressing it once again dims the lamp and returns the magnification to the previous range.

* "Freeze" means acquiring an image into the memory and displaying it, as a still image, on the observation display.

- MAGNIFICATION knob
  Selects the image magnification. An image for the selected magnification is displayed enlarged 2.47 times on the observation display. The magnification displayed applies to the photographic recording system.

Table 3.3 Relationship between magnification, accelerating voltage, and working distance

Maximum magnification

Accelerating voltage (kV)	SEM mode WD (mm)						LM mode
	1.5	3	6	8	15	25	All WD
0.5	370 K	350 K	250 K	220 K	150 K	100 K	3.3 K
1	550 K	500 K	370 K	300 K	220 K	150 K	4.5 K
2	650 K	650 K	500 K	430 K	300 K	200 K	6.5 K
5			650 K	600 K	430 K	270 K	9.5 K
10				650 K	550 K	370 K	12 K
15					650 K	430 K	14 K
20						500 K	16 K
25							17 K
30						550 K	19 K

Minimum magnification

SEM mode WD (mm)						LM mode
1.5	3	6	8	15	25	All WD
1200	700	350	250	140	100	25

⑤ FOCUS

- AUTO button
  This button performs the Auto function. Pressing it causes the lamp to blink and the automatic function **WD SET** (working distance set), **AFC** (automatic focus) or **AST** (automatic stigmator) specified with **Setup–Operation** on the menu bar to operate.
- FOCUS knob
  This knob performs focusing. Use **Focus** displayed by selecting **Control–Column** from the menu bar for coarse focusing when the working distance (WD) was changed or the focus was changed significantly.

⑥ IMAGE

- CONTRAST knob
  Adjusts the contrast of the screen.
- BRIGHTNESS knob
  Adjusts the brightness of the screen.

3.3.3 Mouse

The mouse has a wheel and is used for operations on the observation screen as well as for moving an image. The setting of the button and wheel is as follows.

Left button
- Click: Used for various Windows operations.
- Drag: Used for operations such as moving the image or specimen stage, distance measurement, and figure writing.

Right button
- Click: Used for various Windows operations, and moving the specimen stage.

Wheel
- Rotate: Used for changing the magnification.

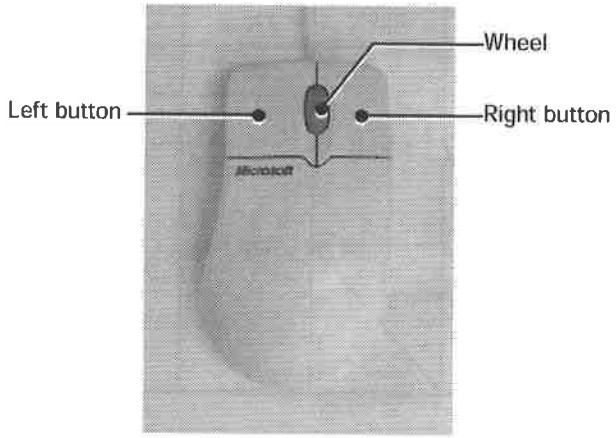


Fig. 3.10 Mouse

3.3.4 Joystick

When the 3-axis motor stage controller is installed in the SEM, you can move the specimen by using the joystick.

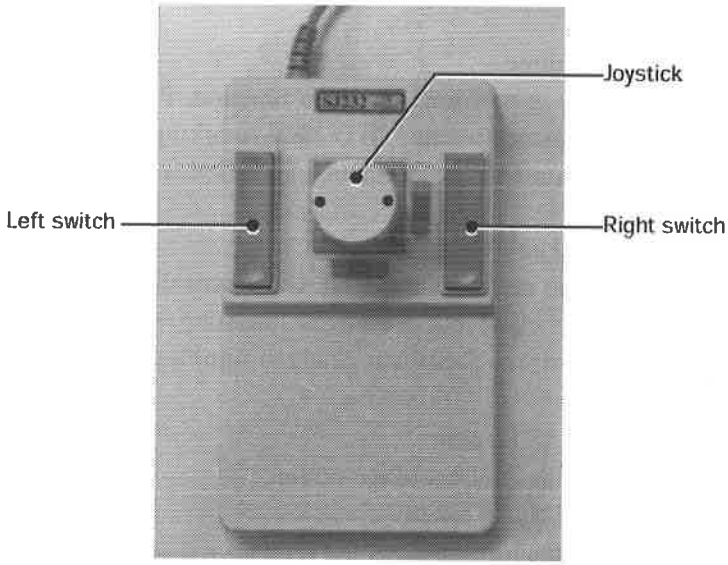


Fig. 3.11 Joystick

Joystick:	Used for moving the specimen in the X and Y directions. Twisting the joystick rotates the specimen.
Left switch:	Designated for eliminating backlash in initialization.
Right switch:	Designated for recording present position in initialization.

3.3.5 Keyboard

You can key in alphanumeric and other characters with the keyboard.

⇒ For further information, refer to the instruction manual of the PC.

3.4 SEM FLOPPY-DISK UNIT

The OPN POWER ⏻, | buttons are the off and on switches for the units related to the operation and display system.

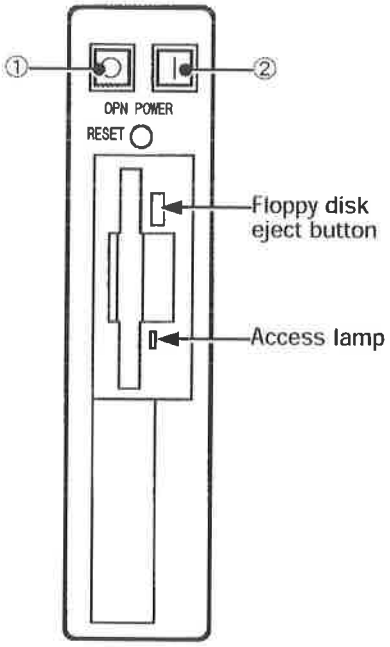


Fig. 3.12 SEM floppy-disk unit and OPN POWER ⏻, | buttons

① ⏻ button

Turns off the power. (The pumping system continues operation if the power is turned off.)

② | button

Turns on the power.

Note: The RESET button and floppy disk drive are for the service engineer.

3.5 PERSONAL COMPUTER

The personal computer (PC) is used for switching the power on and off, and reading and writing of various data.

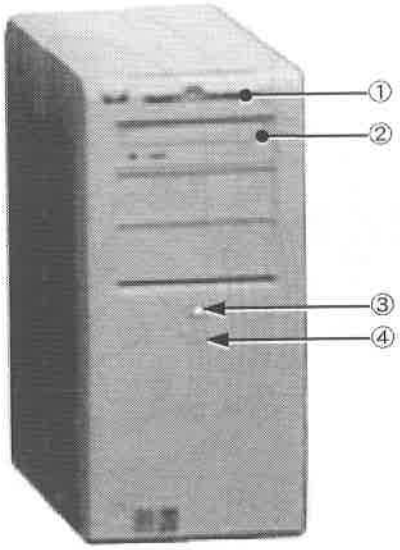


Fig. 3.13 Personal computer

① Floppy-disk drive
Used for reading data from a floppy disk or for writing data on a floppy disk.

② CD-ROM drive
Used for installing software.

③ Power switch
Used for the PC.

④ Reset switch
Used if Windows NT hangs up.

3.6 OIL ROTARY PUMP

The oil rotary pump is connected to the vacuum system via the anti-vibration device with a rubber hose.

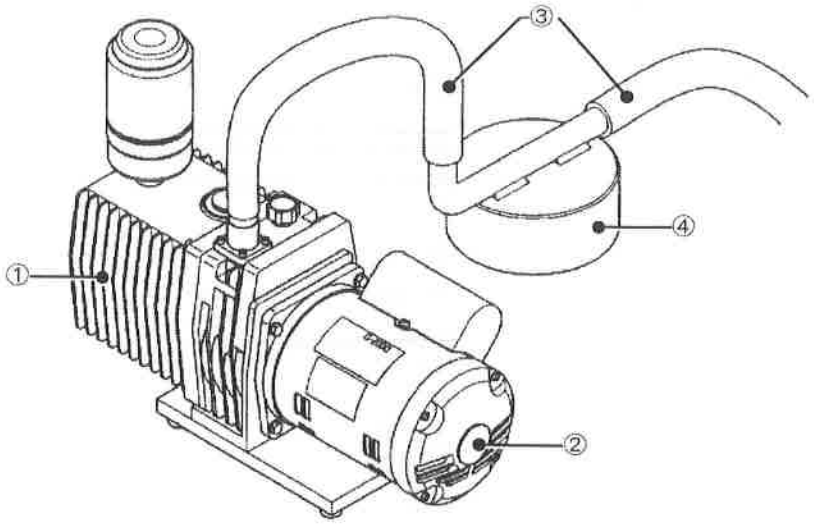


Fig. 3.14 Oil rotary pump

① Oil rotary pump
For roughing the column and backing the oil diffusion pump.

② Motor
Drives the oil rotary pump.

③ Rubber hose
A flexible rubber hose for connecting the oil rotary pump with the vacuum system.

④ Anti-vibration device
Isolates the vibrations that come from the pump via the rubber hose.

3.7 MAIN POWER SUPPLY UNIT

3.7.1 VAC POWER ON/OFF Switch (Vacuum System Power Switch)

This switches the main power supply unit for the vacuum system. The power supply for the sputter ion pumps is not controlled by this switch.

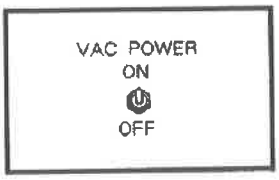


Fig. 3.15 VAC POWER ON/OFF switch

⚠ CAUTION

Never remove the rear panel for maintenance such as replacement of fuses or any other electric parts; otherwise you may get an electric shock. Be sure to ask JEOL service personnel for such work.

3.7.2 MAIN POWER (Breaker Power Switch)

The MAIN POWER ON/OFF switch turns on or off the power for the entire instrument. When the current is excessive, the power is turned off automatically. **The switch is used only in an emergency. Do not tamper with this switch in routine operation.**

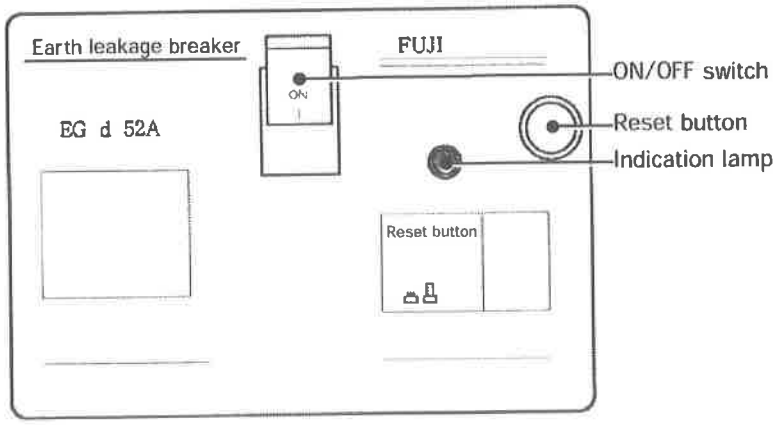


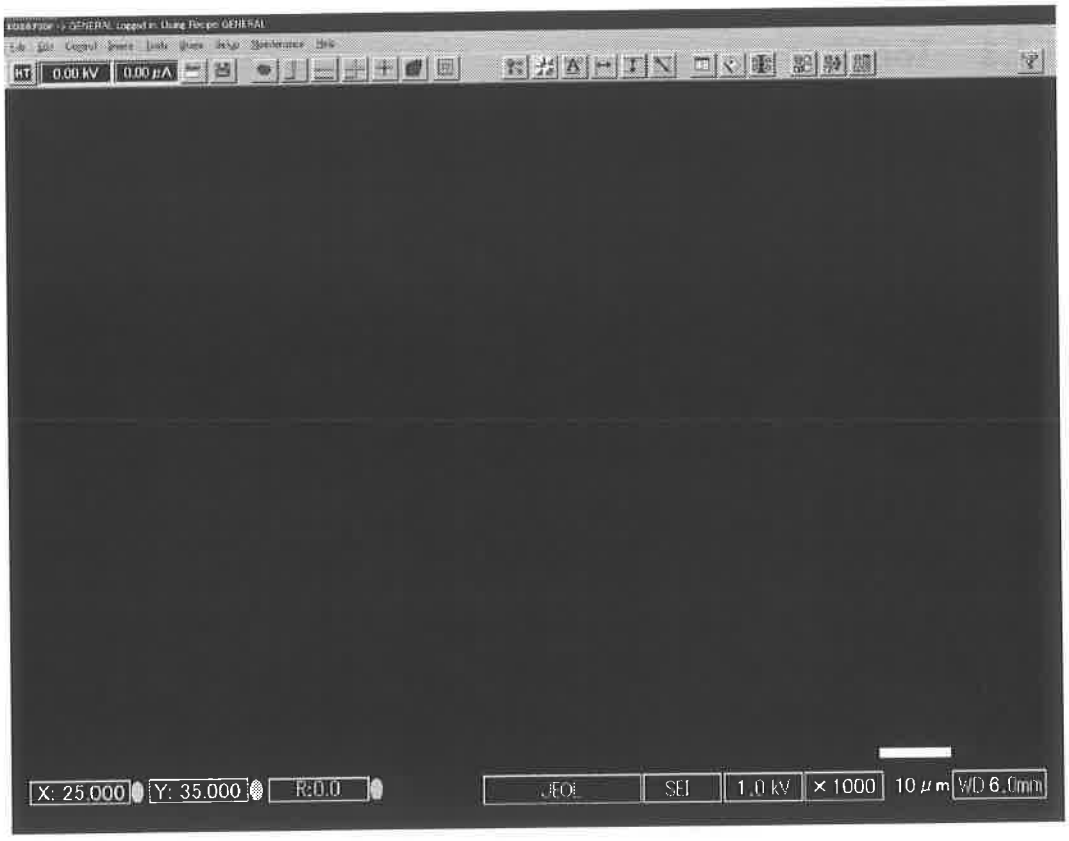
Fig. 3.16 MAIN POWER switch

4

BASIC SCREEN

4.1 BASIC SCREEN

The title bar, menu bar, tool bar, specimen position, observation conditions and the like are displayed on the basic screen.



4.1.1 Title Bar

When you have logged into the system, the user and recipe names are shown.

4.1.2 Menu Bar

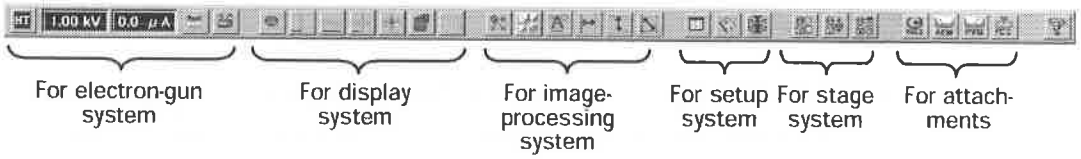
The names of various menus for condition setting are shown on the menu bar.

File: Opens the File menu.
Edit: Opens the Edit menu.
Control: Opens the Control menu.
Image: Opens the Image menu.

Tools: Opens the Tools menu.
Stage: Opens the Stage menu.
Setup: Opens the Setup menu.
Maintenance: Opens the Maintenance menu.
Help: Opens the Help menu.

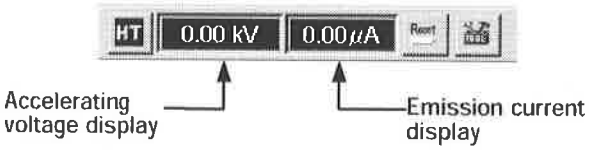
4.1.3 Tool Bar

Buttons are shown for various operations and settings.



4.1.3a Buttons for electron-gun system

These buttons are used to operate the electron-gun system as well as to show the accelerating voltage and emission current.



The **Accelerating Voltage On/Off** button
This button allows you to switch on and off the accelerating voltage.
Blue background: The accelerating voltage is off, and can be switched on.
Green background: The accelerating voltage is on.
Black background: The accelerating voltage is off, but cannot be switched on.

: Displaying and setting the accelerating voltage
Use this button to display and set the accelerating voltage. When you click the accelerating voltage display section, a pull-out menu that has five preset accelerating voltages appears, enabling you to select the desired accelerating voltage.

: Display of the emission current

The **Emission Reset** button
This button allows you to reset the emission current. If the emission current is less than the set value, click the button to reset the current to the set value.

The **Maintenance** button
Clicking this button opens the Maintenance menu.

4.1.3b Buttons for display system

The **Standard Screen** button
Clicking this button changes to the full-screen mode.

The **Side-by-Side Split Screen** button
Clicking this button splits the screen into two sections, left and right.

The **Top-and-Bottom Split Screen** button
Clicking this button splits the screen into two sections, top and bottom.

The **Four Way Split Screen** button
Clicking this button splits the screen into four sections.

The **Spot Mode** button
Clicking this button changes to the spot mode. It is useful for point analysis, stopping the scanning of the electron beam.

The **Screen-Reducing** button
Clicking this button reduces the observation screen (its size is variable). It is useful for improving the image quality as well as surface analysis.

The **Scan Rotation On/Off** button
This button allows you to switch on Scan Rotation.

Scan Rotation is on.
Clicking the button changes Scan Rotation to off.

4.1.3c Buttons for image processing system

The **Image File Handling** button
Clicking this button opens the Load/Save/Print Image window.

The **Image Contr/Bright/Gamma** button
Clicking this button opens the Contrast/Brightness/Gamma window.

The **Append Annotate and Measurement** button
Clicking this button opens the Append Annotate and Measurement tool bar.

The **X Measure** button
Clicking this button changes to the X cursor measurement mode.

The **Y Measure** button
Clicking this button changes to the Y cursor measurement mode.

The **Diagonal Measure** button
Clicking this button changes to the diagonal measurement mode.

4.1.3d Buttons for setup system

The **Operation Setup** button
Clicking this button opens the Instrument Operation window.

The **Recipe** button
Clicking this button opens the Recipe window.

The **Column** button
Clicking this button opens the Column window.

4.1.3e Buttons for stage system

The buttons below are shown when the optional 3-axis motor stage controller is installed.

The **Specimen Exchange** button
Clicking this button opens the Sample Exchange window.

The **Stage Control** button
Clicking this button opens the Stage Control window.

The **Map Control** button
Clicking this button opens the Stage Map window.

4.1.3f Buttons for attachments

The buttons below are shown when the optional attachments are installed.

The **RBEI** button
This button allows you to move the retractable backscattered electron detector.

Gray background:	The retractable detector is retracted.
Brown background:	The retractable detector is in motion.
Green background:	The retractable detector is at the observation position.

The **AEM** button
Clicking this button opens the AEM window displaying the absorbed current.

The **PVG** button
Clicking this button opens the Penning Gauge window.

The **PCD** button
This button allows you to move the Faraday cup (the probe current detector).

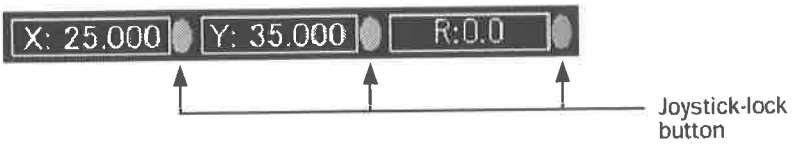
Gray background:	The Faraday cup is retracted.
Green background:	The Faraday cup is being irradiated by the electron beam.

4.1.3g Help

The **Help** button
Clicking this button opens the Help menu for the SEM operation.

4.1.4 Specimen Positions Indication

The specimen positions are shown.



X: Indicates the X-axis position.
Y: Indicates the Y-axis position.
R: Indicates the rotation angle.
Joystick-lock button
In orange: The axis corresponding to the lock button is locked, and it does not move with the joystick.
In green: The axis corresponding to the lock button is released, and it moves with the joystick.
Every time you click the lock button, its color changes alternately.

4.1.5 Observation Conditions Indication

The present observation conditions for the SEM image are shown.

Photo Numbering

Numbers are indicated on the photograph. You can key in up to 6 alphanumeric characters from the keyboard. If the last character is a number, the numbering sequence is automatically advanced by one position every time a photograph is taken.

The **Image Selector** button

The name of the image signal under observation is indicated. Clicking the button shows a pull-up menu, from which you can select a signal name. The signals named on the menu can be set using **Setup–Operation–Signal Name**.

The **Accelerating Voltage** button

The present accelerating voltage is indicated. Clicking the button shows a pull-up menu, from which you can select an accelerating voltage. The accelerating voltages that you want to use frequently can be set on the menu using **Setup–Operation–Instant Accel. Voltage Table**.

The **Magnification** button

The present magnification is indicated. Clicking the button shows a pull-up menu, from which you can select a magnification.

The magnifications that you want to use frequently can be set on the menu using **Setup–Operation–Instant Magnification Table**.

The **Scale** bar

The magnification scale is indicated with a bar.

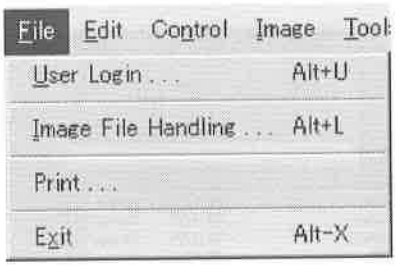
The **Working Distance** button

The working distance for focusing is indicated. Clicking the button shows a pull-up menu, from which you can select a working distance. You cannot change the working distance combinations on the menu.

4.2 FILE MENU

With the File menu you can carry out operations such as selection of the user and handling of image files.

- **Click File on the menu bar.**



User Login: You can select the user that you want to log in as.
Image File Handling: You can handle image files.
Print: You can carry out printing.
Exit: You can end the SEM operation.

4.2.1 User Login

You can set users and select a user from them. If you store the SEM image observation conditions for each user, you can observe images under the stored SEM image observation conditions simply by selecting the user.
If you do not use the User login command, the standard SEM image observation conditions are applied.
⇒ Refer to Sect. 6.5 SETTING USER LOGIN of this instruction manual.

- **Select File–User Login.**

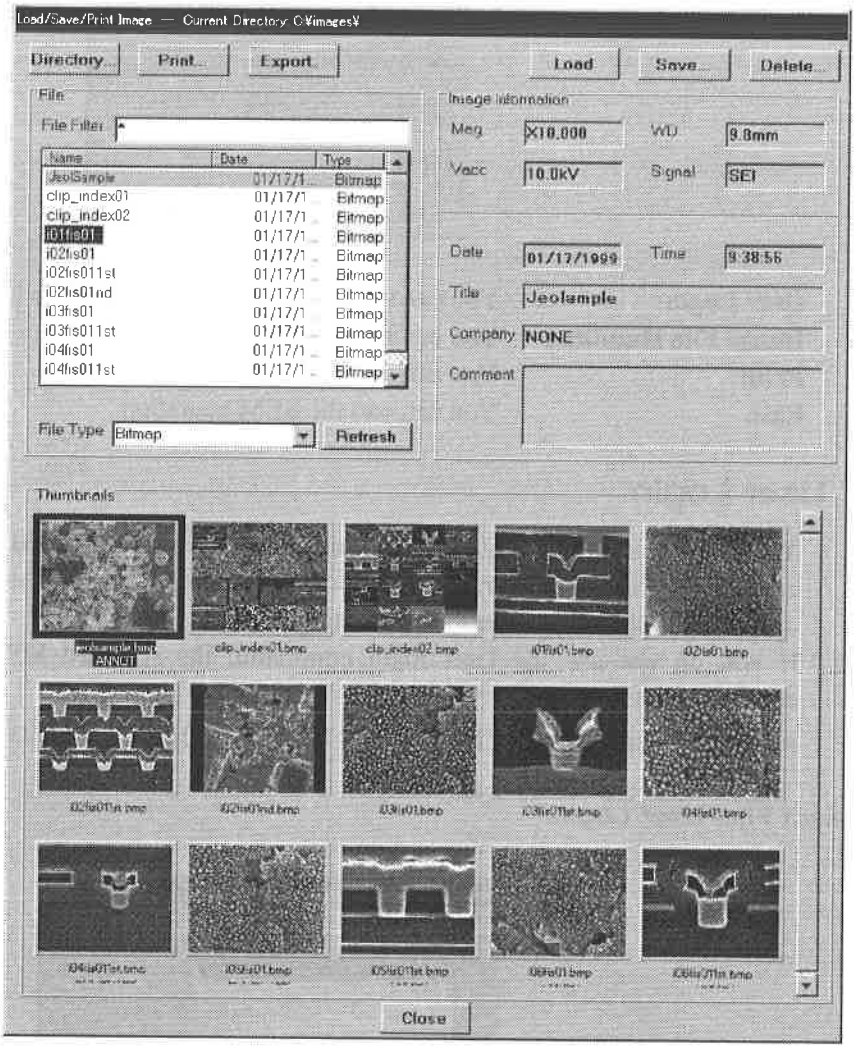
Available Operators: The list of recorded users is displayed.
Login: You can log in as the selected user.
Cancel: You can cancel selection of the user.
If you cancel selection of the user, the standard SEM image observation conditions are applied.

4.2.2 Image File Handling

You can save and load images by clicking **Image File Handling**.

- **Select File–Image File Handling**

Button with equivalent function:  **Image File Handling**



Directory: Selects a folder for saving an image.

Print: Changes the image to the output format for printing.

Export: Saves an image with its text in a folder. The image can be saved in bmp, jpeg, or tif format. Such information as text edited on the observation screen is printed together with an image. The text is not rewritable after saving it.

Load: Loads the image saved in the folder.

Save: Saves an image in a folder. The image can be saved in bmp, jpeg, or tif format. Such information as text edited on the observation screen is saved together with the image. The text is rewritable after saving it. Clicking the **Save** button opens the **Save As** dialog box.

Delete: Opens the **Delete File** dialog box and you can delete the selected image from the folder.

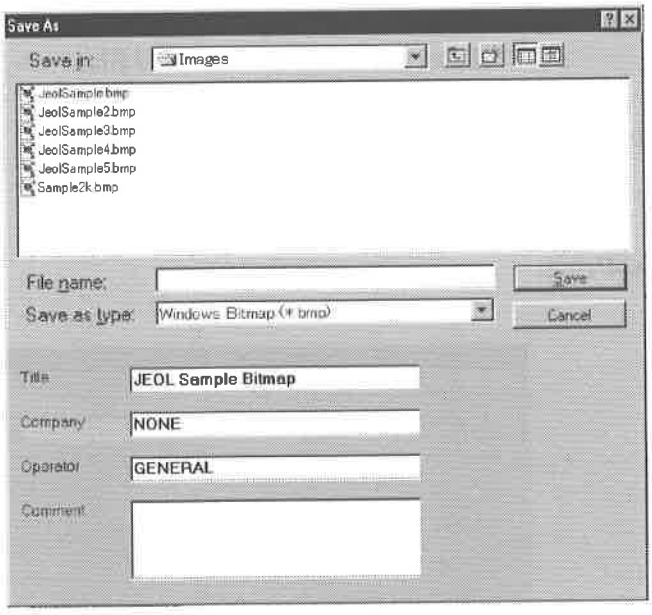
File Filter: The file name of a selected image is indicated in the File Filter box. The list of the saved image files is indicated in the File–Name list box.

File Type: You can select the file format.

Image Information: Information such as image observation conditions, date and time of photographing, image name, and comment are indicated.

Thumbnails: The saved images are displayed as thumbnails.

4.2.2a Save As dialog box



Save in: A folder for saving images is indicated.
The file names of the saved images are indicated in the list box.

File name: Enter the name of the file in which you want to save images.

Save as type: Select a file format with which to save the file.

a. Windows Bitmap (*.bmp): Bitmap format
b. TIFF (*.tif): TIFF format
c. JPEG (*.jpg): JPEG format

You can again edit text and figures that you wrote on the image in all the formats.

Title: You can key in title for the image.

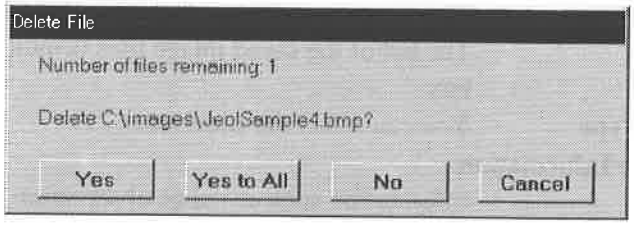
Company: The department to which the operator who is logged in belongs is automatically input. You can rewrite it, if you want.

Operator: The operator name that the operator selected with the user login is automatically input. You can rewrite it, if you want.

Comment: You can enter a comment for the image.

Save: You can save the image and close the Save AS dialog box.

4.2.2b Delete File dialog box



Number of files remaining:
The number of files selected for deletion is indicated.

Delete C: The name of the first file to be deleted is indicated.

Yes: Deletes the file of the indicated name.

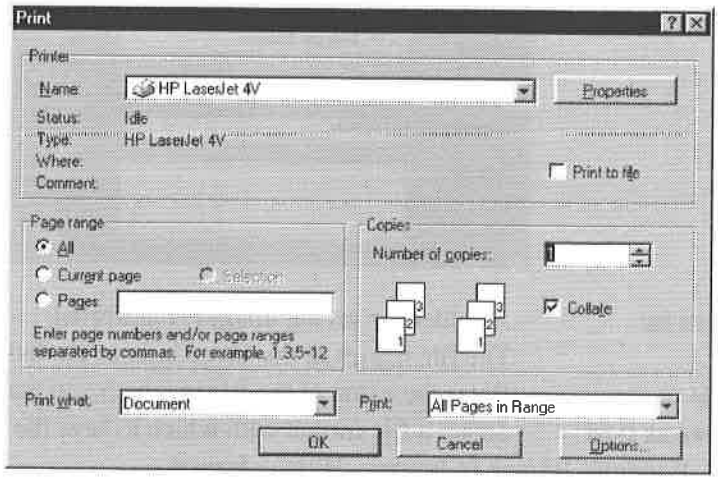
Yes to All: Deletes all the selected files.

No: Does not delete the indicated file.

4.2.3 Printing

You can print the image.

- **Select File–Print.**



Printer Name: The printer name is indicated.

Properties: Clicking Properties opens the **Properties** dialog box.

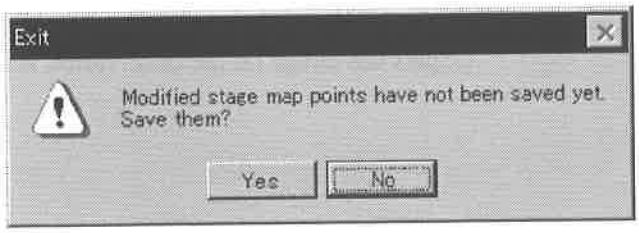
Number of copies:
You can select the number of copies for printing.

4.2.4 Finishing

You can finish the SEM operation.

- **Select File–Exit.**

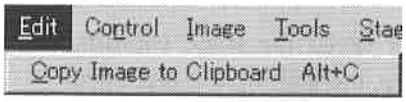
  If you have not saved the stage coordinates after correcting the Points File of Stage Map–Points Map, the **Exit** dialog box opens.



Yes: Finishes the SEM operation after saving the stage coordinates.
No: Finishes the SEM operation without saving the stage coordinates.

4.3 EDIT MENU

- Click Edit on the menu bar.

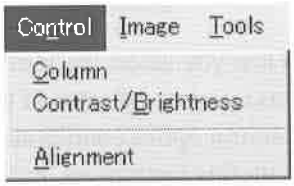


Copy Image to Clipboard:
Copies the image on the observation screen to the clipboard.

4.4 CONTROL MENU

You can carry out operations such as condition setting and alignment of the electron optical system.

- **Click Control on the menu bar.**



Column: You can set the conditions of the electron optical system.
Contrast/Brightness:
You can adjust the contrast and brightness of the observation image.
Alignment: You can align the electron optical system.

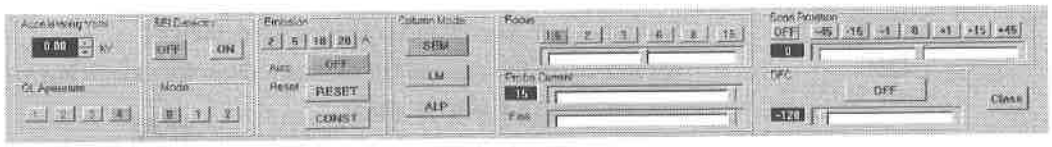
4.4.1 Column

You can set the conditions of the electron optical system.

- **Select Control–Column.**

Button with equivalent function: **Column**

Note: When the SEM is activated, all the conditions are set for secondary-electron image observation.



Accelerating Volts, OL Aperture, SEI Detector, Emission, Column Mode, Focus, Probe Current, Scan Rotation and DFC (Dynamic Focus) are indicated on this window.

4.4.1a Accelerating Volts

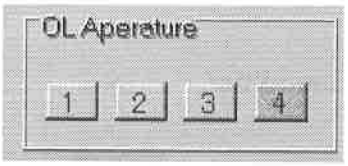
You can set the accelerating voltage that you want to use.

Directly key in numbers, or click ▲▼.
When you click ▲▼, the accelerating voltage increases or decreases by 1 step.

Note: Variation in 1 step 0.5 to 2.9kV: 0.01 kV
3 kV or more: 0.1 kV

4.4.1b OL Aperture

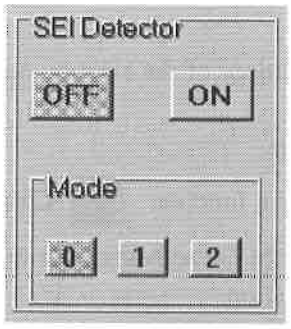
You can select the number of the objective lens aperture that you want to use.



1/2/3/4: When you select the same number as that of the scale of the objective lens aperture selector of the column, you can obtain the optimum electron optics conditions.
With this instrument, however, be sure to select the number 4 objective lens aperture since the objective lens aperture selector is set to the scale 4 at the time of the installation.

4.4.1c SEI Detector

You can set the conditions for using the secondary electron detector.



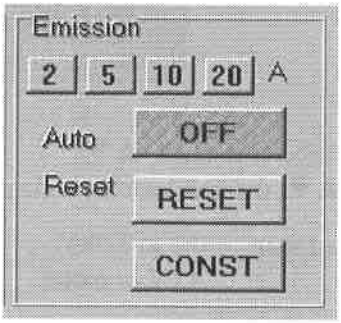
OFF: Switches off the secondary electron detector.
ON: Switches on the secondary electron detector, allowing you to observe the secondary electron image.

Note: When the accelerating voltage on/off button HT is blue or black, you cannot switch on the secondary electron detector.

Mode **0/1/2**: You can select the mode of the secondary electron detector. Mode **2** is to be selected in normal use, but when observing a specimen that readily charges up, select a smaller mode number to reduce the charge-up.

4.4.1d Emission

You can set the emission current.



2/5/10/20 μA: Used for setting the emission current. Normally, set it to 10 μA.

Auto Reset: Used for selecting whether the emission is automatically reset or not.

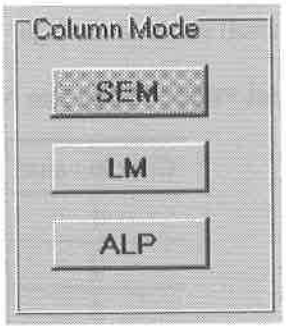
OFF: Used for manually resetting the emission. If the emission current falls, click the **Emission Reset** button  on the tool bar.

RESET: If the emission current falls to 50% of the preset value, it is automatically reset to the preset value while this button is highlighted by clicking it in advance.

CONST: Constantly maintains the preset emission current during operation. Normally, this mode is used when the optional EDS analysis is carried out. However, it is not recommended for image photography because it causes unevenness of brightness and defocusing.

4.4.1e Column Mode

You can select the mode of the electron optical system.



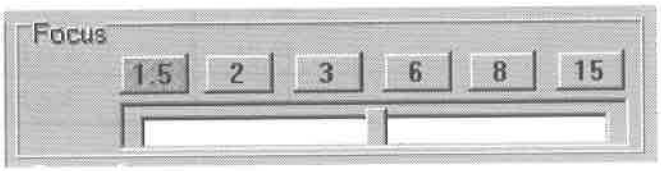
SEM: Used for observing an image in the normal SEM (high-magnification) mode.

LM: Used for observing an image at low magnification for such operations as searching for the field of view.

ALP: Used for adjustments such as electron-gun axis alignment and CL astigmatism correction. Do not use it for normal image observation. Mainly, the maintenance service engineers use it.

4.4.1f Focus

Used for coarse focusing.

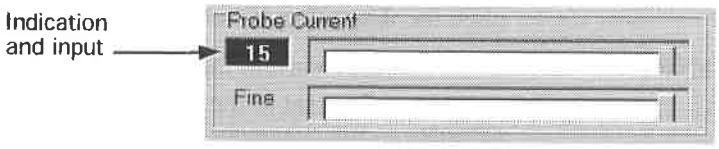


WD **1.5/2/3/6/8/15**: Used for setting the focus to the selected working distance.

Scroll bar: Used for changing the focus with the selected working distance as a center. The focusing operation here is coarse focusing. To perform fine focusing, use the FOCUS knob on the OPERATION panel.

4.4.1g Probe Current

Used for setting the probe current.



Indication and input box:
The coarse value is indicated, and the desired numerical value (1 to 15) can be input.

Upper scroll-bar: Used for coarse adjustment.

Lower scroll-bar: Used for fine adjustment. In normal use, set this scroll bar to the right end.

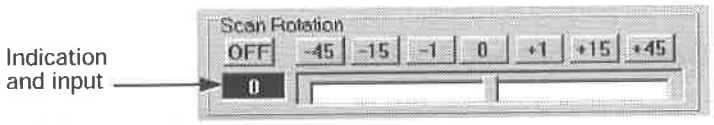
Note: The table below shows the approximate probe current values corresponding to the coarse values. These probe current values are set when the No. 4 aperture is used and the Fine scroll bar is at the right end.

Probe current values when the No. 4 objective lens aperture is used

Coarse value	Probe current value (A)
1	1×10^{-12}
2	2×10^{-12}
3	3×10^{-12}
4	6×10^{-12}
5	1×10^{-11}
6	2×10^{-11}
7	3×10^{-11}
8	6×10^{-11}
9	1×10^{-10}
10	2×10^{-10}
11	3×10^{-10}
12	6×10^{-10}
13	1×10^{-9}
14	2×10^{-9}
15	3×10^{-9}

4.4.1h Scan Rotation

You can set the scan rotation (the image rotation).



ON/OFF: Clicking the ON/OFF switch turns the scan rotation on and off alternately.

–45/–15/–1/+1/+15/+45:
Every time you click one of the angle buttons, the image is rotated by the angle amount that you selected. The minus sign signifies counterclockwise, and the plus sign signifies clockwise rotation.

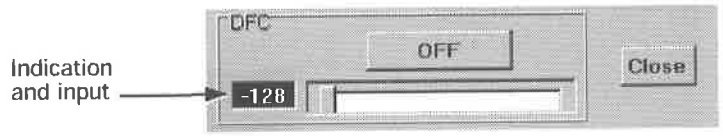
0: The image rotation angle is reset to 0 degrees.

Scroll bar: Moving the scroll bar continuously rotates the image up to ±45°. Moving it to the right rotates the image in the clockwise direction and moving it to the left rotates the image in the counterclockwise direction.

Indication and input box:
The image rotation angle is indicated, and you can input numerical values from 0 to 360, in degrees.

4.4.1i Dynamic Focus (DFC)

You can adjust the dynamic focus.



DFC: Clicking the DFC switch turns on the dynamic focus. The background becomes green. Clicking it once again turns off the dynamic focus.

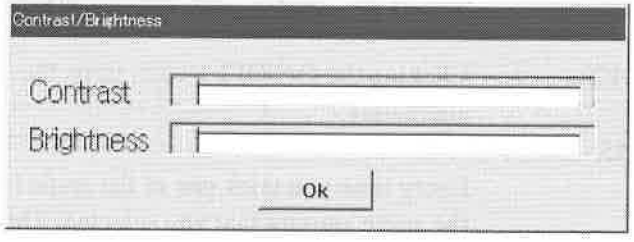
Scroll bar: Moving the scroll bar changes the amount of the dynamic focus.

Indication and input box:
The amount of the dynamic focus is indicated. The indicated value is a relative amount. You can key in numerical values from –128 to 127 in this box.

4.4.2 Contrast/Brightness Window

You can adjust the contrast and brightness of the image. This function is the same as the CONTRAST and BRIGHTNESS knobs on the OPERATION panel.

- **Select Control–Contrast/Brightness.**



Contrast: Moving the scroll bar to the right makes the contrast higher, and moving it to the left makes the contrast lower.

Brightness: Moving the scroll bar to the right makes the brightness higher, and moving it to the left makes the brightness lower.

Ok: Closes the Contrast/Brightness window.

Note: While this window is open, the CONTRAST and BRIGHTNESS knobs on the OPERATION panel do not function.

4.4.3 Alignment Window

You can align the electron optical system using the Alignment window.

- **Select Control–Alignment.**

Gun Alignment: Clicking the **Gun Alignment** button enables you to align the electron gun by using the **ALIGNMENT–X** and **Y** knobs on the OPERATION panel.

OL Aperture: Clicking the **OL Aperture** button enables you to align the objective lens aperture by using the **ALIGNMENT–X** and **Y** knobs on the OPERATION panel.

Stig Center X: Clicking the **Stig Center X** button enables you to align the astigmatism corrector X by using the **ALIGNMENT–X** and **Y** knobs on the OPERATION panel.

Stig Center Y: Clicking the **Stig Center Y** button enables you to align the astigmatism corrector Y by using the **ALIGNMENT–X** and **Y** knobs on the OPERATION panel.

OL Stigmator: Clicking the **OL Stigmator** button enables you to correct the objective lens astigmatism by using the **ALIGNMENT–X** and **Y** knobs on the OPERATION panel.

CL Stigmator: Clicking the **CL Stigmator** button enables you to correct the condenser lens astigmatism by using the **ALIGNMENT–X** and **Y** knobs on the OPERATION panel.

Center: Clicking the **Center** button enables you to perform adjustment to correct for the shift in the position of the image which occurs when the mode is switched between the SEM mode and the LM mode.

X, Y indication boxes:
The X and Y values of the alignment item that you have selected by clicking are indicated.

Align Clear: Resets the clicked alignment items (X=0, Y=0).

Lens Clear: Removes the hysteresis of the lenses.

Image Shift–Reset:
Switches off **Image Shift** (X=0, Y=0).

Close: Closes the Alignment window.

4.5 IMAGE MENU

You can carry out various kinds of image processing by using the Image menu.

- **Click Image on the menu bar.**

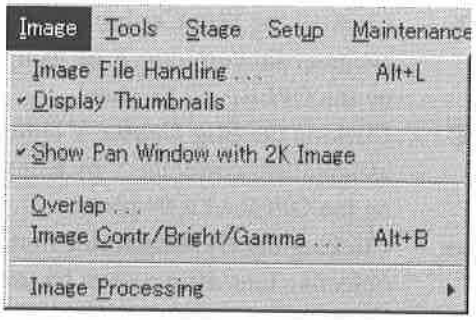
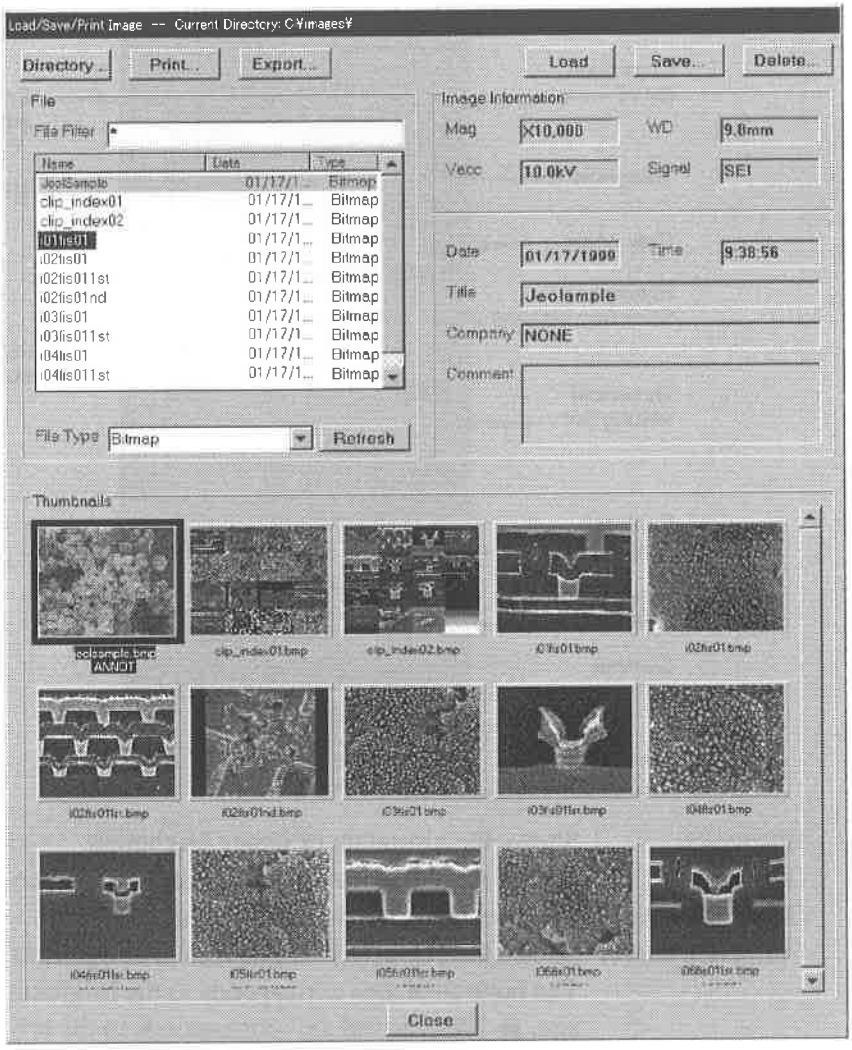


Image File Handling: Used for manipulating the image file.
⇒ Refer to Sect. 4.2.2 Image File Handling of this instruction manual.
Display Thumbnails: Used to switch on and off the display of thumbnail images.
Show Pan Window with 2K Image:
Opens the Pan window when the loaded 2680 × 2048 image is displayed on the observation screen.
Overlap: Used to overlap the images.
Image Contr/Bright/Gamma:
Used for correcting the image brightness and to show pseudo-color.
Image Processing: Used for manipulating the image filter.

4.5.1 Overlap

You can overlap an image loaded from the image file with the displayed image. Since the two images are shown in green and orange respectively, this function is effective for comparison of the two images.

- **Select Image–Overlap.**



Directory: Selects a folder for saving an image.

Load: Loads from the folder the image to be overlapped.

Save: Saves the overlapped image in a folder. Clicking the **Save** button opens the **Save As** dialog box.

File Filter: The selected image file name is indicated in the File Filter box. The list of saved image files is indicated in the list box.

File Type: You can select the file format.

Image Information: Information such as image observation conditions, date and time when photographed, image name, and a comment are indicated.

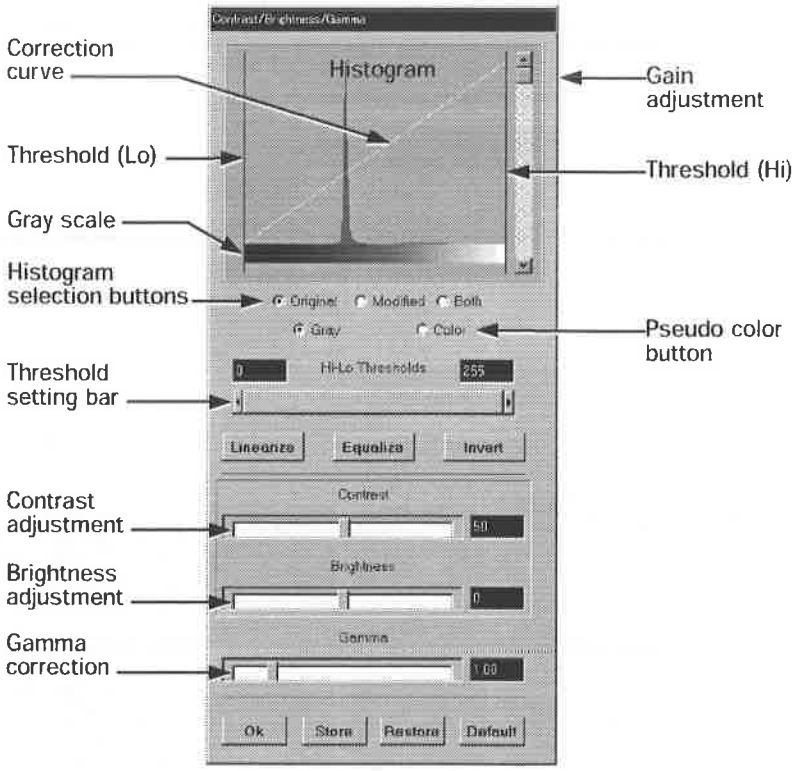
Thumbnails: The saved images are displayed as thumbnails.

4.5.2 Brightness Correction/Pseudo-Color

You can perform image processing such as the correction of image brightness and the display in pseudo-color on frozen images on the observation screen.

- **Select Image–Image Contr/Bright /Gamma.**

  Button with equivalent function:  **Image Contr/Bright /Gamma**



Histogram: Shows the histogram of image brightness.

Gray scale: Shows the brightness of the image on the observation screen.

Gain adjustment: Enlarges the vertical axis of the histogram.

Correction curve: Shows the characteristic graph of the brightness correction. The horizontal axis corresponds to the brightness of the original image, and the vertical axis corresponds to the brightness on the screen.

Threshold (Lo): Displayed in black on the screen. It shows the minimum brightness of the original image. All of the lower brightnesses are black.

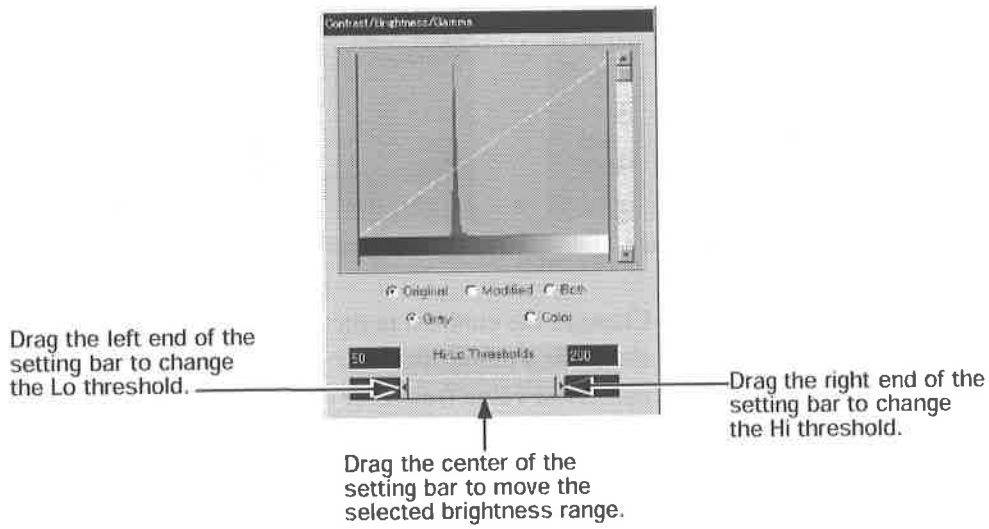
Threshold (Hi): Displayed in white on the screen. It shows the maximum brightness of the original image. All of the higher brightnesses are white.

Hi–Lo Thresholds:

The set thresholds are shown as numerical values. The left numerical value is the Lo threshold, and the right numerical value is the Hi threshold. You can key in numerical values from 0 to 255.

Threshold setting bar:

Used for setting the threshold of the brightnesses shown on the screen. You can select the brightness range for correction.



Histogram selection buttons:

Original: Shows the histogram before the brightness correction.

Modified: Shows the histogram after the brightness correction.

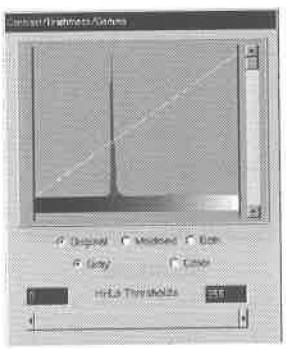
Both: Shows the overlayed histograms before and after the brightness correction.

Pseudo-color buttons:

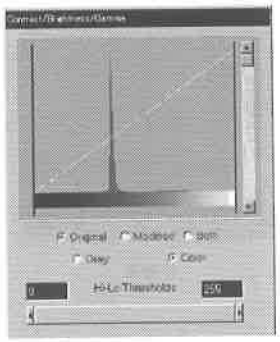
You can choose between a monochrome and a pseudo-color image.

Gray: Shows the monochrome image.

Color: Shows the pseudo-color image in the selected brightness range.



Gray scale

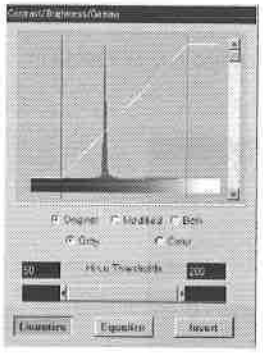


Pseudo-color

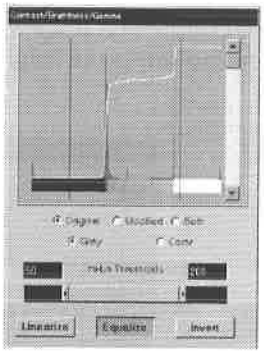
Linearize: Linearizes the correction curve in the selected brightness range.

Equalize: Equalizes the histogram in the selected brightness range.

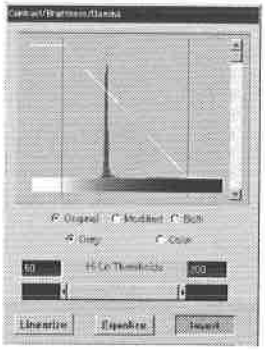
Invert: Inverts the brightness in the selected brightness range.



Linearize

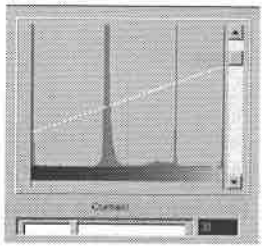


Equalize

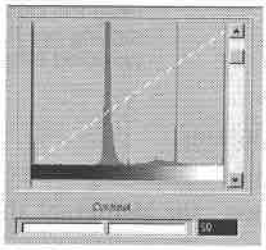


Invert

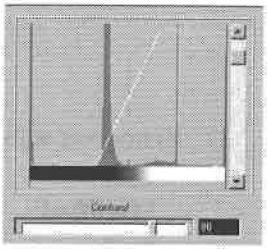
Contrast: Changes the contrast in the selected brightness range. The contrast is shown as a numerical value in the indication box. You can key in a numerical value from 0 to 99.



Low contrast

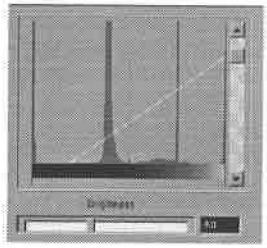


Standard contrast

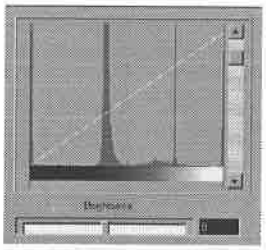


High contrast

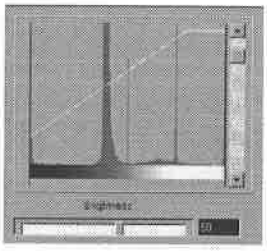
Brightness: Changes the brightness in the selected brightness range. The brightness is shown as a numerical value in the indication box. You can key in a numerical value from –255 to 255.



Dark

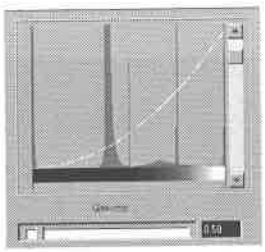


Standard

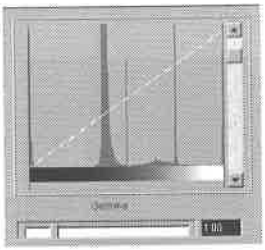


Bright

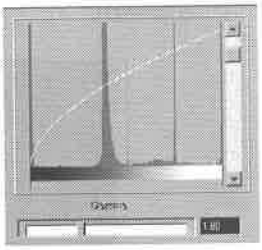
Gamma: Changes the gamma value in the selected brightness range. The gamma value is shown as a numerical value in the indication box. You can key in a numerical value from 0.20 to 5.00.



Low



Standard



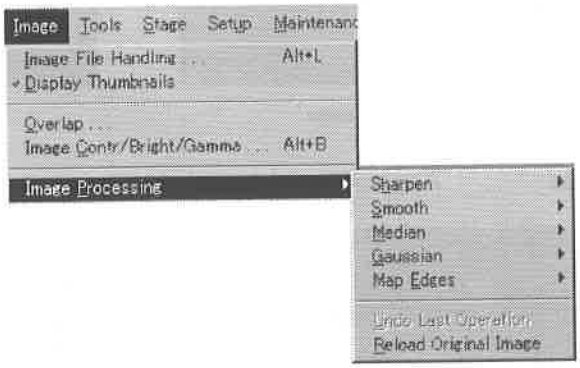
High

Ok: Closes the Contrast/Brightness/Gamma dialog box.
Store: Stores the settings.
Restore: Recalls the settings that were stored.
Default: Resets the settings to the defaults.

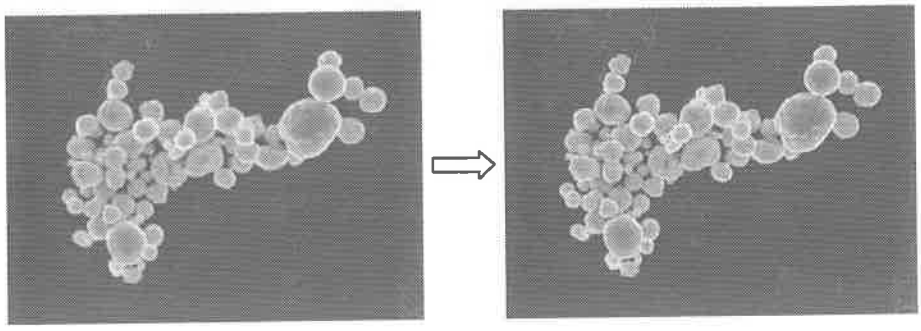
4.5.3 Image Processing

You can carry out image processing by using various filters.

- **Select Image–Image Processing.**



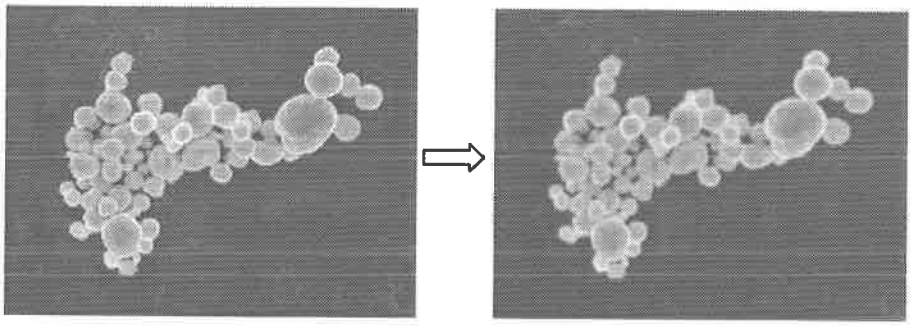
Sharpen: Performs image sharpening.



Original image

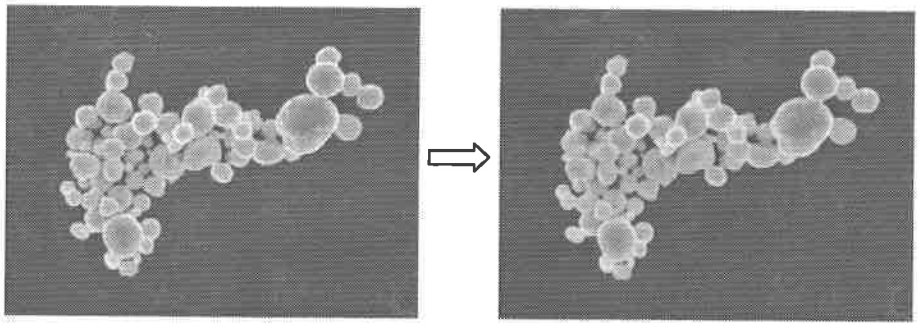
Processed image

Smooth: Performs image smoothing.



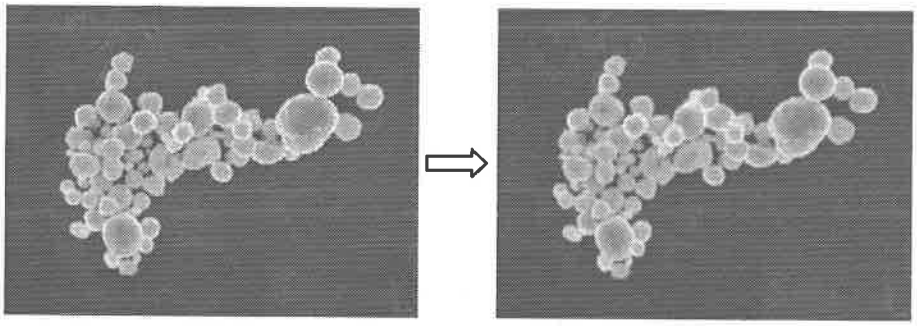
Original image Processed image

Median: Applies a median filter.



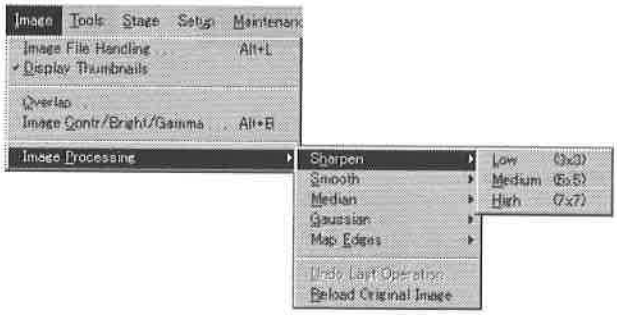
Original image Processed image

Gaussian: Applies a gaussian filter.

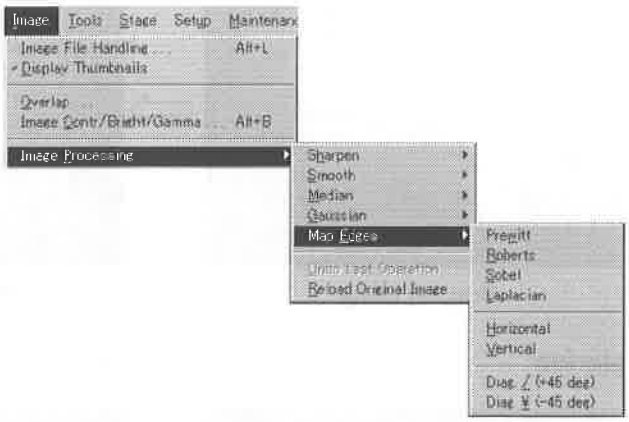


Original image Processed image

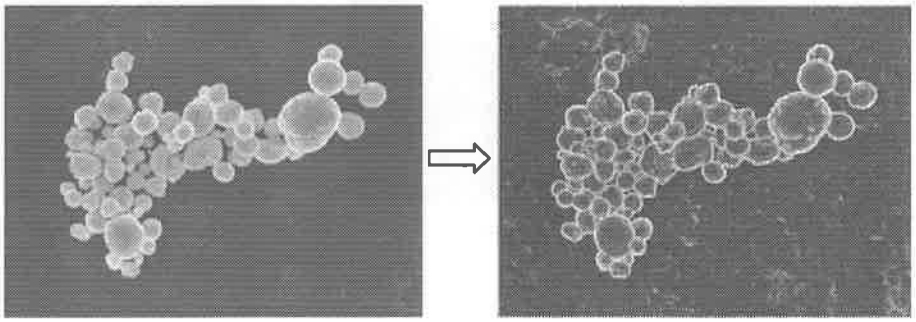
Note: For the above four filters, you can select from the submenu one of three filters, Low (3 × 3), Medium (5 × 5), High (7 × 7).



Map Edges: Performs various kinds of edge emphasis. Select a filter from the submenu.

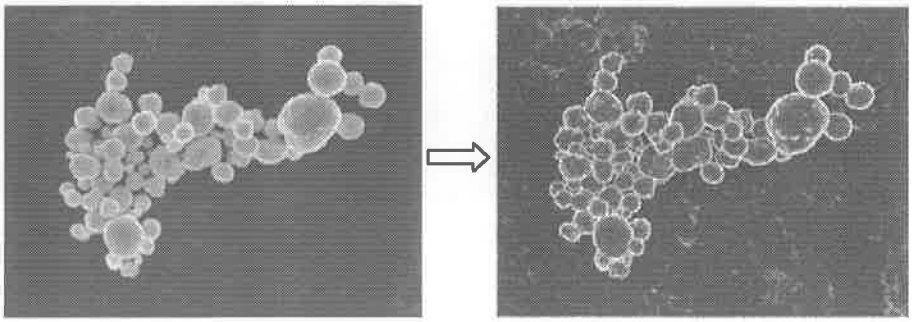


Prewitt:



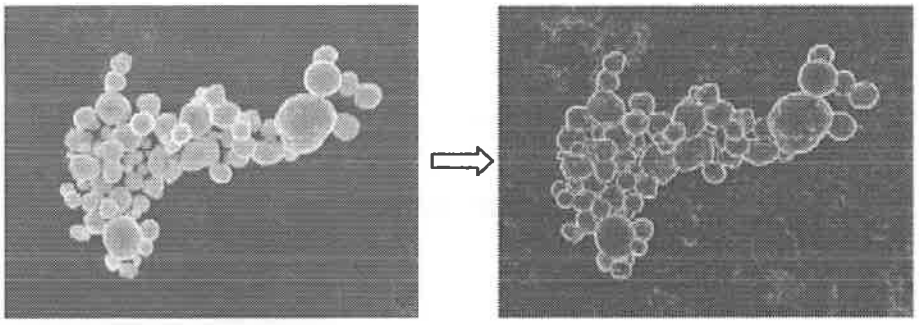
Original image Processed image

Roberts:



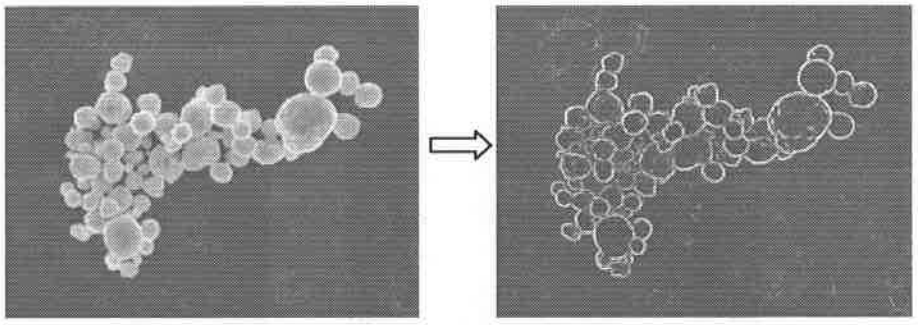
Original image Processed image

Sobel:



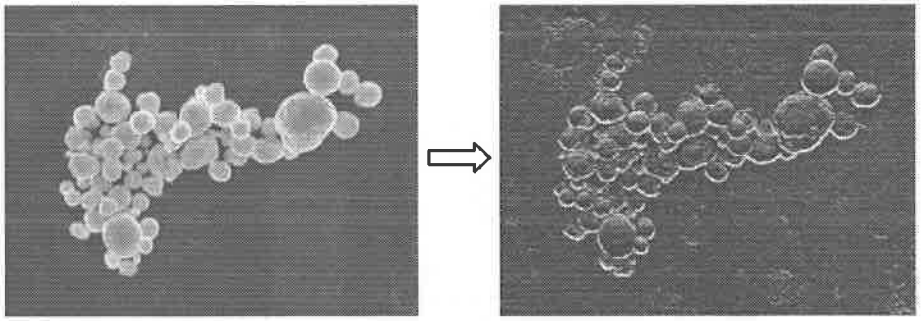
Original image　　Processed image

Laplacian:



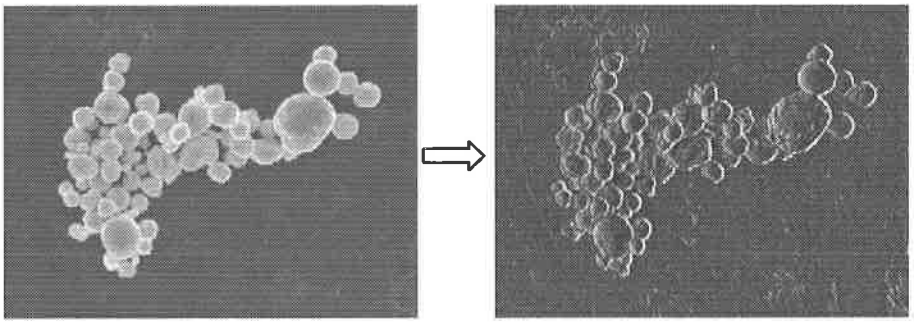
Original image　　Processed image

Horizontal:



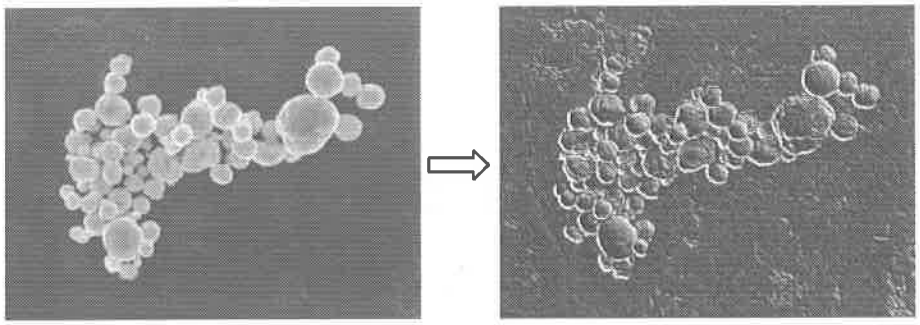
Original image　　Processed image

Vertical:



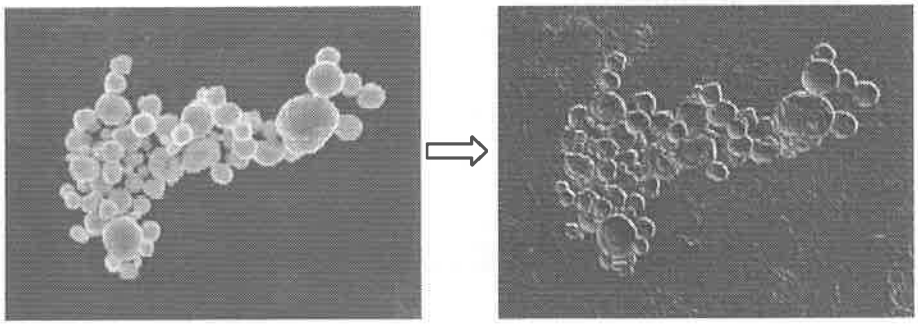
Original image　　Processed image

Diag. ∠ (+45 deg):



Original image　　Processed image

Diag. ⦤ (–45 deg):



Original image　　Processed image

Undo Last Operation:

Returns to the previous image.

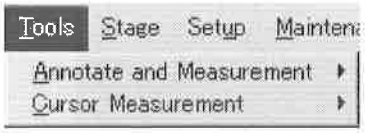
Reload Original Image:

Returns to the original image that existed before the image processing.

4.6 TOOLS MENU

You can carry out text editing, inputting and distance measurement.

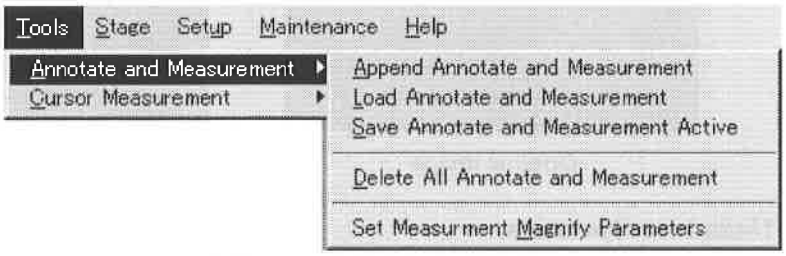
- **Click Tools on the menu bar.**



Annotate and Measurement:
Enables you to edit the text and measure the distance between two arbitrary points.

Cursor Measurement:
Measures the distance between two points specified by the cursors.

4.6.1 Annotate and Measurement



Append Annotate and Measurement:
Enables you to input and edit text, and perform simple figure drawing and measurement.

Load Annotate and Measurement:
Loads the saved text.

Save Annotate and Measurement Active:
Saves the text that you created.

Delete All Annotate and Measurement:
Deletes all the text and figures on the screen.

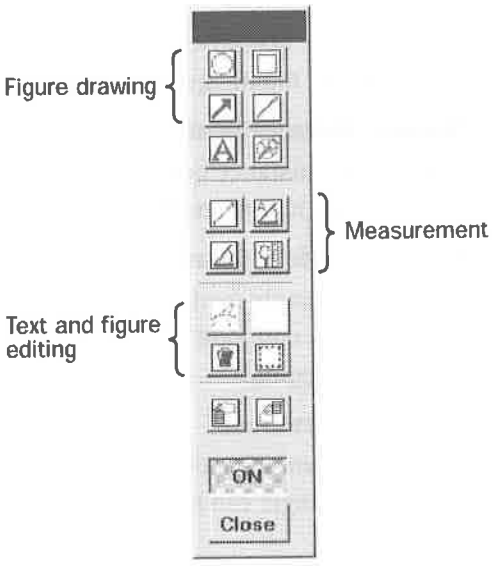
Set Measurement Magnify Parameters:
Sets the size, shape and magnification of the Magnifier.

4.6.1a Append Annotate and Measurement tool bar

- **Select Tools–Annotate and Measurement–Append Annotate and Measurement.**

  Button with equivalent function:  **Append Annotate and Measurement**

  The Append Annotate and Measurement tool bar opens. Entry of text or figures is possible using the tool bar buttons. Measuring the distance between two points is also possible.



Circle Drawing
Click the position for the center of the circle on the image and drag it. When you release the mouse button, a circle is drawn on the image.

Rectangle Drawing
Click the location for one corner on the image and drag it. When you release the mouse button, a rectangle is drawn on the image.

Arrow Drawing
Click the position for the head of the arrow on the image and drag it. When you release the mouse button, an arrow is drawn on the image.

Line Drawing
Click one endpoint for the line on the image and drag it. When you release the mouse button, a line is drawn on the image.

Text Entry
Click the position at which you want to enter the text. Then, the **Annotate Text Entry** dialog box opens.

Aa: A sample of the font is shown.
Text Entry box: You can key in the text that you want to write.

Background ON/OFF: You can select whether the background is displayed (ON) or not (OFF).

Colors BG/FG: The left box is for background color, and the right box is for text color. Click the box to open the color palette.

Font Setting

Click this icon to open the Font select window.

Magnifier Indication

Shows that the magnifier is in action. When you carry out measurement in this condition, the image near the pointer is enlarged.

Distance Measurement

Measures the distance between the two points specified with the mouse pointer. Dragging can move the measurement point.

Distance/Angle Measurement

Measures the angle made by two lines and the lengths of the two line segments. The endpoint of a segment and the vertex of the angle can be moved by dragging.

Angle Measurement

Measures the angle made by two lines. The endpoint of a segment and the vertex of the angle can be moved by dragging.

Calibration

Carries out the calibration of the measurement of a line segment.

Font Setting

Sets the font that you want to use for the text. Click this icon to open the Font Select window.

Color Setting

Changes the color of the characters and figures. Click this icon to open the Color Palette.

Delete

Deletes text, figure and measurement value. Click this icon, and then click the object that you want to delete.

Domain Designation

Deletes more than one text, figure and measurement value. Draw a dashed box around the objects that you want to delete. Click the Delete button to delete all the objects shown inside the dashed box.

Load

Loads the saved text and figures.

Save

Saves the edited text and figures.

ON/OFF: Switches between showing and hiding the text, figures and measurement values.

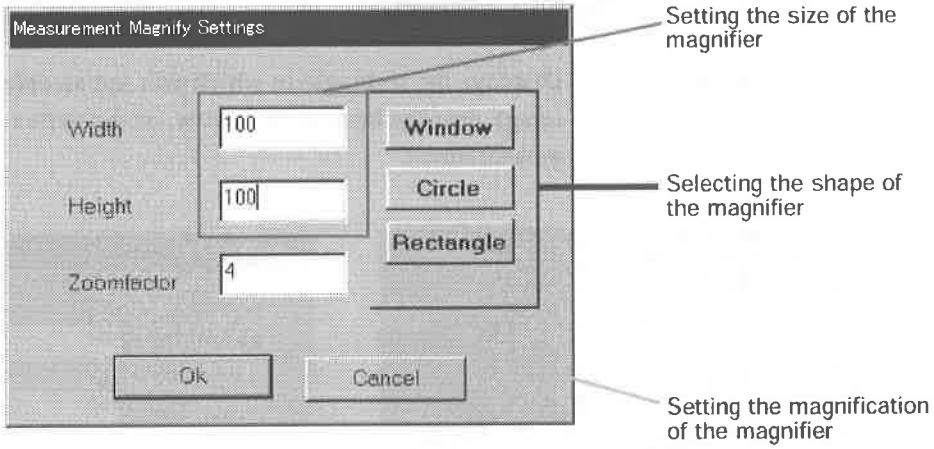
Close: Closes the Append Annotate and Measurement tool bar.

4.6.1b Set Measurement Magnify Parameters

You can set the shape and size of the magnifier as well as its magnification before using the **Magnifier Indication** button  of the Append Annotate and Measurement tool bar.

- **Select Tools–Annotate and Measurement–Set Measurement Magnify Parameters.**

The Measurement Magnify Settings dialog box opens.

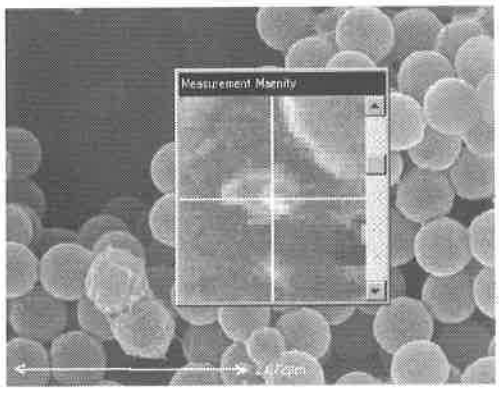


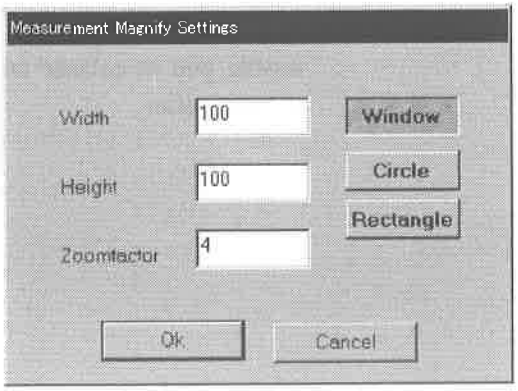
1. Selecting the shape of the magnifier

You can select the shape of the magnifier that you want to use from ① **Window**, ② **Circle** and ③ **Rectangle**.

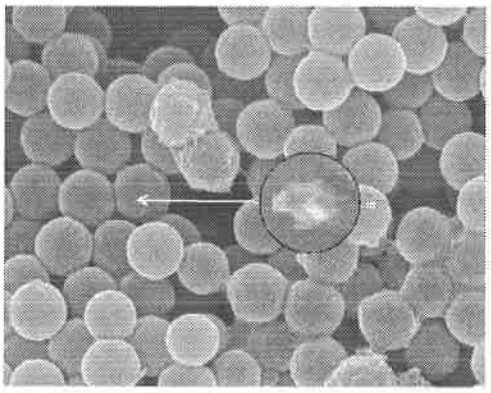
Click the button of the desired shape, and then click the **OK** button.

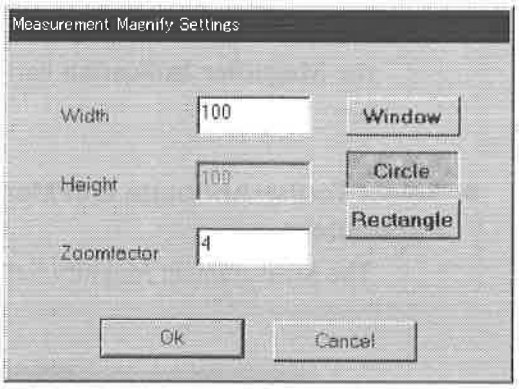
① **Window:** Displays a window in which you see an enlargement of the image near the head of the arrow, or the vertex of the angle, for measurement.



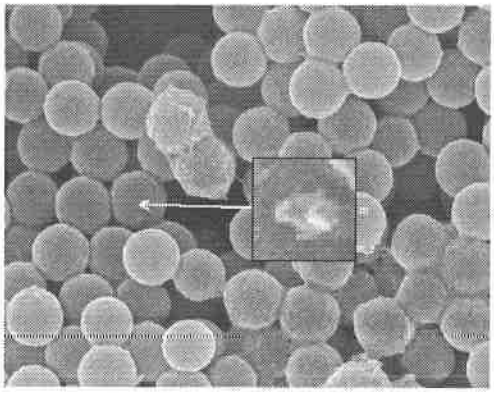


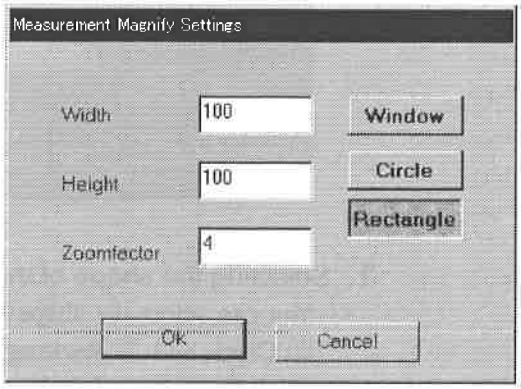
② **Circle:** Displays a circle in which you see an enlargement of the image near the head of the arrow, or the vertex of the angle, for measurement.





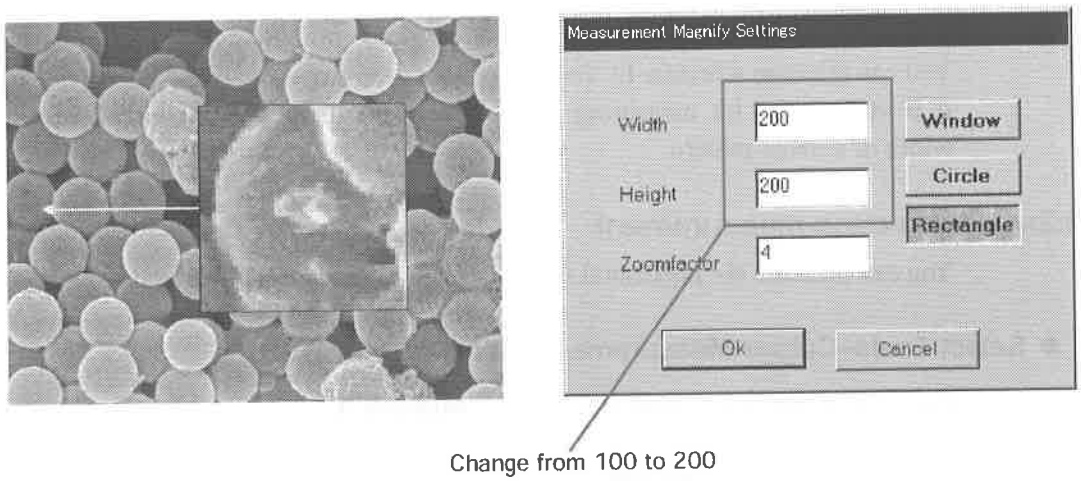
③ **Rectangle:** Displays the rectangle in which you see an enlargement of the image near the head of the arrow, or the vertex of the angle, for measurement.





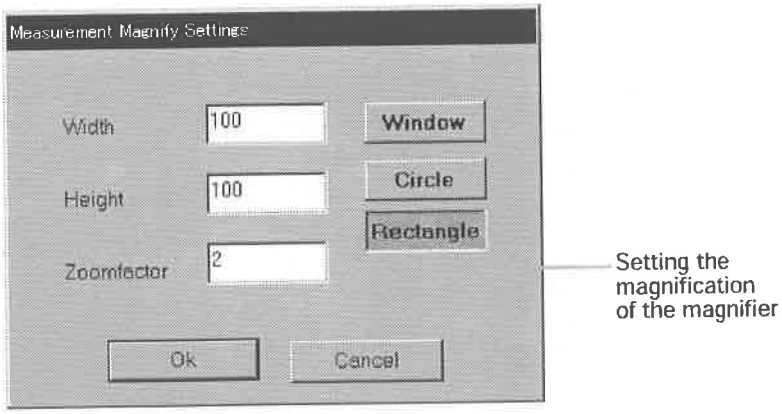
2. Setting the size of the magnifier

You can change the size of the magnifier. The case of the rectangle is shown below. In the above case of 1–③ **Rectangle**, if you want to enlarge to twice as large in each dimension of the magnifier (Width: 100, Height: 100), double each value of both the Width and the Height (from 100 to 200). Clicking the **Ok** button will enable you to enlarge twice as large in each dimension of the width and height of the magnifier.

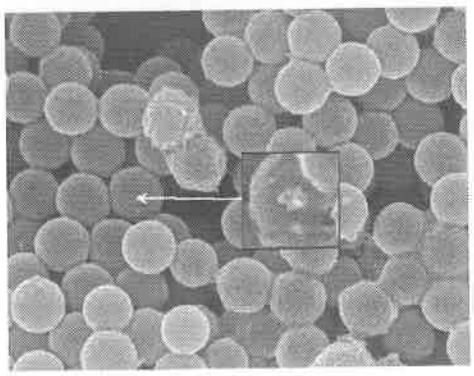


3. Setting the magnification of the magnifier

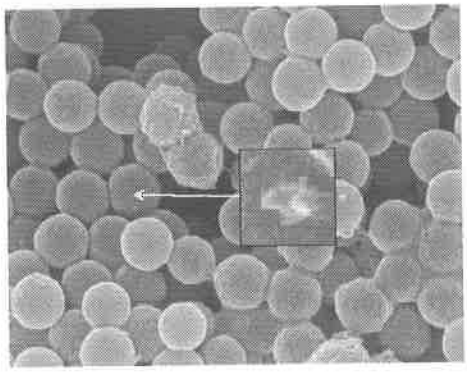
You can set the magnification of the magnifier by using the Zoomfactor function. The larger the magnification is, the coarser the image is. Set the magnification to a value from 2 to 4 in ordinary use.



The case of changing the magnification from two to four is shown below as an example.



Magnification: two times



Magnification: four times

4.6.2 Measurement Using the Cursors

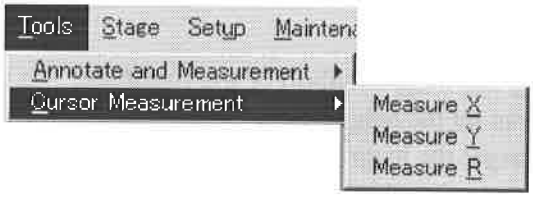
You can measure a feature by enclosing it between two cursors.
It is very useful for measuring sizes such as the diameter of a circular feature or the width of a linear pattern.

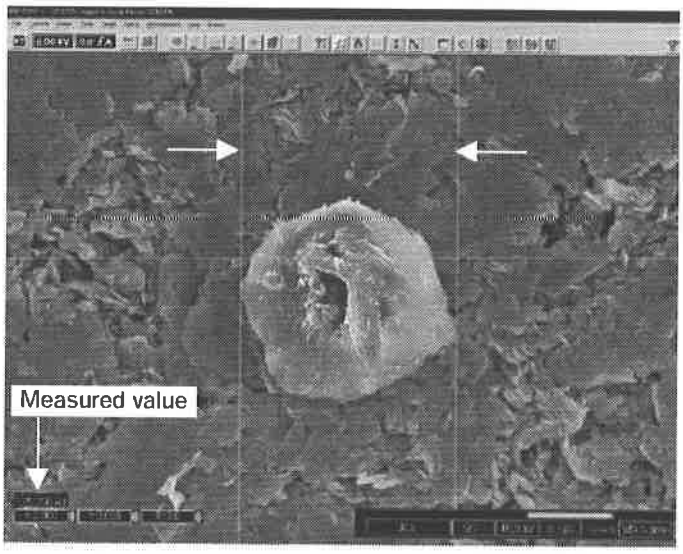
4.6.2a X direction measurement

You can measure the horizontal size of a feature between two vertical cursors.

- **Select Tools–Cursor Measurement–Measure X.**

Button with equivalent function:  **Measure X**





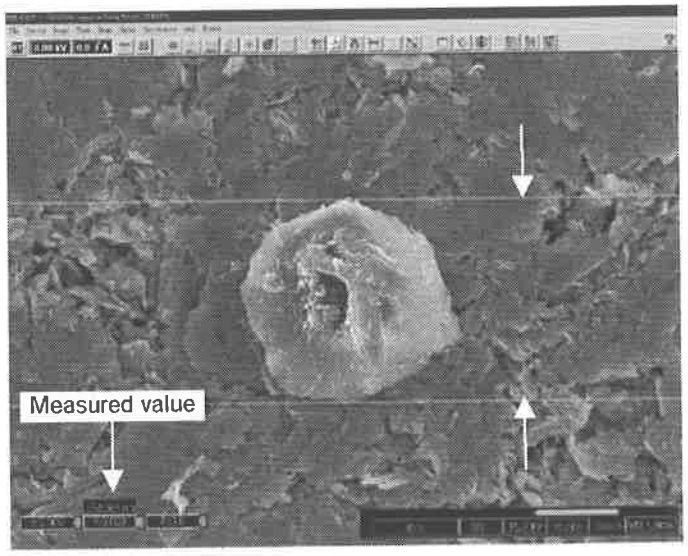
The measured size is indicated at the bottom left of the screen.

4.6.2b Y direction measurement

You can measure the vertical size of a feature between two horizontal cursors.

- **Select Tools–Cursor Measurement–Measure Y.**

Button with equivalent function: **Measure Y**



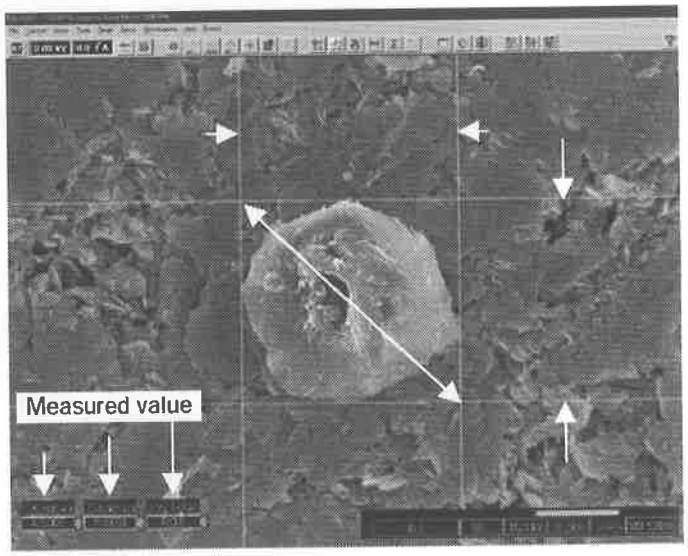
The measured size is indicated at the bottom left of the screen.

4.6.2c Diagonal measurement

You can measure the vertical, horizontal and diagonal sizes of a feature in a rectangle formed by two vertical and two horizontal cursors.

- **Select Tools–Cursor Measurement–Measure R.**

Button with equivalent function: **Measure R**

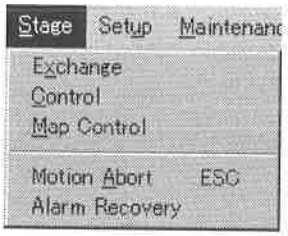


The measured horizontal, vertical and diagonal sizes are indicated at the bottom left of the screen.

4.7 STAGE MENU

You can carry out various kinds of specimen-movement operations.

- **Click Stage on the menu bar.**



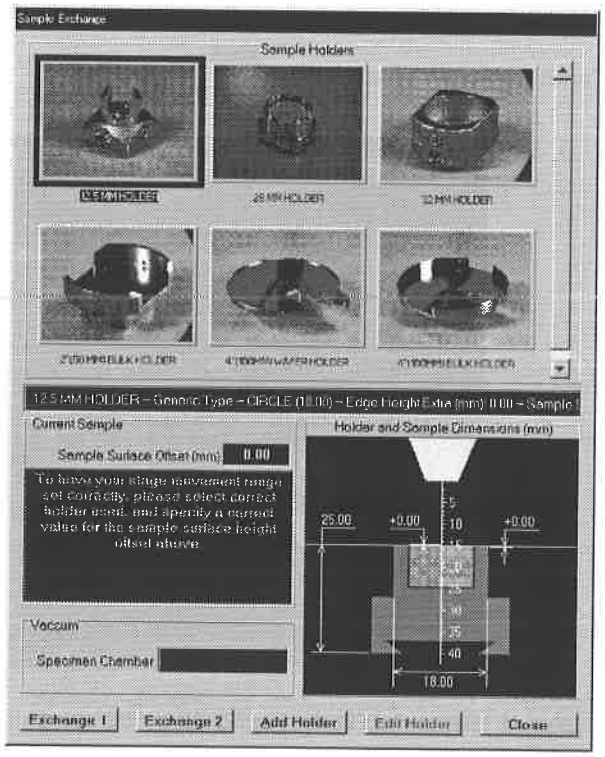
Exchange: Performs specimen-exchange operations.
Control: Performs step movement of the stage.
Map Control: Performs the specimen stage movement by using a saved image or the coordinates.
Motion Abort: Stops the stage movement immediately.
Alarm Recovery: If the specimen holder in movement comes into contact with the detector, an alarm sounds and the specimen holder stops. Clicking the **Alarm Recovery** button frees the holder to move.

4.7.1 Specimen Exchange

You can carry out operations such as specimen exchange and specimen-holder selection.

- **Select Stage–Exchange.**

Button with equivalent function:  **Specimen exchange**



Sample Holders: Shows the image index of the specimen holders. Click the specimen holder that you want to use, and then the holder is outlined in black. With this operation, such information as the movement range of the stage is loaded.

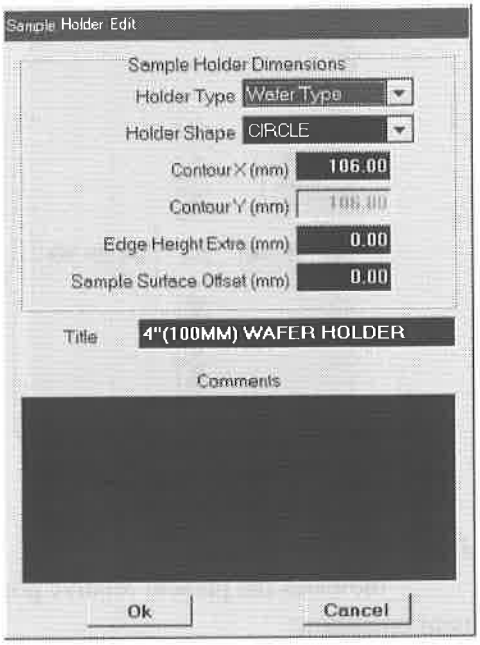
Vacuum: The pressure in the specimen chamber is indicated if the optional Penning vacuum gauge is installed.

Specimen holder in use:
The selected specimen holder is indicated.

Exchange 1: Moves the specimen holder to the specimen-exchange position.

Add Holder: Adds information on a new specimen holder that is not included in the image index of the specimen holders.

Note: This requires a floppy disk that contains the specimen holder information. As soon as the new specimen holder image is added to the image index of the specimen holders, the Sample Holder Edit dialog box appears.



Holder Type: Indicates the specimen holder type.

Holder Shape: Indicates the specimen holder shape.

Contour X (mm): Indicates the size in the X direction.

Contour Y (mm): Indicates the size in the Y direction.

Edge Height Extra (mm):
Set to **0** in normal use. Use this function when using a special specimen holder.

Sample Surface Offset (mm):
Indicates **0** in normal use. If the specimen is higher than the standard position, key in the excess height.

Title: The name of the specimen holder.

Comments: Key in any information you want.

Edit Holder: Select the specimen holder that you want and click this button. Then, the Sample Holder Edit dialog box is opened.

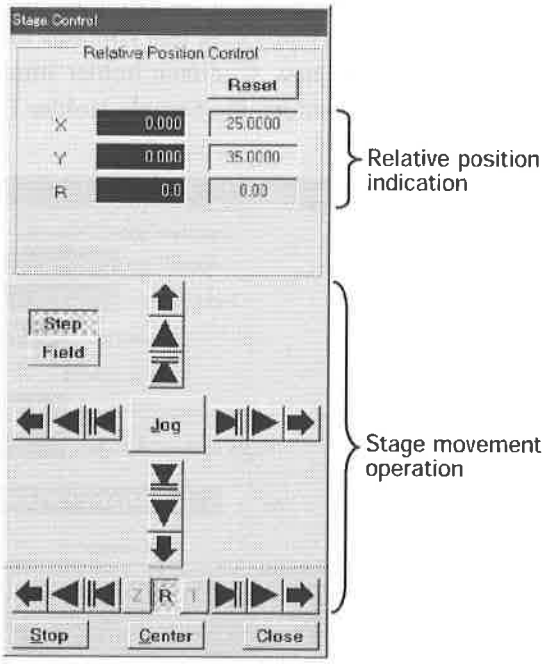
Close: Accepts the specimen holder that you selected, and closes the Sample Exchange window.

4.7.2 Stage Control

You can carry out step movement of the specimen stage using Stage Control.

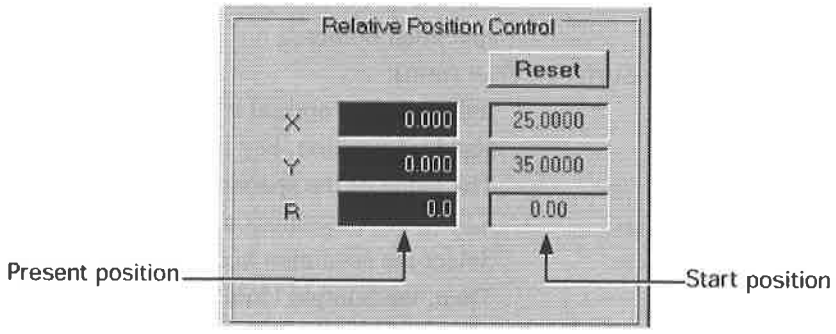
- **Select Stage–Control.**

Button with equivalent function: **Stage Control**



Relative Position Control:
Indicates the present relative position at which the specimen stage is.
Stage movement operation:
You can carry out specimen movement operations using these buttons.
Stop: Forcefully stops the specimen movement.
Center: Moves to the specimen exchange position.

◆ Relative position indication

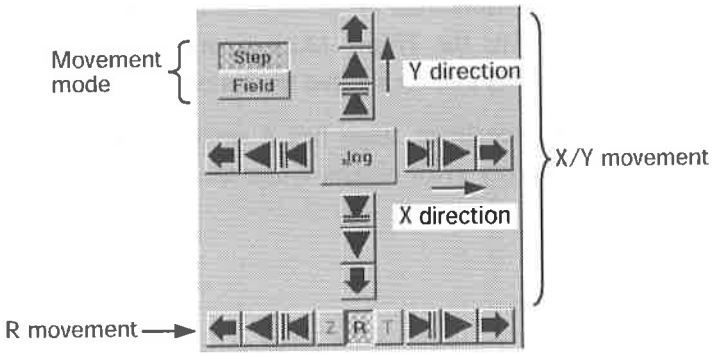


Reset: Makes the present X, Y and R zero, and loads the present position of the stage into the start-position boxes.

Present position: Indicates the specimen stage position, taking the start position as the origin.

Start position: When reset, indicates the specimen stage position using the absolute coordinate system.

◆ Stage-movement operation



Step: Moves the specimen stage by the preset step size.

⇒ Refer to Sect. 4.8.3b Step in this instruction manual for information on setting the step size.

Field: Moves the specimen stage by the preset fraction of the screen size.

⇒ Refer to Sect. 4.8.3c Field in this instruction manual for information on setting the fraction of the screen size.

Jog: Removes the backlash of the specimen stage.

X/Y movement buttons:
Moves the specimen stage in the X and Y directions.

R movement buttons:
Rotates the specimen stage.

Continuous movement
Clicking one of these buttons moves the stage continuously in the direction of the arrow.

Step movement 1
Clicking this button carries out the step movement or field movement by the preset movement amount.

Step movement 2
Clicking this button carries out the step movement or field movement by the preset movement amount.

4.7.3 Stage Map Control

You can perform the specimen stage movement by using a saved image or the coordinates.

- **Select Stage–Map Control.**

Button with equivalent function: **Map Control**

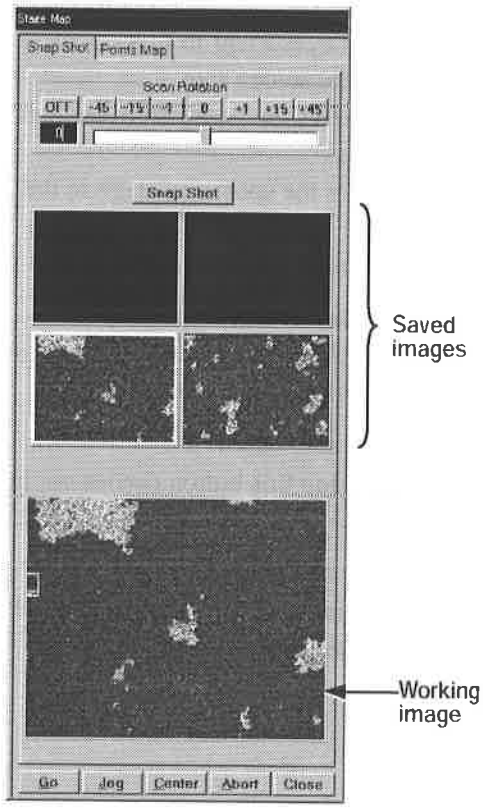
There are two functions, Snap Shot and Points Map. With the Snap Shot function, you can designate an observation range on a saved image and then move the specimen stage to that range. With the Points Map function, you can save the coordinates of an observation position, and then move the specimen stage to its position.

Note: Since the specimen stage has a small amount of backlash, a small amount of reproducibility error occurs when these functions for the specimen-stage movement are used.

4.7.3a Snap Shot

You can designate an observation range on a saved image and then move the specimen stage to the range.

- **Click the Snap Shot tab.**



Scan Rotation: Rotates the image.

⇒ Refer to Sect. 4.4.1h Scan Rotation in this instruction manual.

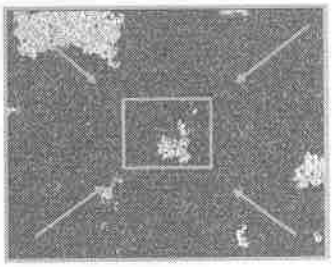
Snap Shot: Loads the image the observation range of which is to be designated. Clicking this button loads the image into the green selected frame.

Saved images: Displays up to four images that were loaded. Select a frame to load the desired image and click the frame. Then, the frame color changes to green. If an image was already loaded in the frame, it is enlarged as the working image in the working image area.

Working image: You can specify the observation range on the displayed working image as well as observe it under enlarged magnification.

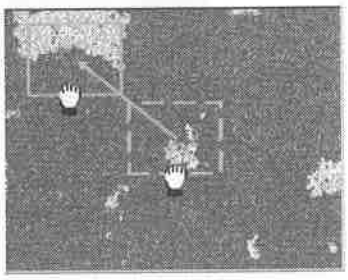
Reducing the observation area:

Turn the MAGNIFICATION knob on the OPERATION panel in the clockwise direction. The green frame is reduced as the knob is turned.



Moving the observation range:

Drag the green frame to the position that you want to observe.



Go: Moves the specimen to the designated observation position.

Jog: Removes the backlash of the specimen stage.

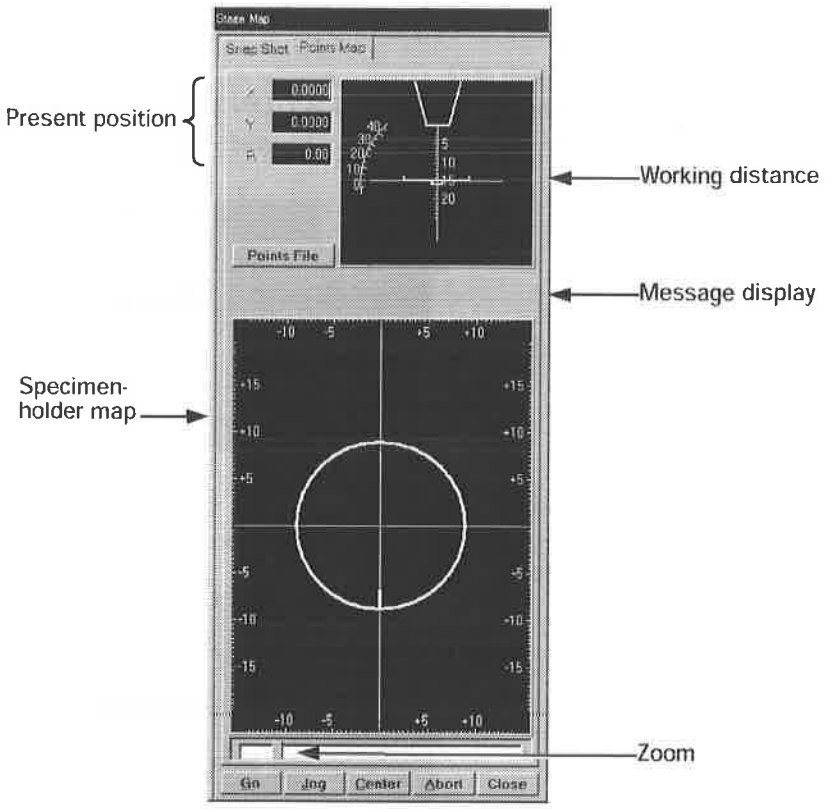
Center: Moves the specimen stage to the center (the specimen-exchange position).

Abort: Stops the specimen movement immediately.

4.7.3b Points Map

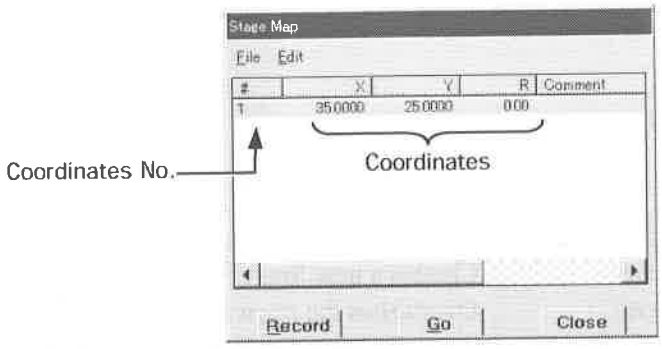
You can directly move the specimen stage to saved coordinates by recalling those saved coordinates. The shape of the specimen holder and the working distance are indicated.

- **Click the Points Map tab.**



Present position: Indicates the same Relative position as on the **Stage Control** window.
Working distance: Indicates the working distance as the height of the specimen holder.
Points File: Opens the **Stage Map** window and loads the saved coordinates.
Message display: Shows messages regarding operation.
Specimen-holder map:
The map on which you can move the specimen holder.
Zoom: Enlarges the specimen-holder map.
Go: Moves the selected position to the observation position.
Jog: Removes the backlash of the specimen stage.
Center: Moves the specimen stage to the center (the specimen-exchange position).
Abort: Stops the specimen movement immediately.

◆ Stage Map window



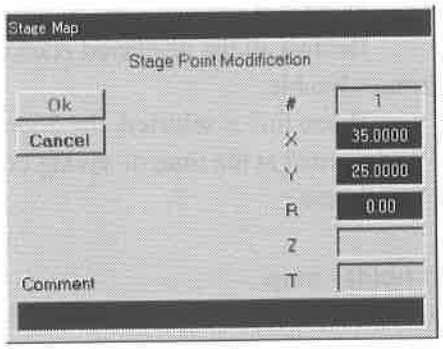
Coordinates list box:
Indicates the coordinates saved in the Stage Map.

#: Indicates the coordinates number corresponding to the numbers indicated on the specimen-holder map.

X, Y, R: Indicates the values of each set of coordinates.

Comment: Indicates the comment for each coordinate.

- Stage Point Modification:
  Double-click the coordinates that you want to edit; the Stage Point Modification dialog box opens.



X, Y, R indication boxes:
Indicate the X, Y, R coordinates positions. Rewriting is possible.

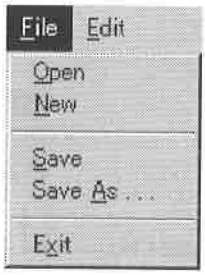
Comment box:
A comment can be keyed in.

Record: The present specimen-stage position is added to the Stage Map as new coordinates.

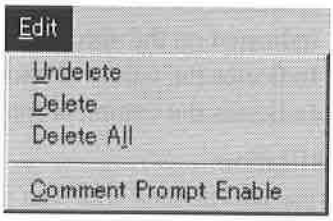
Go: Moves the specimen stage to the selected coordinates.

Close: Closes the Stage Map window.

File command: Used for operations on the Stage Map window.



Open: Opens the saved Stage Map.
New: Creates a new Stage Map.
Save: Overwrites the open Stage Map.
Save As: Saves the open Stage Map with another name.
Close: Closes the open Stage Map.
Edit command: Edits the Stage Map.

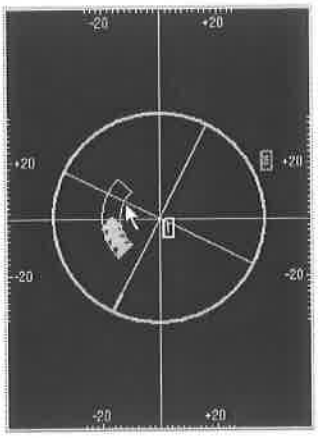


Undelete: Returns to the previous set of coordinates.
Delete: Deletes the selected set of coordinates.
Delete All: Deletes all the displayed coordinates.
Comment Prompt Enable:
When this is selected, the Stage Point Modification dialog box is opened at the time of saving coordinates, and you can key in comments.

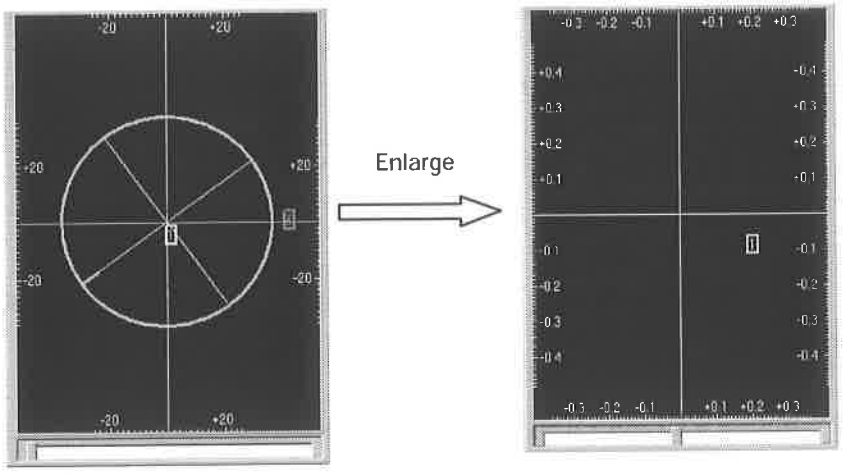
◆ Specimen-holder map

You can move the specimen stage by using the specimen-holder map.

- Stage movement
  Put the pointer on the position to which you want to move the specimen stage, and then right-click it. The specimen stage will move to the designated position.
- Stage coordinate movement
  Click the coordinate number to which you want to move the specimen stage, and then click the **Go** button. The specimen stage will move to the position designated by the coordinate number.
- Specimen rotation
  Put the pointer near the center of the specimen holder, and drag it. Then, the ▶ symbol is shown in the direction of rotation. The more ▶ symbols, the higher the rotation speed.



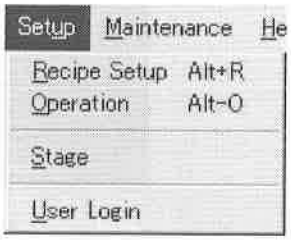
- Zoom
  Move the scroll bar under the specimen holder map to the right to enlarge the map.



4.8 SETUP MENU

You can set conditions such as observation conditions and operation conditions using the Setup menu.

- **Click Setup on the menu bar.**



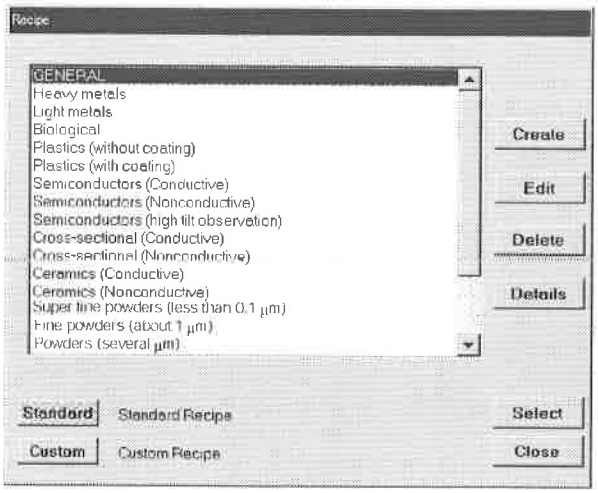
Recipe Setup: Selects and creates a Recipe.
Operation: Sets up the OPERATION panel.
Stage: Sets up the optional 3-axis motor stage controller.
Brightness correction for photography:
Corrects the brightness of the optional photographic recording system.
User Login: Sets the user login conditions.

4.8.1 Recipe

You can select a recipe suitable for the specimen or observation purpose.

- **Select Setup–Recipe Setup.**

Button with equivalent function:  **Recipe Setup**



List box: Shows the list of the recipes.
Create: Creates a new recipe. Clicking this button opens the Recipe Details window for the new recipe.
Edit: Edits a recipe. Clicking this button opens the Recipe Details window for the selected recipe.

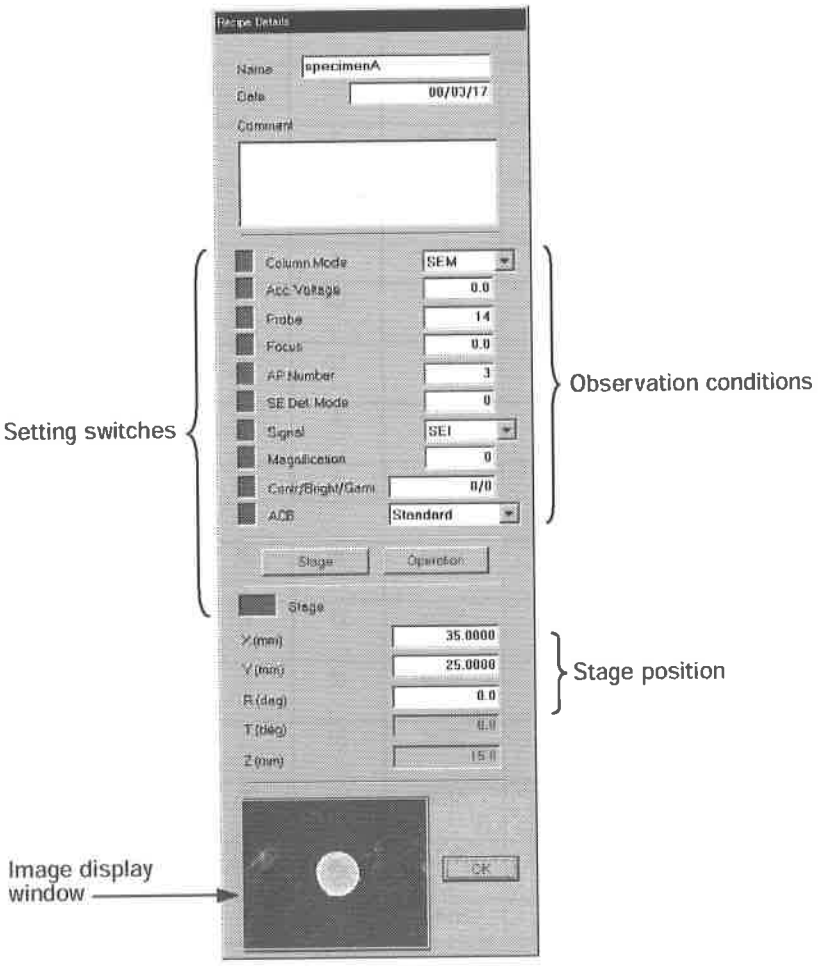
Delete: Deletes a recipe. Clicking this button opens the Delete recipe dialog box for the selected recipe.

Details: Shows details for the recipe. Clicking this button opens the Recipe Details window for the selected recipe.

Standard: Indicates the recipes for general specimen observation. With **Standard**, such operations as **Create**, **Edit** and **Delete** are not possible.

Custom: Indicates the recipes that the user created for specialized observation.

◆ Recipe Details window



Name: Indicates the recipe name

Date: Indicates the date of the recipe creation.

Comment: Indicates the comment.

Setting switches: Clicking one of these switches alternately changes the switch color between green and white. When it is green, the observation condition or the specimen stage position is applied to the recipe.

Observation conditions:
Indicates the conditions set in the recipe.

Stage: Opens or closes the Stage Setup window.

Operation: Opens or closes the Operation window.

◆ Standard recipe contents

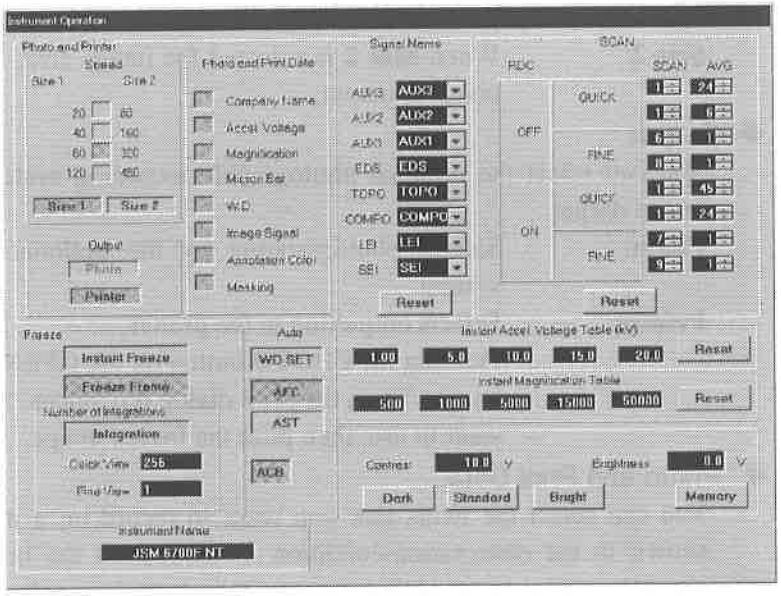
Name	Comment	Column mode	Accl. Volt	Probe	WD	AP Number	SED mode	Signal	Magnification
Heavy metals	Fe, Cr, Ni, ···	SEM	15	7	6	4	2	SEI	700
Light metals	Al, Mg, Si, ···	SEM	5	7	6	4	2	SEI	700
Biological	With coating	SEM	10	7	6	4	2	SEI	700
Plastics (without coating)	Vulnerable to heat	SEM	1	7	2	4	0	SEI	1700
Plastics (with coating)	Vulnerable to heat	SEM	5	7	6	4	2	SEI	700
Semiconductors (Conductive)	Surface observation	SEM	10	7	6	4	2	SEI	700
Semiconductors (Nonconductive)	Surface observation	SEM	1	7	2	4	2	SEI	1700
Semiconductors (high tilt observation)	Tilt observation	SEM	1.2	7	15	4	2	SEI	250
Cross-sectional (Conductive)	Thin coating	SEM	3	7	6	4	2	SEI	700
Cross-sectional (Nonconductive)	Thin coating	SEM	1	7	2	4	0	SEI	1700
Ceramics (Conductive)	Surface observation	SEM	5	7	6	4	2	SEI	700
Ceramics (Nonconductive)	Surface observation	SEM	1.5	7	2	4	0	SEI	1700
Super fine powders (less than 0.1 μm)	Particle diameter	SEM	15	7	6	4	2	SEI	700
Fine powders (about 1 μm)	Particle shape and diameter	SEM	3	7	6	4	2	SEI	700
Powders (several μm)	Particle shape	SEM	5	7	6	4	2	SEI	700
Observation conditions for use with optional attachments									
Qualitative EDS	Element confirmation	SEM	20	8	15	3	2	SEI	250
Qualitative EDS (minerals)	Containing light element	SEM	15	8	15	3	2	SEI	250
BEI observation of metals		SEM	15	8	8	3	2	COMPO	500
BEI observation of MR heads	MR, GM heads, ···	SEM	10	7	8	3	2	COMPO	500
Lower detector (Low mag)	Low magnification	SEM	1.5	7	15	3	2	LEI	250
Lower detector (High mag)	High magnification	SEM	1.5	7	8	3	2	LEI	500
Cryo observation	Cooled specimen	SEM	5	7	6	3	2	SEI	700

4.8.2 Instrument Operation Setup

You can carry out settings for the OPERATION panel.

- **Select Setup–Operation.**

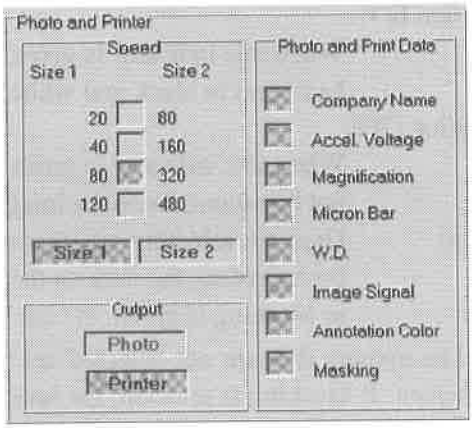
  Button with equivalent function:  **Operation Setup**



The window contains sections for Photo and Printer, Signal Name, SCAN, Freeze, Auto, Instant Accel. Voltage Table, Instant Magnification Table, Contrast/Brightness (ACB) and Instrument Name.

4.8.2a Photo and Printer

You can set the items related to the PHOTO button on the OPERATION panel.
Clicking the check box next to an option changes the check box color alternately to green and gray. Green color indicates that the option is selected and gray indicates that it is not selected.



◆ Speed

You can select the scanning speed for photographing or outputting the image.

Size 1 – 20/40/80/120:
Scanning speeds (seconds per frame of image).

Size 2 –80/160/320/480:
Scanning speeds (seconds per frame of image).

Size 1: When **Size 1** is selected for image size, an image of 1280 ×1024 pixels is output.

Size 2: When **Size 2** is selected for image size, an image of 2560 ×2048 pixels is output.

◆ Output

You can select the optional photographic recording system or the printer for the image output.

Photo: Selects photographing by the optional photographic recording system.

Printer: Selects outputting to the printer.
Pressing the PHOTO button on the OPERATION panel freezes the image. Then, the print dialog box opens. Select the printer that you want to use; then print the frozen image.

◆ Photo and Print Data

You can select the items that you want to record on a photograph from the data shown in the observation-condition indication on the basic screen. Clicking the check box next to an option changes the check box color alternately to green and gray. Green color indicates that the option is selected and gray indicates that it is not selected. The selected options will be recorded on the photograph. Gray options will not be recorded on the photograph.

Micron Bar: Used for selecting whether the magnification scale and its value are to be recorded or not.

Annotation Color:
Each time you click this item, the Annotation Color indication changes sequentially to Annotation B/W and to Annotation OFF. When this indicator is green, the text and figures on the image will be output in color.

Annotation B/W:
When this indicator is green, the text and figures on the image will be output in black and white.

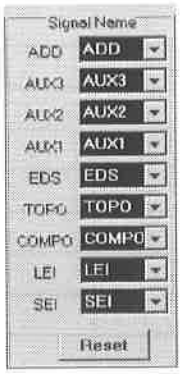
Annotation OFF:
When this indicator is green, the text and figures on the image will not be output. Only the image is output.

Masking: Used for selecting whether a black background is necessary or not for recording the data on the photograph. When the check box next to Masking is green, the background is black.

Note: The options that are not selected are indicated in green on the observation screen. If Masking is selected, the image is masked on the screen; if Masking is not selected, the image is not masked on the screen.

4.8.2b Signal Name

You can set the **Signal Name** of the image to be indicated on the image selector in the observation-condition indication on the basic screen.

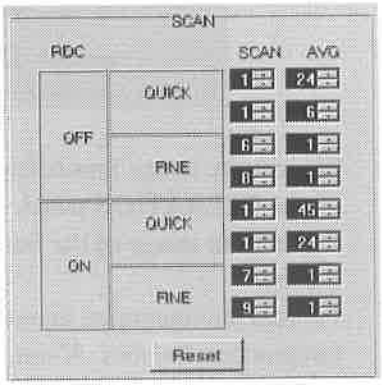


ADD: Indicates the sum of two or more image signals.
The signal names are indicated as defaults, and you can change the names if you want. Select the name that you want from the list or enter a new name into the indication box using up to 5 alphanumeric characters, and then press the Enter key.

Reset: Returns the signal names to the initial state.

4.8.2c SCAN

You can perform settings related to the SCANNING MODE buttons on the OPERATION panel (the scanning speed and the number of integrations during the observation).



RDC OFF: The **RDC IMAGE** button lamp is off (Full screen mode).
RDC ON: The **RDC IMAGE** button lamp is on (Reduced screen mode).
QUICK: The **QUICK VIEW** button is selected.
FINE: The **FINE VIEW** button is selected.
SCAN: The scanning speed indication boxes. Select the desired numeric values from the list or key them in. Refer to the table below for the relation between the numeric values and scanning speed.
AVG: The integration time indication boxes. Select the desired numeric values from the list or key them in. For easy operation, a recursive filter is used for the image integration.

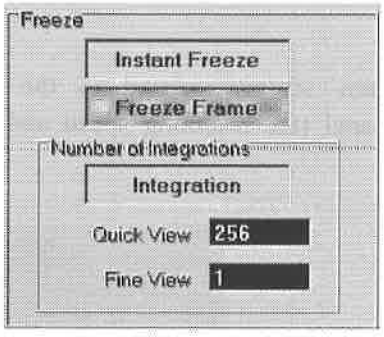
Reset: Returns the scanning speed and integration time to their initial values.

Speed number	Scanning speed (seconds/screen)
1	0.28
2	0.5
3	0.9
4	1.8
5	3.5
6	6.9
7	19 (16)
8	38 (31)
9	79 (66)
10	121 (100)

The numbers in parentheses ( ) are for 60 Hz.

4.8.2d Freeze

You can select the method of freezing an image. Clicking the check box changes its color alternately between green and gray. Green color indicates that the option is selected and gray indicates that it is not selected.



Instant Freeze: Freezes the image immediately when you press the **FREEZE** button on the OPERATION panel.

Freeze Frame: Freezes the image of the frame that you are observing as soon as it is loaded.

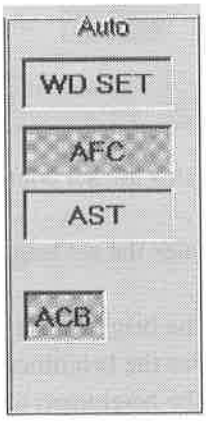
Integration: Freezes the integrated image as soon as the preset number of integrations finishes. A simple addition filter, which is better for image quality, is used for the image integration.

Quick View: Sets the number of integrations to be used in the QUICK VIEW mode.

Fine View: Sets the number of integrations to be used in the FINE VIEW mode.

4.8.2e Auto

You can select settings for the **AUTO** button on the OPERATION panel.
Clicking the check box changes its color alternately between green and gray. Green color indicates that the option is selected and gray indicates that it is not selected.



WD SET: Focuses at the working distance (WD) set with the WD control (coarse) of the specimen stage.
AFC: Press the **AUTO** button, and **AFC** (auto focus) operates.
AST: Press the **AUTO** button, and **AST** (automatic stigmator) operates.
ACB: Press the **AUTO** button and **AFC** or **AST** operates, and then Automatic Contrast/Brightness operates.

4.8.2f Instant Accel. Voltage Table

You can select and set up five accelerating voltages that you often use.
Click the **Accelerating Voltage** button in the observation conditions indication on the basic screen to show the set accelerating voltages in the menu.

The set values are shown in the indication boxes. You can also directly key in the desired values.
Reset: Returns to the initial values.

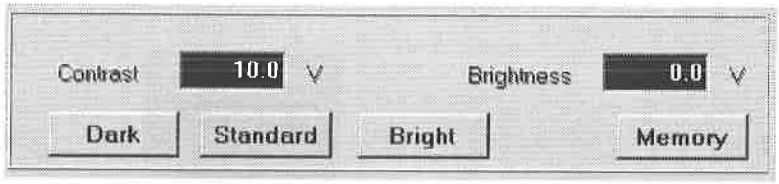
4.8.2g Instant Magnification Table

You can select and set up five magnifications that you often use.
Click the **Magnification** button in the observation conditions indication on the basic screen to show the set magnifications in the menu.

The set values are shown in the indication boxes. You can also directly key in the desired values.
Reset: Returns to the initial values.

4.8.2h Contrast/Brightness (ACB)

You can perform settings for the automatic contrast/brightness (**ACB**) button on the OPERATION panel.



Contrast: Indicates the set contrast. You can also directly key in the desired value.

Brightness: Indicates the set brightness. You can also directly key in the desired value.

Dark: Sets the brightness to a darker value than the value set by the **ACB**.

Standard: Returns the brightness to standard value when the **ACB** operates.

Bright: Sets the brightness to a brighter value than the value set by the ACB.

Memory: Memorizes the present contrast and brightness as the settings of the **ACB**.

4.8.2i Instrument Name

The instrument name indicated here is saved as text together with the image data when the image is saved.

4.8.3 Stage

You can perform settings for the motor stage control.
The settings are for General, Step, Field and Joystick.

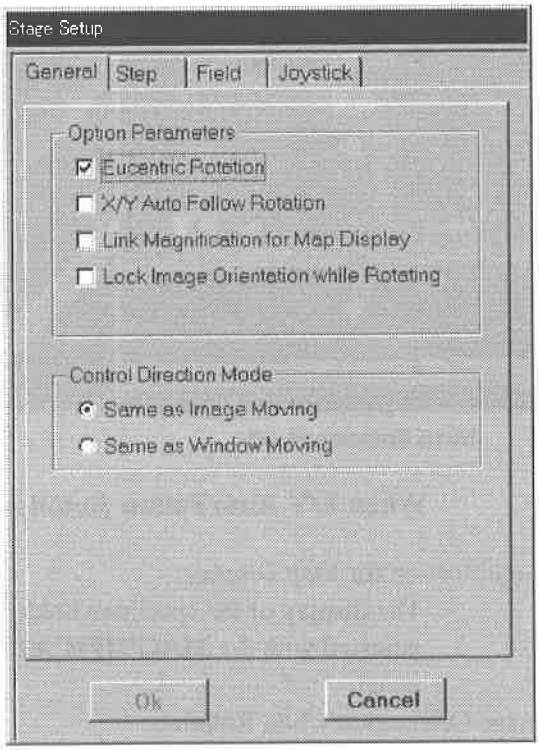
Note: The Stage Setup dialog box is opened only when the optional 3-axis motor stage controller is installed in the SEM.

- **Select Setup–Stage.**

  The Stage Setup window opens.

4.8.3a General

You can perform basic settings for the motor-stage movement.



Option Parameters: When the box next to an option is selected, its function works.

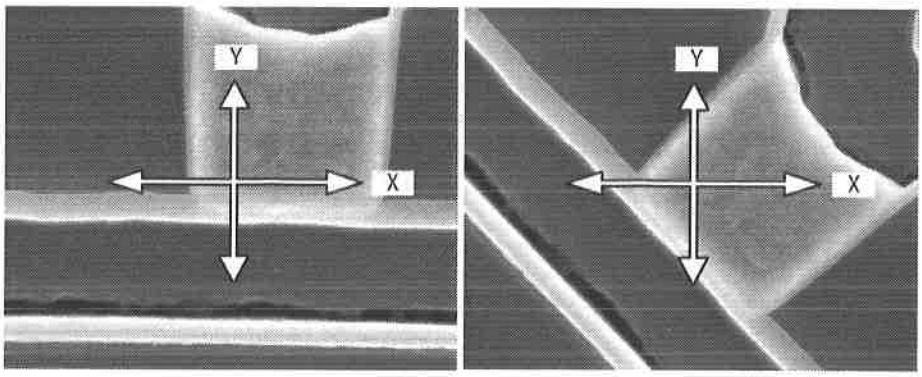
Eucentric Rotation:

When the specimen stage is rotated, the specimen rotates with the observation position as the specimen center.

Note: When observing the periphery of a disc-shaped specimen, do not select the Eucentric Rotation option.

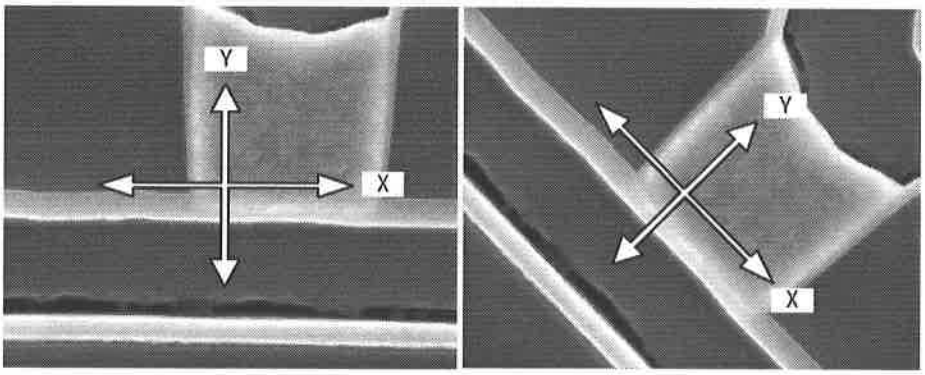
X/Y Auto Follow Rotation:

Even if Scan Rotation is on, the direction of movement of the specimen does not change on the screen. The X axis movement is in the horizontal direction on the screen, and the Y axis movement is in the vertical direction.



Scan Rotation is off Scan Rotation is on

When X/Y Auto Follow Rotation is selected



Scan Rotation is off Scan Rotation is on

When X/Y Auto Follow Rotation is not selected

Link Magnification for Map Display:

The display of the specimen holder map is linked to the magnification adjusted with the **MAGNIFICATION** knob on the OPERATION panel.

Lock Image Orientation while Rotating:

Locks the image in the same orientation while the specimen stage is rotating.

Control Direction Mode:

Sets the relationship between the direction in which the joystick is tilted and the direction in which the specimen moves.

Same as Image Moving:

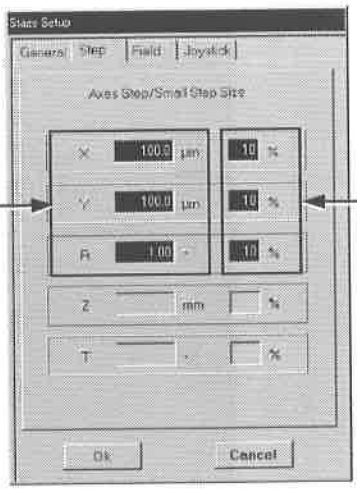
Moves the specimen in the direction in which the joystick is tilting.

Same as Window Moving:

Moves the specimen against the direction in which the joystick is tilting.

4.8.3b Step

You can set the amount of specimen movement per step before using **Step** of the Stage Control.



Settings for the ▶ button

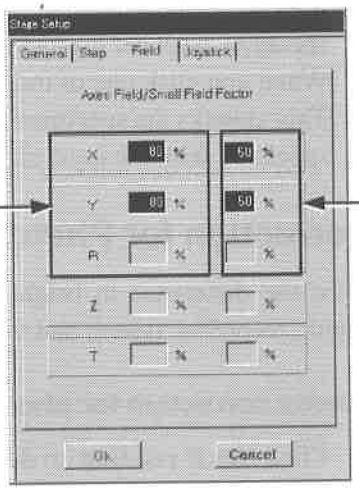
Directly key in numerical values to set the amount of movement.

Settings for the ▶| button

Key in percentages of the amounts set for the ▶ button.

4.8.3c Field

You can set the amount of specimen movement to a percentage of the screen size before using **Field** of the Stage Control.



Settings for the ▶ button

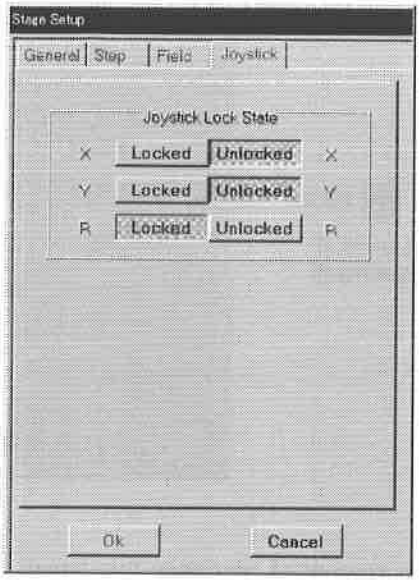
Set the amount of specimen movement to a percentage of the screen size.

Settings for the ▶| button

Key in percentages of the amounts set for the ▶ button.

4.8.3d Joystick

You can select Locked or Unlocked for the axis of movement of the joystick. You can also select it on the basic screen.



Locked: When you click one of these buttons, it will be recessed and green. This locks the specimen along this axis, so you cannot move the specimen with the joystick.

Unlocked: When you click one of these buttons, it will be recessed and green. This unlocks the specimen along this axis, so you can move the specimen with the joystick.

4.8.4 Brightness Correction for Photography

You can correct for the difference in brightness between photographs taken with the optional photographic recording system and the observation screen.

- **Select Setup–Brightness correction for photography.**

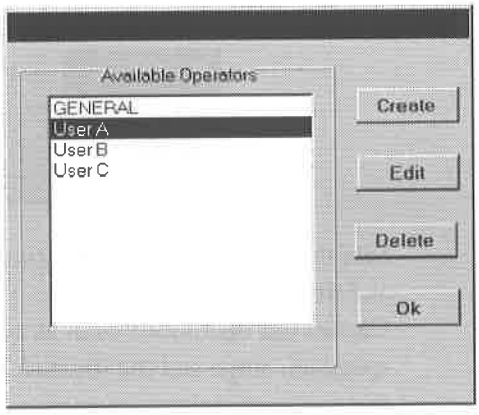
Yes: Click Yes if you find no difference in brightness between the photograph and the screen. The correction values for brightness used on the screen are saved, and the dialog box is closed.

No: Click No when you find a difference in brightness between the photograph and the screen. The brightness correction is suspended, and the dialog box is closed.

4.8.5 User Login

You can establish users. Each user can have individual operation conditions, which take effect the next time he or she logs in.

- **Select Setup–User Login.**



Available Operators:
The stored users' names are displayed.

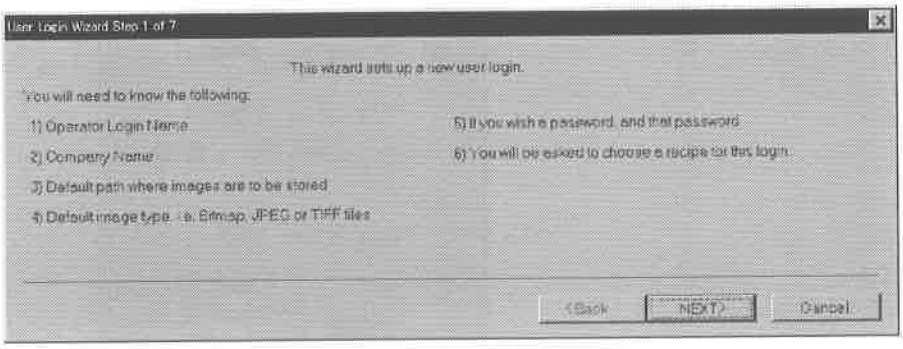
Create: A new user name is saved. Click this button to show the User login wizard, which enables you to set the new user's conditions.

Edit: Edits the stored information. Select a user name, and click this button to show the User login wizard.

Delete: Deletes the stored user name. Select a user name, and click this button. Then, the Delete dialog box appears for your confirmation.

◆ User Login Wizard

Select **Create** or **Edit** to show this wizard. If you carry out each step indicated by this wizard, you create a new user name or edit the stored user name.



Back: Returns to the previous step.

NEXT: Proceeds to the next step.

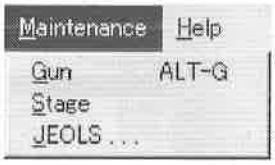
Cancel: Cancels the creation of a new user, and terminates the wizard.

4.9 MAINTENANCE MENU

You can monitor the operations of the SEM.

- **Click Maintenance on the menu bar.**

  Button with equivalent function:  **Maintenance**



Gun: Sets the environmental conditions mainly related to the electron gun, and displays their states.

Stage: Carries out operations such as correction of the origin position of the specimen stage and the joystick setting.

JEOLS: For use by maintenance engineers only.

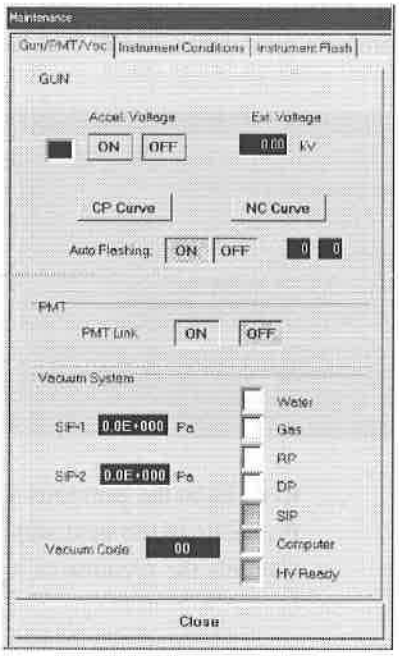
4.9.1 Gun

Displays the states of Gun/PMT/Vac, Instrument Conditions and Instrument Flash, and allows you to set them.

- **Select Maintenance–Gun.**

  The Maintenance window opens.

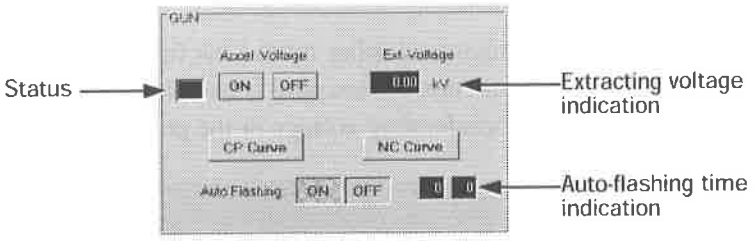
4.9.1a Gun/PMT/Vac



There are three panels of GUN, PMT and Vacuum System. Each panel shows the relevant state.

◆ GUN

Performs environmental settings and operation state display of the electron gun.



Accel. Voltage

Status box:

Blue: You can turn the accelerating voltage ON.

Green: The accelerating voltage is ON.

Black: You cannot turn the accelerating voltage ON.

ON: Turns the accelerating voltage ON.

OFF: Turns the accelerating voltage OFF.

Ext. Voltage: Indicates the extracting voltage (kV).

CP Curve: The CP curve shows the change with time of the emission current. Click this button to open the CP Curve window.

NC Curve: For use by maintenance engineers only. It is not used in normal operation.

Auto Flashing: Used to perform automatic flashing at a predetermined time.

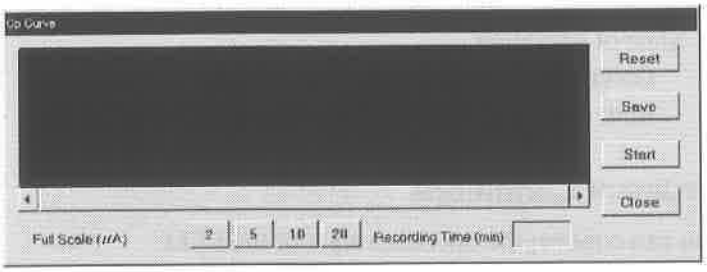
ON: Automatic flashing will be performed.

OFF: Automatic flashing will not be performed.

Time indication:

Indicates the time when automatic flashing is performed. Directly enter the desired numerical values if you want to change them. The time is set with a 24-hour indication.

- CP Curve window



Full Scale (μA) 2/5/10/20:

Selects the full scale of the emission current (the vertical axis).

Recording Time (min):

Key in the recording time.

You can see the whole CP curve by moving the scroll bar under the graph when more than 30 minutes have passed.

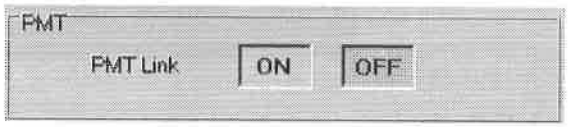
Reset: Resets the recording time of the CP curve.

Save: Saves the recorded CP curve as a text file.

Start: Starts recording the CP curve, and the button indication becomes **Stop**. When you click it once again, the recording stops.

◆ PMT

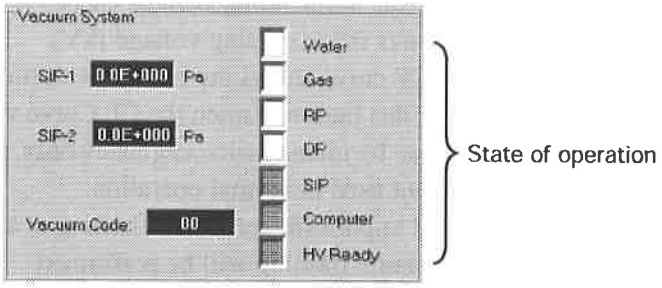
Turns the PMT (photomultiplier tube) Link function on or off.
PMT Link is a function for keeping constant the contrast of the secondary-electron image when the accelerating voltage or the probe current is changed.



ON: Turns PMT Link on.
OFF: Turns PMT Link off.

◆ Vacuum System

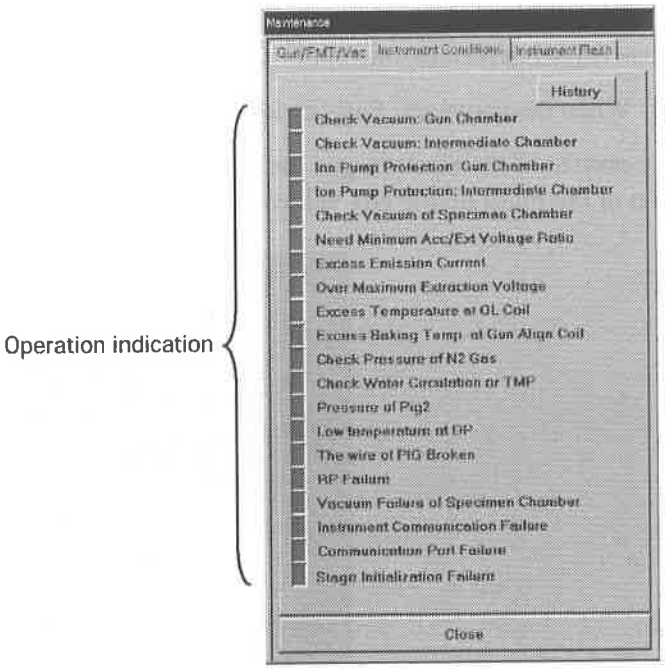
Indicates the state of the vacuum system.



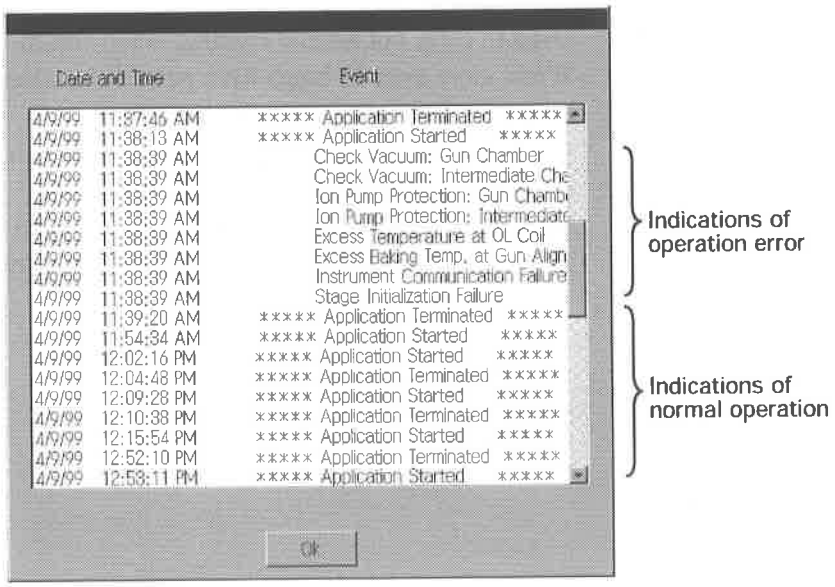
SIP-1: Indicates the pressure in Pa of the ion pump in the electron gun chamber.
SIP-2: Indicates the total pressure in Pa of the ion pump in the No. 1 and No. 2 intermediate chambers.
Vacuum Code:
If trouble occurs in this system, this code enables a maintenance-service engineer to check the state of vacuum operation.
State of operation
Green: Normal operation.
Red: Error detected in the red items.

4.9.1b Instrument Conditions

You can confirm the operation state of the SEM.
⇒ Refer to Sect. 5.2.2 When an Error Message is Displayed of this instruction manual.
Operation indication box
Green: Normal operation.
Red: Error detected in the red items.



History: Clicking the **History** button displays the history of SEM operation errors.



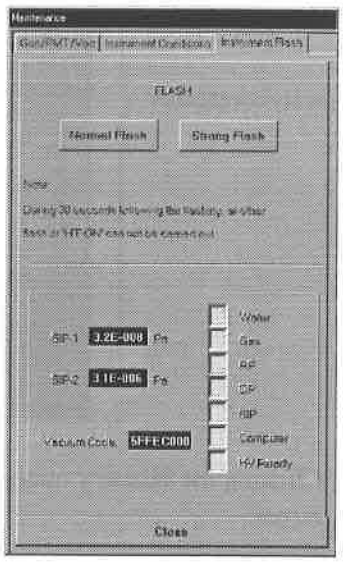
Note: A service engineer clears the history of operation errors.

4.9.1c Instrument Flash

You can carry out flashing manually using Instrument Flash.

Note: When the automatic flashing is on, usually this manual flashing is not necessary.

The pressures of the electron-gun and the intermediate chambers are shown in the lower section of the Flash dialog box below.



Normal Flash: Used to carry out normal flashing when emission noise occurs often. When more than 15 hours have passed since the last normal flashing, however, it is performed automatically.

Strong Flash: Used to carry out strong flashing when the emission noise cannot be removed by performing normal flashing.
When 150 hours (about one week) have passed since the last strong flashing, however, it is performed automatically.

4.9.2 Stage Maintenance

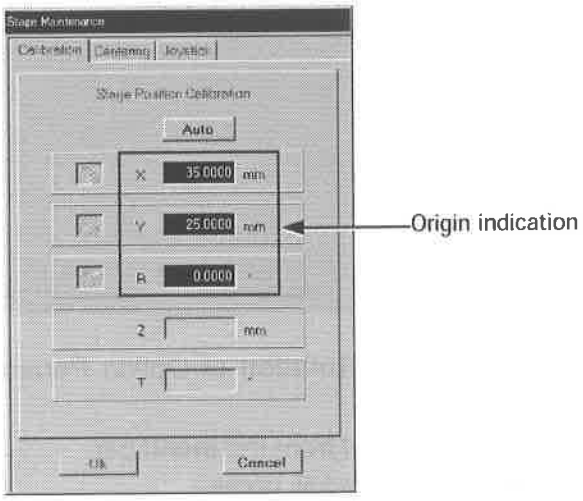
You can calibrate the origin of the specimen stage and set the operation of the joystick.

- **Select Maintenance–Stage.**

  The Stage Maintenance window opens.

4.9.2a Calibration

You can adjust the specimen stage so that its rotation center can be at the origin position.



Auto: Automatically searches for the origin position to calibrate.

Note: The calibration is carried out for the axis indicated by the green box at the left of the origin indication.

Origin indication:

Indicates the coordinates of the origin.

Ok: Saves the calibrated position and closes the Stage Maintenance window.

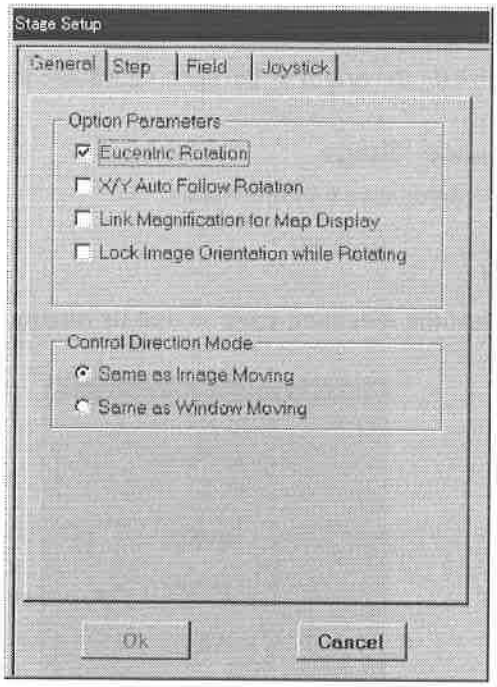
Cancel: Stops the operation and closes the Stage Maintenance window.

4.9.2b Centering

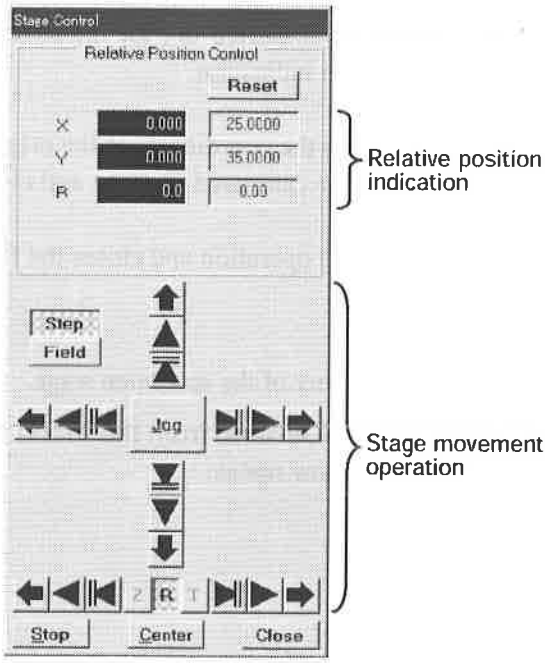
You can set the rotation center of the specimen stage.

1. Select **Setup–Stage–General** from the menu bar.

   The **Stage Setup** window opens.

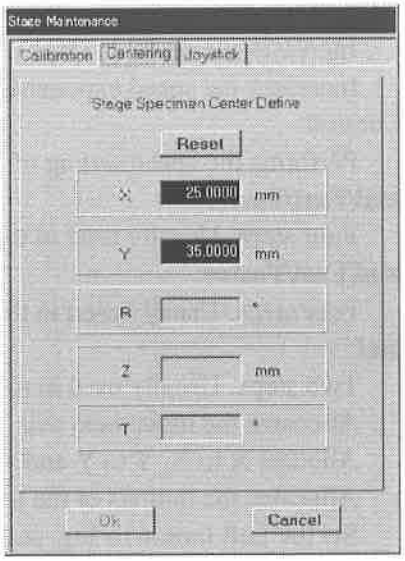


2. Deselect **Eucentric Rotation** of Option Parameters, and then click the **Ok** button.
3. Select **Stage–Control** from the menu bar.
   The **Stage Control** window opens.



4. Rotate the image on the screen by using the buttons to the left and right of **R.** Then, move the rotation center to the center of the observation screen by using the buttons pointing outward from **Jog**.

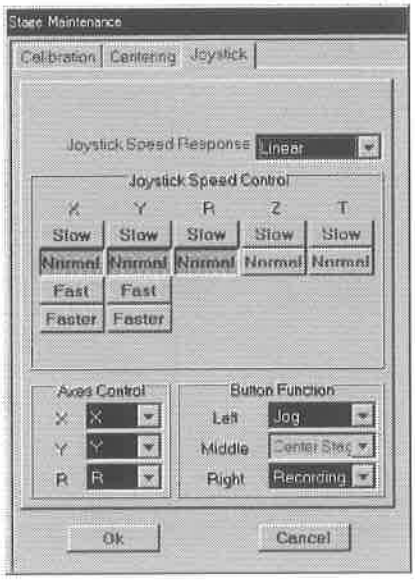
5. Select **Maintenance–Stage–Centering** from the menu bar.
   The **Stage Specimen Center Define** window opens.



6. Click the **Reset** button.
7. Click the **Ok** button.
   The **Stage Specimen Center Define** window closes.
8. Select **Setup–Stage–General** from the menu bar.
   The **Stage Setup** window opens.
9. Again check **Eucentric Rotation** of Option Parameters, and then click the **Ok** button.
   This procedure finishes setting of the rotation center of the specimen stage.

4.9.2c Joystick

You can set the operation of the joystick.



Joystick Speed Response:
Selects the relation between tilt of the joystick and movement speed of the specimen stage.
Linear: Increases the speed linearly with the tilt angle.
Step: Increases the speed in steps with the tilt angle.
Exponential: Increases the speed exponentially with the tilt angle.

Joystick Speed Control:
Performs the speed setting of the joystick.
X–**Slow/Normal/Fast/Faster**:
Four steps. Usually used in the **Normal** position.
Y–**Slow/Normal/Fast/Faster**:
Four steps. Usually used in the **Normal** position.
R–**Slow/Normal**:
Two steps. Usually used in the **Normal** position.

Axes Control: Allocates the movement axis of the joystick.
Allocate X to X, Y to Y and R to R in normal use.

Button Function: Allocates the buttons of the joystick.
Set the Left button to Jog, and the Right button to Recording Position in normal use.
None: Allocates no function to the joystick buttons.
Jog: Removes the backlash and achieves high precision in the specimen stage placement.
Recording Position:
Saves the present coordinates of the specimen stage in the Stage Map file.

⇒ Refer to the Stage Map window in Sect. 4.7.3b Points Map of this instruction manual.

Center: Moves the specimen stage to the origin position.
Abort: Stops the specimen stage motion.

Ok: Saves the calibrated position, and returns the indication to the standard value.

5

OPERATION

5.1 START-UP, SHUTDOWN, AROUND-THE-CLOCK OPERATION OF THE ENTIRE VACUUM SYSTEM, AND ACTION TO TAKE IN THE EVENT OF A POWER FAILURE OR EMERGENCY

The vacuum system is broadly divided into the ultra-high vacuum system (ion pump vacuum system) and the high vacuum system.
The vacuum system normally runs continuously, day and night. Particularly, ensure that the ultra-high vacuum system runs continuously, day and night, throughout the year.

> **⚠ CAUTION**
>
> **Be sure to run the ion pump vacuum system, which is the ultra-high vacuum system (UHV), continuously throughout the year.**

If the operation of the ultra-high vacuum system is normal, the SIP indicator of Vacuum System on the Gun/PMT/Vac window of the Maintenance menu glows green.
If the system is left without power for more than four hours due to a power failure, for example, the vacuum in the ultra-high vacuum system (electron gun chamber, 1st intermediate chamber, and 2nd intermediate chamber) cannot be restored easily (it is necessary to perform column baking); hence it is recommended that you provide an optional reserve power supply in case of a power failure.
A description of the method of starting up and shutting down the vacuum system, except for the ultra-high vacuum system, is set out below.

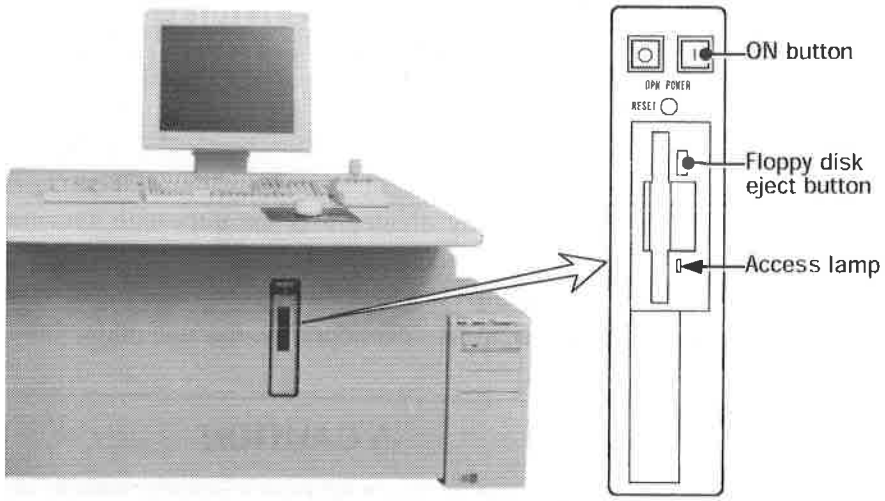
5.1.1 Start-up and Shutdown of the High Vacuum System

The following operation is unnecessary when the entire vacuum system is operating continuously. Refer to 5.1.2 "Around-the-clock Operation of the Entire Vacuum System".

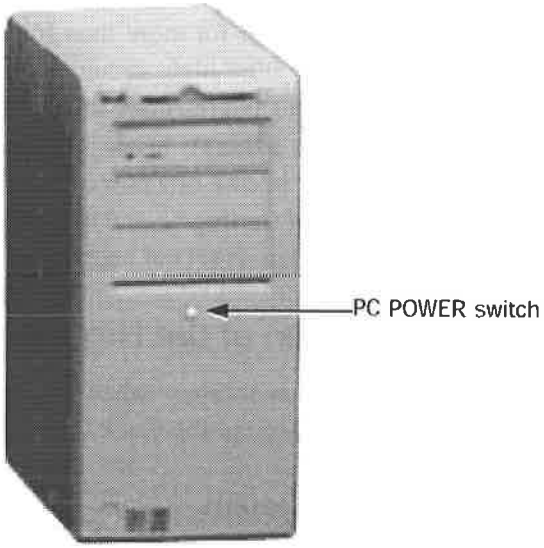
■ Starting up the high vacuum system

The following procedure for starting up the high vacuum system assumes that the ultra-high vacuum system is operating continuously (the power board switch, ion pump switch, and vacuum system switch are ON).

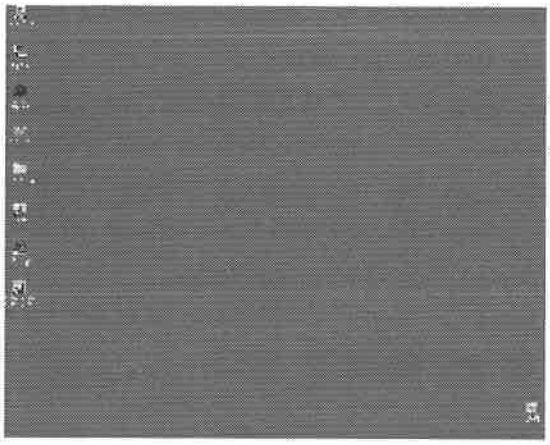
1. Open the valve on the nitrogen gas cylinder and verify that the secondary pressure gauge of the cylinder reads 0.4 to 0.5 MPa.
2. Turn on the cooling water.
3. Turn ON the VAC POWER switch. The vacuum system starts.
   Two hours after you turn ON the VAC POWER switch, the specified vacuum is reached, and the Accelerating Voltage On/Off button HT on the tool bar of the basic screen changes from black to blue. In this condition, high voltage generation and image observation are possible.
4. Press the On button | I | of the SEM floppy-disk unit.
   The button lamp lights.



5. Press the power On/Off switch of the PC.
The access lamp lights.



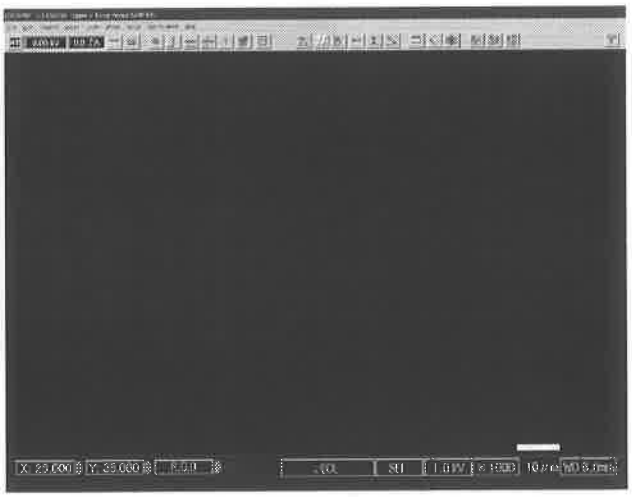
6. Start Windows NT, following the instructions on the screen.
The desktop is displayed.



7. Double-click the **SEM control** icon 

on the desktop.

The basic screen of the system is opened.



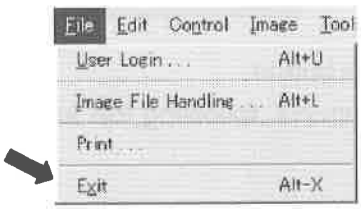
■ Shutting down the high vacuum system

The procedure for shutting down the entire vacuum system except the ultra-high vacuum system is as follows.

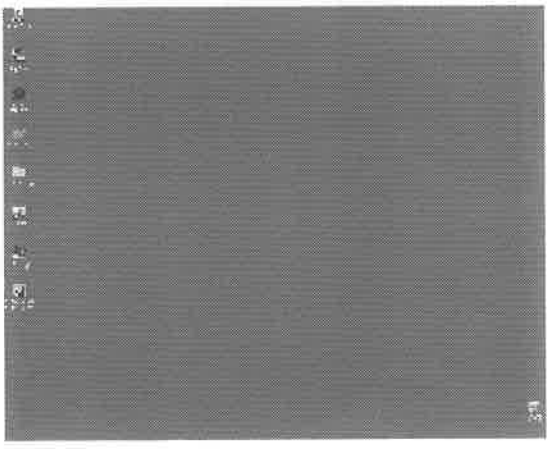
1. If an electron beam is being emitted (the Accelerating Voltage On/Off button 

is green), click the button 

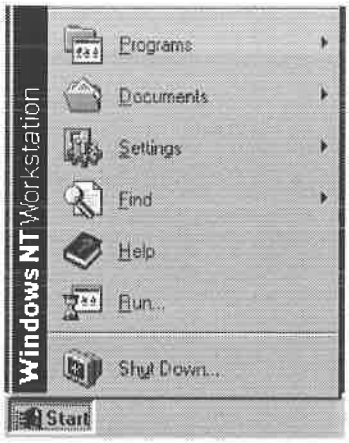
on the tool bar so that the button becomes blue
2. Select **File–Exit** from the menu bar.



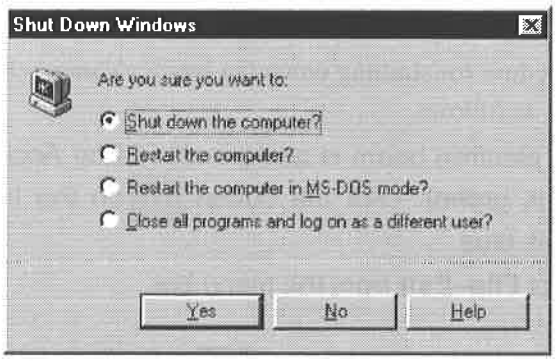
The Windows NT desktop is displayed.



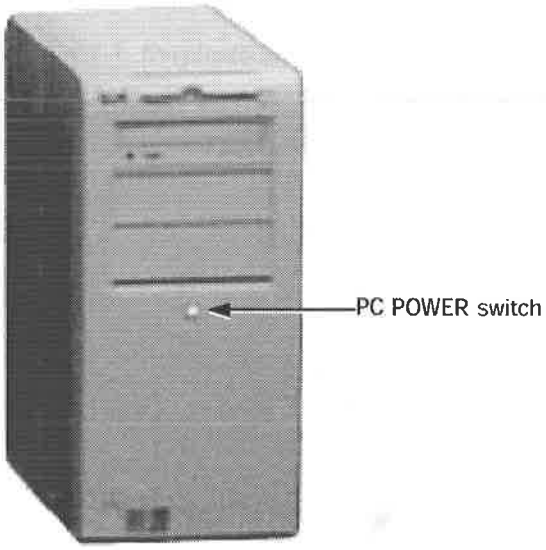
3. Click the **Start** button.
   The Start menu is opened.



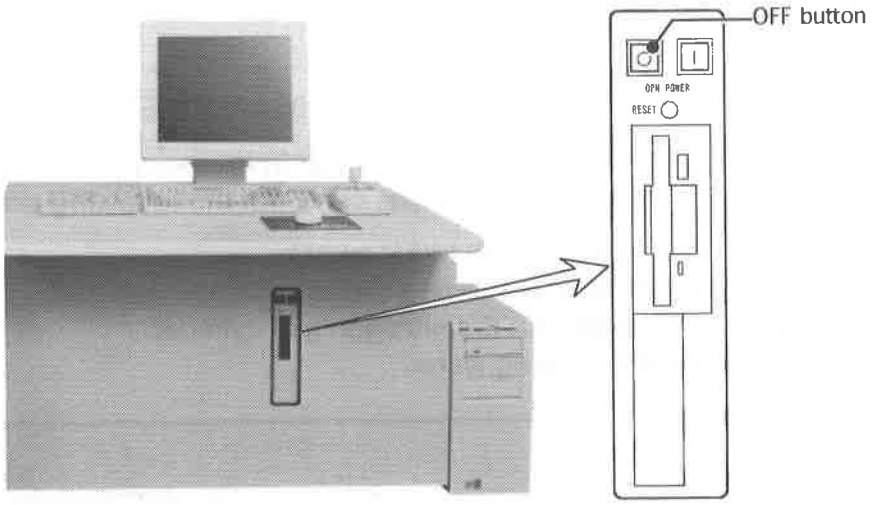
4. Select **Shut Down** from within the Start menu.
   The Shut Down Windows dialog box is opened.



5. Click the **Yes** button.
6. Stop Windows NT, following the instructions on the screen, and turn the PC off.



7. Press the Off button [O] of the SEM floppy-disk unit.



8. Turn OFF the VAC POWER switch.
   As a result of this procedure, the instrument, with the exception of the ultra-high vacuum system, stops automatically.
9. Wait for about two minutes; then turn off the cooling water.
10. Close the valve on the nitrogen gas cylinder.

5.1.2 Around-the-clock Operation of the Entire Vacuum System

The JSM-6700F normally runs continuously. However, when not using the instrument such as at night, or when shutting down the operation and display system in order to save electricity,

- Keep the VAC POWER switch ON.
- Keep the cooling water on.
- Keep the valve on the nitrogen gas cylinder on.

5.1.3 Action to Take in the Event of a Power Failure

In the event of a power failure, the instrument stops in a fail-safe condition. However, if power to the instrument is cut off for more than four hours, it is difficult to restore the vacuum in the ultra-high vacuum system (ion pump). For this reason, it is recommended that you provide an optional reserve power supply in case of a power failure. To restore the vacuum in the ultra-high vacuum system, it is necessary to perform column baking. Have this done by your local JEOL service center.

- **Method of restoring the instrument in the event of a power failure**

1. Start up the instrument according to Sect. 5.1.1 "Start-up and Shutdown of the High Vacuum System".
2. Using Vacuum System on the Gun/PMT/Vac window of the Maintenance menu, verify that the SIP indicator is green. If the SIP indicator is red, it is necessary to perform electron gun baking.

5.1.4 Action to Take in an Emergency

In case of an emergency, such as a fire, carry out the following procedure.

ACTION TO TAKE IN AN EMERGENCY

If it is necessary to shut down the instrument in an emergency, or if the instrument abruptly stops, carry out the following procedure.

1. **Turn OFF the MAIN POWER switch.**
2. **Turn OFF the power board switch.**
3. **Close the valve on the nitrogen gas cylinder.**
4. **Turn off the cooling water.**

5.2 ACTION TO TAKE IN THE EVENT OF TROUBLE

This instrument incorporates various safety devices. If an abnormality occurs, the instrument automatically goes into a safe condition. Also, depending upon the nature of the abnormality, the protection circuit may operate, shutting down the instrument to ensure safety.

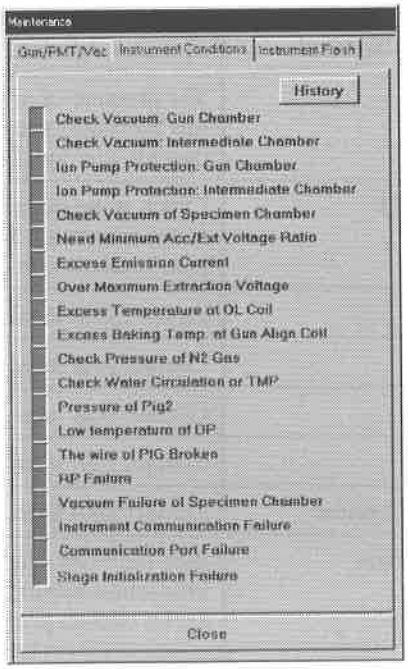
5.2.1 Action to take if the protection circuit operates and shuts down the instrument

1. Check to see if the cooling water has been cut off.
2. Check to see if the pressure of the nitrogen gas has fallen below 0.35 MPa.
3. If there is no cooling water and/or the gas pressure is low, restore the water supply and/or the pressure of the nitrogen gas to normal, then restart the high vacuum system according to 5.1.1 "Start-up and Shutdown of the High Vacuum System".

If the instrument stopped when the pressure of both the cooling water and the nitrogen gas was normal, it is likely that either the heater of the oil diffusion pump is broken or there is some other trouble in the vacuum system. In such a case, contact your local JEOL service center.

5.2.2 When an Error Message is Displayed

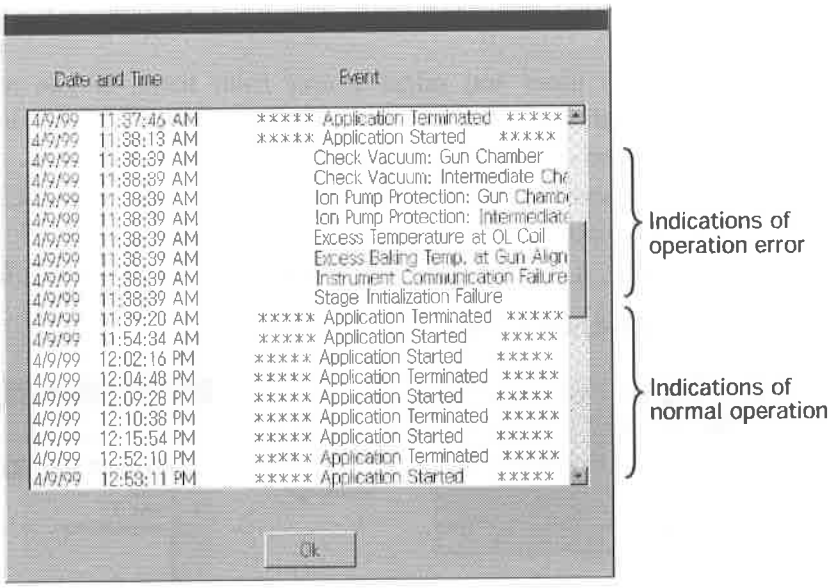
If an abnormality occurs, an error message appears on the observation screen.



In the items with the red indication boxes, an abnormality has occurred. Solve the problems according to the table below.

Error messages	Description of trouble, and corrective action
Check Vacuum: Gun Chamber	The pressure in the electron gun chamber has increased. Wait until the pressure decreases and this message disappears. If this message does not go away, or if it appears while emissin is taking place, contact your local service center.
Check Vacuum: Intermediate Chamber	The pressure in the intermediate chamber has increased. Wait until the pressure decreases and this message disappears. If this message does not go away, or if it appears while emissin is taking place, contact your local service center.
Ion Pump Protection: Gun Chamber	The high voltage of the ion pump for the electron gun chamber has gone off. Contact your local service center.
Ion Pump Protection: Intermediate Chamber	The high voltage of the ion pump for the intermediate chamber has gone off. Contact your local service center.
Check Vacuum of Specimen Chamber	The pressure in the specimen chamber has increased. Wait until the pressure decreases. It takes about two hours after the message disappears until the accelerating voltage is applied. If this trouble persists, contact your local service center.
Need Minimum Acc/Ext Voltage Ratio	Carry out flashing. If this message appears once again, or does not disappear, contact your local service center.
Excess Emission Current	Carry out flashing. If this message appears often, or does not disappear, contact your local service center.
Over Maximum Extraction Voltage	Carry out flashing. If this message appears often, or does not disappear, contact your local service center.
Excess Temperature at OL Coil	The temperature of the objective-lens coil has increased above the normal value. Confirm that the cooling water is flowing. If this trouble persists, contact your local service center.
Excess Baking Temp. at Gun Align Coil	This message does not appear during normal operation.
Check Pressure of N2 Gas	The pressure of nitrogen gas is low. Check the gas pressure. If this message appears even when the gas pressure is sufficient, contact your local service center.
Check Water Circulation or TMP	Check water circulation. If this message appears even when the water circulation is sufficient, or the TMP is evacuating, contact your local service center.
Pressure of Pig2	Contact your local service center.
Low temperature of DP	Contact your local service center.
The wire of PIG Broken	Contact your local service center.
RP Failure	Contact your local service center.
Vacuum Failure of Specimen Chamber	Contact your local service center.
Instrument Communication Failure	Stop the SEM according to the procedure in section 5.1.1 of this instruction manual and restart it. If this message appears once again, contact your local service center.
Communication Port Failure	Stop the SEM according to the procedure in section 5.1.1 of this instruction manual and restart it. If this message appears once again, contact your local service center.
Stage Initialization Failure	Stop the SEM according to the procedure in section 5.1.1 of this instruction manual and restart it. If this message appears once again, contact your local service center.

Note: Click the **History** button to confirm the operational history of the SEM.



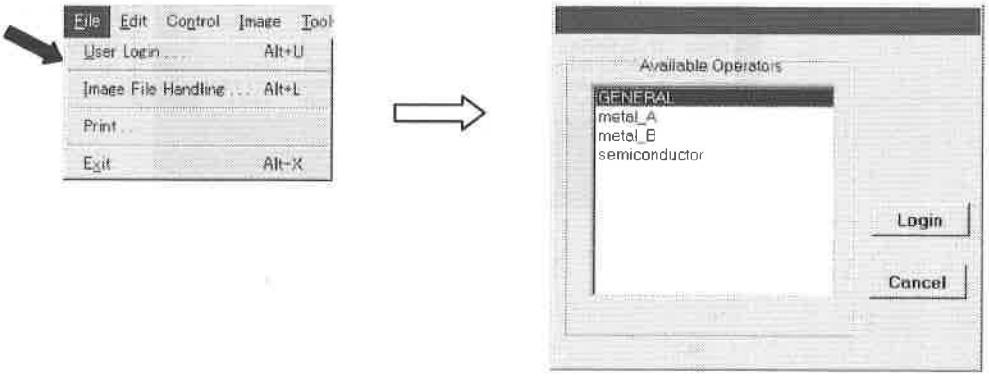
5.3 LOGGING IN AND SELECTING RECIPE

5.3.1 User Login

You can set up users and select a user from them. If you store the SEM image observation conditions for each user, you can observe images under the stored SEM image observation conditions simply by selecting the user.
If you do not use the User log-in command, the standard SEM image observation conditions are applied.

⇒ Refer to Sect. 6.5 SETTING USER LOGIN of this instruction manual.

1. Select **File–User Login**.



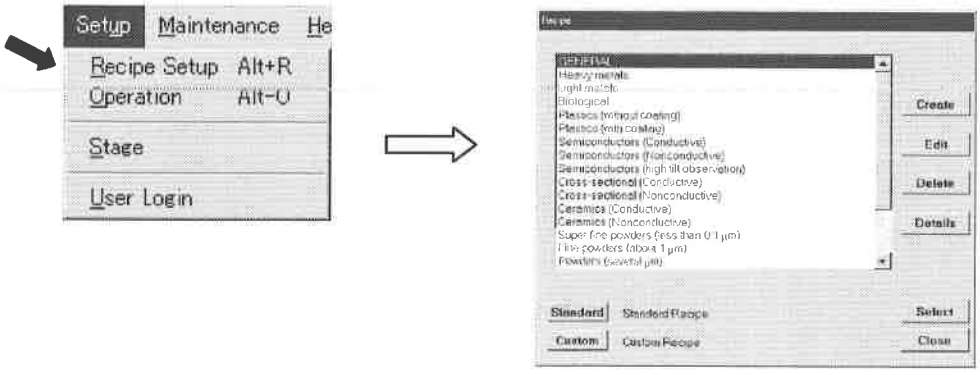
2. Click the **Login** button.

5.3.2 Selecting Recipe

Standard specimen-observation conditions are programmed in the recipes, and so selecting a recipe allows you to set the appropriate observation conditions.

1. Select **Setup–Recipe Setup** from the menu bar.

   Button with equivalent function: **Recipe Setup**
   The Recipe dialog box opens.



2. Select the desired recipe from the list, and click the **Select** button.
   The observation mode, accelerating voltage, probe current, working distance and other parameters for the SEM are set.

Notes: 1. If you want to know the details of the recipe, click **Details**.
2. When you want to call up a recipe made by the user, click the **Custom** button.

> The observation conditions set with the recipe are for routine use. For special purposes, slight changes in the conditions are recommended for better results.
>
> ⇒ Refer to Sect. 5.5 OBSERVING A SPECIMEN of this instruction manual.
>
> When you have gotten good results by changing conditions, store the conditions in a custom recipe.
>
> ⇒ Refer to Sect. 4.8.1 Recipe of this instruction manual.

3. Adjust the WD control (coarse) of the specimen stage to the set working distance.

5.4 SPECIMEN EXCHANGE

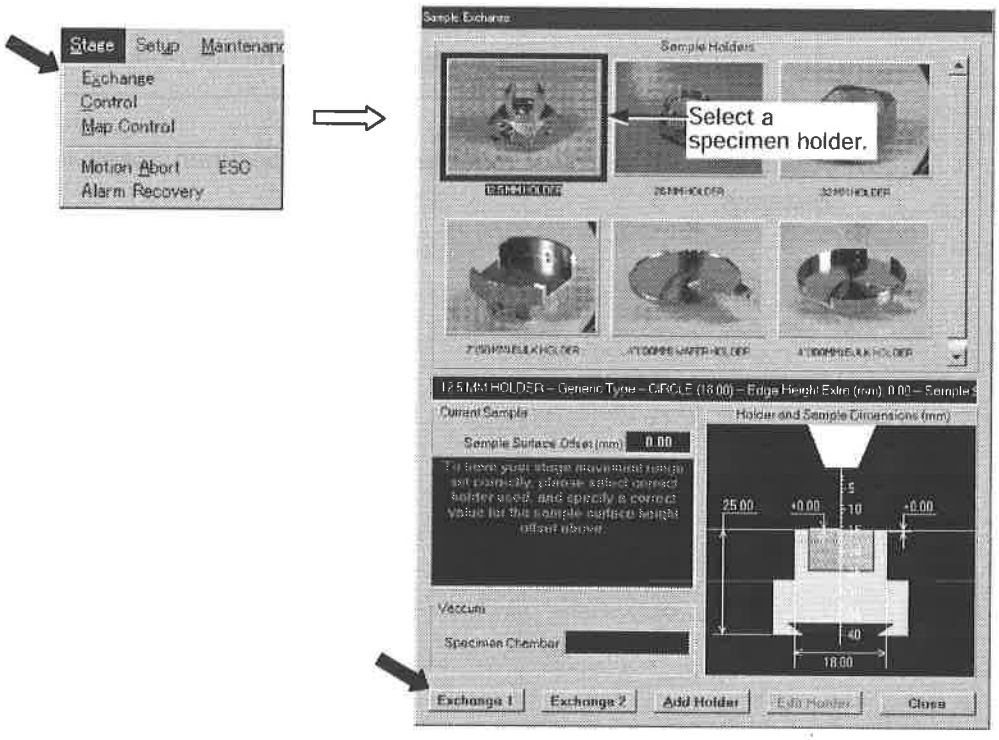
When exchanging the specimen holder in the specimen chamber, do so through the airlock specimen-exchange chamber, keeping the specimen chamber under high vacuum.

5.4.1 Selecting the Specimen Holder

1. Select **Stage–Exchange** from the menu bar.

   Button with equivalent function: **Specimen Exchange**

   The Sample Exchange window opens.



2. Click the specimen holder to be used.

   The area in which the specimen stage can move is set according to the specimen holder to be used. A box is drawn around the selected specimen holder.

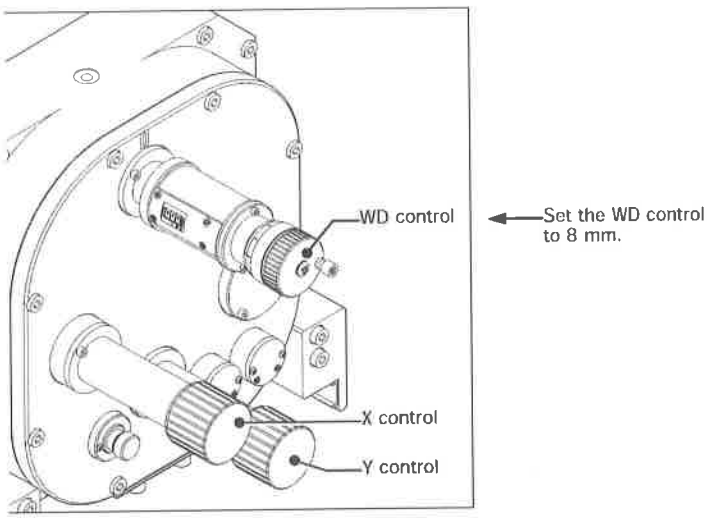
3. Click **Exchange 1**.

   The specimen stage moves to the specimen exchange position.

4. Set the working distance (WD) control (coarse) to 8 mm.

5. Confirm that the Accelerating Voltage On/Off button HT on the tool bar is blue (the accelerating voltage is off).

   If it is green (the accelerating voltage is on), click the Accelerating Voltage On/Off button to make it blue.



5.4.2 Specimen-Exchange Preparation

With the JSM-6700F, initially both the specimen chamber and the specimen-exchange chamber are under high vacuum, and the isolation valve between them is open.

1. Confirm the following by looking at the panel of the specimen-exchange chamber.

   VENT button lamp: Off
   EVAC button lamp: On
   EXCH POSN indication lamp: On
   Specimen-exchange position of the specimen stage:

	Specimen stage TYPE 1	Specimen stage TYPE 2
X-direction	Exchange position 35 mm	Exchange position 40 mm
Y-direction	Exchange position 25 mm	Exchange position 40 mm

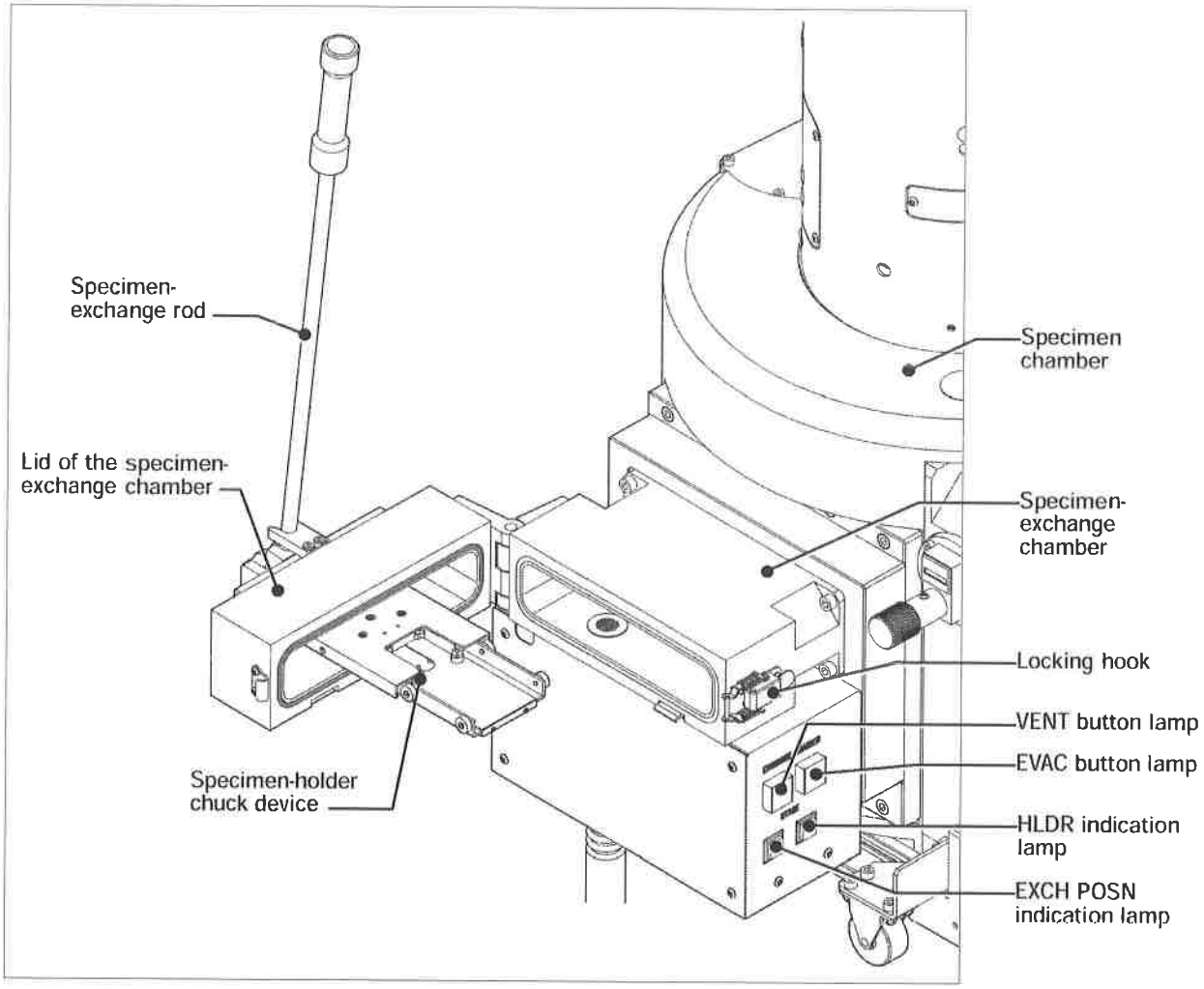
   Tilt: 0°
   Rotation: 0°
   Working distance (WD): 8 mm
   HLDR indication lamp: Off

2. Press the VENT button lamp on the panel of the specimen-exchange chamber.

   Then, the isolation valve (V2) closes, and nitrogen gas begins to enter into the specimen-exchange chamber. The VENT button lamp blinks until the specimen-exchange chamber arrives at atmospheric pressure.

3. Confirm that, after the specimen-exchange chamber has arrived at atmospheric pressure, this VENT button lamp stays on.

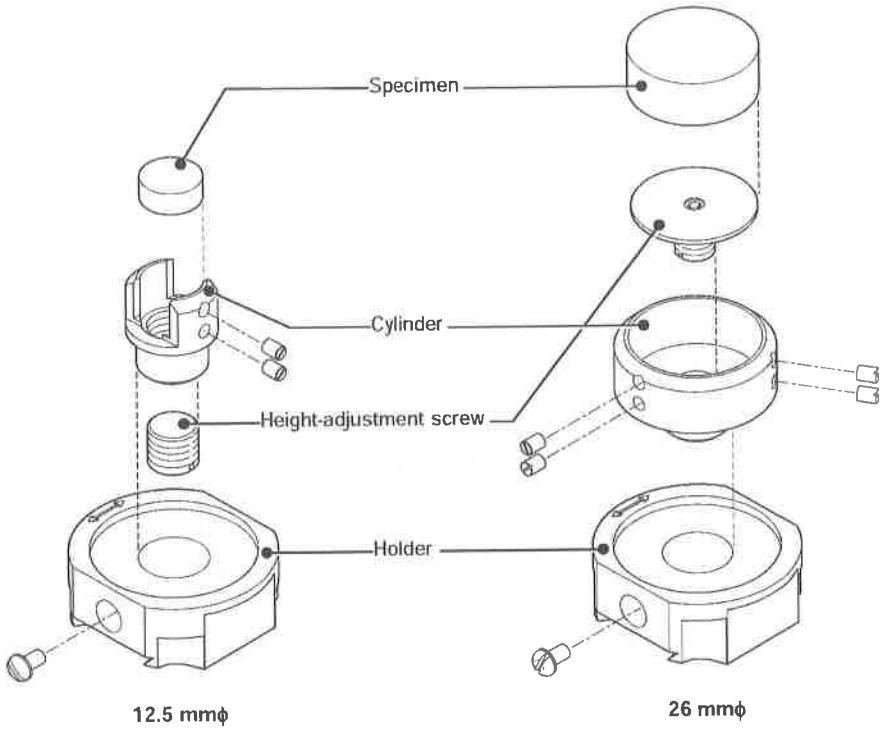
4. Detach the locking hook from the specimen-exchange chamber, and open the lid of the specimen-exchange chamber.



Specimen-exchange airlock panel

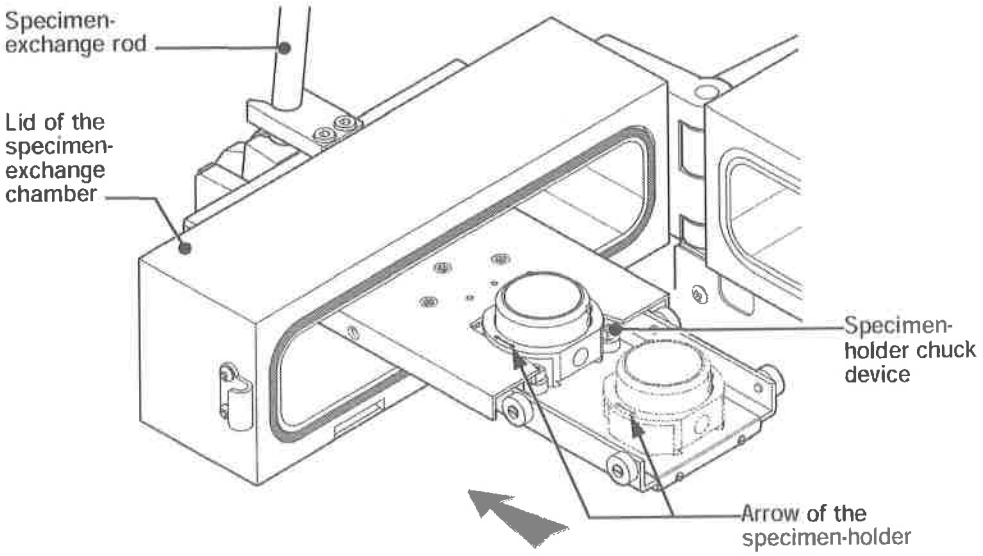
5.4.3 Inserting the Specimen

1. Insert the specimen into the cylinder. Then, using the height-adjustment screw, align the surface of the specimen with the upper surface of the cylinder, and attach the specimen with the screws.
2. Insert the cylinder into the holder; then attach it with the screw.



Standard specimen holders

3. Confirm that the lid of the specimen-exchange chamber is open.
   For how to open the lid of the specimen-exchange chamber, refer to Sect. 5.4.2 Specimen-Exchange Preparation.
4. Mount the specimen-holder on the platform of the end of the specimen-exchange rod so that the arrow marking of the specimen-holder may be parallel to the direction of the specimen-exchange rod.
5. Slide the specimen-holder into the inside of the specimen-holder chuck device as shown by the arrow in the figure below and chuck the holder.
6. Close the lid of the specimen-exchange chamber and lock it with the hook.



Specimen-exchange rod

7. Press the EVAC button lamp on the panel of the specimen-exchange chamber.
   The EVAC button lamp blinks until the specimen-exchange chamber arrives at a high vacuum after the evacuation has finished.
8. Confirm that the EVAC button lamp lights steadily, since the isolation valve (V2) opens when the evacuation has finished. Also confirm the following.
   EXCH POSN indication lamp: On
   HLDR indication lamp: Out
9. Fully insert the specimen-exchange rod, keeping it horizontal.
10. After confirming that the HLDR indication lamp on the specimen-exchange chamber has lit up, fully withdraw the specimen-exchange rod.
11. Tilt up the specimen-exchange rod.
    This completes the exchange of the specimen. You can open the isolation valve (V1) of the electron gun.

5.4.4 Taking Out the Specimen

1. Before taking out the specimen, confirm the following by looking at the panel of the specimen exchange chamber.
   EXCH POSN indication lamp: On
   HLDR indication lamp: On
2. Return the specimen-exchange rod to the horizontal position.
   The isolation valve (V1) of the electron gun closes automatically.
3. Fully insert the specimen-exchange rod. Then, withdraw it.
   When the specimen holder has been taken out from the specimen stage, the HLDR indication lamp on the panel of the specimen-exchange chamber goes out.
4. Fully withdraw the specimen-exchange rod.
5. Tilt up the specimen-exchange rod.
6. Press the VENT button lamp on the panel of the specimen-exchange chamber.
   Then, the isolation valve (V2) closes, and nitrogen gas begins to enter into the specimen-exchange chamber. The VENT button lamp blinks until the specimen-exchange chamber arrives at atmospheric pressure.
7. Confirm that, after the specimen-exchange chamber has arrived at atmospheric pressure, this VENT button lamp stays on.
8. Detach the locking hook from the specimen-exchange chamber, and open the lid of the specimen-exchange chamber.

5.4.5 Maintenance of the Specimen-exchange Rod

When you cannot insert the specimen-exchange rod smoothly, coat it with vacuum grease.

5.5 OBSERVING A SPECIMEN

This section describes the method of displaying an observation image and performing operations on it, starting with the generation of an electron probe.
The following are the basic operations for observing an image.

5.5.1 Observation Preparations

Basically, use the standard screen mode when observing images.

■ Initial settings

The items shown in Table 5.1 are automatically set to their initial values when the instrument is started up.
Initial observation conditions, suitable for general specimens when you observe secondary electron images for the first time are also shown in Table 5.2. For practical specimens, please refer to Sect. 5.5.4 Generating an Electron Probe.

Table 5.1 Initial settings on the observation display and the OPERATION panel

Item	Condition setting
Control–Column	
Emission	10 μA
Auto Reset	OFF
Column Mode	SEM
Scan Rotation	0
DFC	0
Observation Conditions Indication –Image Selector	SEI
OPERATION panel ALIGNMENT	STIG

Table 5.2 General observation conditions

Item	Condition recommended
Control–Column	
Accelerating Voltage	3 – 5 kV
Probe Current	7 – 8
Fine	Right end
Observation Conditions Indication –WD	8 mm (Specimen stage should be set at 8 mm)
OPERATION panel	
MAGNIFICATION	LOW MAG (if there is no image)
SCANNING MODE	QUICK VIEW

Note: If the quantity of secondary electrons from the specimen is small, resulting in insufficient contrast, set the PMT Link setting on the Gun/PMT/Vac window of the Maintenance menu to OFF.

■ Setting the accelerating voltage

The initial setting of the accelerating voltage is 5 kV. However, it is necessary to select the value of the accelerating voltage according to the kind of specimen and the purpose of observation.
The merits of performing observation at low and high accelerating voltages, respectively, are described below.

Low accelerating voltage	High accelerating voltage
• It is possible to prevent specimens that have poor electrical conductivity from becoming charged. • The quantity of secondary electrons emitted increases, improving the image quality. • Fine irregularities on the surface of the specimen can be observed.	• Images can be observed at high resolution. • A high accelerating voltage is used for analysis.

■ Setting the probe current

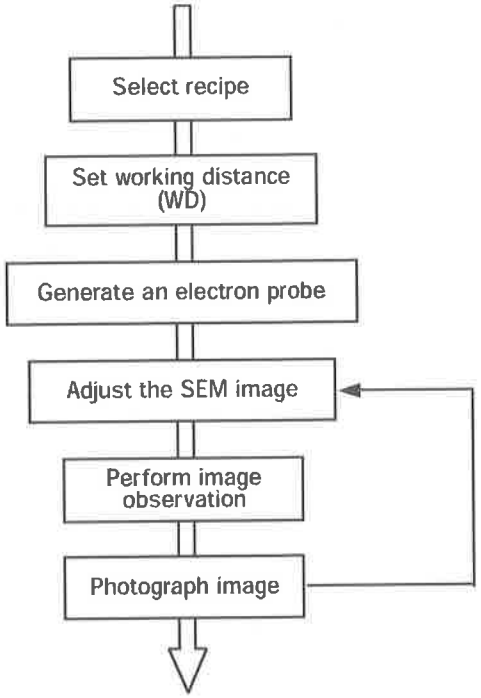
The quality of a secondary electron image is affected by the quantity of secondary electrons emitted. If the quantity of secondary electrons decreases, the intensity of the secondary electron signal will decrease, causing the image quality to fall. For this reason, it is necessary to increase the probe current when the specimen has a low secondary-electron emission rate.

If you reduce the probe current, the image quality deteriorates, resulting in an image with a poor S/N ratio. Although the probe current is initially set to 8, you should adjust it while observing the quality of the image.

Note: If you increase the probe current, the observation image may sometimes become dark. In such a case, carry out Alignment, and then perform image observation once again.

5.5.2 Image Observation Flowchart

This chapter mainly describes the basic operations for observing a specimen by using the OPERATION panel.



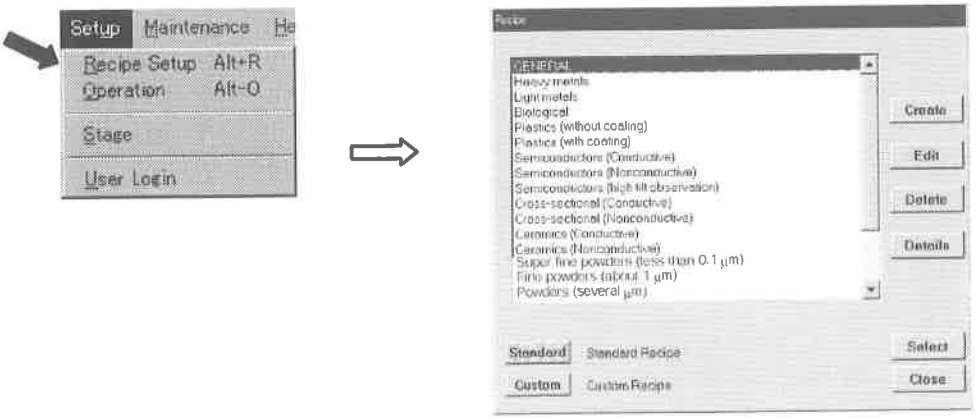
5.5.3 Selecting Recipe

Standard specimen-observation conditions are programmed in the recipe, and so selecting the recipe allows you to set the appropriate observation conditions.

1. Select **Setup–Recipe Setup** from the menu bar.

   Button with equivalent function: **Recipe Setup**

   The Recipe dialog box opens.



2. Select the desired recipe from the list, and click the **Select** button.
   The observation mode, accelerating voltage, probe current, working distance and other parameters are set for the SEM.

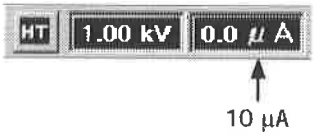
Notes: 1. If you wish to know the details of the recipe, click the **Details** button.
2. When you want to call up a recipe made by the user, click the **Custom** button.

> The observation conditions set with the recipe are for routine use. For special purposes, slight changes in the conditions are recommended for better results.
> When you have gotten good results by changing conditions, store the conditions in a custom recipe.
> ⇒ Refer to Sect. 4.8.1 Recipe of this instruction manual.

3. Adjust the WD control (coarse) of the specimen stage to the set working distance.

5.5.4 Generating an Electron Probe

1. Confirm that the Accelerating Voltage On/Off button HT on the tool bar is blue (the accelerating voltage is off).
2. Click the Accelerating Voltage On/Off button.
   The Accelerating Voltage On/Off button changes to green.
   As the emission current increases, the SEM image appears.
3. Confirm that the emission current is 10 μA.

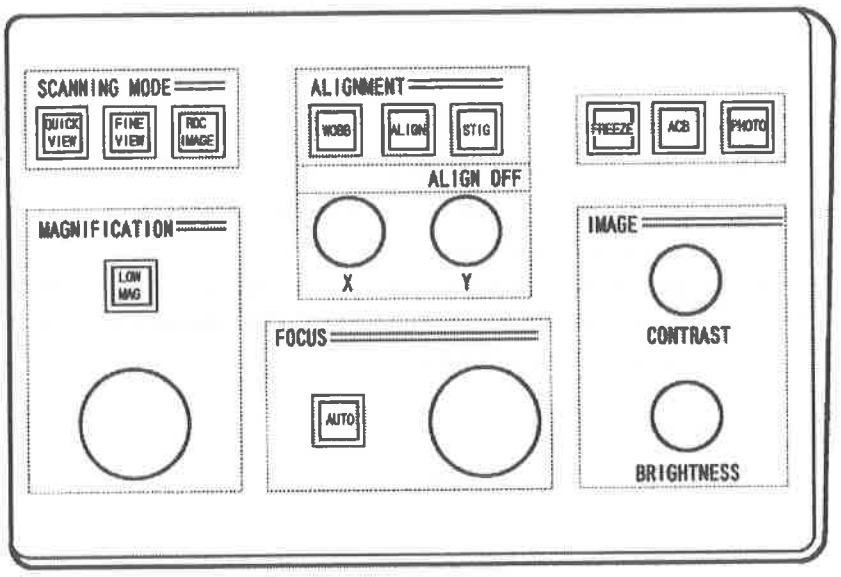


5.5.5 Finishing Observation of SEM Image

◆ Click the Accelerating Voltage On/Off button HT on the tool bar.
The Accelerating Voltage On/Off button changes to blue.

5.5.6 Adjusting SEM Image

Adjustment of the SEM image can be performed with the OPERATION panel.



OPERATION panel

5.5.6a Adjusting the contrast and brightness of the SEM Image

- Adjust the SEM image by using the **IMAGE–CONTRAST** and **IMAGE–BRIGHTNESS** knobs to select the optimum conditions.
- Alternatively, press the **ACB** button for automatic adjustment instead of using the **IMAGE–CONTRAST** and **IMAGE–BRIGHTNESS** knobs.

5.5.6b Selecting scanning speed

- Press the **SCANNING MODE–QUICK VIEW** or **–FINE VIEW** button to select the optimum scanning speed.

  Note: Each button allows you to select two scanning speeds. Every time you press the button, the scanning speed changes between the two.
- The use of the **QUICK VIEW**, whose response is very rapid, is appropriate for such operations as the movement of field of view, the adjustment of focus, and the correction of astigmatism. This mode is adequate for preventing the specimen from becoming charged. Combine it with the **RDC IMAGE** or perform more accumulations so as to improve image quality.
- The use of the **FINE VIEW**, whose response is slow, is not appropriate for adjusting the general SEM image. This mode allows you to observe the details of specimens with a high image quality.

5.5.6c Adjusting magnification

- Turn the **MAGNIFICATION** knob to change the magnification.
- Click the **Magnification** button, which is one of the observation condition indications on the lower right-hand corner of the screen, to select one of the preset magnifications.

- Pressing the **MAGNIFICATION–LOW MAG** button sets the magnification to the low-magnification mode (LM mode) and facilitates looking for a field of view.
- Every time you push the **LOW MAG** button, the system changes between the high-magnification mode (SEM mode) and low-magnification mode.

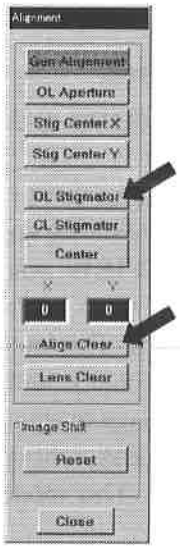
5.5.6d Adjusting focus

- Adjust focus by using the **FOCUS** knob.
- Alternatively, press the **FOCUS–AUTO** button instead of using the **FOCUS** knob to perform automatic focusing.
- When the image is considerably out of focus, turn the **FOCUS** knob at the lowest magnification in the SEM mode (the **LOW MAG** button-lamp stays unlit) so as to clearly see the change of focus.

5.5.6e Correcting astigmatism

- Astigmatism correction is required if the image is blurred in a particular direction instead of being uniformly blurred in all directions when you have changed the focus. By turning the **ALIGNMENT–STIG–X, Y** knobs, adjust the focus to be uniformly blurred in all directions while the **ALIGNMENT–STIG** button-light remains on.
- Confirm that the focus is achieved, and if it is not correctly adjusted, repeat the astigmatism correction.
- If there is astigmatism to a great extent, carry out astigmatism correction using the following procedure.

a. Press the **ALIGNMENT–ALIGN** button of the OPERATION panel.
The Alignment window is opened on the screen.



b. Click the **OL Stigmator** button.
c. Click the **Align Clear** button.
The astigmatism correction value is reset to its initial state.

Note: If the astigmatism does not improve, or becomes worse in spite of this operation, perform astigmatism correction or alignment, referring to Sect. 5.15 ALIGNMENT AND ASTIGMATISM CORRECTION of this instruction manual.

5.6 SHIFTING FIELD OF VIEW

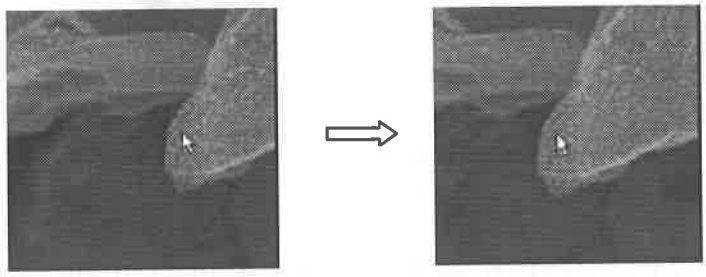
If the optional 3-axis motor stage controller is installed in the SEM, you can perform various kinds of stage control.

5.6.1 Shifting Image under Observation

5.6.1a Using the mouse for image shifting

◆ Move the mouse pointer to the point which you want to shift to the center of the field of view, and right-click it.

The point indicated by the mouse pointer shifts to the center of the screen.



5.6.1b Using the mouse for fine adjustment of image

You can perform the fine adjustment of the image by using the electromagnetic image shift.

◆ Perform fine adjustment of the field of view by dragging the point that you want to shift.

Shift is displayed in the observation conditions indication.

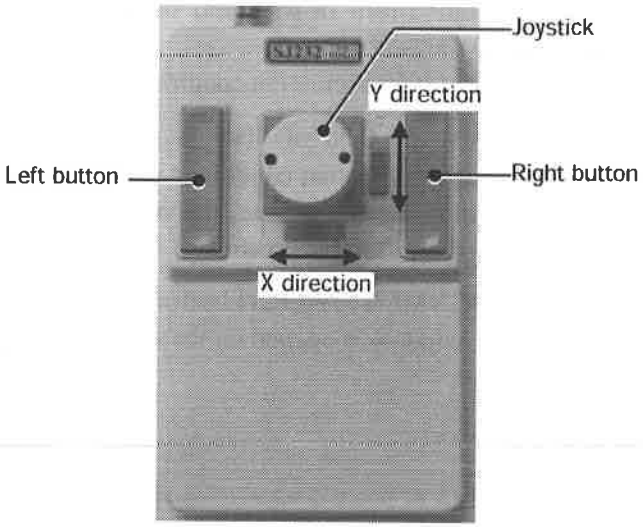
Note: Fine adjustment of field of view is possible when the background of **Shift** displayed in the observation conditions indication is blue.
When the background is orange, the movement is impossible. Reset the Image shift by using the following procedure.

a. Press the **ALIGNMENT–ALIGN** button of the OPERATION panel.
The Alignment window is opened on the screen.

b. Click the **Image Shift–Reset** button.
The field of view moves to the position of the specimen stage.

5.6.1c Using the joystick for field-of-view movement

◆ The specimen stage moves in the direction in which you tilt the joystick. When you tilt it a lot, the movement is fast. When you put the joystick at the neutral position, the specimen-stage movement stops.



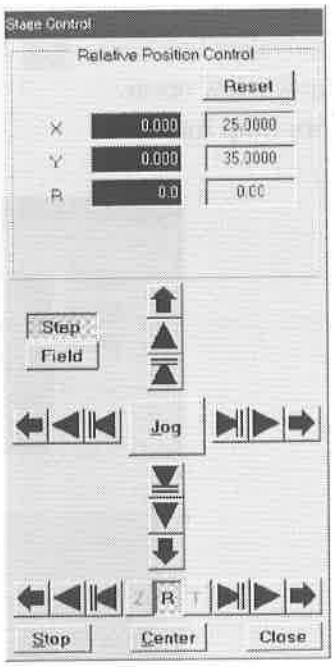
- Pressing the left button removes the backlash of the specimen stage.
- Pressing the right button makes the software memorize the present position of the specimen stage.

5.6.1d Using Stage Control

1. Select **Stage–Control** from the menu bar.

   Button with equivalent function:  **Stage Control**

   The Stage Control window opens.



2. Click the arrow button  .

   The specimen stage moves.

3. Click the **Stop** button at the position where you want to stop the movement.
4. Click the **Jog** button.

   The backlash of the specimen stage is removed.

   The position of the specimen stage is indicated in the Relative Position Control boxes.

5.6.2 Moving Specimen Stage by Inputting Coordinates

This method is useful when you know the coordinates of the position to which you want to move the specimen stage.

1. Click the specimen position indications at the lower left of the observation screen.

   The color of the position display changes.

2. Key in the coordinates of the position to which you want to move.
3. Press the **Enter** key.

   The specimen stage moves to those coordinates.

5.6.3 Moving Specimen Stage to Recorded Coordinates

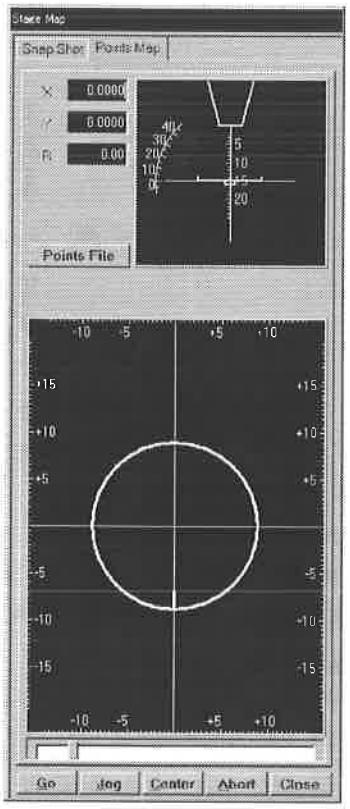
This method is useful for observing again at a position at which you once observed.

5.6.3a How to move specimen stage to recorded coordinates

1. Select **Stage–Map Control** from the menu bar.

   Button with equivalent function: **Stage Map**

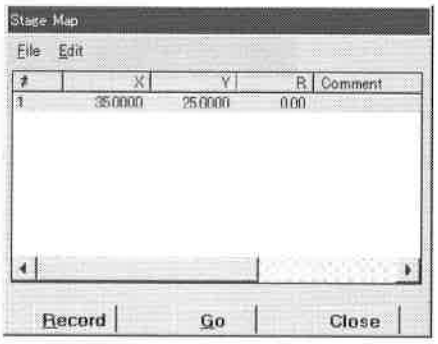
   The Stage Map window opens.
2. Click the **Points Map** tab.



3. Click the **Points File** button.

   The Stage Map window opens.
4. Select **File–Open**, and then select a coordinate file to be used.

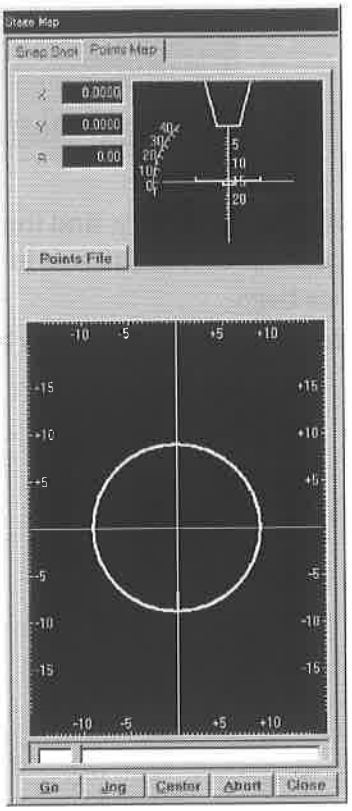
   The list of recorded coordinates is indicated in the Stage Map window.



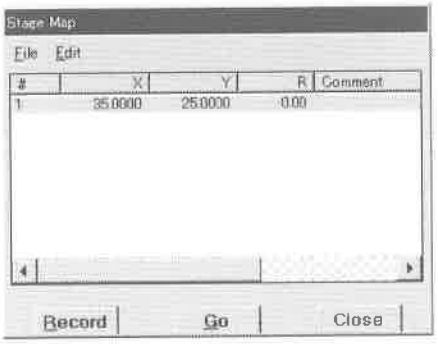
5. Select the desired coordinates or the position of the coordinates on the Points Map window, and click the **Go** button.
   The specimen stage will move to the position of the selected coordinates.

5.6.3b How to record coordinate position in Points File

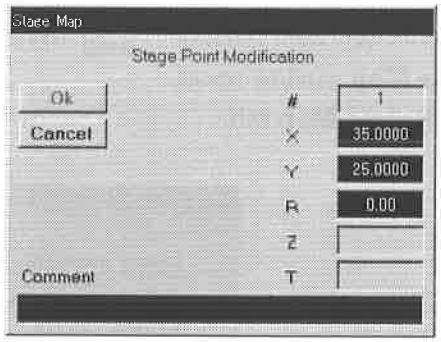
1. Select **Stage–Map Control** from the menu bar.
   Button with equivalent function: **Map Control**
   The **Stage Map** window opens.
2. Click the **Points Map** tab.



3. Click the **Points File** button.
   The Stage Map window opens.



4. Select **File–New**.
   A new Stage Map window will open.
5. Click the **Record** button.
   The **Stage Point Modification** dialog box will open, and the present position will be indicated.



6. Key in comments if necessary, and then click the **Ok** button.
   The present position will be indicated in the Stage Map window as new coordinates of the specimen stage.
7. Select **File–Save As** to save the new coordinates.

5.6.4 Using Recorded Images for Specimen Movement

This method is useful for selecting the desired field of view so as to move the specimen stage by recording the specimen stage coordinates of more than one position and their corresponding images.

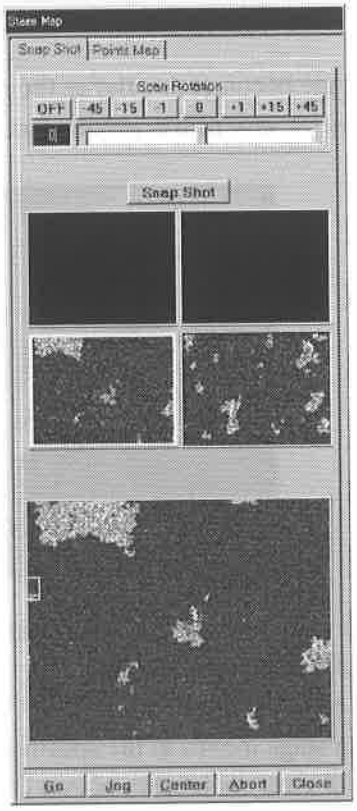
5.6.4a How to select field of view from image

1. Select **Stage–Stage Map** from the menu bar.

   Button with equivalent function: **Stage Map**

   The Stage Map window opens.

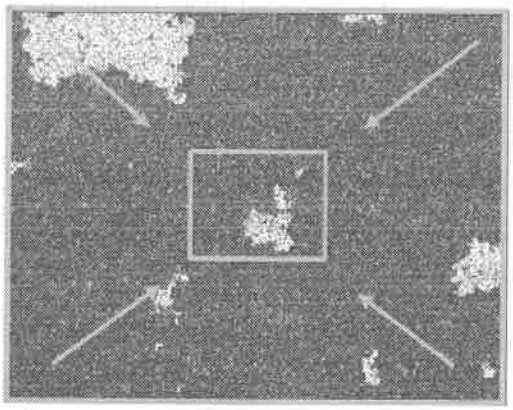
2. Click the **Snap Shot** tab.



3. Click the image in which the desired field of view was recorded.

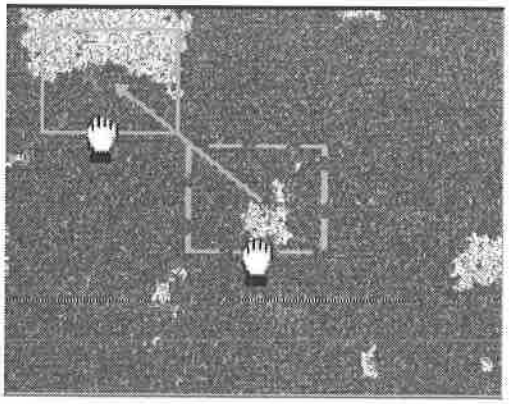
   The image is enlarged in the operation area.

4. Turn the **MAGNIFICATION** knob on the OPERATION panel in the clockwise direction so as to obtain a higher magnification.



The green frame becomes smaller as the magnification becomes larger.

5. Drag the green frame to the position at which you want to observe.



The position before dragging is indicated in the dashed frame, and the present position is indicated in the solid frame.

6. Click the **Go** button.

The specimen stage moves to the specified position, and an image will be displayed.
Note: A small error sometimes occurs due to the backlash of the specimen stage.

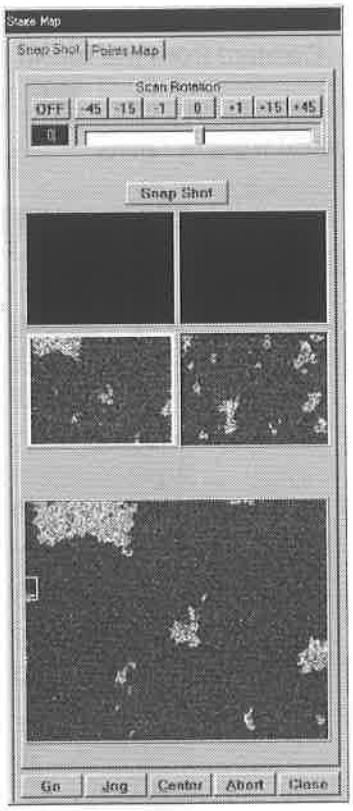
5.6.4b How to record field of view

1. Select **Stage–Stage Map** from the menu bar.

   Button with equivalent function:  **Stage Map**

   The Stage Map window opens.

2. Click the **Snap Shot** tab.



3. Select one frame of the four frames for recording, and click the **Snap Shot** button.

   The field of view under observation is recorded in the selected frame. At the same time, the coordinates of the specimen stage are recorded.

4. Record other images in the other frames, if you want.

   Note: Up to four images can be recorded.

5.6.5 Moving Specimen at Regular Pitches

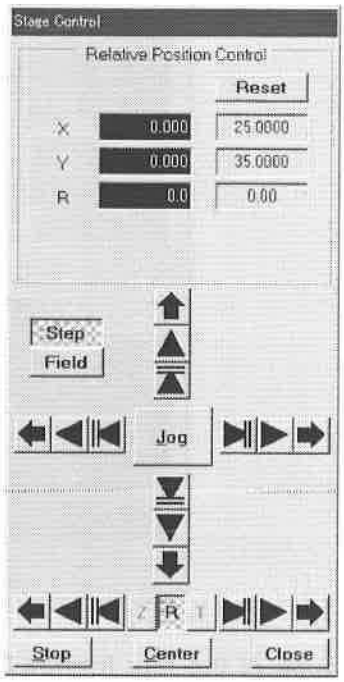
There are two functions for moving the specimen stage. One is for performing a fixed movement of the specimen stage without relation to magnification (Step movement), and the other is for performing movement by a fixed fraction of the observation screen with relation to magnification (Field movement).

5.6.5a Step movement

1. Select **Stage–Control** from the menu bar.

   Button with equivalent function: **Stage Control**

   The Stage Control window opens.



2. Click the **Step** button.
3. Click ▶ or ▶|.

   The specimen stage moves by the preset amount.

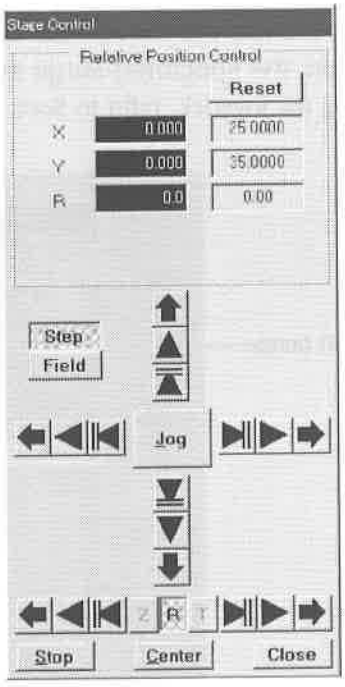
   ⇒ For setting the amount, refer to Sect. 4.8.3b Step of this instruction manual.
4. Click the **Jog** button.
   - The backlash of the specimen stage is removed, and the precision of the movement becomes higher.
   - The position of the specimen stage is indicated in the Relative Position Control boxes.

5.6.5b Field movement

1. Select **Stage–Control** from the menu bar.

   Button with equivalent function: **Stage Control**

   The Stage Control window opens.



2. Click the **Field** button.
3. Click ▶ or ▶|.

   The specimen stage moves by the preset fraction of the observation screen.

   ⇒ For setting the step sizes, refer to Sect. 4.8.3c Field of this instruction manual.
4. Click the **Jog** button.
   - The backlash of the specimen stage is removed, and the precision of the movement becomes higher.
   - The position of the specimen stage is indicated in the Relative Position Control boxes.

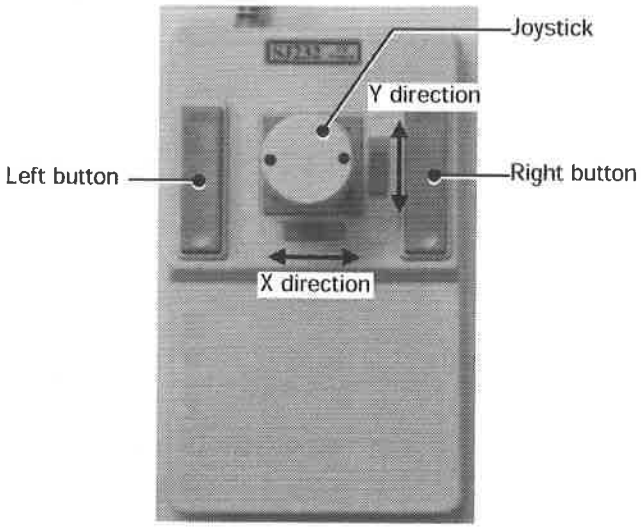
5.6.6 Continuous Movement

If you want to move the specimen stage continuously, use the joystick or Stage Control.

5.6.6a Using the joystick

◆ The specimen stage moves in the direction in which you tilt the joystick. When you tilt it a lot, the movement is fast. When you put the joystick at the neutral position, the specimen-stage movement stops.

⇒ For setting the joystick, refer to Sect. 4.8.3d Joystick of this instruction manual.



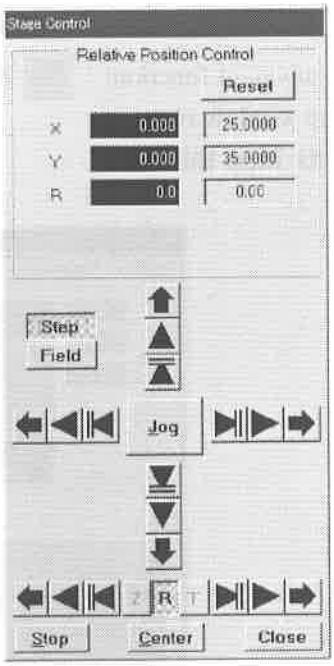
- Pressing the left button removes the backlash of the specimen stage.
- Pressing the right button makes the software memorize the present position of the specimen stage.

5.6.6b Using Stage Control

1. Select **Stage–Control** from the menu bar.

   Button with equivalent function: **Stage Control**

   The Stage Control window opens.



2. Click the arrow button .

   The specimen stage moves.

3. Click the **Stop** button at the position where you want to stop the movement.

4. Click the **Jog** button.

   The backlash of the specimen stage is removed.

   The position of the specimen stage is indicated in the Relative Position Control boxes.

5.6.7 Using Stage Map for Specimen-Stage Movement

You can move the specimen stage using Stage Map. This movement is very useful when observing a large specimen.

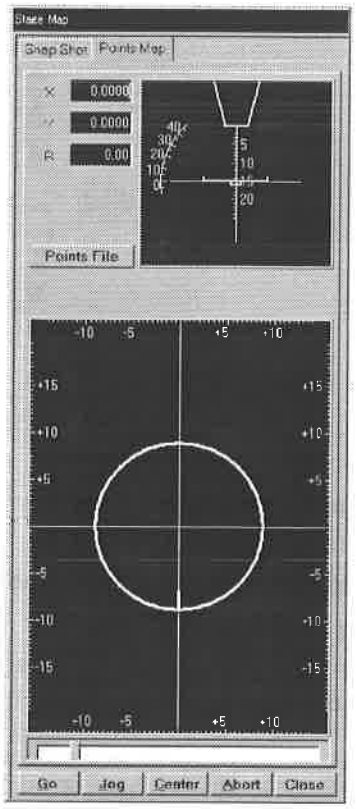
■ How to move specimen stage

1. Select **Stage–Map Control** from the menu bar.

   Button with equivalent function: **Map Control**

   The Stage Map window opens.

2. Click the **Points Map** tab.



   The stage map is displayed.

   Note: Move the scroll bar under the map to change the magnification.

3. Move the pointer to the position that you want to observe, and right-click it.

   The specimen stage moves.

   Note: Click the **Abort** button if you want to stop the stage while it is moving.

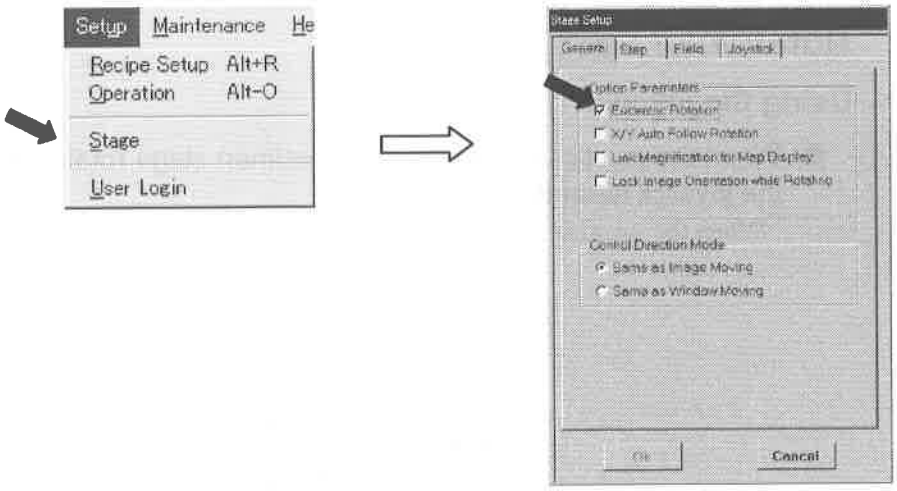
4. Click the **Jog** button.

   - The backlash of the specimen stage is removed.
   - The position of the specimen stage is indicated in the Relative Position Control boxes.

5.6.8 Moving a Disk-shaped Specimen along the Edge

If the eucentric rotation function is on, the deviation of field of view is small when the specimen is rotated. This function, however, is not adequate for moving the disk-shaped specimen along the edge. To do so, turn off the eucentric rotation function.

1. Select **Setup–Stage–General** from the menu bar.



2. Deselect **Eucentric Rotation**.
3. Click the **Ok** button.
4. Rotate the specimen stage.

   The specimen stage rotates around the center of the specimen holder.
   Since the field of view generally moves a lot, use a low magnification.

5.7 FIELD-OF-VIEW ROTATION

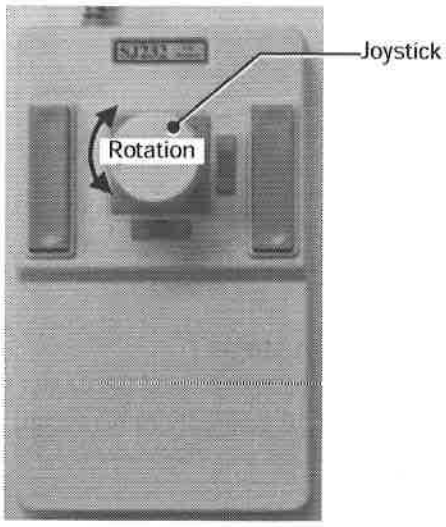
Specimen-stage rotation is performed so that the observation direction of the specimen may be changed in combination with specimen tilting or the position of the specimen relative to the detector may be changed. On the other hand, scan rotation is for rotating the image by changing the scanning line direction. It is carried out for the purpose of improving the appearance on the observation screen.

5.7.1 Rotation of Specimen Stage

5.7.1a Using the joystick

◆ When the joystick is twisted, the specimen stage rotates in the direction that the joystick twisted.

When the joystick is twisted a lot, the specimen stage rotates rapidly.



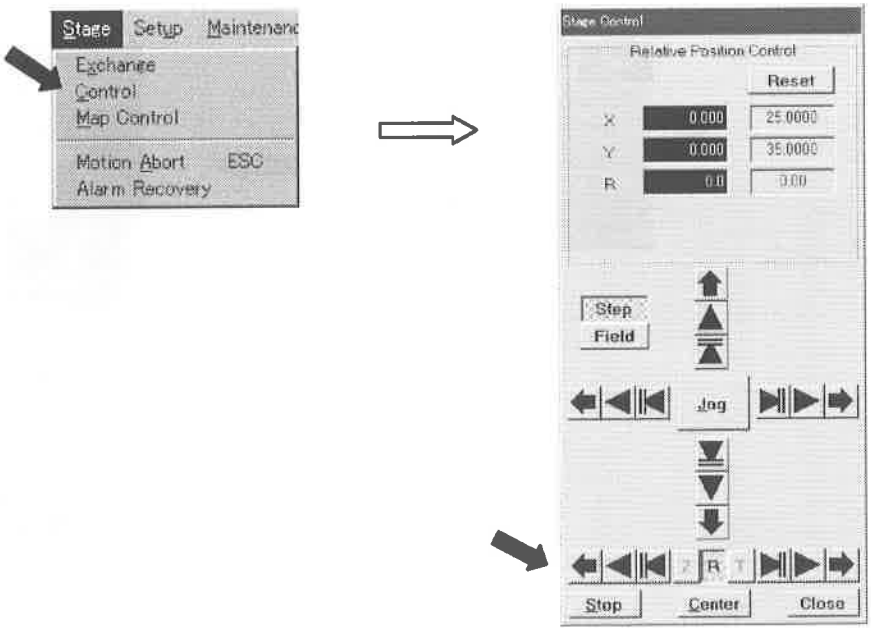
Note: If you click the X and Y joystick-lock buttons at the lower left corner of the observation screen to make the button become orange, only stage rotation can be performed.

5.7.1b Using Stage Control

1. Select **Stage–Control** from the menu bar.

   Button with equivalent function:  **Stage Control**

   The Stage Control window opens.



2. Click the **R** button.

    Continuous rotation. Click the **Stop** button to stop it.

    Step rotation through a large angle.

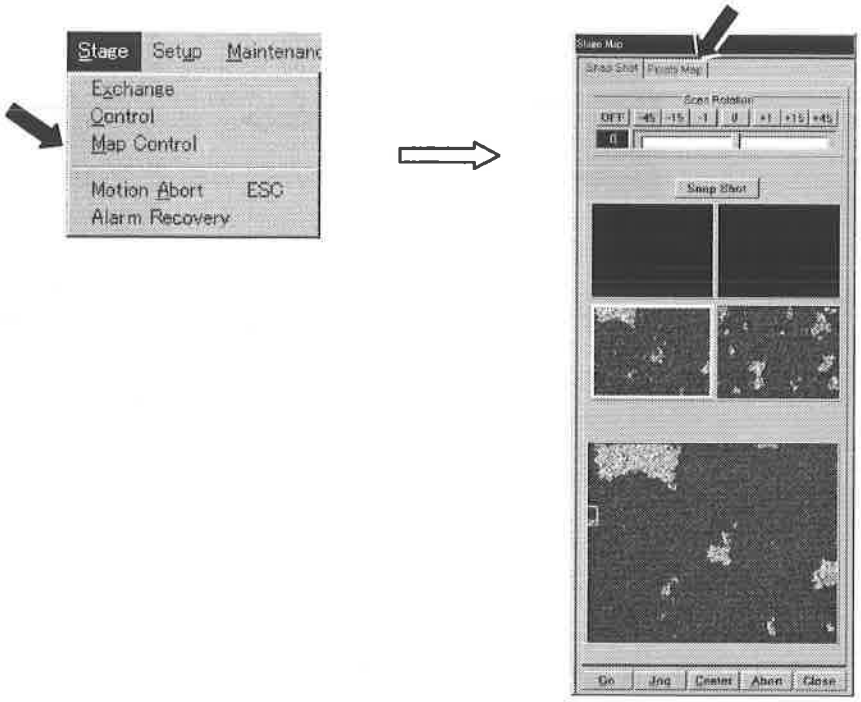
    Step rotation through a small angle.

5.7.1c Using Stage Map

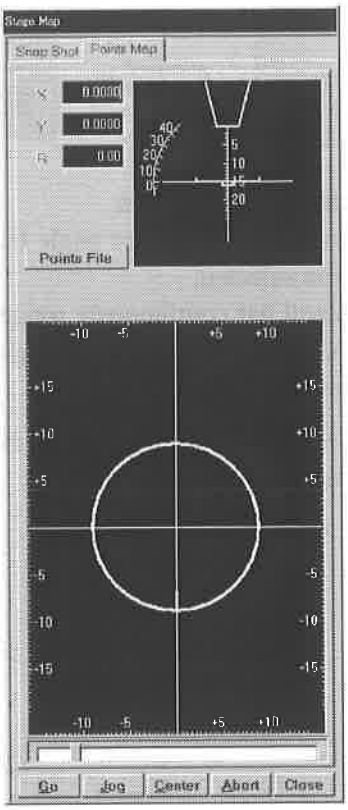
1. Select **Stage–Map Control** from the menu bar.

   Button with equivalent function: **Stage Map**

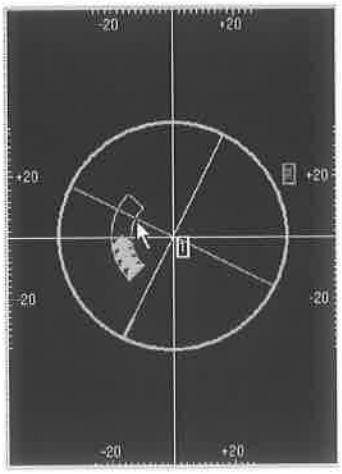
The Stage Map window opens.



2. Click the **Points Map** tab.
   The **Points Map** window appears.



3. Put the pointer near the center of the specimen holder, and drag it.



   The specimen stage rotates and an arrow ▶ is shown in the rotation direction. The more arrows shown, the higher the rotation speed.

4. Click the **Jog** button.
   - The backlash of the specimen stage is removed.
   - The position of the specimen stage is indicated in the Relative Position Control boxes.

5.7.2 Scan Rotation

1. Select **Control–Column–Scan Rotation** from the menu bar.

2. Click one of the angle buttons.

   Every time you click one of the angle buttons, the rotation angle is changed by the amount that you selected.

   Moving the scroll bar continuously rotates the field of view. With the scroll bar, the field of view can be rotated up to 45 degrees in either direction.

   Click the **0** button to reset the angle.

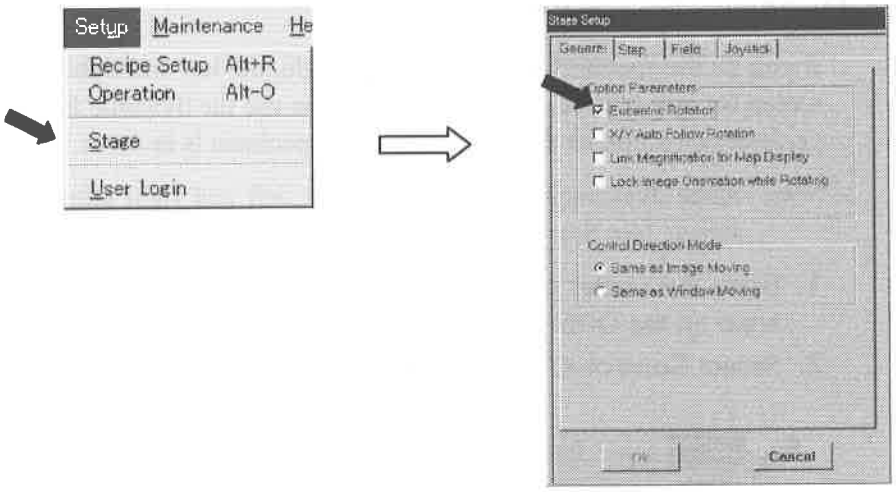
Note: When the rotation angle is preset, click the R icon to turn Scan Rotation alternately on and off.

5.8 TILTING SPECIMEN

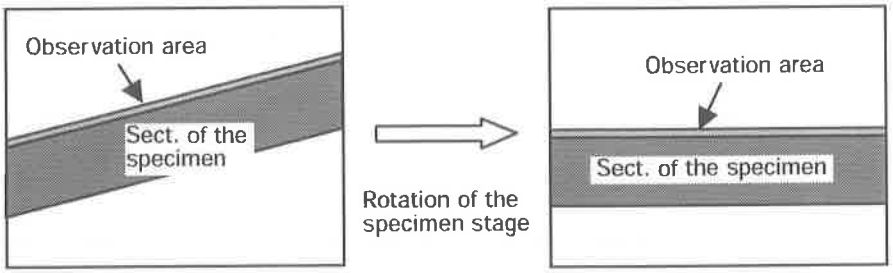
5.8.1 How to Tilt Specimen

Tilting the specimen is useful for changing the observation direction, or putting a specimen surface that is difficult to observe into an easier position for observation, or for preventing charging of the specimen.
The following operation procedure is explained under the condition that scan rotation is OFF. If scan rotation is ON, the direction of the tilting is different.

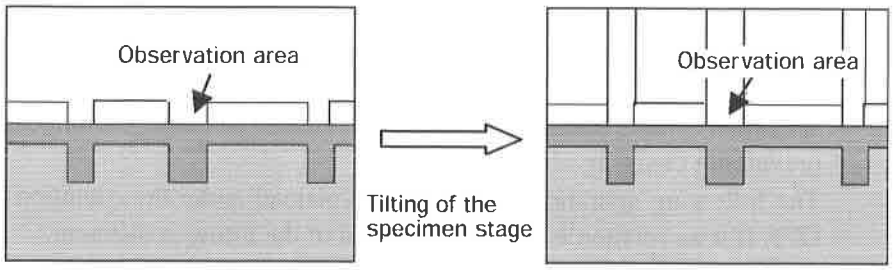
1. Click **Setup–Stage–General** on the menu bar and confirm that Eucentric Rotation is checked in Option Parameters.
   If it is not checked, click the check box.



2. Move a feature for observation to the center of the screen.
3. Align the direction in which you want to tilt the specimen with the horizontal direction of the observation screen by rotating the specimen stage. (The tilt axis is in the vertical direction on the observation screen.)



4. Tilt the specimen by using the tilt control of the specimen stage.



⇒ To determine the specimen tilting range, refer to the label on the lid of the specimen stage.

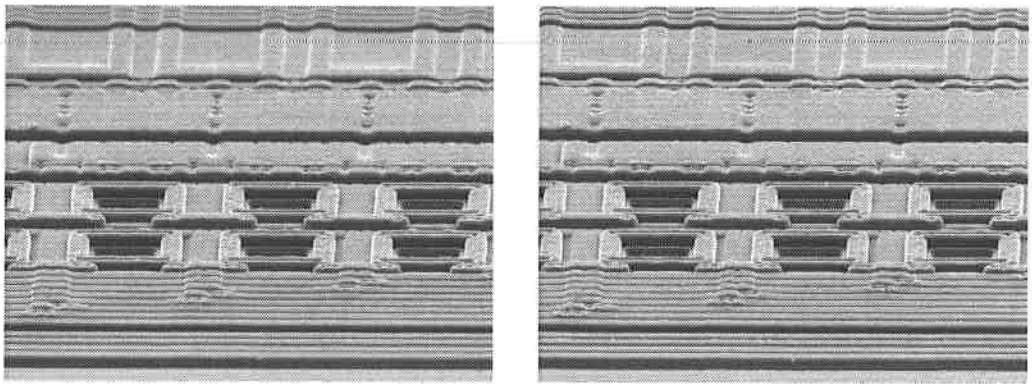
5.8.2 Dynamic Focusing

If you tilt the specimen through a large angle, the left and right edges of the observation screen become blurred. In such a case, if you use the dynamic focusing function, you can perform correction so that the entire tilted specimen is in focus.

Note: Since dynamic focusing corrects the left and right edge blur of the observation screen, turn Scan Rotation off.

1. Bring the center part of the observation screen into focus using the **FOCUS** knob on the OPERATION panel.
2. Select **Control–Column** from the menu bar.

3. Click the **DFC** button.
   The button will become green.
4. Move the scroll bar to bring the image into focus.
   Use the **FOCUS** knob on the OPERATION panel to adjust the defocusing of the center part.



Before correction **After correction**

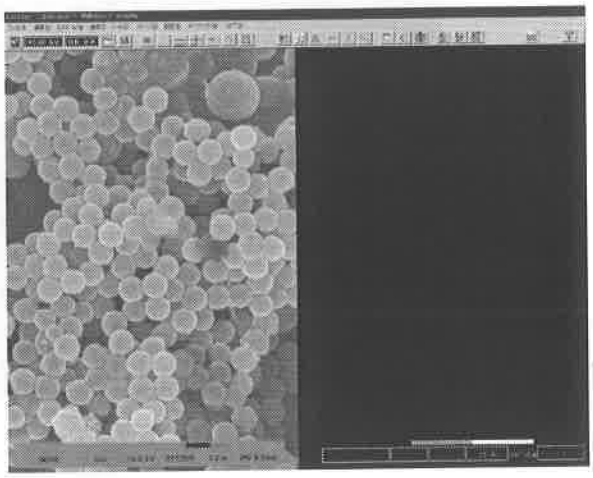
Correction of focus by means of dynamic focusing

5.9 VARIOUS SCREEN MODES

5.9.1 Side-by-Side Split Screen

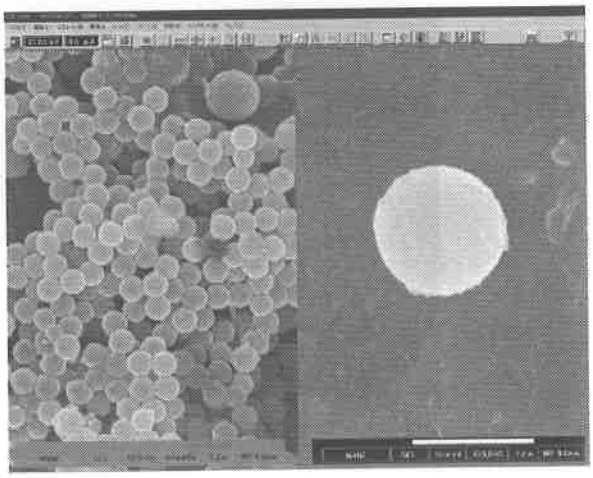
The observation screen is divided into left and right panels for comparing different images.

1. Click the **Side-by-Side Split Screen** button  on the tool bar.



The observation screen is divided into left and right panels. Initially, the active view is the one on the left.

2. Press the **FREEZE** button on the OPERATION panel.
   The image on the left is frozen.
   Note: A saved image can be loaded in the view.
   ⇒ Refer to Sect. 5.12.2b Image overlapping of this instruction manual.
3. Click the observation conditions indication on the right view.



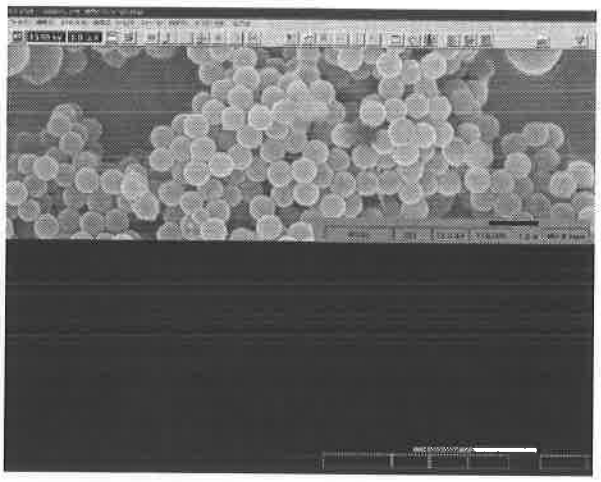
The right view becomes active, and the background of the observation conditions indication will be black. The left view becomes inactive, and the background of the observation conditions indication will be gray.

4. Load an image that you are observing, or a saved image, in the right view.
   Two images are displayed at the same time.

5.9.2 Top-and-Bottom Split Screen

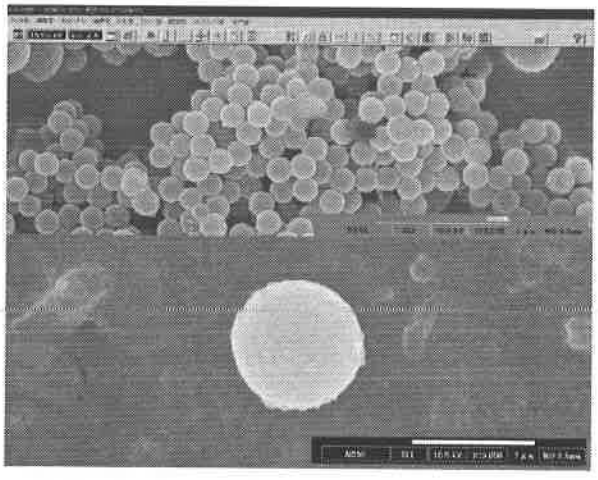
The observation screen is divided into upper and lower views for comparing different images.

1. Click the **Top-and-Bottom Split Screen** button on the tool bar.



The observation screen is divided into upper and lower views. Initially, the active view is the top one.

2. Press the **FREEZE** button on the OPERATION panel.
   The image on the top is frozen.
   Note: A saved image can be loaded in the view.
   ⇒ Refer to Sect. 5.12.2b Image overlapping of this instruction manual.
3. Click the observation conditions indication on the lower view.



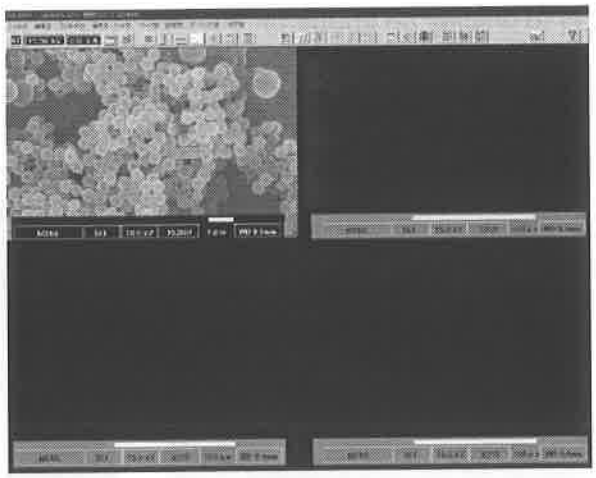
The lower view becomes active, and the background of the observation conditions indication will be black. The upper view becomes inactive, and the background of the observation conditions indication will be gray.

4. Load an image that you are observing, or a saved image, in the lower view.
   Two images are displayed at the same time.

5.9.3 Four-Way Split Screen

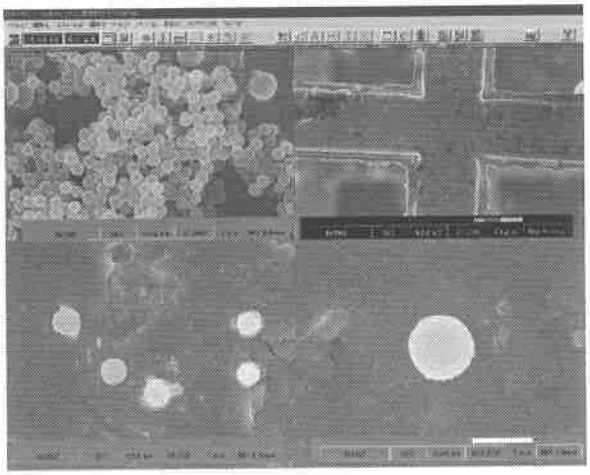
The observation screen is divided into four quarters for comparing different images.

1. Click the **Four-Way Split Screen** button  on the tool bar.



The observation screen is divided into four quarters. Initially, the active view is the one at the upper left.

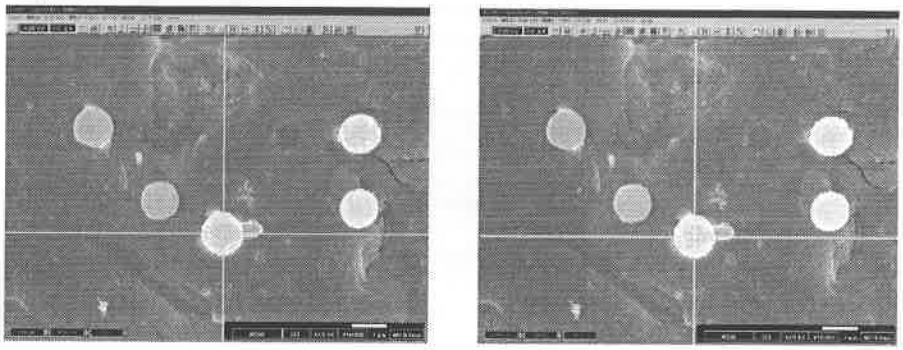
2. Press the **FREEZE** button on the OPERATION panel.
   The upper-left image is frozen.
   Note: A saved image can be loaded in the view.
   ⇒ Refer to Sect. 5.12.2b Image overlapping of this instruction manual.
3. Click the observation conditions indication on another view.
   It becomes active, and the background of the observation conditions indication will be black. The upper-left view becomes inactive, and the background of the observation conditions indication will be gray.
4. Load an image that you are observing, or a saved image in the active view.
5. Load the remaining images one by one.
   Four images are displayed at the same time.



5.9.4 Spot Mode

The spot mode stops the electron beam scan, and irradiates a point on the specimen with the electron beam. It is used mainly for point analysis.

1. Press the **SCANNING MODE–FINE VIEW** button on the OPERATION panel so as to display an image on the observation screen.
2. Click the **Spot Mode** button on the tool bar.
   The image is frozen, and the green cross cursors appear on the observation screen.



3. Put the mouse pointer near the point of intersection of the cursors.
   The shape of the pointer changes to .
4. Drag the point of intersection to the position that you want.
5. Click the left button of the mouse.
   The cursors change to orange, and the electron beam stops on the selected position.

- **How to change the irradiation position of the electron beam**

1. Click the **Spot Mode** button on the tool bar.
   The cursors change to green, and are ready for movement.
2. Put the mouse pointer near the point of intersection of the cursors.
   The shape of the pointer changes to .
3. Click the left button of the mouse.
   The cursors change to orange, and the electron beam stops on the selected position.

- **How to return to the standard screen**

◆ Click the **Standard Screen** button on the tool bar.
The freezing of the image is canceled, and the green cross cursors disappear from the observation screen.

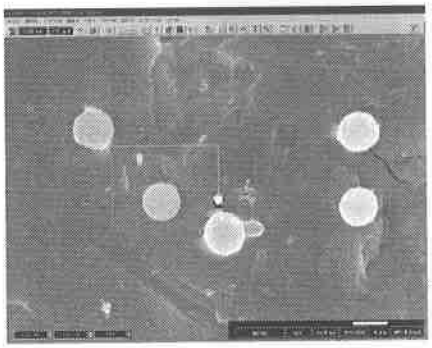
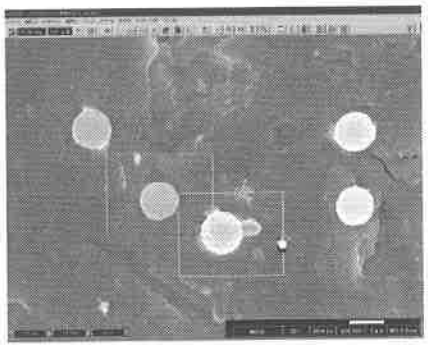
5.9.5 Reduced Screen Mode

The reduced screen mode scans the electron beam over a limited range. It is used mainly for surface analysis as well as for improving the image.

◆ Click the **Screen-Reducing** button  on the tool bar.
The observation screen is reduced, and a green frame appears.

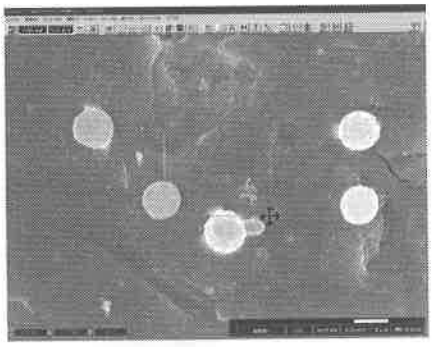
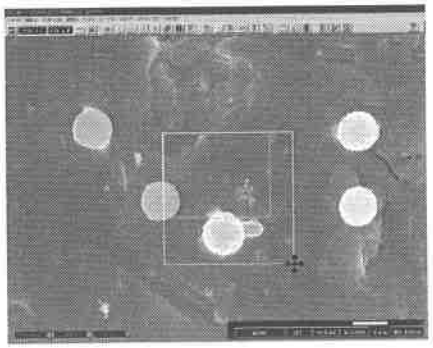
- **How to move the screen**

◆ Put the pointer inside the green frame, and drag it.
The shape of the pointer changes to  , and you can move the frame.

- **How to change size of the screen**

◆ Put the pointer near the lower right of the green frame, and drag it.
The shape of the pointer changes to  , and you can change the size of the frame.

- **How to return to the standard screen**

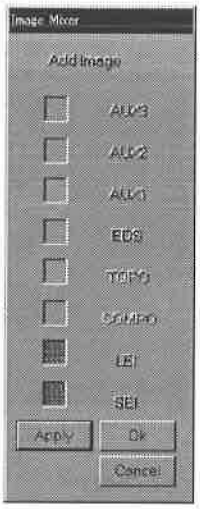
◆ Click the **Standard Screen** button  on the tool bar.
The reduced screen mode is canceled, and the green frame disappears.

5.10 SELECTION AND ADDITION OF IMAGE SIGNALS

If the optional detectors are installed in the SEM, you can select two or more image signals and display them as an added image, adding the image signals.

5.10.1 Selection of Image Signals

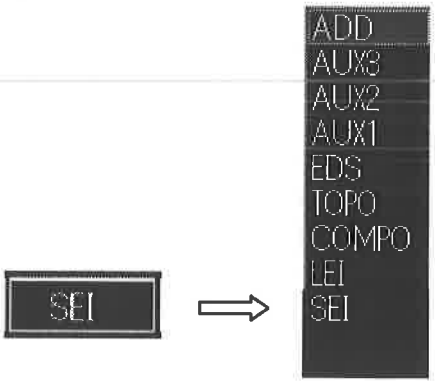
1. Select **Control–ADD Images** from the menu bar.
   The Image Mixer dialog box opens.



2. Select two or more signals
3. Click the **Apply** and **Ok** buttons.

5.10.2 Addition of Image Signals

1. Click the **Image Selector** button of the observation conditions indication.
   The pull-up menu opens.
   Note: Be sure to select two or more signals in advance according to the procedure of Sect. 5.10.1 Selection of Image Signals.



2. Select **ADD**.
   The image of the sum of the signals is displayed.

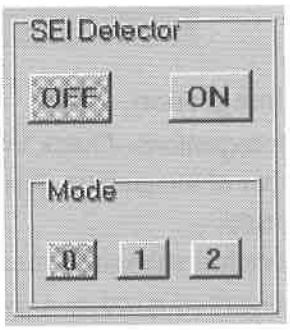
5.11 OBSERVING A SPECIMEN THAT READILY BECOMES ELECTRICALLY CHARGED

To observe an insulating specimen without a metallic coating, a low accelerating voltage of about 1 kV is often used. To diminish the influence of the electrical charge, it is also useful to change the mode of the secondary-electron detector, or to change the scanning speed.

5.11.1 Changing the Mode of the Secondary-Electron Detector

1. Set the accelerating voltage to about 1 kV.
2. Select **Control–Column** from the menu bar.

   Button with equivalent function:  **Column**
3. Set the mode of the SEI Detector to **0** or **1**.



   Note: Mode **0** is more effective.
4. Set the probe current to a rather small number.

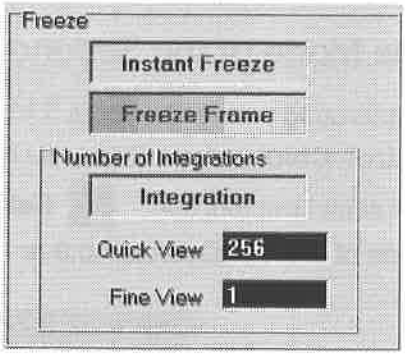
   Note: The range from 5 to 7 is recommended, if the image quality is acceptable.

5.11.2 Changing Scanning Speed

Making the scanning speed rapid can diminish the electrical charge, but image quality becomes worse. To improve the image quality, use image integration.

1. Select **Setup–Operation** from the menu bar.

   Button with equivalent function: **Operation**



2. Select **Freeze–Integration**.
3. Set Number of Integrations–Quick View to 128 or 256.

   Note: The number of integrations depends upon the electrical charge condition and image quality.
4. Set a low accelerating voltage of about 1 kV.
5. Set the probe current to a rather small number.

   Note: The range from 5 to 7 is recommended, if the image quality is acceptable.
6. Press the **SCANNING MODE–QUICK VIEW** button on the OPERATION panel.
7. Confirm that the image quality is not influenced by the electrical charge.

   Note: If you find that it is, look for conditions under which the influence is not exerted. Even after this procedure, if you find the electrical influence to be a problem, the following step cannot solve this problem.
8. Press the **FREEZE** button on the OPERATION panel.

   The image integration begins. When the designated number of integrations finishes, the image will be frozen.

   Note: You can choose another method. After setting the Freeze mode to **Instant Freeze** and Number of Integrations to about 256, press the **FREEZE** button on the OPERATION panel when you have obtained good image quality, while observing the image.

5.12 IMAGE RECORDING

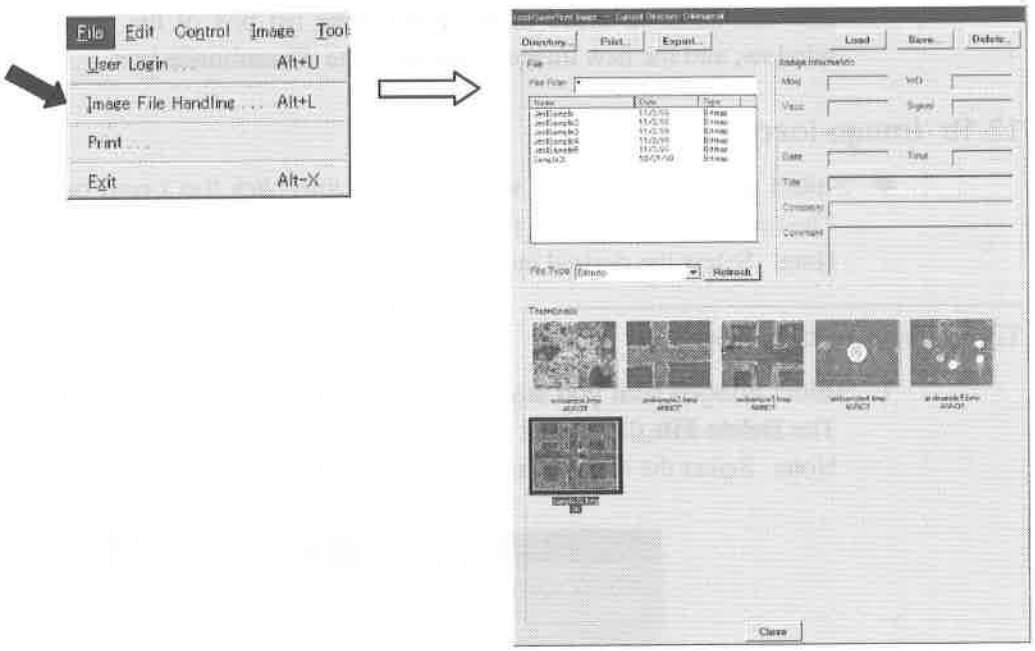
5.12.1 Image Saving and Loading

Press the **FREEZE** button on the OPERATION panel. The observation screen is frozen under the preset scanning conditions. Then, you can save or load the image.

◆ Select **File–Image File Handling** from the menu bar.

Button with equivalent function: **Image File Handling**

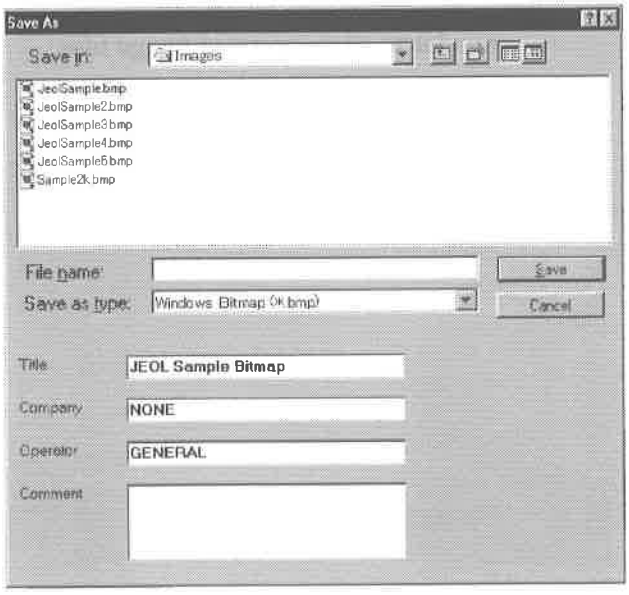
The Load/Save/Print Image window opens.



5.12.1a Image saving

1. Click the **Save** button.

The **Save As** dialog box opens.



2. Enter desired information such as a file name.

Notes: 1. In the Save in box, the folder set with the User Login command is indicated by default.

2. If the last character of the file name is a number, the numbering sequence that follows is advanced automatically by one when the same file name is used for saving.

3. Company and Operator are entered automatically, but they can be changed.

3. Click the **Save** button.

The image is saved in the specified folder and the **Save As** dialog box closes. The new file name is added in the **File Name** list box of the Load/Save/Print Image window, and the new image is added in the **Thumbnails** box.

5.12.1b Image loading

◆ Select an image that you want to load, and click the **Load** button.

The image is displayed on the observation screen.

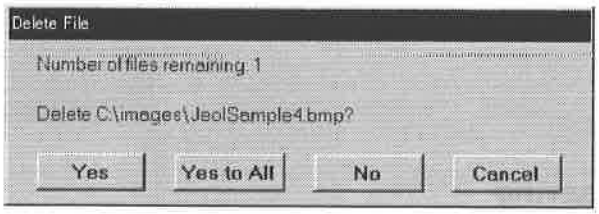
Note: Select the desired image from the File Name list, or the Thumbnails box.

5.12.1c Image deleting

1. Select images that you want to delete, and click the **Delete** button.

The **Delete File** dialog box will open.

Note: Select the desired images from the File Name list, or the Thumbnails box.



2. Click the **Yes** button.

The image file displayed in the Delete C: space will be deleted.

Note: When more than one image is selected, click the **Yes to All** button if you want to delete all the selected image files.

5.12.2 Image Processing

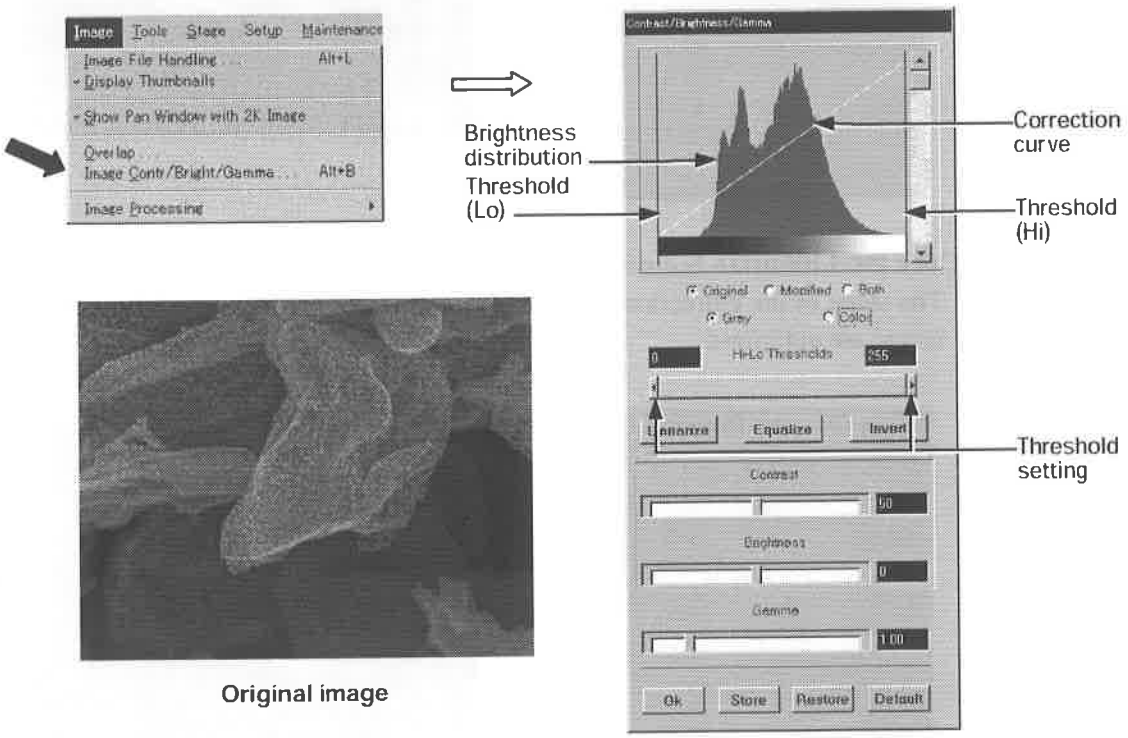
5.12.2a Image correction

If the contrast and brightness of the loaded image are not appropriate, they can be adjusted later. The adjustment is also applied to the images saved in the file by loading it on the observation screen. You can display images in pseudo-color by color-coding the different brightnesses.

◆ Select **Image–Image Contr/Bright/Gamma** from the menu bar.

Button with equivalent function: **Image Contr/Bright/Gamma**

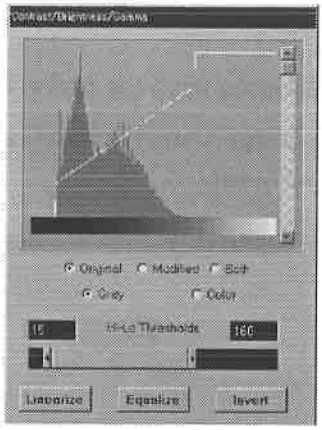
The Contrast/Brightness/Gamma window opens.

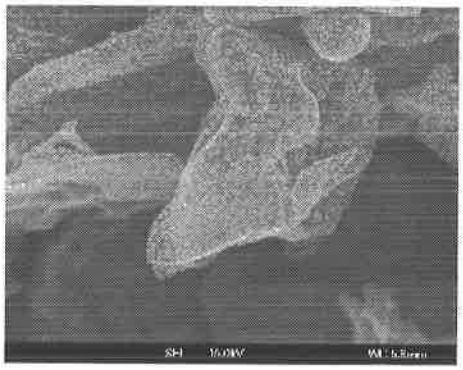


Original image

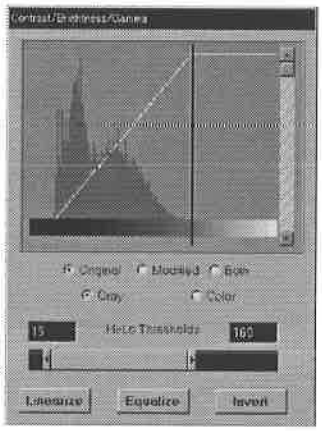
■ Brightness correction

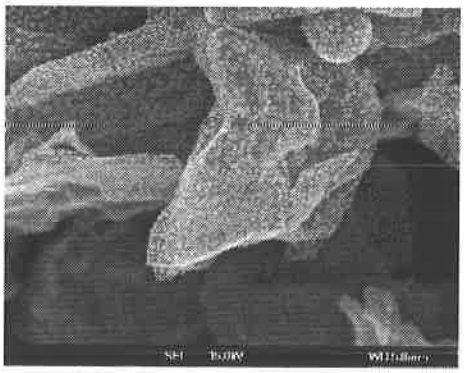
1. Align the cursor of the threshold Lo with the left end of the brightness distribution histogram and that of the threshold Hi with the right end of the histogram by dragging the threshold setting scroll bar.





2. Click the **Linearize** button.
   The slope of the correction curve is changed, and the contrast and brightness of the image are optimized.



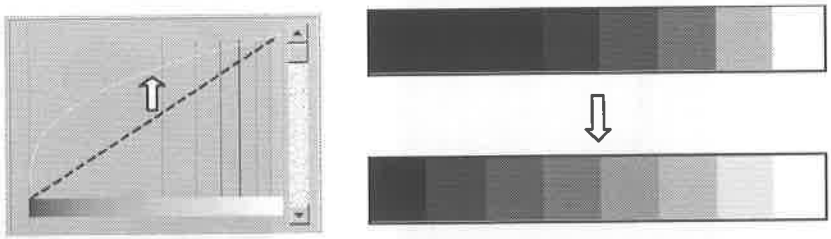


3. Perform fine adjustment by using the **Contrast** and **Brightness** scroll bars, if necessary.

■ Gamma correction

You can control the contrast either between the dark parts or between the bright parts by performing nonlinear correction using the **Gamma** scroll bar.

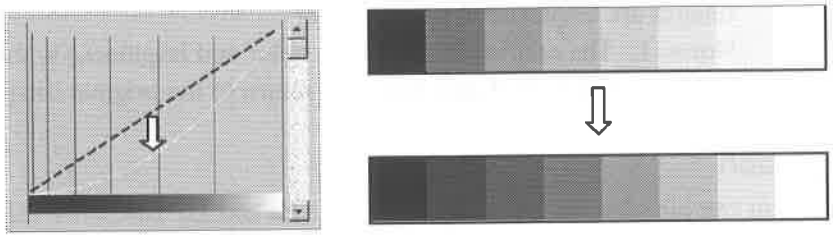
◆ To make the gamma correction larger: Move the scroll bar to the right.



Correction value = 3.0

Dark values are separated.
Note: Set the correction value to 1.00 to return to the original contrast.

◆ To make the gamma correction smaller: Move the scroll bar to the left.



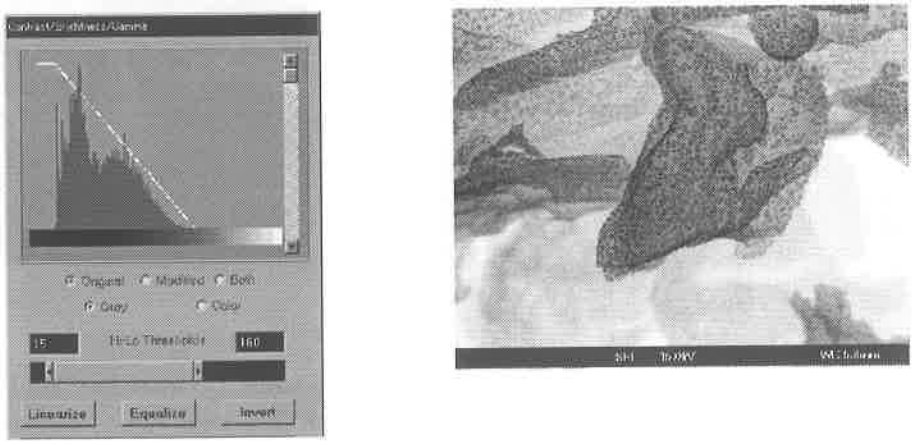
Correction value = 0.5

Bright parts are controlled.
Note: Set the correction value to 1.00 to return to the original contrast.

■ Reversing black and white

You can reverse black and white in an image.

◆ Click the **Invert** button.

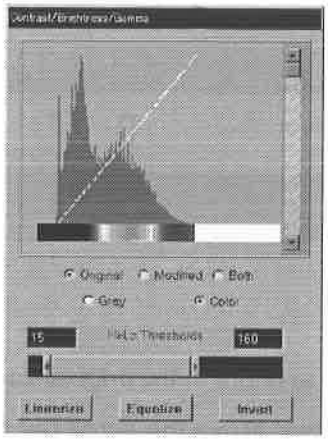


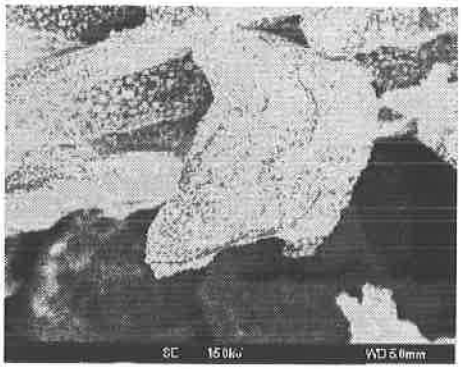
The correction curve changes and black and white are reversed in the image.
Note: Click the **Invert** button again to return to the original image.

■ Pseudo-color

You can display images in pseudo-color by color-coding the different brightnesses.

◆ Click the **Color** button.





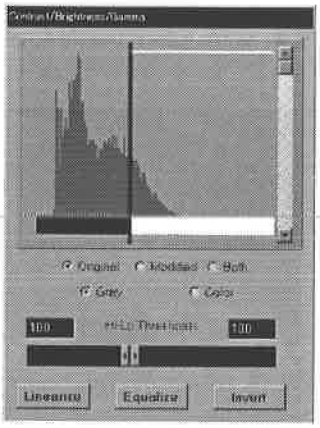
Images are displayed in pseudo-color.

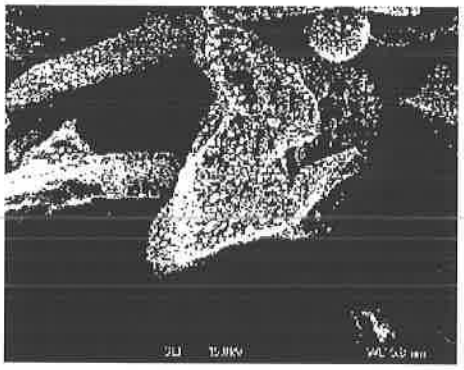
Notes: 1. The relationship between color and brightness is shown on the gray scale.
2. Click the **Gray** button to return to the original image.

■ Binarization

You can binarize the image by setting the Hi and Lo Threshold values.

1. Match the scroll arrow of Threshold value Hi to that of Threshold value Lo on the scroll bar.
   A binarized image is displayed.
2. Move both the scroll arrows at the same time, and set them to the brightness level that you want.





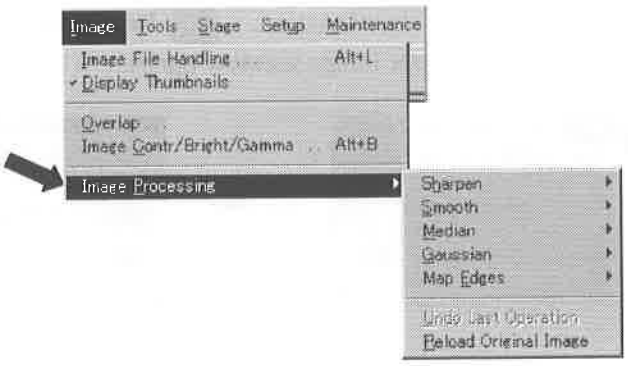
Moving the scroll arrow of Threshold value Lo increases the brightness threshold value, while moving the scroll arrow of Threshold value Hi decreases the brightness threshold value.

■ Image Processing

You can carry out image processing such as sharpening, smoothing and edge mapping by using the image filter.

◆ Select **Image–Image Processing** from the menu bar.

The pull-down menu opens.



⇒ For the details of various filters, refer to Sect. 4.5.3 Image Processing of this instruction manual.

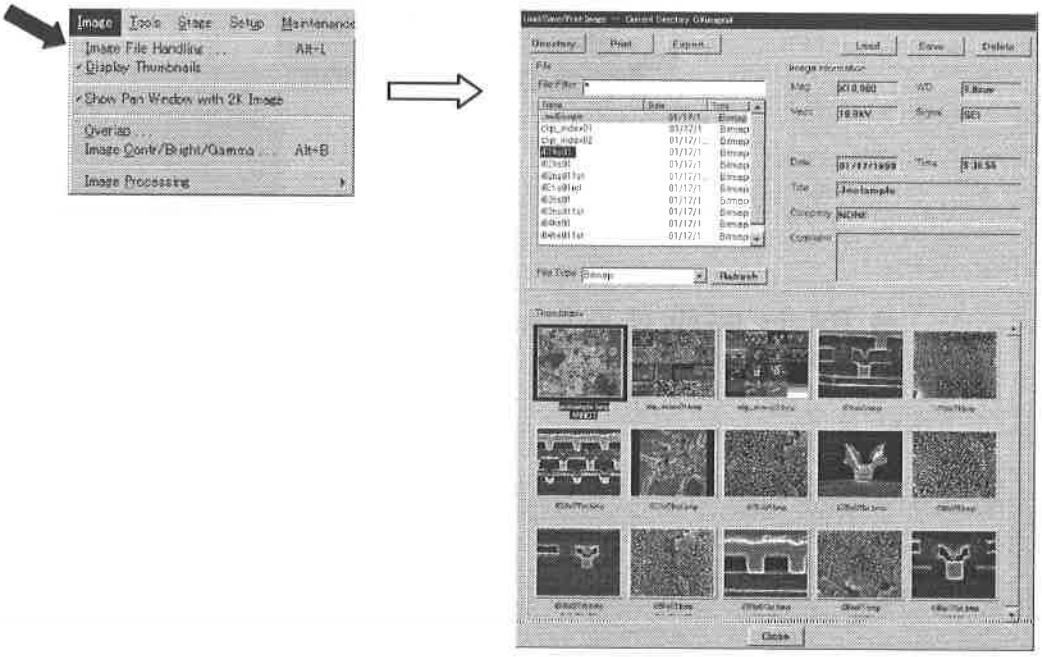
5.12.2b Image overlapping

You can overlap an image loaded from an image file with the displayed image. Since the two images are shown in green and orange respectively, this function is useful for comparison of the two images.

1. Select **Image–Image File Handling** from the menu bar.

   Button with equivalent function: **Image File Handling**

   The Load/Save/Print Image window opens.

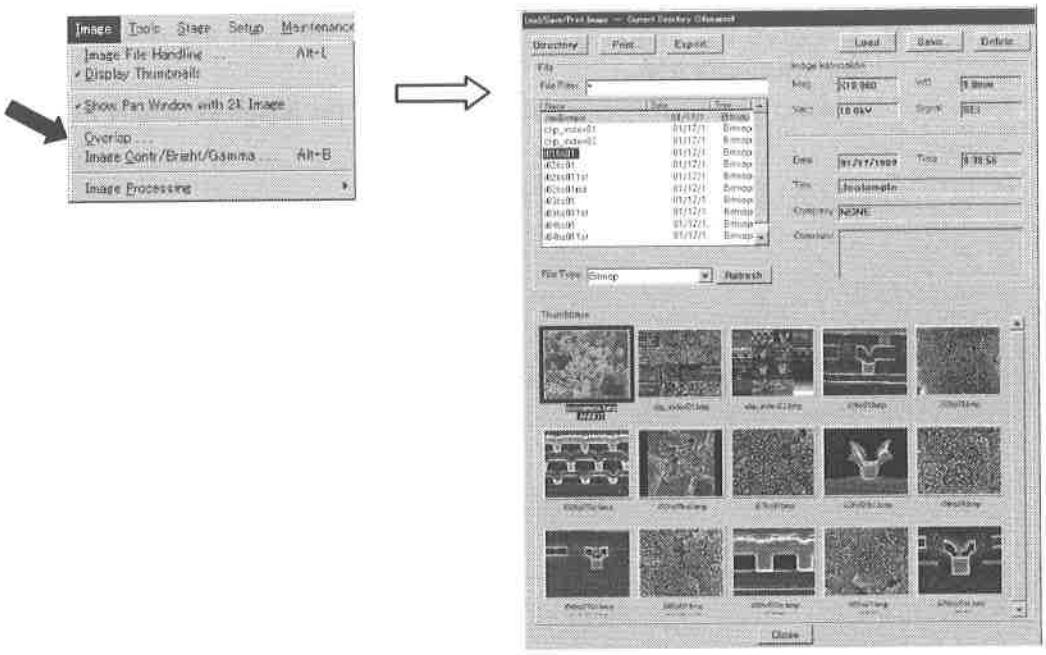


2. Select the image that you want to load, and click the **Load** button.

   The image is displayed on the observation screen.

   Note: If you want to overlap a loaded image with the image that you are observing, press the **FREEZE** button on the OPERATION panel so as to freeze the image that you are observing.

3. Select **Image–Overlap** from the menu bar.



4. Select the image that you want to overlap, and click the **Load** button.
   The two images overlap.
   Note: The first image is displayed in green, and the second one in orange.
5. Click the **Save** button to save the overlapped images, if necessary.

5.12.2c Stereo displaying

Using green and orange filters, you can carry out stereoscopic observation of two overlapping images of a specimen photographed after tilting it.

1. Confirm that the **Scan Rotation On/Off** button is  .
   If it is  , click it to change it to  .
2. Save the first image.
   Note: If a distinctive structure is at the center of the observation screen, the following operations are easy. It is also useful to use the **Diagonal Measurement** cursor.
3. Press the **FREEZE** button on the OPERATION panel so that the image of the specimen that you are observing appears on the observation screen.
4. Tilt the specimen by 5° to 10° in the clockwise direction.
   Note: Use low magnification before tilting the specimen in order not to lose the field of view.
5. Move the field of view so that it does not deviate far from the first image.
   Note: Since vertical deviation interferes with good observation of a stereo image, minimizing deviation is essential.
6. Press the **FREEZE** button on the OPERATION panel to freeze the image.
   Note: Save the image if necessary.
7. Select **Image–Overlap** from the menu bar.
   Note: The **Load/Save/Print Image** window opens.

8. Select the saved first image, and click the **Load** button.
   The first image is displayed in green, and the second one in orange.
9. Observe the image using a green filter for your left eye and an orange filter for your right eye.
   Note: Use filters that match the colors of the image as closely as possible.

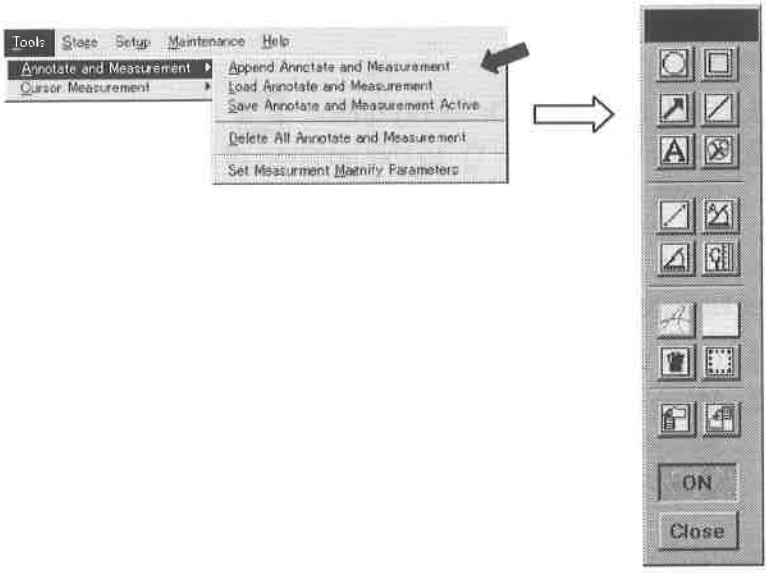
5.13 ENTERING TEXT AND DRAWING FIGURES

5.13.1 Append Annotate and Measurement Tool Bar

◆ Select **Tools–Annotate and Measurement–Append Annotate and Measurement** from the menu bar.

Button with equivalent function: **Append Annotate and Measurement**

The Append Annotate and Measurement tool bar opens. Entry of text or figures is available using the tool bar buttons.



The shape of the pointer changes according to the kind of operation as follows:

For normal operation

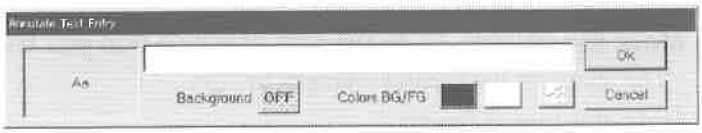
For moving text and figures

For changing the shape of text and figures

5.13.2 Entering Text

1. Click the **Annotate Text Entry** button.
2. Move the pointer to the position at which you want to input text, and click on it.

The **Annotate Text Entry** window opens.



3. Enter the desired text and click the **Ok** button.

Change the background, color and font, when required.

The text entered into the image is shown.

5.13.3 Editing Text

1. Click the **Annotate Text Entry** button  .
2. Move the pointer to the text that you want to edit, and click it.
   The **Annotate Text Entry** window opens.
3. Edit the text and click the **Ok** button.

5.13.4 Drawing Figures

You can draw circles, rectangles, straight lines and arrows on the observation screen.

5.13.4a Circle

1. Click the **Circle Drawing** button  .
2. Move the pointer to the position of the center of the circle that you want to draw, and drag it toward the lower right.
   A circle is drawn.

5.13.4b Rectangle

1. Click the **Rectangle Drawing** button  .
2. Move the pointer to the position of the upper left corner of a rectangle that you want to draw, and drag it toward the lower right.
   A rectangle is drawn.

5.13.4c Straight line

1. Click the **Line Drawing** button  .
2. Move the pointer to the position of one end of the straight line that you want to draw, and drag it to the other end.
   A straight line is drawn.

5.13.4d Arrow

1. Click the **Arrow Drawing** button  .
2. Move the pointer to the position of the head of the arrow line that you want to draw, and drag it to its tail.
   An arrow is drawn.

5.13.5 Moving Text or Figures

1. Move the pointer to the text or figure that you want to move.
   The shape of the pointer changes to .
2. Drag the text or figure.
   The text or figure moves.

5.13.6 Enlarging or Reducing Text or Figures

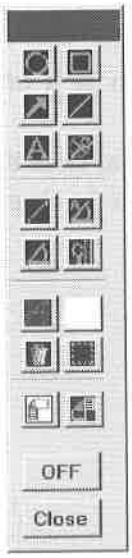
1. Move the pointer toward the lower right corner of the text or figure that you want to enlarge or reduce.
   The shape of the pointer changes to ✥.
   Note: In the case of a straight line, move the pointer near to one end of the line, and in the case of an arrow to its tail.
2. Drag the text or figure.
   The text or figure is enlarged or reduced.

5.13.7 Deleting Text or Figures

1. Click the **Delete** button.
2. Move the pointer to the text or figure that you want to delete.
   The text or figure is shown by a dashed line.
3. Click on it.
   The text or figure is deleted.

5.13.8 Deleting Temporarily

- Click the **ON/OFF** button ON.
  The ON indication of the **Append Annotate and Measurement** tool bar changes to OFF, and the text or figure is deleted temporarily. Click again to show it.



5.13.9 Deleting More Than One Text or Figure

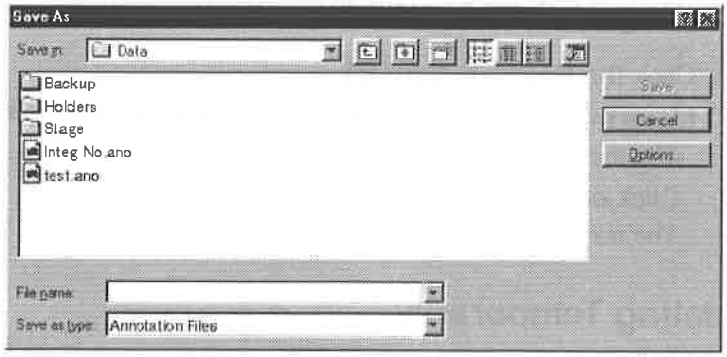
1. Click the **Domain Designation** button.
2. Draw a box around the text or figures that you want to delete.
   The selected items are shown by a dashed line.
3. Click the **Delete** button.

5.13.10 Saving and Loading Text

You can save and load the text and figures that you create.

5.13.10a Saving text

1. Enter text or draw figures.
2. Click the **Save** button  of the **Append Annotate and Measurement** tool bar.
   The **Save As** dialog box opens.



3. Key in a file name and click the **Save** button.
   A file with the extension .ano is created.

5.13.10b Loading text

1. Click the **Load** button  of the **Append Annotate and Measurement** tool bar.
2. Select a file name, and click the Open button.
   Items are displayed on the observation screen.

5.14 MEASURING SIZE

5.14.1 Measuring Distances and Angles

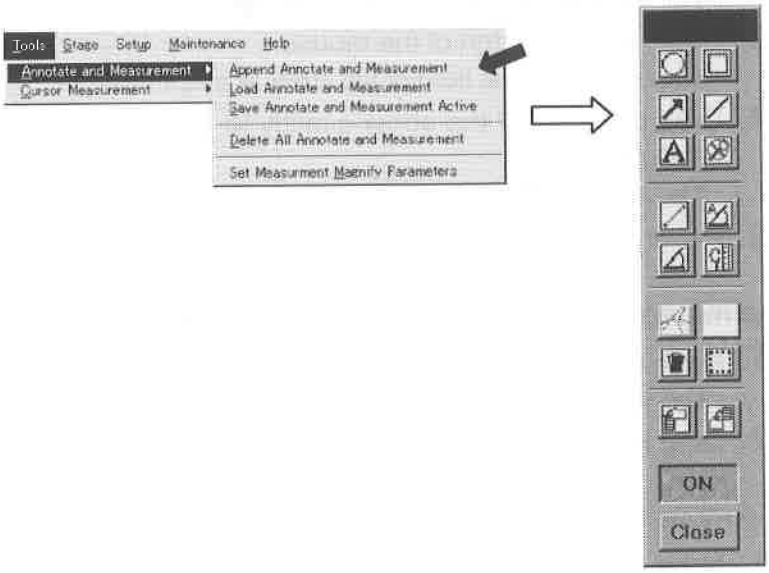
5.14.1a Measuring the distance between two points

When the double-headed arrow cursor is displayed on the screen, you can measure the distance between two points.

1. Select **Tools–Annotate and Measurement–Append Annotate and Measurement** from the menu bar.

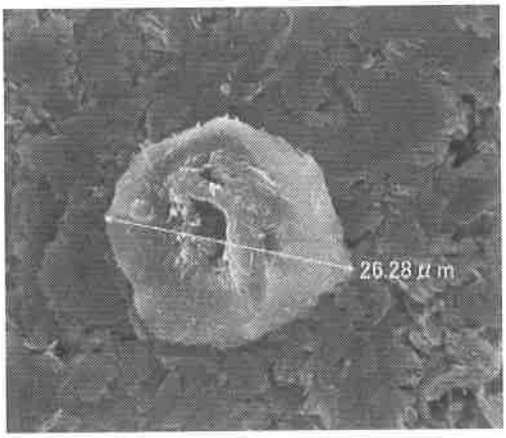
   Button with equivalent function: **Append Annotate and Measurement**

   The Append Annotate and Measurement tool bar opens.



2. Click the **Distance Measurement** button .
3. Move the pointer to one end of the feature to be measured, and then click it.

   The double-headed arrow cursor is displayed.



4. Move the pointer to near the head of the double-headed arrow that is in the measurement direction.
   The shape of the pointer changes to ✥.
5. Drag the cursor to the other end of the feature to be measured.
   The measured distance is shown.

- **How to match both the heads of the double-headed arrow exactly to both the ends of the feature**

1. Click the **Magnifier** button.
   The indication of the Magnifier button changes to .
2. Move the pointer to near one head of the double-headed arrow.
   The shape of the pointer changes to ✥.
3. Press the left button of the mouse.
   The image near the head of the arrow is magnified.
4. Drag the head of the arrow exactly to the end of the feature and release the left button.
   The image near the head of the arrow returns to the previous size.
5. Perform the same operation at the other head of the arrow.

- **How to move one head of the double-headed arrow**

1. Move the pointer to near one head of the double-headed arrow.
   The shape of the pointer changes to ✥.
2. Drag the head of the arrow to the position that you want.

- **How to move the double-headed arrow cursor**

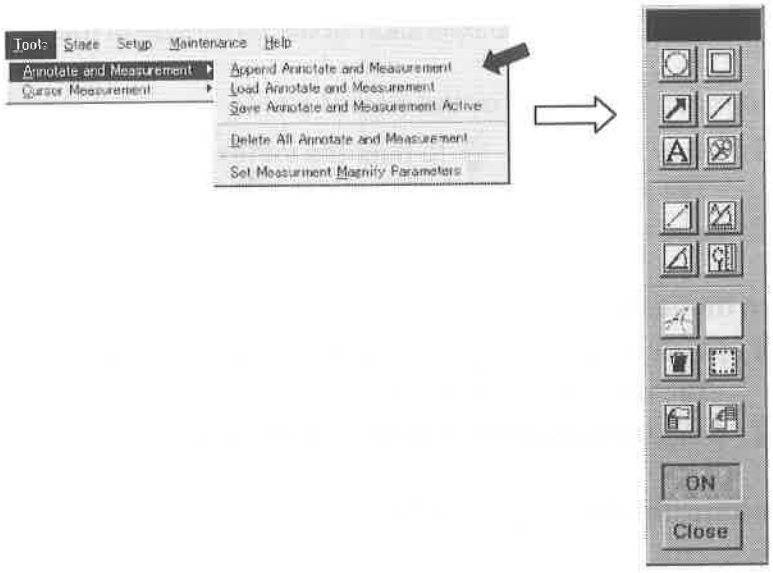
1. Move the pointer to near the center of the double-headed arrow.
   The shape of the pointer changes to .
2. Drag the arrow to the position that you want.

5.14.1b Measuring the angle

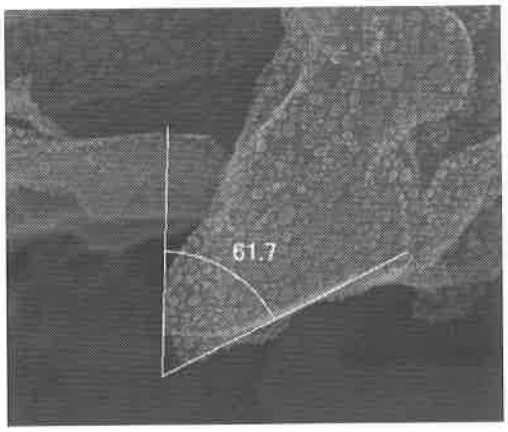
When the angle cursor is displayed on the screen, you can measure the angle formed by two line segments.

1. Select **Tools–Annotate and Measurement–Append Annotate and Measurement** from the menu bar.

   Button with equivalent function: **Append Annotate and Measurement** button
   The Append Annotate and Measurement tool bar opens.



2. Click the **Angle Measurement** button  .
3. Move the pointer to the vertex of the angle to be measured, and then click it.
   The angle cursor is displayed.



4. Move the pointer to near the end of one side of the cursor.
   The shape of the pointer changes to ✥.
5. Drag each end of the sides of the angle cursor.
   The measured value of the angle is shown.

- **How to measure the angle more accurately**

1. Click the **Magnifier** button  .
   The indication of the **Magnifier** changes to  .
2. Move the pointer to near the vertex or the end of one side of the angle.
   The shape of the pointer changes to ✥.
3. Press the left button of the mouse.
   The image near the pointer is magnified.
4. Drag one side of the angle exactly to the desired position, and release the left button.
   The image near the pointer returns to the previous size.

5. Perform the same operation at the other side of the angle.

- **How to move the vertex or the end of a side**

1. Move the pointer to near the vertex or the end of one side of the angle.
   The shape of the pointer changes to .
2. Drag the vertex or the end to the position that you want.

- **How to move the angle cursor**

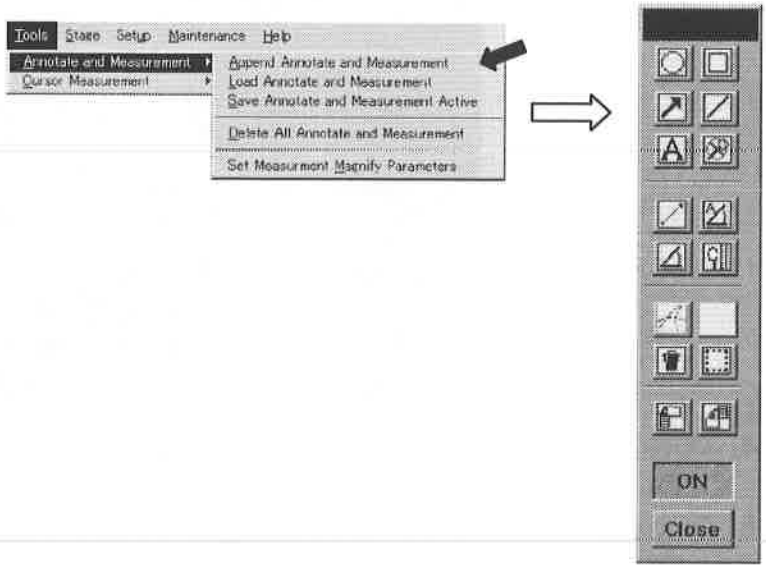
1. Move the pointer to near the center of the angle cursor.
   The shape of the pointer changes to .
2. Drag the cursor to the position that you want.

5.14.1c Measuring the angle and its sides

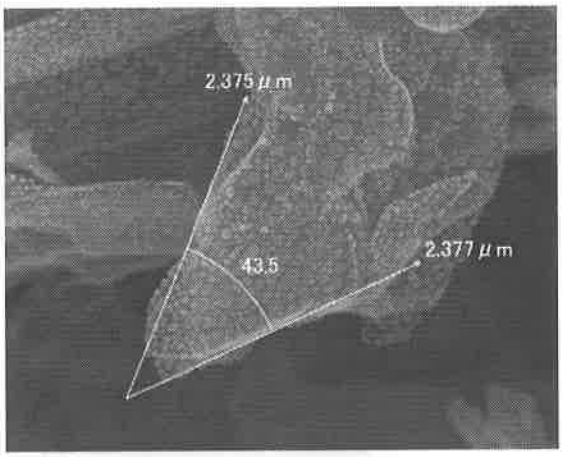
When the angle cursor with arrows is displayed on the screen, you can measure the angle formed by two line segments and the lengths of the two segments.

1. Select **Tools–Annotate and Measurement–Append Annotate and Measurement** from the menu bar.

   Button with equivalent function: **Append Annotate and Measurement** button
   The Append Annotate and Measurement tool bar opens.



2. Click the **Distance/Angle Measurement** button .
3. Move the pointer to the vertex of the angle to be measured, and then click it.
   The angle cursor with arrows is displayed.



4. Move the pointer to near the end of one side of the cursor.
   The shape of the pointer changes to ✥.
5. Drag each end of the sides of the cursor, including the angle to be measured.
   Measured values of the angle and two sides are shown.
6. Drag each end of the sides of the cursor to the desired position.
   The measured values of the two sides are again shown.

- **How to measure the angle and its sides more accurately**

1. Click the **Magnifier** button.
   The indication of the **Magnifier** changes to .
2. Move the pointer to near the vertex or the end of one side of the angle.
   The shape of the pointer changes to ✥.
3. Press the left button of the mouse.
   The image near the pointer is magnified.
4. Drag one side of the angle exactly to the desired position, and release the left button.
   The image near the pointer returns to the previous size.
5. Perform the same operation at the other side of the angle.

- **How to move the vertex or the end of the side**

1. Move the pointer to near the vertex or the end of one side of the angle.
   The shape of the pointer changes to ✥.
2. Drag the vertex or the end to the position that you want.

- **How to move the angle cursor**

1. Move the pointer to near the center of the angle cursor.
   The shape of the pointer changes to .
2. Drag the cursor to the position that you want.

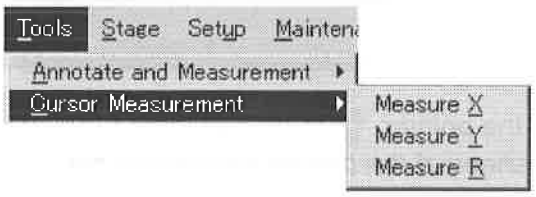
5.14.2 Measurement Using the Cursors

You can measure a feature by putting it between two cursors.
This is very useful for measuring a size such as the diameter of a circular feature or the width of a linear pattern.

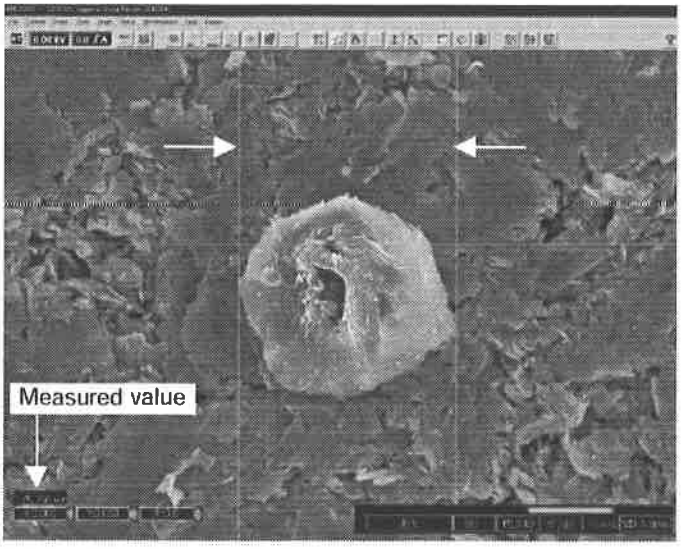
5.14.2a X direction measurement

You can measure the horizontal extent of a feature between two vertical cursors.

1. Select **Tools–Cursor Measurement–Measure X**.



Button with equivalent function: **Measure X**
Two vertical cursors and the distance between them are indicated on the observation screen.



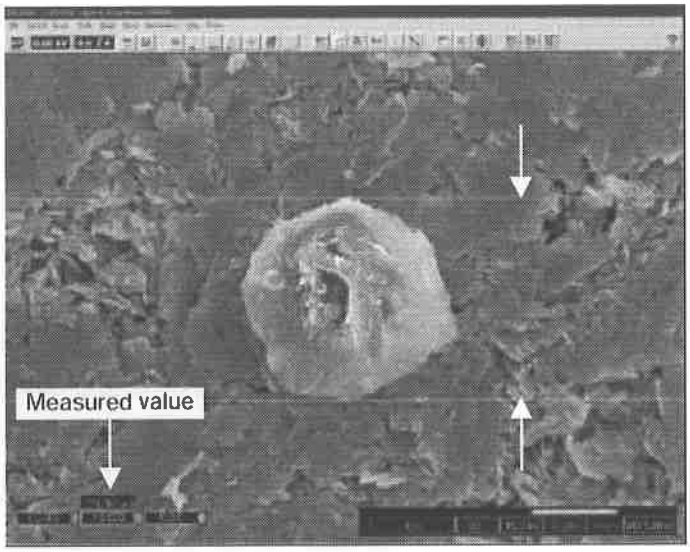
2. Move the pointer to near a cursor.
   The shape of the pointer changes to .
3. Move the cursor to the point that you want to measure.

5.14.2b Y direction measurement

You can measure the vertical extent of a feature between two horizontal cursors.

1. Select **Tools–Cursor Measurement–Measure Y**.

Button with equivalent function: **Measure Y**
Two horizontal cursors and the distance between them are indicated on the observation screen.

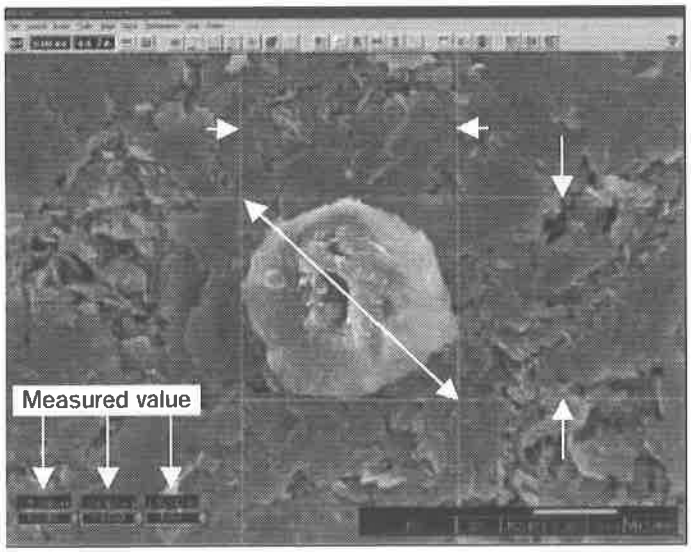


2. Move the pointer to near a cursor.
   The shape of the pointer changes to .
3. Move the cursor to the point that you want to measure.

5.14.2c Diagonal measurement

You can measure the vertical, horizontal and diagonal extents of a feature in a rectangle formed by two vertical and two horizontal cursors.

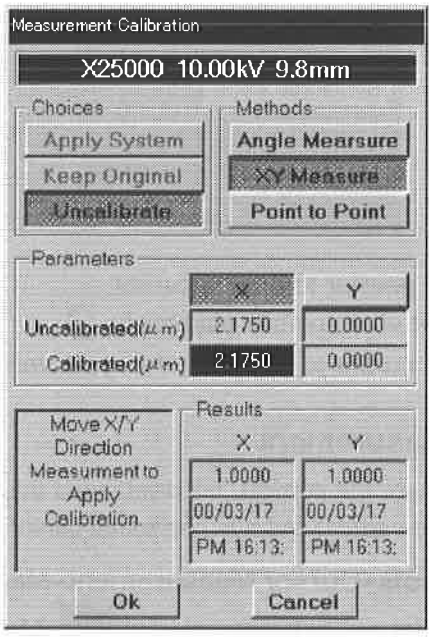
1. Select **Tools–Cursor Measurement–Measure R.**
   Button with equivalent function: **Measure R**
   Two vertical and two horizontal cursors and measured values are indicated on the observation screen.



2. Move the pointer to near a cursor.
   The shape of the pointer changes to .
3. Move the cursor to the point that you want to measure.

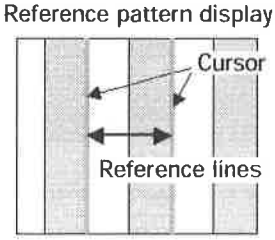
5.14.2d Calibration

You can calibrate the measured value of the length of a line (X, Y).
Select **Tools–Annotate and Measurement–Append Annotate and Measurement** from the menu bar.
The Append Annotate and Measurement tool bar opens.
Click the **Calibration** button  of the tool bar to open the Measurement Calibration dialog box.



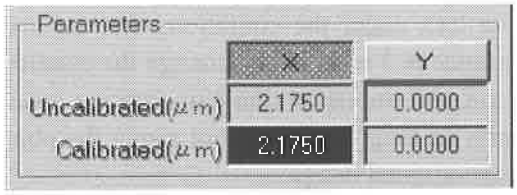
You can use one of three methods of measurement for calibration.
With Cursor measurement, an example of measurement is given below.

1. Display a reference specimen on the observation screen.
2. Click the **Calibration** button  to open the Measurement Calibration dialog box.
3. Select the **Uncalibrate** button from **Choices**.
4. Select the **XY Measure** button from **Methods**, and then select **X** from **Parameters**.
5. Align the cursors with the reference lines.
   Rotate the specimen and align it with the cursors by using R movement of the Stage menu.

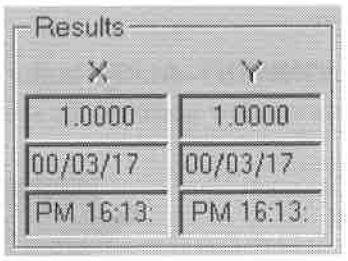


In the box next to **Uncalibrated**, the measured value is displayed.

In the box next to **Calibrated**, enter the calibration value of the reference specimen after performing the calibration.



A correction factor to the default and the date and time are indicated in the Results boxes. (For example, if you key in 1.0000 after the calibration was performed, the results are shown below.)



6. Perform the same operation for the Y direction.
7. Click the **Ok** button to save the correction factors. From then on, calibrated measurement results are displayed based upon the saved correction factors.

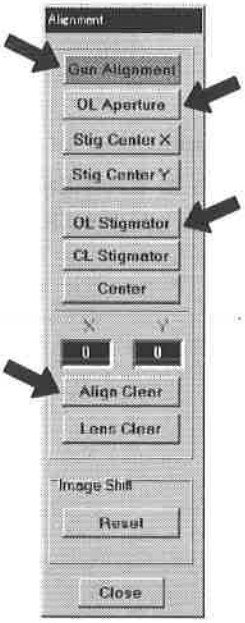
5.15 ALIGNMENT AND ASTIGMATISM CORRECTION

In the JSM-6700F, the objective lens aperture is aligned with the electron optical axis of the objective lens under the conditions that the accelerating voltage is 15 kV and the working distance is 3 mm. If you change the conditions, you can align the axis using the deflection coil. All the deflection-coil-exciting conditions are recorded in the computer. Consequently, as long as you do not move the objective lens aperture, you can always observe a well-aligned image.

5.15.1 Ordinary Alignment and Astigmatism Correction

Almost no alignment and astigmatism correction are required in daily use. If the image is not as sharp as usual, or it moves a lot when the focus is being adjusted, carry out the following procedure.

1. Press the **ALIGNMENT–ALIGN** button of the OPERATION panel.
   The Alignment window opens on the screen.

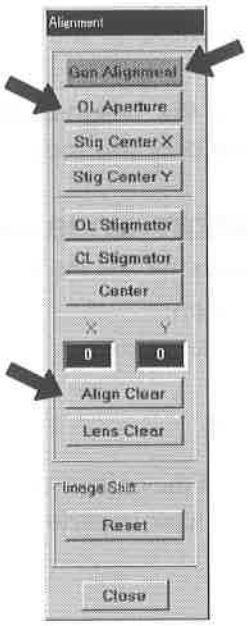


2. Click the **Gun Alignment** button.
3. Click the **Align Clear** button.
   The electron gun alignment is reset to its initial state at the time of installation.
4. Click the **OL Aperture** button.
5. Click the **Align Clear** button.
   The alignment of the OL aperture is reset to its initial state at the time of installation.
6. Click the **OL Stigmator** button.
7. Click the **Align Clear** button.
   The astigmatism correction of the objective lens is reset to its initial state at the time of installation.
8. Click the **Close** button.
   The Alignment window is closed.

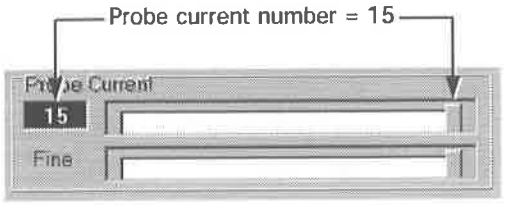
5.15.2 Auxiliary Alignment

After the alignment was reset to its initial state by performing the above procedure, if you find the axis misaligned, perform the following procedure for auxiliary alignment.

1. Press the **ALIGNMENT–ALIGN** button on the OPERATION panel.
   The Alignment window opens on the screen.



2. Click the **Gun Alignment** button.
3. Click the **Align Clear** button.
4. Click the **OL Aperture** button.
5. Click the **Align Clear** button.
6. Set the magnification to the smallest value of the SEM mode.
7. Drag the Probe Current scroll bar to the right end.
   The number in the Probe Current input box will be 15.



8. Click the **Gun Alignment** button of the Alignment window.
   The **ALIGNMENT–X** and **Y** knobs on the OPERATION panel are set to electron gun alignment.
9. Maximize the brightness of the image by using the **ALIGNMENT–X** and **Y** knobs.
10. Set the number in the Probe Current input box to 7.

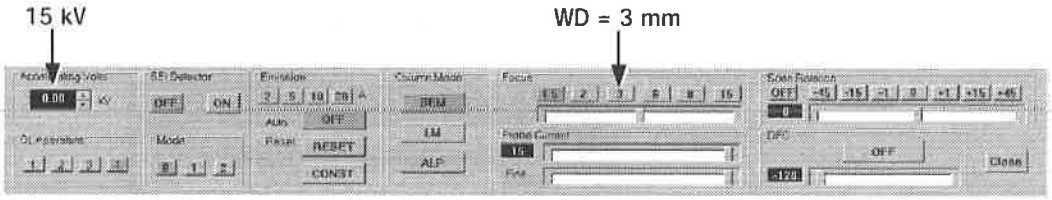
11. Press the **ALIGNMENT–WOBB** button on the OPERATION panel.
    The focus changes periodically, while the image moves synchronized with the focus. If the magnification is high, the image moves to one direction, and if the magnification is low, the image rotates.
12. Click the **OL Aperture** button of the Alignment window.
    The **ALIGNMENT–X** and **Y** knobs on the OPERATION Panel are set to OL aperture alignment.
13. Minimize the movement of the image by using the **ALIGNMENT–X** and **Y** knobs.
14. Gradually increase the magnification and adjust so that the image almost does not move but only the focus changes at magnifications of several tens of thousands.
15. Press the **ALIGNMENT–WOBB** button on the OPERATION panel.
    The button lamp goes out and the focus fluctuation stops.
16. Click the **Close** button.
    The Alignment window closes.

5.15.3 Precise Alignment

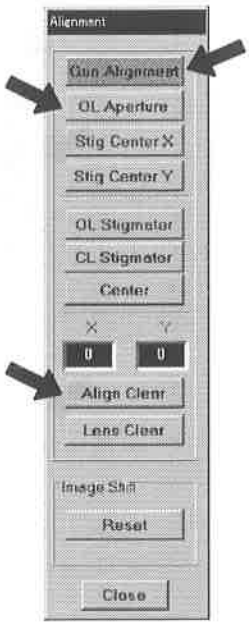
After you have performed the ordinary alignment and auxiliary alignment, if you find the axis still misaligned, you have to perform precise alignment.

5.15.3a Preparation

1. Prepare an alignment reference specimen, and attach the specimen to the specimen holder, aligning the surface of the specimen with the reference of the specimen holder.
   ⇒ Refer to Sect. 5.4.3 Inserting the Specimen of this instruction manual.
   Note: Choose a specimen of one to several μm in length and width. Of course, the specimen must be electrically conducting.
2. Select **Control–Column**. Set Accelerating voltage to 15 kV and Focus–(WD) to 3 mm.



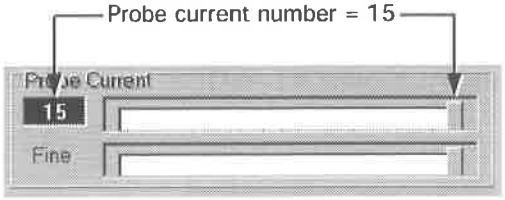
3. Turn the WD control (coarse) knob of the specimen stage to the 3 mm mark.
4. Bring the specimen into approximate focus using the WD control (fine) knob of the specimen stage.
5. Press the **ALIGNMENT–ALIGN** button on the OPERATION panel.
   The Alignment window opens on the screen.



6. Click the **Gun Alignment** button.
7. Click the **Align Clear** button.
8. Click the **OL Aperture** button.
9. Click the **Align Clear** button.

5.15.3b Alignment of electron gun

1. Set the magnification to the smallest value of the SEM mode.
2. Drag the Probe Current scroll bar to the right end.
   The number in the Probe Current input box will be 15.

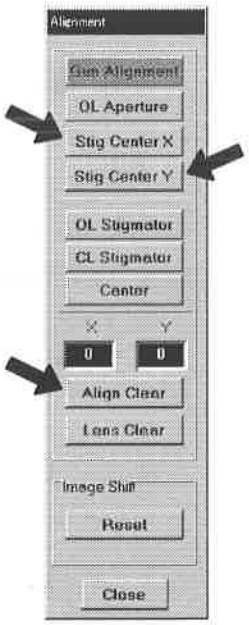


3. Click the **Gun Alignment** button of the Alignment window.
   The **ALIGNMENT–X** and **Y** knobs on the OPERATION panel are set to the electron gun alignment.
4. Maximize the brightness of the image by using the **ALIGNMENT–X** and **Y** knobs.
5. Set the number in the Probe Current input box to 7.

5.15.3c Alignment of stigma center

If the image moves when the astigmatism correction is performed, perform the alignment of the stigma centers.

1. Center a feature on the observation screen, and bring the feature into focus.
2. Click the **Stig Center X** button.



3. Click the **Align Clear** button.
4. Click the **Stig Center Y** button.
5. Click the **Align Clear** button.
6. Press the **ALIGNMENT–WOBB** button on the OPERATION panel.
7. Click the **Stig Center X** button.
8. Minimize the movement of the image by using the **ALIGNMENT–X** and **Y** knobs on the OPERATION panel.
9. Click the **Stig Center Y** button.
10. Minimize the movement of the image by using the **ALIGNMENT–X** and **Y** knobs on the OPERATION panel.
11. Repeat steps 7 to 10 of this procedure.
12. Press the **ALIGNMENT–WOBB** button on the OPERATION panel to deselect it.

5.15.3d Finishing alignment operation

- Click the **Close** button.
  The Alignment window closes.

5.15.4 Precise Correction of Astigmatism

Clicking the **OL Stigmator** and **Align Clear** buttons returns the astigmatism correction values to the initial state at the time of installation. Therefore, you need almost no astigmatism correction for magnifications of up to several tens of thousands. However, if astigmatism appears due to electrical charging of the specimen, or observation at a higher magnification is necessary, you have to perform the precise astigmatism correction each time.

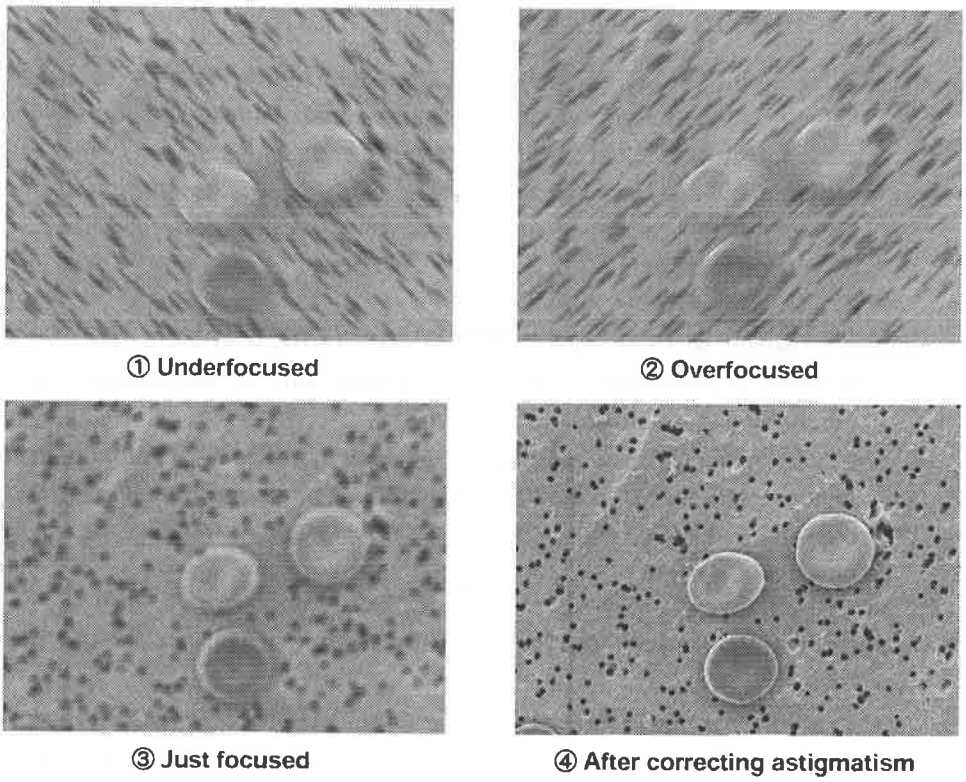
- **Check whether or not there is astigmatism (Stigma).**

  If there is astigmatism, accurate focusing will be impossible, preventing you from obtaining a clear image.
  If there is astigmatism, and the image goes out of focus when you change the focus, the features will appear to "to be elongated" in a particular direction. To be more precise, the directions of image elongation at underfocusing and overfocusing are orthogonal to each other, as shown in Fig. ① and Fig. ②.

- **If there is astigmatism, perform astigmatism correction using the following procedure.**

  Confirm that the STIG button on the OPERATION panel is lit (if the ALIGN button is lit, press the STIG button); then perform adjustment using the X and Y knobs so as to obtain the clearest image.

  1. Set the focus correctly between the overfocused and underfocused conditions, as shown in Fig. ③ (Just focused).
  2. Rotate the astigmatism correction knobs (STIG-X, Y knobs) so as to obtain a clear image.
  3. Repeat steps 1 and 2 so as to correct both the astigmatism and the focus.
     If the image no longer "flows", adjustment is completed, as shown in Fig. ④.



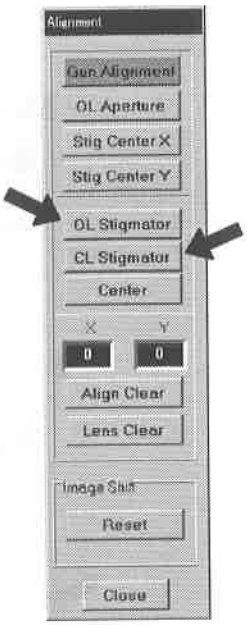
Focusing and correcting astigmatism

Notes: 1. If astigmatism correction fails to take place when you carry out an astigmatism correction operation, reset the values of **OL Stigmator** to X = 0, Y = 0, then carry out the astigmatism correction operation once again.
a. Select **Control–Alignment**, and display the Alignment window.
b. Click **OL Stigmator**.
c. Click **Align Clear**, then set the OL Stigmator values to X = 0, Y = 0.
2. If the image flows when you rotate the astigmatism correction knob, carry out the **Stig Center X/Y** adjustment of Sect. 5.15.3c Alignment of stigma center of this instruction manual.

5.15.5 Correcting Astigmatism When Probe Current Is Large

If the probe current is large (for example, the Probe Current No. is 14), you have to correct astigmatism of the condenser lens.

1. Press the **ALIGNMENT–ALIGN** button on the OPERATION panel.
   The Alignment window opens on the screen.

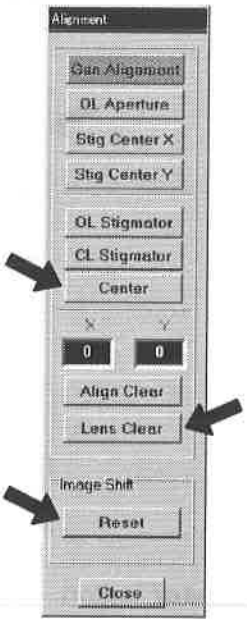


2. Click the **CL Stigmator** button.
3. Adjust the focus.
4. Correct the astigmatism of the image by using the **ALIGNMENT–X** and **Y** knobs on the OPERATION panel.
5. Set the number in the Probe Current input box to 7.
6. Click the **OL Stigmator** button.
7. Adjust the focus.
8. Correct the astigmatism of the image by using the **ALIGNMENT–X** and **Y** knobs on the OPERATION panel.
9. Click the **CL Stigmator** button.
10. Adjust the focus.
11. Correct the astigmatism of the image by using the **ALIGNMENT–X** and **Y** knobs on the OPERATION panel.
12. Finally, click the **OL Stigmator** button.

5.15.6 Adjusting for Deviation in Field of View between High Magnification Mode and Low Magnification Mode

If the deviation in field of view between the high magnification mode (SEM mode) and the low magnification mode (LM mode) is large when you change the mode, you can adjust it by using the following procedure.

1. Press the **ALIGNMENT–ALIGN** button on the OPERATION panel.
   The Alignment window opens on the screen.



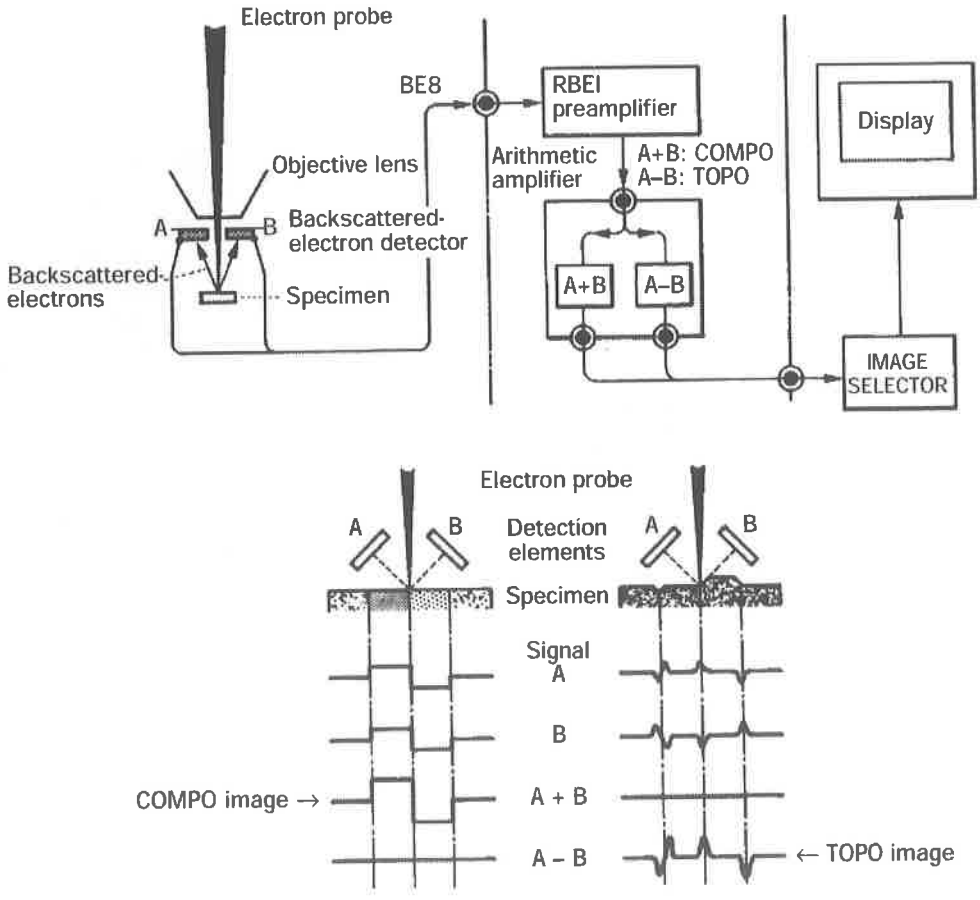
2. Click the **Image Shift–Reset** button.
   Image Shift becomes **0**.
3. Center a feature on the observation screen, keeping the minimum magnification in the SEM mode.
   Note: Be sure to use the specimen stage movement.
4. Bring the feature into focus.
5. Press the **MAGNIFICATION–LOW MAG** button on the OPERATION panel.
   Note: The SEM mode changes to the LM mode.
6. Click the **Lens Clear** button.
7. Bring the feature into focus.
8. Click the **Center** button.
9. Move the feature to the center of the observation screen by using the **ALIGNMENT–X** and **Y** knobs on the OPERATION panel.
   Note: Select a magnification that makes it easy to look for the feature.
10. Press the **MAGNIFICATION–LOW MAG** button on the OPERATION panel.
    The LM mode changes to the SEM mode.
11. Click the **Lens Clear** button.
12. Repeat steps 4 to 11 of this procedure several times.

5.16 OBSERVING A BACKSCATTERED ELECTRON IMAGE (OPTIONAL)

The backscattered-electron image is formed by an optional backscattered-electron detector that consists of two semiconductor detector elements, enabling both COMPO and TOPO images to be displayed.

- A COMPO image shows contrast according to the difference between the atomic numbers comprising the specimen, enabling you to obtain information on the composition distribution over a wide range of the specimen prior to X-ray analysis.
- A TOPO image shows contrast according to the ruggedness of the surface of the specimen, as if the specimen is illuminated by light from one direction. Hence, it is used to judge the shape of the specimen.

The figure below indicates the principle according which a backscattered-electron image (COMPO image, TOPO image) is formed. Use the backscattered-electron detector at a working distance of at least WD 8 mm.

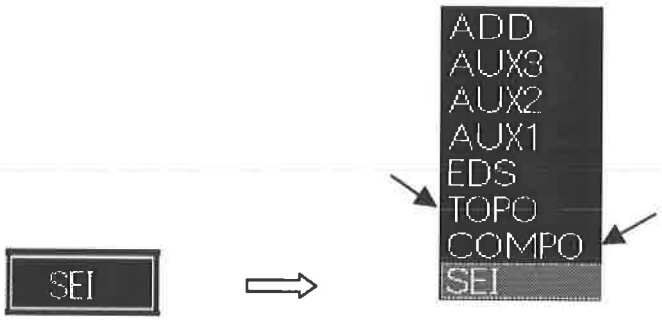


Principle of formation of COMPO and TOPO images

■ Observing a Backscattered-Electron Image

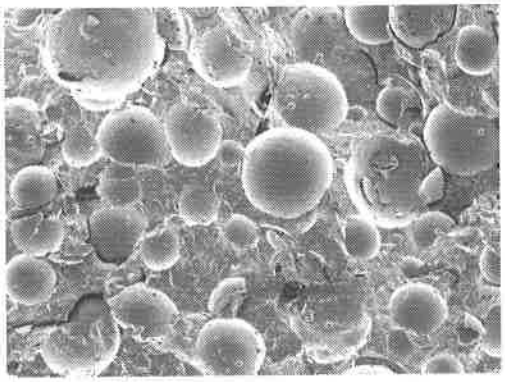
The following procedure for displaying a backscattered-electron image is based on the assumption that you have already observed the secondary-electron image and completed CL stigmator adjustment.

1. Set the WD in the range of 8 to 25 mm and the tilt control to 0°.
2. Click the **RBEI** button (which has a gray background) on the tool bar.
   The retractable BE detector is automatically inserted in three to seven seconds.
   The background of the **RBEI** button will become green.
   Note: While the retractable BE detector is in motion, the background of the **RBEI** button is brown.
   After the retractable BE detector is inserted, the valve V1 automatically closes for one minute, and then it opens again.
3. Press the FINE VIEW button on the OPERATION panel to set a low scanning speed.
4. Set the magnification to minimum using the MAG knob on the OPERATION panel.
5. Click the **Image Selector** button on the observation-condition indication.
   The pop-up menu opens.

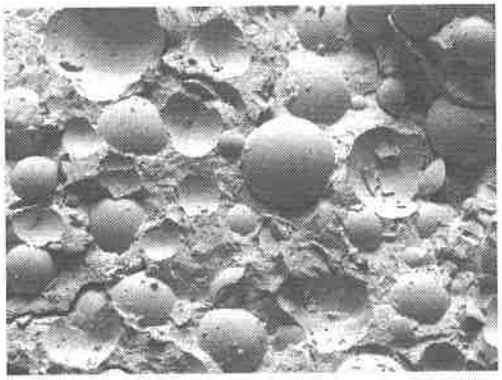


6. Select COMPO for a composition image or TOPO for a topographical image.
7. Adjust the brightness using the CONTRAST and BRIGHTNESS knobs on the OPERATION panel.
   If the image is dark, preventing it from being observed, click the **Column** button (or select **Control-Column**); then increase Probe Current from the Control window.
8. Set the magnification to the desired value; then focus the image.
9. Readjust the brightness of the image using the CONTRAST and BRIGHTNESS knobs on the OPERATION panel.
   Notes: 1. Normally, if you lower the accelerating voltage, you must increase the probe current. If the image quality is poor, increase the probe current; then adjust the brightness.
   2. The shorter the working distance is made, the greater the intensity of the signal becomes. The minimum WD that permits observation using the backscattered-electron detector is WD 8 mm.

3. If the specimen does not readily produce a high-contrast image, and also the number of backscattered-electrons is small, it may not always be possible to observe a backscattered-electron image of satisfactory quality.



Secondary-electron image



Backscattered-electron image

5.17 PHOTOGRAPHY (OPTIONAL)

The following is a description of the method of using an optional photographic recording system to make a photograph at an appropriate exposure that meets the desired conditions.

5.17.1 Setting the Exposure Conditions

Set the f number (aperture) knob on the photographic recording system according to the sensitivity of the film.

Table 5.3 Film sensitivity and f number

Film sensitivity		Photo-recording unit f number knob
ISO	DIN	
50	18	5.6
100	21	8
200	24	11
400	27	16

5.17.2 Taking a Photograph

There are two methods of taking a photograph. These are as follows.

- Taking a photograph directly from a live image
- Taking a photograph from a frozen image

■ Taking a photograph from a live image

1. Make preparations according to the instruction manual of the photographic recording system and the film holder.
2. Display the image to be photographed on the observation screen.
3. Adjust the CONTRAST and BRIGHTNESS knobs on the OPERATION panel to obtain the brightness at which you wish to photograph the image.
4. Press the PHOTO button on the OPERATION panel to start the photographing process.
   While the image is being photographed, the PHOTO button blinks.
5. Process the film.
   Follow the instructions in the supplied instruction manual for the method of using the photo-recording unit and film.
   Once the photographing process has been completed, the photographed image is automatically frozen on the observation screen. Use this frozen image if you wish to photograph the image again, or if you wish to save the image on the clipboard or a floppy disk.
6. If you wish to observe the image once again, release the FREEZE button on the OPERATION panel.

■ Photographing a frozen image

A frozen image is displayed on the observation screen when an image is frozen by pressing the FREEZE button on the OPERATION panel, when an image is loaded from the clipboard or a floppy disk, or after a live image has been photographed. Photograph a frozen image using the following procedure.

1. Check the brightness of the image displayed on the observation screen.
   If it is necessary to correct the brightness of the image on the screen, select **Image–Image Contr/Bright/Gamma** from the menu bar, then perform adjustment using the scroll bar.
2. Press the PHOTO button on the OPERATION panel.
   While the image is being photographed, the PHOTO button blinks.
3. Process the film.
   Follow the instructions in the attached instruction manual for the method of using the photo-recording unit and film.

5.17.3 Observation Screen Display and Adjusting the Brightness of the Photograph

The optional photographic recording system has been initially set so that the brightness of the photograph is the same as the brightness of the image on the screen. If, however, the brightness of the photograph fails to match the brightness of the on-screen image due to the gradual reduction of brightness of the display of the photographic recording system with time, carry out the procedure to match the brightness again, referring to Sect. 6.4 BRIGHTNESS CORRECTION FOR PHOTOGRAPHY of this instruction manual.

6

SETTINGS

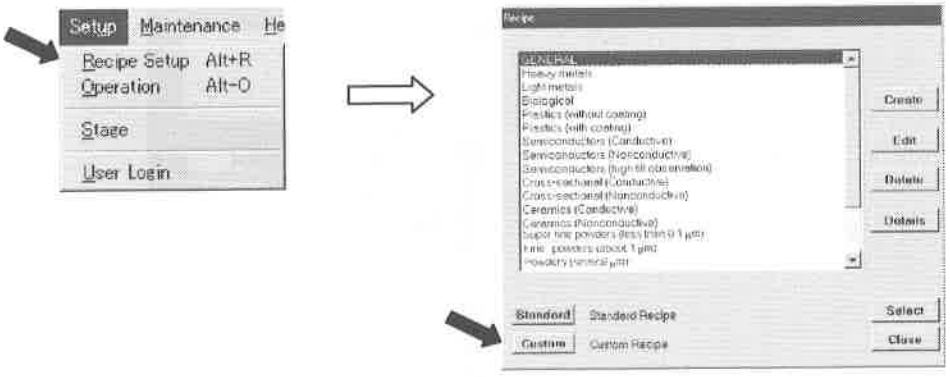
6.1 RECIPE RECORDING, EDITING AND DELETING

If you record observation conditions as a recipe, you will be able to observe any specimen under the same conditions.

1. Select **Setup–Recipe Setup**.

Button with equivalent function: **Recipe Setup**

The Recipe dialog box opens.



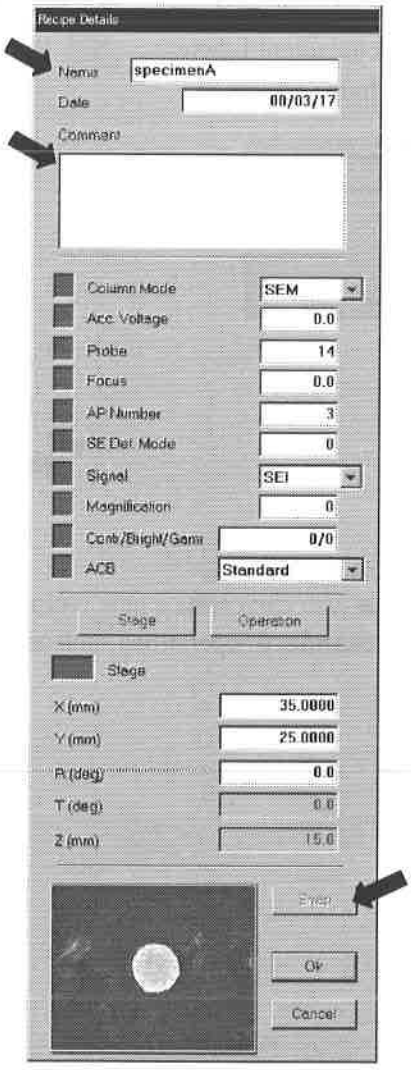
2. Click the **Custom** button.

With **Custom**, you can create a new recipe, and edit or delete a selected recipe.

Note: With **Standard**, operations such as **Create**, **Edit** and **Delete** are not possible.

6.1.1 Recording New Recipe

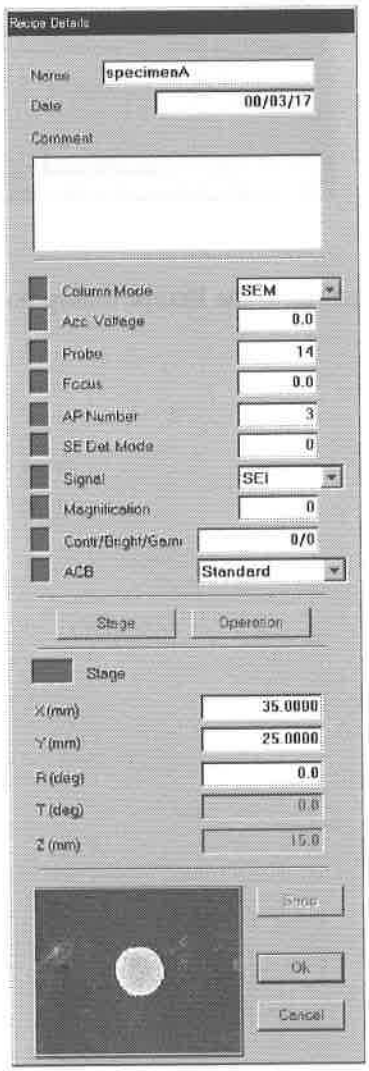
1. Click the **Create** button.
   The Recipe Details window opens.



2. Enter a name and a comment for the recipe.
3. Confirm the check boxes for the observation conditions and the stage.
   A green check box means that the corresponding item is recorded in the recipe, and a blank one means that the corresponding item is not recorded in the recipe.
4. Click the **Snap** button.
   The image corresponding to the recipe is saved.
5. Click the **Ok** button.
   The screen returns to the Recipe dialog box, and the created recipe is saved.

6.1.2 Editing Recipe

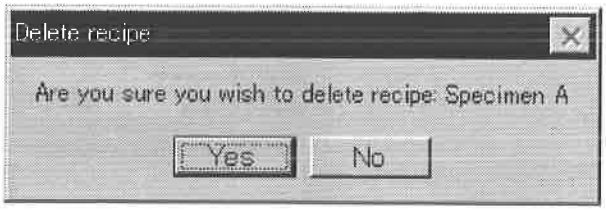
1. Click the **Edit** button.
   The Recipe Details window opens.



2. Edit the desired items.
3. Click the **Ok** button.
   The screen returns to the Recipe dialog box.

6.1.3 Deleting Recipe

1. Select a recipe that you want to delete, and click the **Delete** button.
   The Delete recipe dialog box opens.



2. Click **Yes**.
   The screen returns to the Recipe dialog box. The selected recipe is deleted.

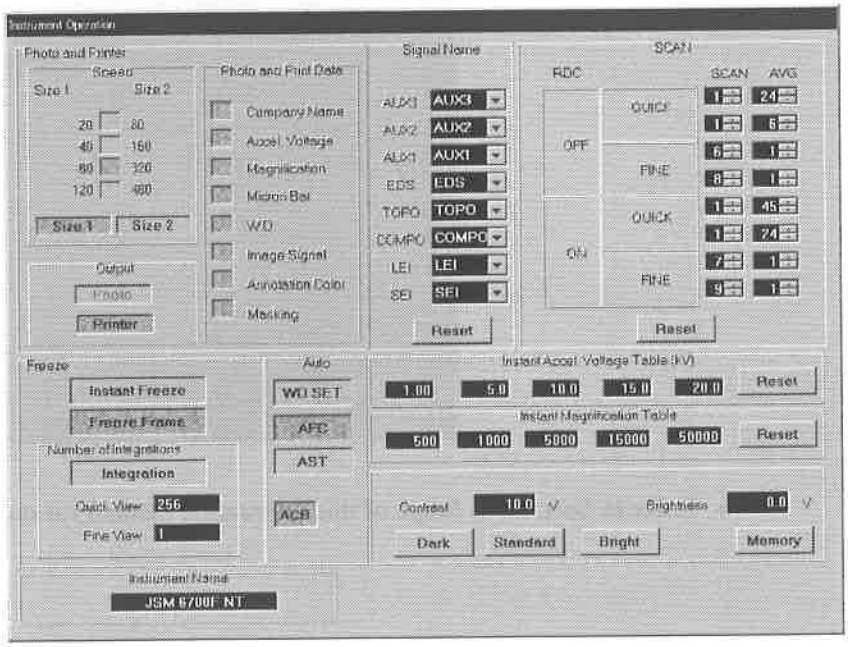
6.2 INSTRUMENT OPERATION SETUP

You can carry out setup for the OPERATION panel.

◆ Select **Setup–Operation** from the menu bar.

Button with equivalent function:  **Operation**

The Instrument Operation window opens.

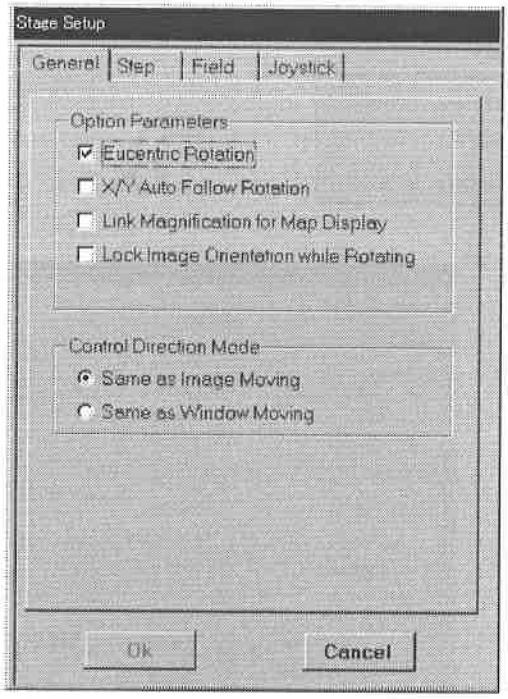


⇒ Refer to Sect. 4.8.2 Instrument Operation Setup of this instruction manual for more details.

6.3 STAGE SETUP

You can carry out settings for the optional 3-axis motor stage controller.
The settings are for **General**, **Step**, **Field** and **Joystick**.

◆ Select **Setup–Stage** from the menu bar.
The Stage Setup dialog box opens.



⇒ Refer to Sect. 4.8.3 Stage of this instruction manual for more details.

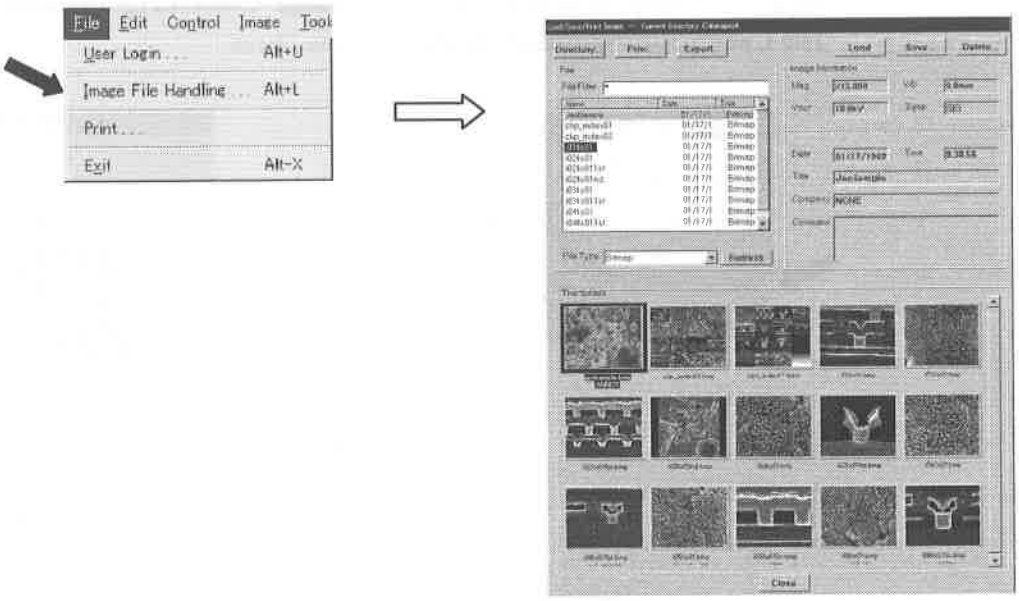
6.4 BRIGHTNESS CORRECTION FOR PHOTOGRAPHY

You can correct for the difference of brightness between photographs taken with the optional photographic recording system and the observation screen. The difference of brightness occurs due to the deterioration of the display of the photographic recording system with the passage of time. The procedure is as follows.

1. Select **File–Image File Handling** from the menu bar.

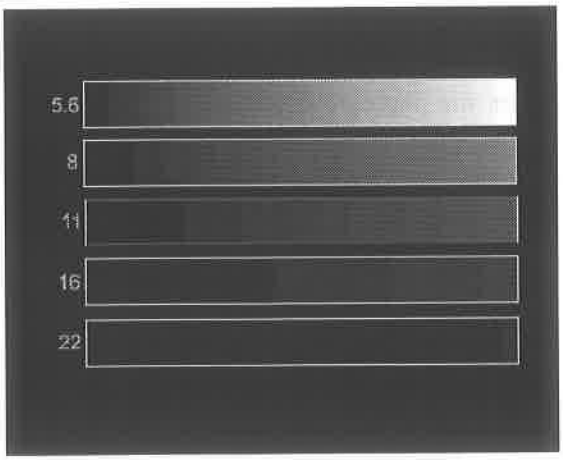
   Button with equivalent function: **Image File Handling**

   The **Load/Save/Print Image** window opens.



2. Insert the test-pattern floppy disk in the **A**: drive.
3. Click the **Directory** button and select the **A**: drive. Then, click the **Load** button.

   The test pattern is displayed on the observation screen.

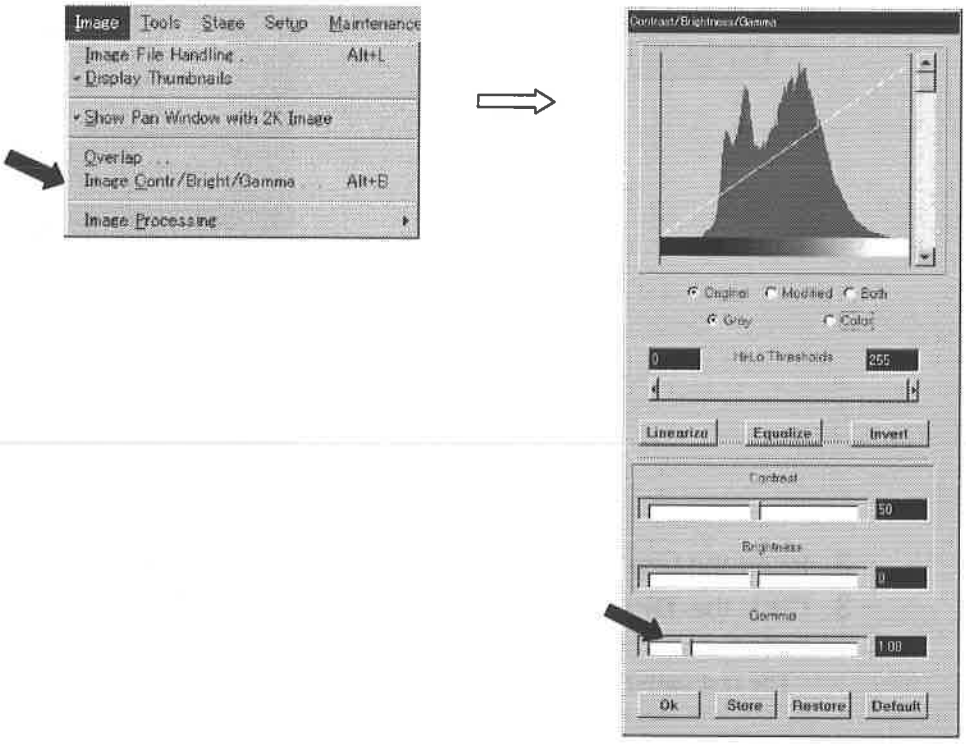


4. Press the **PHOTO** button on the OPERATION panel to take a photograph of the test pattern.
5. Confirm the quality of the photographed test pattern.
   If the pattern is evenly photographed across the range from black to white, changing the settings is not necessary.
   - If the whole photograph is too dark, set a smaller f number on the camera.
   - If the whole photograph is too bright, set a larger f number on the camera.
   - If the brightness of the pattern is not even between the left and right, perform the following procedure.

a. Select **Image–Image Contr/Bright/Gamma** from the menu bar.

Button with equivalent function: **Image Contr/Bright/Gamma**

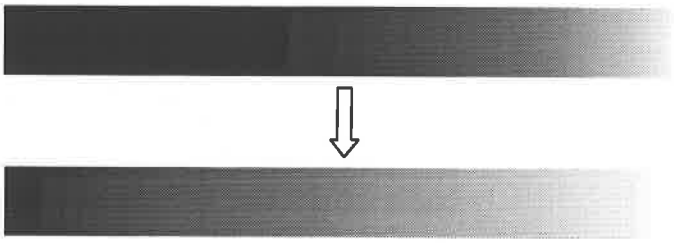
The **Contrast/Brightness/Gamma** window opens.



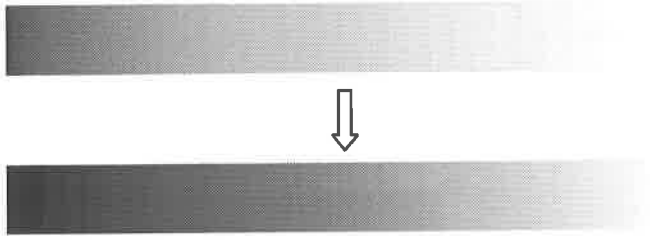
b. Adjust the brightness by moving the Gamma correction scroll bar.

Compare the photographed test pattern with the one displayed on the observation screen.

- If the photographed test pattern is darker than the displayed one, increase Gamma.



- If the photographed test pattern is brighter than the displayed one, decrease Gamma.



c. Repeat photographing and compare the photograph with the screen.
   If you find a difference, repeat steps b and c of this procedure.

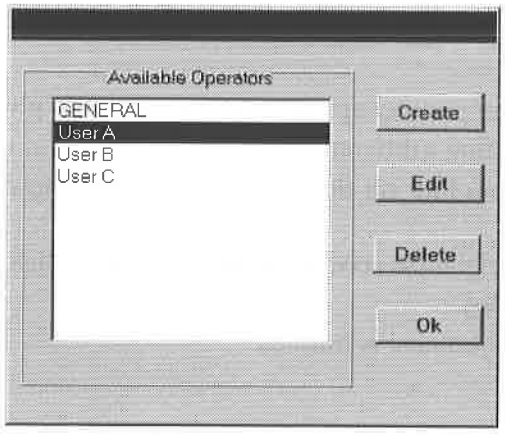
6. After you find no difference, select Setting–Brightness correction for photography.
   The Brightness correction for photography dialog box opens.

7. Click **Yes**.
   The adjustment is finished.

6.5 SETTING USER LOGIN

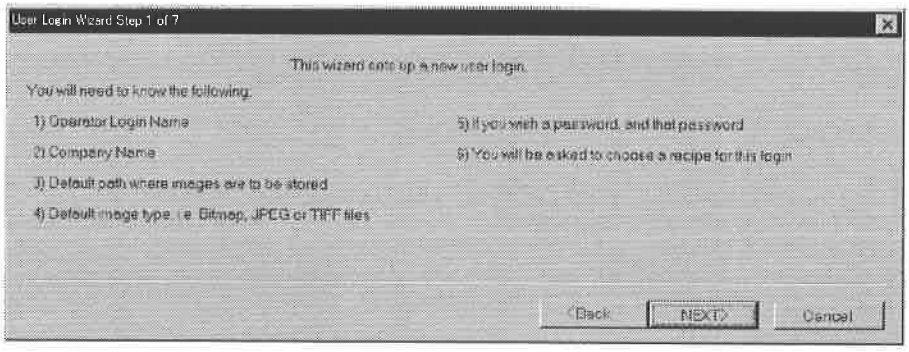
You can set up operation conditions for each user. They will take effect the next time the user logs in.

◆ Select **Setup–User Login**.
The window below opens.

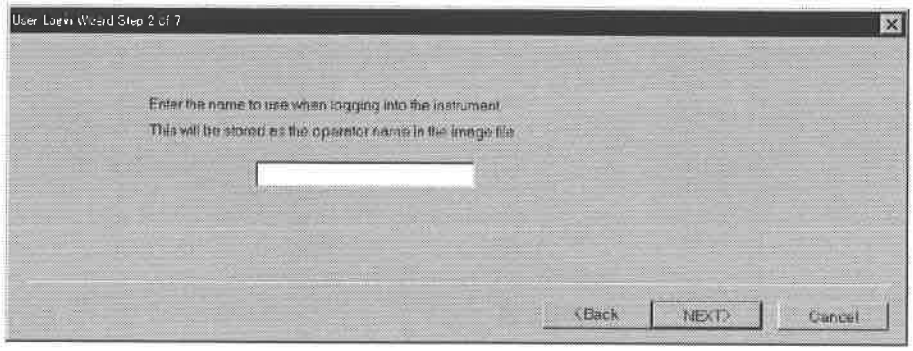


6.5.1 Create

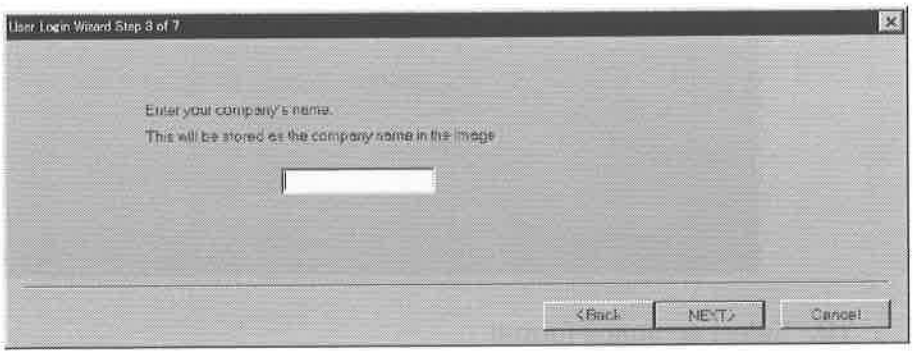
1. Click the **Create** button.
User Login Wizard Step 1 of 7 opens.



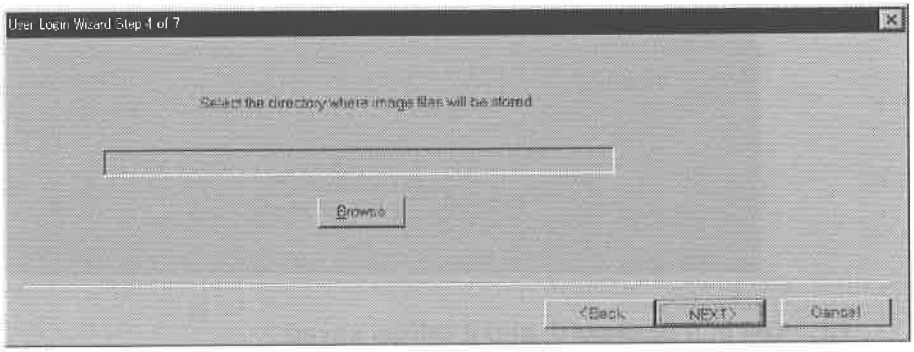
2. Click the **NEXT** button.
User Login Wizard Step 2 of 7 opens.



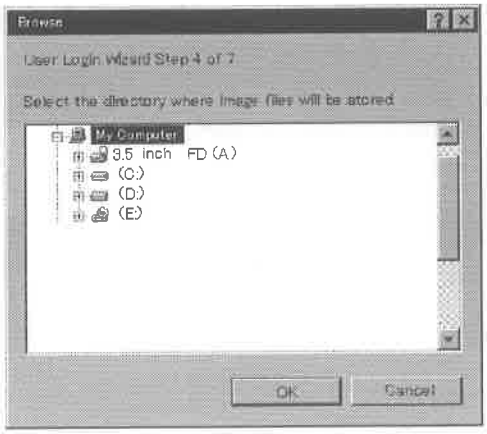
3. Enter a name for the user.
   Enter User D, for example.
4. Click the **NEXT** button.
   User Login Wizard Step 3 of 7 opens.



5. Enter your company's name or department name.
6. Click the **NEXT** button.
   User Login Wizard Step 4 of 7 opens.

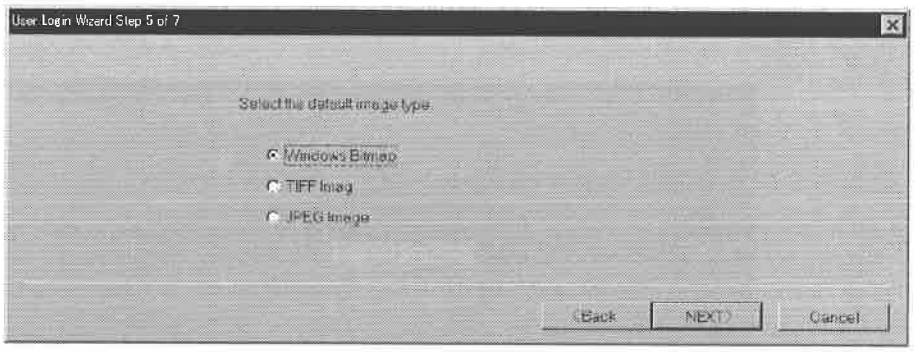


7. Click the **Browse** button.
   The Browse dialog box opens.

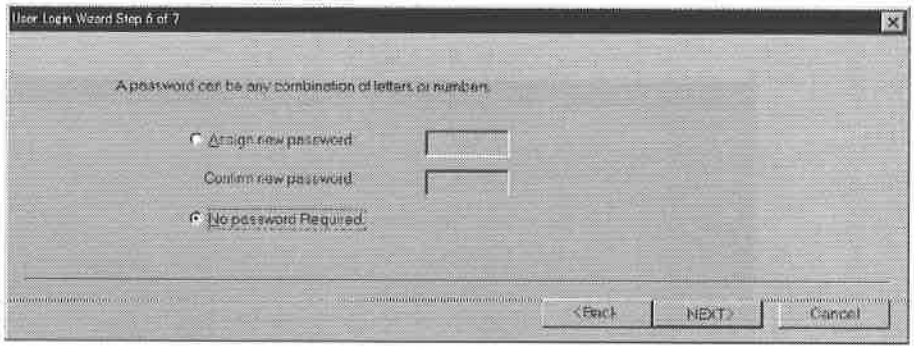


8. Select the folder in which you want to save the user's images, and click the **OK** button.

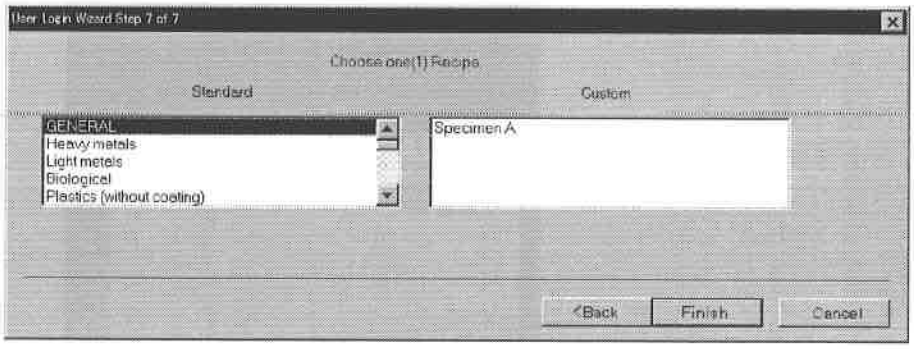
9. Click the **NEXT** button.
   User Login Wizard Step 5 of 7 opens.



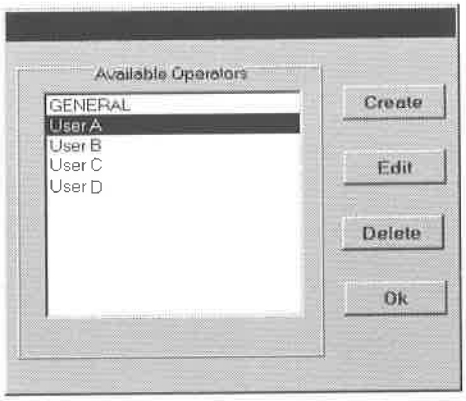
10. Select an image format.
11. Click the **NEXT** button.
    User Login Wizard Step 6 of 7 opens.



12. Key in a password, and it will be saved.
    If you select **No Password Required**, the user can log in without a password.
13. Click the **NEXT** button.
    User Login Wizard Step 7 of 7 opens.

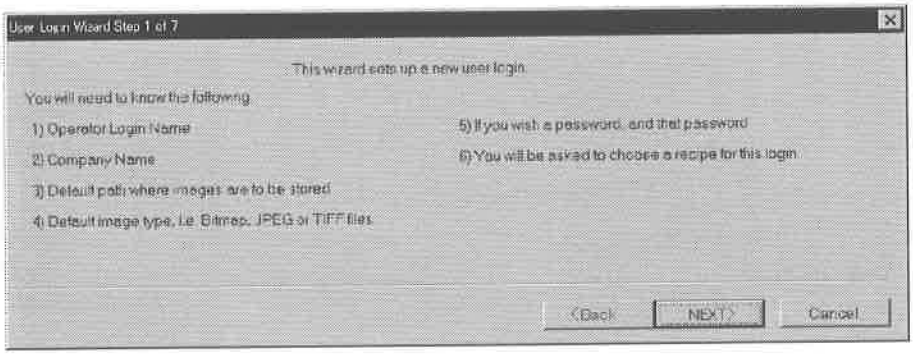


14. Click the **Finish** button.
The setting is finished and the new user (User D in this example) is recorded.



6.5.2 Edit

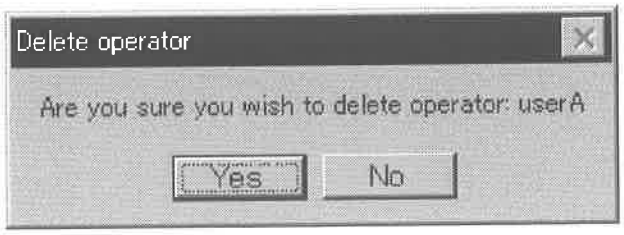
1. Select a user name, and click the **Edit** button.
User Login Wizard Step 1 of 7 opens.



2. Perform editing according to the instructions of User Login Wizard.

6.5.3 Delete

1. Select a user name, and click the **Delete** button
Delete User A, for example. The Delete dialog box opens.



2. Click **Yes**.
The selected User A is deleted.

7

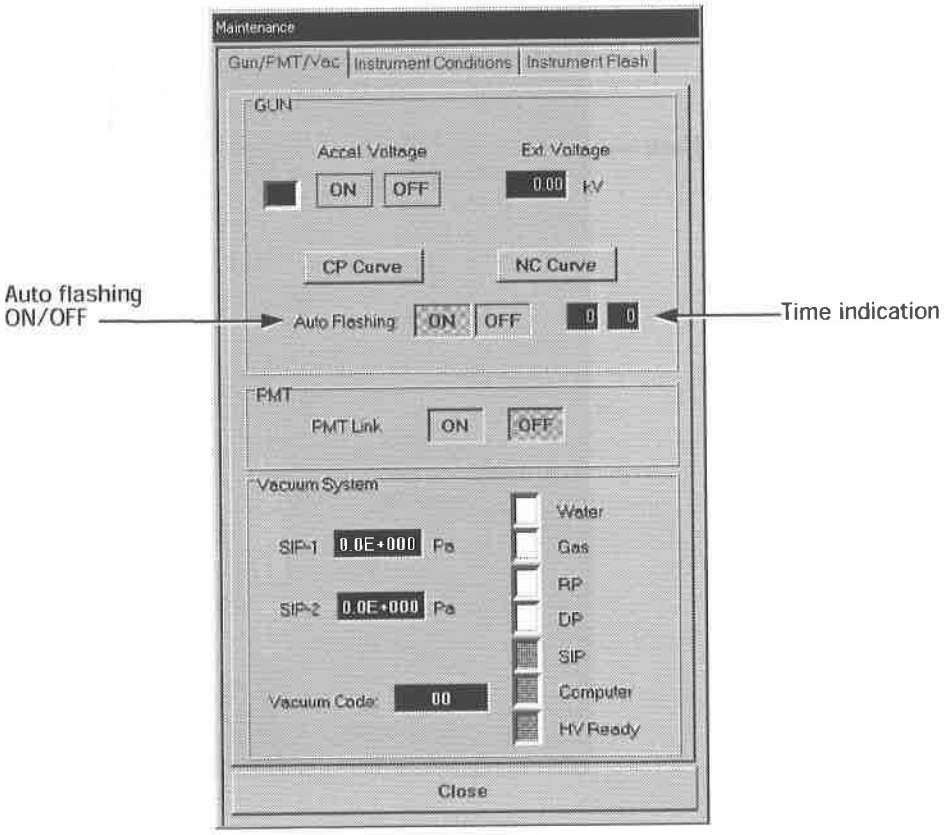
MAINTENANCE

7.1 FLASHING OF ELECTRON GUN

7.1.1 Automatic Flashing

If you set Auto Flashing to ON, the flashing of the electron gun is carried out every day at a predetermined time.

1. Select **Maintenance–Gun** from the menu bar.
   The Maintenance window opens, and the dialog box with the Gun/PMT/Vac tab is displayed.



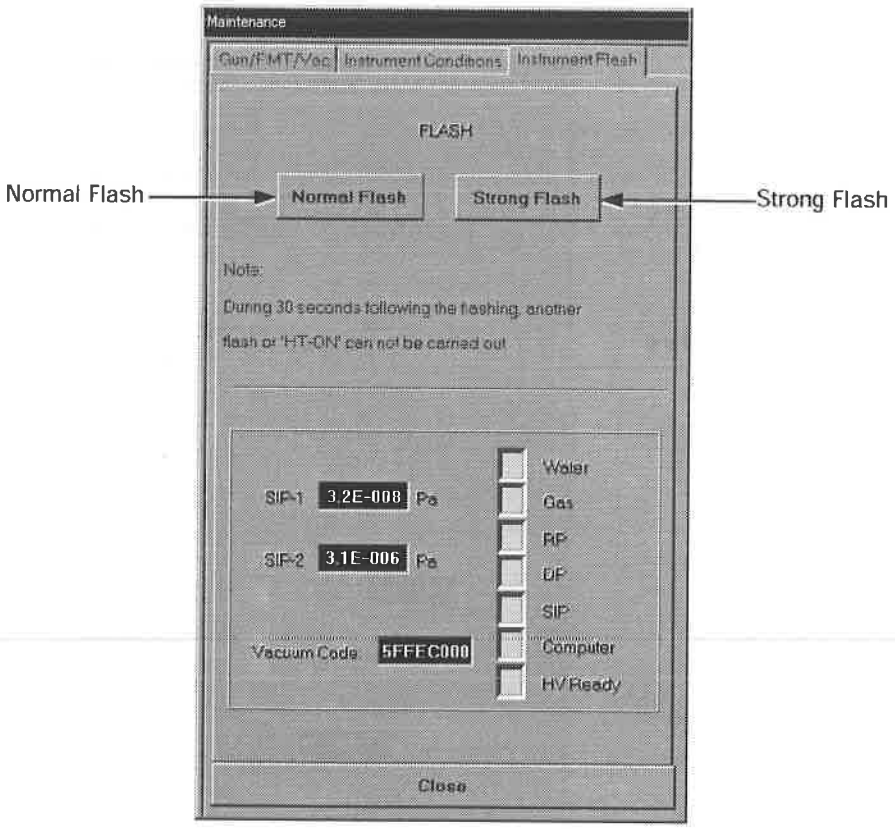
2. Click the **Auto Flashing–ON** box.
   The ON box becomes green.
3. Set the time when the automatic flashing is to be performed in the time indication box.
   Note: Time is indicated on 24-hour basis.

7.1.2 Normal Flash and Strong Flash

You can carry out flashing manually. Choose Normal Flash or Strong Flash as necessary.

Note: When automatic flashing is on, this manual flashing is not usually necessary.

1. Click **Maintenance–Gun/Vacuum** from the menu bar.
   The Maintenance window opens.
2. Click the Instrument Flash tab.



7.1.2a Normal Flash

This mode is for daily flashing. Perform the normal flashing when the emission noise appears frequently. When the message "15 Hours Passed Since Last Flashing" appears on the observation screen, however, the normal flashing is carried out automatically five minutes after the message appears.

◆ Click the **Normal Flash** button.
The Normal Flash will be performed.
Note: You cannot flash or apply the accelerating voltage during the 30 seconds after the last flashing.

7.1.2b Strong Flash

Perform the strong flashing when the emission noise cannot be removed by carrying out the normal flashing. When the message "180 Hours Passed Since Last Strong Flash" appears on the observation screen, however, the strong flashing is carried out automatically five minutes after the message appears.

◆ Click the **Strong Flash** button.

The Strong Flash will be performed.

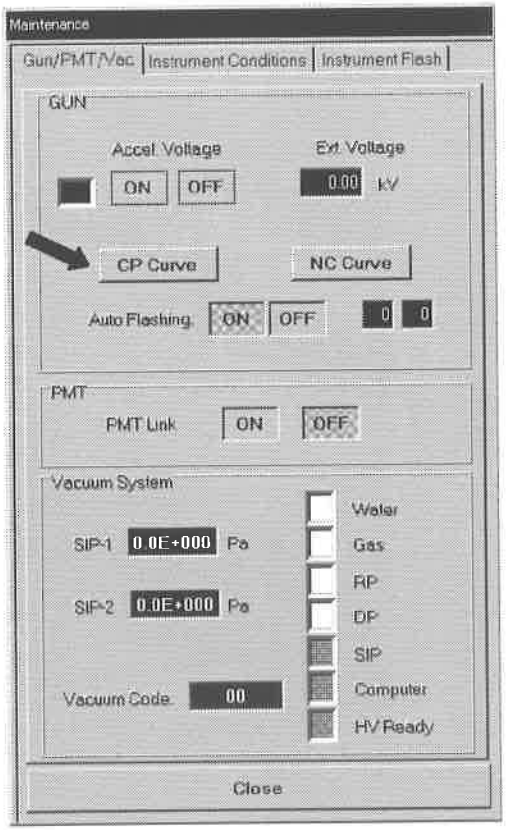
Note: You cannot flash or apply the accelerating voltage during the 30 seconds after the last flashing.

7.1.3 CP Curve

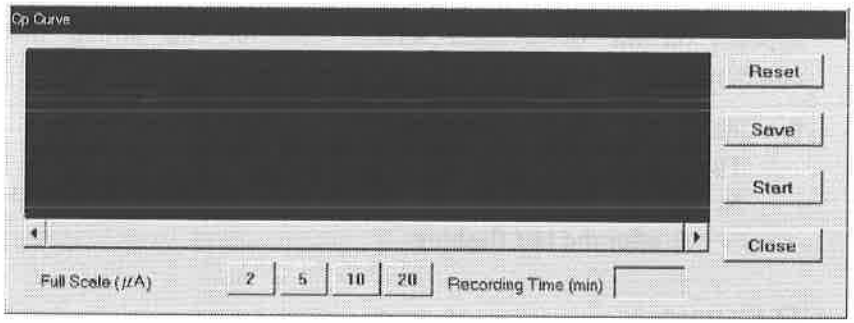
You can display a CP curve, which shows the variation with time of emission current.

1. Select **Maintenance–Gun** from the menu bar.

The Maintenance window opens.



2. Click the **CP Curve** button.
   The CP Curve window is displayed.

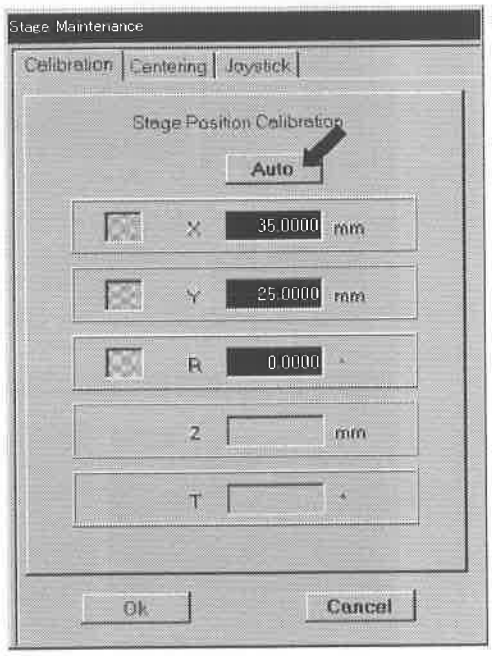


3. Select the Instrument Flash tab, and click the **Normal** or **Strong Flash** button.
4. Wait 30 seconds, and click the Accel. Voltage **ON/OFF** button.
5. After setting **Full Scale** and **Recording Time**, click the **Start** button.
   The CP curve is displayed.

7.2 STAGE POSITION CALIBRATION

If the SEM stops by accident, for example due to a power failure, when the specimen stage is away from the origin, the position of the specimen stage cannot be recognized. In such a case, you have to perform stage position calibration.

1. Select **Maintenance–Stage** from the menu bar.
   The Stage Maintenance dialog box opens.

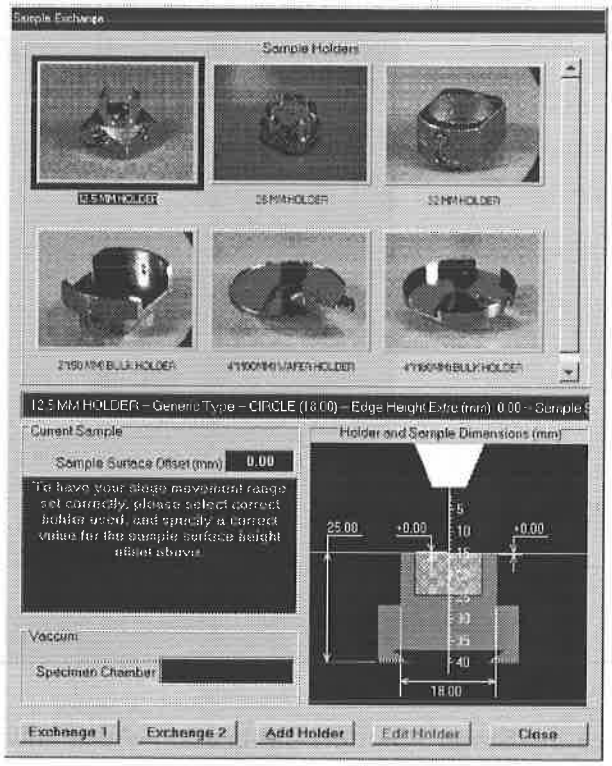


2. Click the **Stage Position Calibration–Auto** button.
   The calibration is performed by automatically looking for the origin position.
   Note: The calibration is carried out for the axis corresponding to the green indication box next to the left side of the origin indication.

7.3 RECORDING SPECIMEN HOLDER

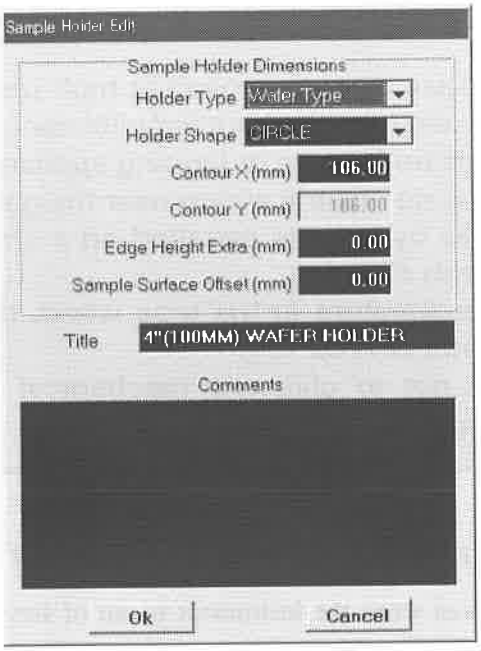
When you purchase a new specimen holder, be sure to record the information concerning the specimen holder.

1. Select **Stage–Exchange**.
   The Sample Exchange window opens.



2. Insert the floppy disk containing the information on the specimen holder into the **A:** drive.

3. Click the **Add Holder** button.
   The Sample Holder Edit dialog box opens.



4. Key in comments and then click the **Ok** button.
   The screen returns to the Sample Exchange window.
5. Confirm that the new specimen holder is recorded.

7.4 INSTRUCTIONS CONCERNING NITROGEN GAS

⚠ WARNING

Dry nitrogen gas is supplied at high pressure in a compressed gas cylinder and must be handled with care. Prior to use, ensure that:

- **there is no furnace or heating appliance near the gas cylinder**
- **there is no electric wiring near the gas cylinder**
- **the gas cylinder is installed on a special stand or secured to a wall with chains**
- **the temperature in the area where the gas cylinder is installed does not exceed 40℃**

Be sure not to give any mechanical shock to the gas cylinder during operation.

7.4.1 Stopping and Resuming the Supply of Nitrogen Gas

Normally, even when the instrument is out of service, the pressure regulator should be kept set at 0.4 MPa and the delivery valve — if one is provided — fully opened. All you have to do when starting or stopping the instrument, therefore, is to open or close the cylinder valve (source valve).

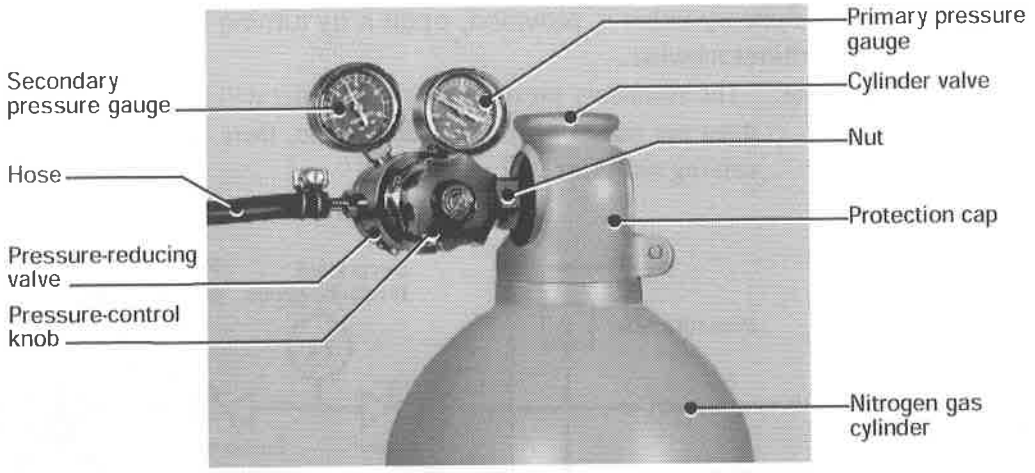
To completely stop or resume the supply of nitrogen gas, proceed as follows.

7.4.1a Stopping the supply of nitrogen gas

1. Close the pressure-reducing valve by turning the pressure-control knob fully counterclockwise until it is blocked.
2. If a delivery valve is provided, close it by turning the delivery valve knob fully clockwise.
3. Close the cylinder valve by turning the cylinder valve open/close handle fully clockwise.

⚠ CAUTION

To minimize hazards in an emergency, make sure that a cylinder valve open/close handle is provided on the cylinder to close the cylinder valve.



Cylinder and pressure regulator

7.4.1b Resuming the supply of nitrogen gas

1. After confirming that the pressure-control knob has been turned counter-clockwise until it has been blocked (the pressure-reducing valve is closed), open the cylinder valve by fully turning the cylinder valve open/close handle counterclockwise.
2. Slowly turn the pressure-control knob clockwise to open the pressure-reducing valve little by little until the secondary pressure gauge indicates the specified pressure, or 0.4 MPa.

> **⚠ WARNING**
>
> **For safety's sake, do not stand in front of the pressure gauge. Be sure to operate the pressure-control knob from an off-centered position to avoid damage to you from a pressure gauge break or a pressure valve break.**

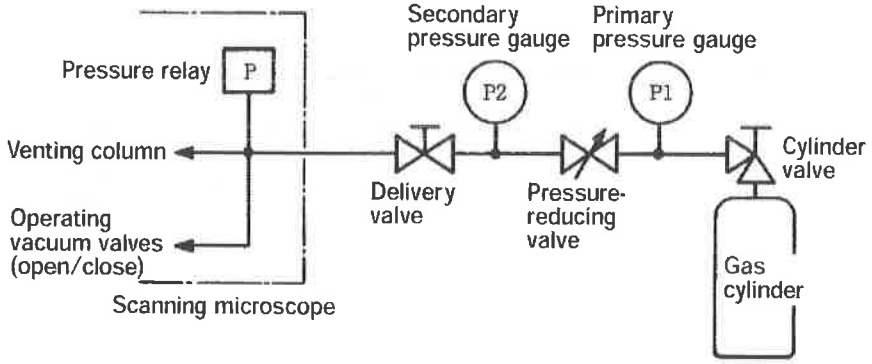
3. After the specified pressure has been set, let it alone for a few minutes and check that there is no change in the indication of the pressure gauge.

   Note: If the secondary pressure gauge's indication rises slowly, the pressure regulator is defective and must be replaced. To replace the pressure regulator, proceed as follows:

   a. Stop supply of nitrogen gas according to Sect. 7.4.1a.
   b. Disconnect the delivery valve (or hose).
   c. Remove the pressure regulator from the connection to the cylinder valve by loosening the nut.
   d. Connect a good pressure regulator (full scale of secondary pressure gauge: about 1 MPa) to the cylinder valve and affix it firmly with the nut. To ensure that the glass front of the pressure gauge is not directly facing the operator, the gauge should be tilted 45° upward for a large-size cylinder and 45° downward for a small-size cylinder.
   e. Connect the delivery valve (or hose).

4. If a delivery valve is provided, open it by turning the delivery valve knob fully counterclockwise.

   Note: The secondary pressure gauge's pointer will drop temporarily. If the pointer does not return to the specified value, there may be gas leakage at the receiving side. Check for leaks.



Example of connection of nitrogen gas cylinder and peripheral units

7.4.2 Replacement of Nitrogen Gas Cylinder

If the secondary pressure drops below 0.35 MPa, the pressure relay will be actuated and the instrument will automatically shut down. Under normal operating conditions, a cylinder with a capacity of 46.7 L and an internal pressure of 15 MPa, for example, will be adequate for about three months' use.

1. Set the VAC POWER switch on the power supply to OFF.
2. Stop the supply of nitrogen gas according to Sect. 7.4.1a.
3. Remove the pressure regulator from the connection to the cylinder valve by loosening the nut.
4. Remove the empty cylinder and install a cylinder filled with dry nitrogen gas in the stand (or secure it to a wall with chains).
5. Connect the pressure regulator to the cylinder valve and affix it firmly with the nut.

   Note: Make sure that the nut at the connection is fully tightened to prevent leakage of gas. Gas leaks can be easily detected by applying soap solution to the connection.
6. Resume supply of nitrogen gas according to Sect. 7.4.1b.

⚠ WARNING

When handling high pressure gases such as nitrogen gas in an enclosed room, regardless of the amount, be sure to open the windows and doors to ventilate the room. Although nitrogen gas is inactive and generally harmless, leakage of a large amount of the gas may lower the oxygen concentration in a room, and suffocation can result.

Note: A pressure relay and a needle valve are provided under the column frame (housing).
The pressure relay will stop the instrument if the pressure drops below 0.35 MPa. The needle valve is set so that the column is brought to atmospheric pressure within about 60 seconds (with nitrogen gas pressure at 0.4 MPa).
If there is a need for shortening the time to complete venting, turn the needle valve counterclockwise. In this case, however, there will be more consumption of nitrogen gas.
A relief valve is provided to let excess gas out if nitrogen gas introduced causes the internal pressure to exceed atmospheric pressure.

7.4.3 Connection to Nitrogen Gas Supply Piping

If a house dry-nitrogen supply is available, it may be used as a gas source, but the following points must be strictly observed.

- The supply must provide a gas pressure adjusted to about 0.4 MPa and a flow rate of about 30 L/min. If the gas pressure exceeds 0.5 MPa, reduce it to 0.4 MPa by use of a pressure regulator.
- The source nozzle (the end for hose connection) of the supply must have ISO 7/1 Rc 1/4 threads.
  If a pressure regulator is used, use one with an outlet nozzle with ISO 7/1 Rc 1/4 threads.
- The nozzle of the instrument and the gas supply should be connected with the supplied hose (5 m).

7.5 MAINTENANCE OF VACUUM SYSTEM

As the instrument is run, the oil of the oil rotary pump (RP) decreases gradually. For the details of the procedures for refilling the RP with oil, replacing heaters of the oil diffusion pump (DP) and maintaining the ultrahigh-vacuum evacuation system (UHV: ion sputter pump used), consult your local JEOL service center.

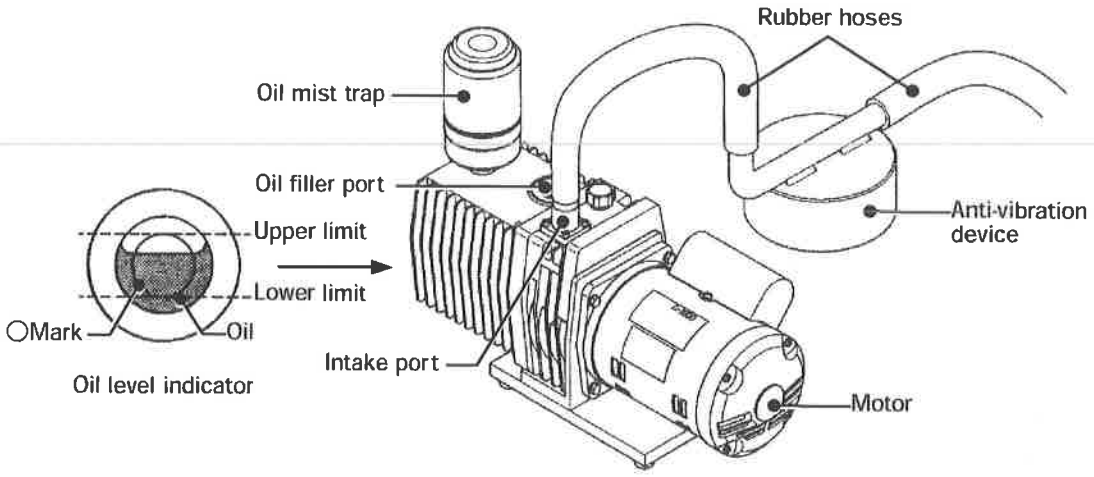
> **⚠ CAUTION**
>
> **Be sure not to remove the rubber hose from the oil rotary pump during operation.**
> **If you do so, the oil in the oil diffusion pump will flow back to the microscope column, causing serious damage to the instrument.**

7.5.1 Refilling Oil Rotary Pump with Oil

1. Check the oil-level indicator of the pump.
   If the oil level is below the lower limit of the ○ mark of the indicator (oil level low), perform the following steps.

> **⚠ CAUTION**
>
> **Do not let the oil level of the oil rotary pump fall below the lower limit even though the pump can operate down to this limit.**
> **If the pump is left with only a small quantity of oil, problems can occur.**

2. Remove the cap from the oil filler port on the top of the pump by turning it counterclockwise.



Oil rotary pump

3. While watching the oil level indicator, add the appropriate type of oil until the oil level rises to the upper limit of the O mark of the indicator.
   Note: Make sure that the oil level does not rise above the upper limit. If oil is added when the instrument is not operating, the oil level will fall when the instrument (pump) is operated. If the oil level falls below the lower limit, add more oil.
4. Screw the cap into the oil filler port.

7.5.2 Replacement of Vacuum Pump Rubber Hose

1. Turn OFF the VAC POWER switch to vent the inside of the electron optical column and the specimen chamber to the atmosphere. When this switch is turned off, the instrument stops the operation except for the UHV evacuation system.
2. Remove the old rubber hose by pulling it out from the nozzle.
   Note: If the old hose is hard to remove, nick the surface of the hose with a knife. In doing so, take care not to nick or scratch the nozzle; otherwise vacuum failure could result.
3. Put a new rubber hose on the nozzle tightly enough to secure the contact.
   Note: If the new hose is hard to slide over the nozzle, apply a small amount of vacuum grease to the surface of the nozzle.
4. Turn ON the VAC POWER switch to re-evacuate the electron optical column and the specimen chamber.

⚠ CAUTION

1. **Replace the pump oil with new oil once a year.**
2. **Replace the oil mist trap once a year, if used.**
3. **For the details of replacing oil, consult your local JEOL service center.**
4. **For the method of replacing the DP heaters, consult your local JEOL service center.**

8

SPECIFICATIONS

8.1 PERFORMANCE

- Resolution of secondary electron image (SEI):
  1.0 nm guaranteed (at accelerating voltage 15 kV)
  2.2 nm guaranteed (at accelerating voltage 1 kV)
- Magnification
  Low mag. (LM) mode: ×25 to ×19,000
  High resolution (SEM) mode: ×100 (WD 25 mm) to ×650,000 (WD 8 mm)
  Magnification correction: Automatic for accelerating voltage and working distance (WD)
  Fixed magnification: Any magnification can be preset for each of the above modes as a fixed magnification. The fixed magnification is instantaneously obtainable from any magnification in the mode being used.
  Image rotation correction: Provided for each EOS mode in each WD
- Image modes: SEI (Secondary electron image)
  COMPO (Backscattered electron image in the composition mode, optional)
  TOPO (Backscattered electron image in the topography image mode, optional)
- Accelerating voltage (Acc. V.): 0.5 to 30 kV
  10 V steps for 0.5 to 2.9 kV
  100 V steps for 2.9 to 30 kV
- Probe current: Order of 10^{-13} to 2×10^{-9} A

8.2 ELECTRON OPTICAL SYSTEM (EOS)

8.2.1 Electron Gun

- Type: Field emission gun with cold cathode
- Emitter: Tungsten single crystal <310> emitter
- Emission current: Variable in 4 steps (2, 5, 10, 20 μA)
  Usually 10 μA
- Alignment: Mechanical and electromagnetic deflection

8.2.2 Lens System

- EOS modes: SEM, LM, ALP (Alignment pattern)
- Condenser lens (CL): Electromagnetic type
- Aperture angle control lens (ACL): Electromagnetic type
- Objective lens (OL): Low aberration objective lens
- Lens clear function: Provided in CL and OL for hysteresis elimination
- Automatic focus: Provided (function in HR), manual focus override
- Focus link: Provided for Acc. V. change
- Automatic magnification correction:
  Provided for Acc. V. and/or WD change
- Image rotation correction: Provided for WD and/or EOS mode change

• OL apertures:	Click-stop type (variable in 4 steps) Fine position controllable in X/Y directions
• Wobbler:	Provided for OL aperture and stigma center alignment Linked to magnification
• Automatic stigmator:	Provided, manual adjustment override
• Dynamic focus:	Provided for specimen tilt correction Linked to Acc. V., Mag. and/or WD
• Scanning coil:	Electromagnetic 2-stage deflection
• Scan rotation:	Provided with rotation correction for WD and/or EOS mode change
• Image fine shifter:	±5 μm shifts in X and Y directions (HR mode, WD 15 mm)
• Memory preset function:	Alignment and stigmator data can be preset for Acc. V. and WD
• User login function:	The following items can be set: Password for private files Observation condition file Image data file Image file storing position Image file storing format
• Recipe function:	Save and load of standard observation conditions, private observation conditions and observation conditions for specific samples: Accelerating voltage Observation mode (SEM, ALP) Probe current data Focus data Objective aperture number Magnification data Contrast/brightness data Input signal (SEI, TOPO, COMPO, AUX) Image mode Automatic exposure (contrast/brightness) Stage position (X, Y, R) Display of image under recorded observation conditions

8.3 SPECIMEN STAGE (SPECIMEN STAGE TYPE 1)

- Specimen movements
  - X-axis: 70 mm (motor driven, manual override)
  - Y-axis: 50 mm (motor driven, manual override)
  - Z-axis: 1.5 to 25 mm (continuous)
  - Tilt: –5° to +60°
  - Rotation: 360° endless (motor driven)
- Specimen position indication: On the observation screen and beside each motor (X, Y, R)
- Specimen position file: Storing and loading of specimen coordinates (X, Y, R)
- Coordinates designation: Absolute coordinates (X, Y, R) or relative distance to move
- Motor drive function: Joystick operation (X, Y, R)
  Mouse operation on the observing screen
  Point Shoot (move to the center)
  Step movement
  Holder map movement
  Image movement
  Rotation eucentric function with moving direction correction
- Specimen holders: For 12.5 (dia.) × 10 (H) mm specimen
  For 26 (dia.) × 10 (H) mm specimen
  Specimen holders for 32 (dia.) × 20 (H) mm specimen and 150 (dia.) × 10 (H) mm specimen are available as options.
- Holder selection: From the standard holders and optional holders
  Holder addition/deletion possible
- Movement limiting function: Automatic setting with holder selection
  Lock/Unlock of moving axis possible
- Specimen exchange chamber (Specimen Airlock Type 1 [SM-71010]):
  150 (dia.) × 10 (H) mm specimen holder can be handled.
- Specimen exchange: Airlock type, single touch chucking type
- Absorbed current measuring terminal:
  Built-in
- Specimen protection buzzer: Built-in
- EDS installation: EDS port (X-ray take-off angle: 30° at WD 15 mm, probe current fluctuation detector built-in)

8.4 ELECTRON DETECTION SYSTEM

8.4.1 Secondary Electron Image (SEI)

• Detector:	Consists of collector, scintillator, light guide and photomultiplier tube
• Secondary electron accelerating voltage:	10 kV
• Video amplifier control:	Manual control with CONTRAST and BRIGHTNESS knobs

8.4.2 Noise Canceler

• Detector:	Alignable in X and Y directions from outside of vacuum Preamplifier built-in Probe current variation detector built-in
• Applied image signal:	Digital signals selected by image selector
• Amplifier gain:	Linked to Acc.V. and extract voltage

8.5 SCANNING/DISPLAY SYSTEM

8.5.1 Liquid Crystal Display for Image Observation (Optional)

• Display panel:	18.1-inch (diagonal)
• Number of pixels:	1280 × 1024

8.5.2 SEM Control System

• Personal computer	
Computer:	IBM PC/AT compatible computer
RAM:	128 MB or more
OS:	Windows NT
• Operation:	Graphic user interface/mouse and controls on the operation panel
• Scan and display mode:	Full-frame scan Reduced scan (1/2 frame size) Limited field scan Line profile Spot 2-part (different magnification/different image) 2-part wide display 4-part display Scaler
• Scan speed at 50 Hz:	4 speeds can be selected from the following 10 speeds:

No.	Vertical (s)	Horizontal (ms)
1	0.28	0.2086
2	0.5	0.4172
3	0.9	0.8344
4	1.8	1.67
5	3.5	3.34
6	6.9	6.68
7	19 (16)	18.35 (15.02)
8	38 (31)	36.71 (30.04)
9	79 (66)	76.97 (63.83)
10	121 (100)	117.6 (97.0)

Note: ( ) shows the scan speed at 60 Hz.

- Picture elements of display: 1280 × 1024
- Image mode: SEI
  TOPO
  COMPO
  LEI
  AUX
- Display: Image
  Acc. V. ON/OFF switch
  Acc. V.
  Acc. V. selection switch
  Emission current
  Reset switch
  Main menu
  Mode selection switch (icon)
  Palettes for selected mode
  Film photo number
  Dialogue
- Text and comment display: Comment selection and display
  Alphanumerics from keyboard
- Data display
  Contents: Acc. V.
  Image signal
  Magnification
  WD
  Micron marker
  Film No.
  Data display position: Horizontally displayed at image bottom
- Measurement function: Distance in X, Y and diagonal directions
  Angle of diagonal line
- Reference and text display: Reference pattern can be selected and pasted
- Image processing system
  Function:
  Averaging: 1 to 1024 times
  Integration: 1 to 256 times in powers of two

Color mode:	Black and white Pseudo color (2-color composite image)
Look-up table display:	γ correction, binary coding, multi-coding, histogram using look-up tables
Gray scale display:	Possible
Image processing function:	Sharpen Smooth Median Gaussian Prewitt Roberts Sobel Laplacian
• Automatic functions:	Automatic focus (combination with ACB possible) Automatic stigmator (combination with ACB possible) Automatic exposure (automatic memory of observation image brightness possible)
• Image filing function	
Display:	Image file directory Image file name List of saved images Observation conditions for the selected image
Image file saving data:	Image + text data (observation conditions)
File format:	BMP JPEG TIFF
Number of files:	Depends on the disk capacity (1.28 MB/image for the BMP format)
Simple reporting function:	Image paste (up to 2 images) on a report frame possible

8.6 VACUUM SYSTEM

• Gun chamber, 1st/2nd intermediate chambers:	Evacuated by an ultrahigh vacuum dry evacuation system with ion pumps
• Specimen chamber:	Evacuated by a fully automatic DP–DP cascade evacuation system
• Dry nitrogen gas connector:	Built-in (with automatic nitrogen gas stopper) Note: Coupler ISO 7/1 Rc 1/4 should be provided by the customer.
• Ultimate pressure	
Gun chamber:	Order of 10^{-7} Pa (standard configuration)
Specimen chamber:	Order of 10^{-4} Pa (standard configuration)
• Evacuation time	
Specimen airlock:	Approx. 1 min. (controlled with the Pirani gauge)

• Gun chamber isolation valve:	Built-in (pneumatic drive. Linked to Acc. V. ON/OFF switch and specimen airlock valve and IN/OUT of optional RBEI)	
• Specimen airlock isolation valve:	Built-in, manual drive, pneumatic drive	
• Vacuum gauges:	Pirani gauge	×3
	Ion pump current monitors (for gun chamber, and 1st/2nd intermediate chambers)	×2
• Vacuum pumps:	60 L/s ion pump (SIP)	×1
	20 L/s SIPs	×2
	420 L/s diffusion pumps (DP)	×1
	120 L/s DP	×1
	100 L/min oil rotary pump (RP)	×1
• Reservoir tank:	10 L tank	×1

8.7 SAFETY DEVICES

Devices are provided to protect against vacuum, water, power, nitrogen gas pressure failures and leakage current. For ultrahigh vacuum protection from power failure, purchase the battery backup power supply (for example JEOL–DATUM UPX–401) separately.

8.8 INSTALLATION REQUIREMENTS

8.8.1 Power and Grounding

• Power:	Single-phase, 200 V (±10%) AC, 50/60 Hz, 6 kVA (standard configuration)	
• Grounding terminal:	100 Ω or less	×1

8.8.2 Cooling Water

• Faucet:	14 mm OD or ISO 7/1 Rc 1/4	×1
• Flow rate:	3 L/min	
• Pressure:	0.05 to 0.25 MPa (gauge pressure)	
• Temperature:	15 to 25℃	
• Drain:	25 mm ID or ISO 7/1 Rc 1/4	×1

8.8.3 Dry Nitrogen Gas

• Pressure:	0.4 to 0.5 MPa (gauge pressure)
• Coupler:	ISO 7/1 Rc 1/4

Note: Dry nitrogen gas must be provided by the customer.

8.8.4 Installation Room

- Temperature: 15 to 25°C
- Humidity: 60% or less
- Stray AC magnetic field: 0.3 μT (p-p) or less (50/60 Hz sine wave, WD 15 mm, Acc.V. 30 kV)*
- Floor vibration: 2 μm (p-p) or less at sine wave of over 5 Hz frequency*
- Acoustic noise: 65 dB or less with flat characteristics*
- Floor space: 3,000 × 2,800 mm or more
- Door width: 850 (W) × 2,000 (H) mm or more

8.8.5 Dimensions and Weight

- Main console: 790 (W) × 1,230 (D) × 1,800 (H) mm, 570 kg
- Operation and display system: 1,100 (W) × 1,000 (D) × 700 (H) mm, 185 kg
- Oil rotary pump (RP): 465 (W) × 180 (D) × 270 (H) mm, 25 kg
- Personal computer**: 205 (W) × 444 (D) × 437 (H) mm, Approx. 15 kg
- Motor drive power supply: 265 (W) × 265 (D) × 135 (H) mm, Approx. 5 kg

Specifications guaranteed when no modification or addition is made, and subject to change without notice.

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* These items are indispensable for this specification. The stray magnetic field, floor vibration and acoustic noise in the installation room should be measured before installation by JEOL, to determine the achievable maximum magnification.

** Depends on the personal computer purchased.

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