OPERATION

This instrument can be operated using the methods available as described below. Regardless of which method is used, the basic operations of a given function are closely related or linked to each other, except for small portions. Therefore, any of them may be selectively used according to current situations.

This chapter mainly describes the basic method of operation using knobs and switches arranged on the operation panels.

☞ For other operation methods, refer to Chap. 4, "Description of Each Part."

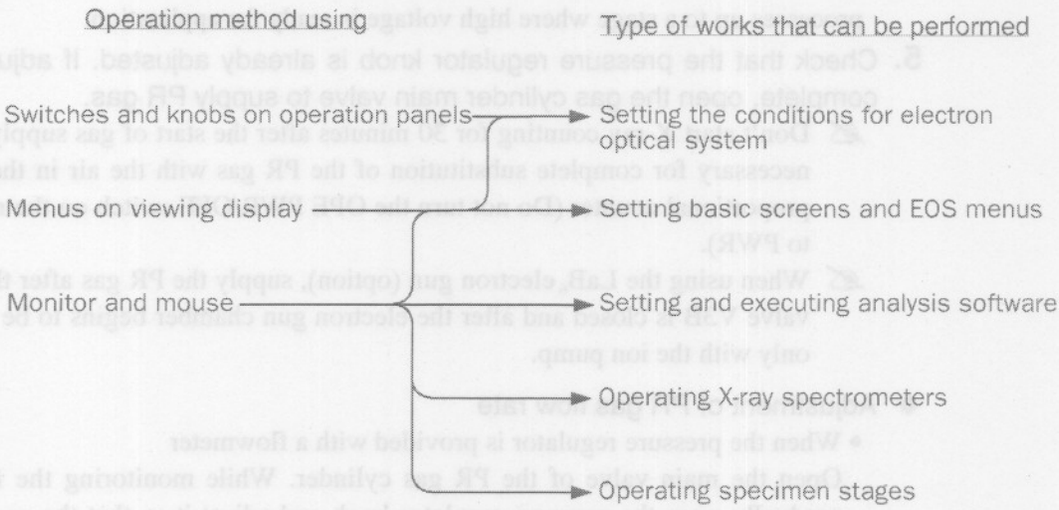
■ Operation using the main panel or the Scanning-image observation display

This method is suitable for dynamic control and for settings on the observation purpose.

☞ Refer to this chapter and Chap. 4, "Description of Each Part."

■ Operation from the monitor window of the computer system (window operation)

This method that uses the mouse and keyboard is suitable for setting the specimen stages and X-ray spectrometers and for performing X-ray analysis. It allows the electron optical system, basic screens, EOS menus, etc. to be set even during measurement.



5.1 STARTUP, SHUTDOWN AND EMERGENCY PROCEDURE

5.1.1 Starting the Entire EPMA

1. Open the nitrogen gas cylinder valve and check that the secondary line pressure is kept at 0.4 to 0.5 MPa (4 to 5 kg/cm^2).

> **⚠ WARNING**
>
> **When handling nitrogen gas or PR gas contained in the high-pressure gas cylinder, be sure to observe the related WARNING clauses described in the SAFETY PRECAUTIONS.**

2. Open the valve of the tap water to flow cooling water.
3. Turn on the power distribution board switches.
4. Turn the POWER key switch on the main panel to START and release the key (it returns to the "I" position).

   This starts the evacuation system and successively carries out the evacuation processes up to a stage where high voltage is ready for application.
5. Check that the pressure regulator knob is already adjusted. If adjustment is complete, open the gas cylinder main valve to supply PR gas.

   ✍ Don't start X-ray counting for 30 minutes after the start of gas supply, a period necessary for complete substitution of the PR gas with the air in the gas flow proportional counter (Do not turn the OPE PWR/OFF switch on the main panel to PWR).

   ✍ When using the LaB_6 electron gun (option), supply the PR gas after the vacuum valve V3B is closed and after the electron gun chamber begins to be evacuated only with the ion pump.

◆ Adjustment of PR gas flow rate

- When the pressure regulator is provided with a flowmeter

  Open the main valve of the PR gas cylinder. While monitoring the flowmeter, gradually open the pressure regulator knob and adjust it so that the gas flow rate may be 6 to 7 mL/min.

  ✍ If the flowmeter reading is initially in a range between 3 and 10 mL/min when the main valve is opened, you need not adjust the flow rate.
- When the pressure regulator is not provided with a flowmeter

  Prepare a cup filled with water. Open the main valve of the PR gas cylinder. Insert the vinyl tube from the spectrometer's PR gas outlet nozzle into the cup of water to a depth of about 5 mm. Gradually open the pressure regulator knob and adjust it so that the flow rate may be 1 to 2 bubbles/sec.

  ✍ If water flows back into the vinyl tube during adjustment, immediately bend it to prevent the water from entering the spectrometer inside.

6. Confirm that more than 30 minutes have passed after starting to supply the gas; then turn the OPE PWR/OFF switch on the main panel to PWR.

   This automatically starts the operation/observation section, and the basic screen will appear on the Scanning-image viewing display (☞ Fig. 5.1).

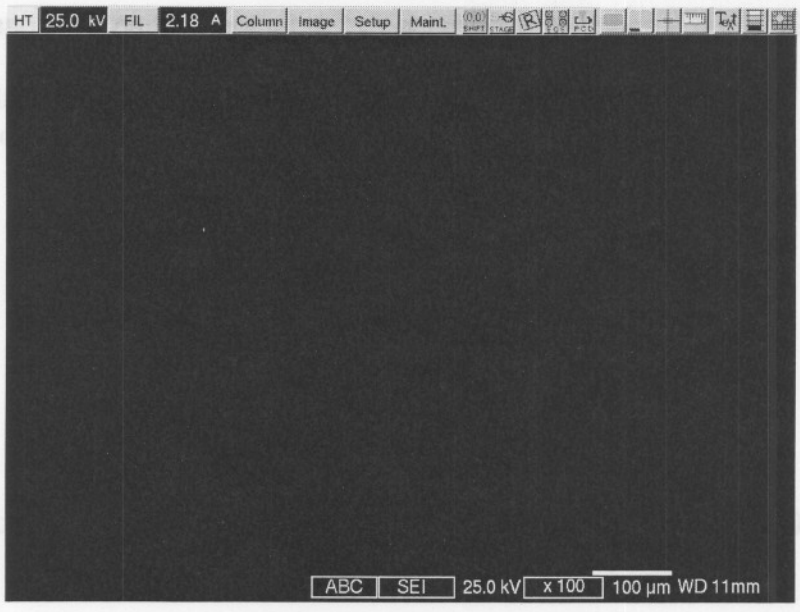


Fig. 5.1 Basic screen on Scanning-image observation display

7. Turn on the power to the server, personal computer (PC) and the peripheral units. When the PC starts up, the Log On window shown in Fig. 5.2 appears.

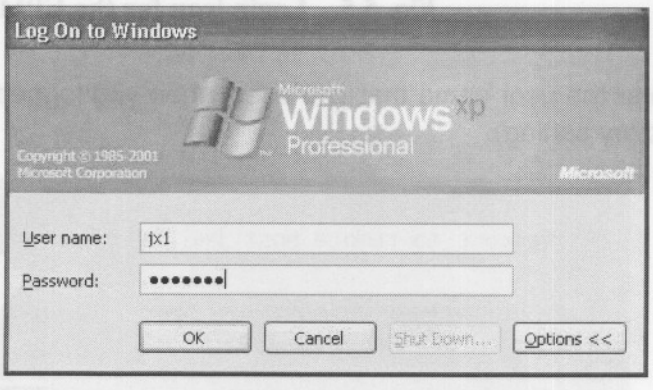


Fig. 5.2 Logon window of the PC

8. Enter a user name (jx1 is the factory setting) and password to log on to the PC. Then, the Logon window of the Network Filing System (NFS) appears.

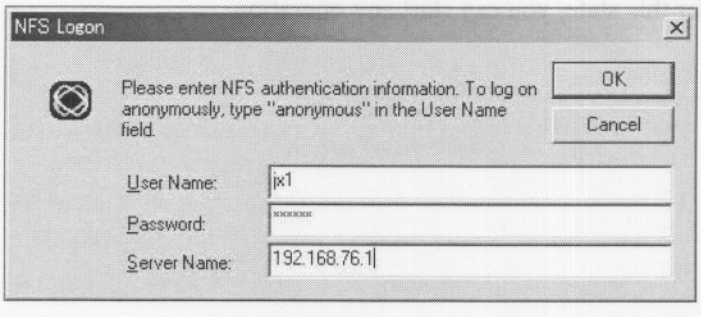


Fig. 5.3 Logon window of the NFS

9. Enter a specified user name (jx1 at factory setting) and password to log on to the NFS.
   When you log on to the PC, the swing mouse icon appears on the task bar (☞ Fig. 5.4). Under this condition, you can move the mouse pointer to the Scanning-image viewing display.

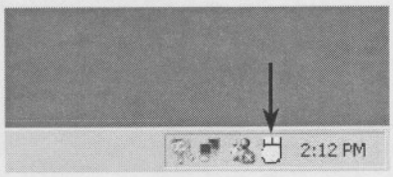


Fig. 5.4 Icon for the swing mouse

10. Double-click on the EPMA icon in the Desktop of the PC (☞ Fig. 5.5).
    The Login screen (☞ Fig. 5.6) of the server appears.

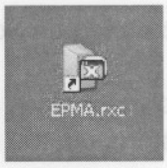


Fig. 5.5 Login icon for the EPMA

11. Enter the user name that you used when you logged on to the PC (jx1 is the factory setting).

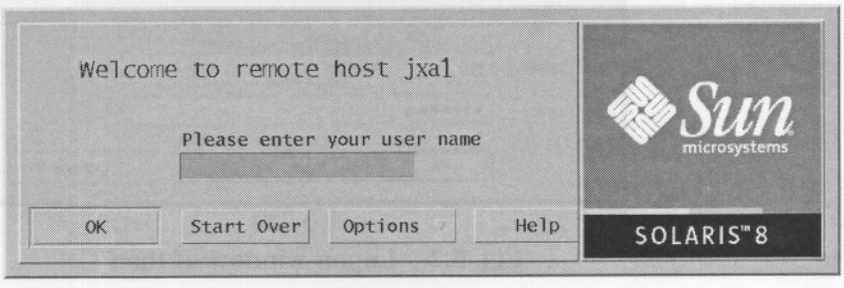


Fig. 5.6 Login screen for the server

Afterwards, the processing proceeds automatically until the EPMA menu appears. Under this state, you can start any operation.

- If necessary (about once a week), initialize the stage and spectrometer positions also.

  Display the **Initialize** menu on the monitor of the PC, and click on the **Quick Initialize** menu item to display the Reset Positions window; then click on the **Spectrometer-Position** and/or **Stage-Position** buttons in the Reset Positions window.

- Displaying the EPMA menu together with the Windows menu

  When you execute the EPMA menu, the server background replaces the Windows background. Under this condition, right-click on the ReflectionX icon on the task bar to deselect **Set background to X pattern**, the Windows wallpaper appears, allowing the EPMA menu to coexist with the Windows menu.

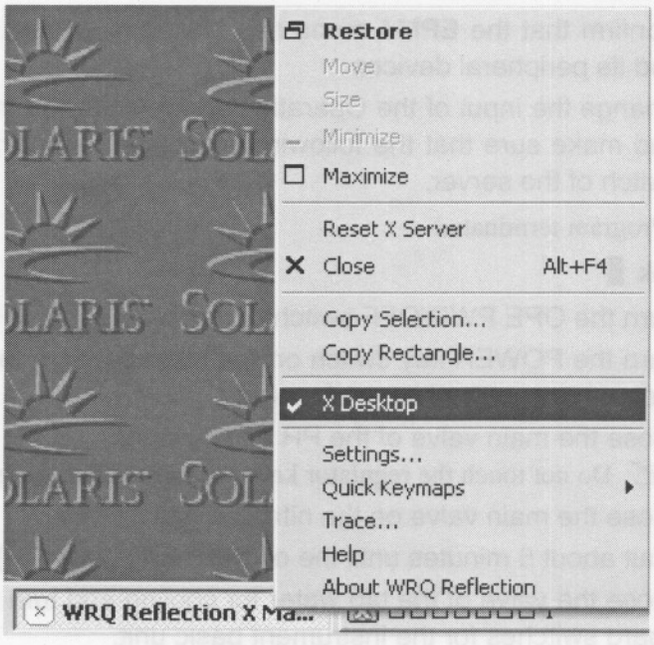


Fig. 5.7 Icon menu for ReflectionX

5.1.2 Shutdown of the Entire EPMA

1. After checking that the column is being kept under high vacuum (the HV READY lamp on the main panel is lit), press the ACCEL VOLTAGE-ON button on the main panel (the button lamp goes out) to shut off the high voltage (accelerating voltage).
2. Terminate all of the analysis and data processing tasks running on the Operation/analysis display, and close all windows other than the EPMA Main Menu window.
3. Click the **Initialize** icon in the EPMA Main Menu window and select **System Shutdown** (☞ refer to Fig. 5.10); then click the **OK** button in the System Shutdown window.
4. Confirm that the EPMA menu has closed, then turn off the power of the PC and its peripheral devices.
5. Change the input of the Operation/analysis display from the PC to the server, and make sure that the following messages appear; then turn off the power switch of the server.

   Program terminated

   ok ▮
6. Turn the OPE PWR/OFF switch of the main panel to OFF.
7. Turn the POWER key switch on the main panel to the "○" position to turn off the power supply of the instrument.
8. Close the main valve of the PR gas cylinder.

   ✍ Do not touch the regulator knob of the pressure gauge.
9. Close the main valve on the nitrogen gas cylinder.
10. Wait about 5 minutes until the oil diffusion pump (DP) cools down.
11. Close the valve of the tap water for cooling and turn off the power distribution board switches for the instrument basic unit.

✍ In the normal use of the instrument, we recommend that you continuously operate the evacuation system and server without stopping them or turning off the power. If necessary, turn off the PC and turn the OPE PWR/OFF switch of the main panel to OFF. Stop the entire EPMA only when you will not use the instrument for a long time.

5.1.3 End and Restart of the EPMA Menu

Follow these steps when finishing or restarting EPMA menu operations or when manipulating the OPE PWR/OFF switch on the main panel after a reset-button operation (☞ refer to Sect. 4.4.2) or an emergency operation (☞ refer to Sect. 5.1.4).

5.1.3a End of EPMA menu

1. Click on the **Initialize** icon in the EPMA menu.

   A pull-down menu will appear.
2. Click **on End of menu** in the pull-down menu.
3. Click **on** the **Ok** button in the End of Menu window.

The EPMA menu closes.
From now on, by opening new terminal windows, as occasion demands, you can use the server computer system as an ordinary server computer.

✍ If you operate the switches of the software for high voltage and the OM monitor using the mouse, the EPMA menu must be displayed. Set the ON and OFF positions of these switches before you close the EPMA menu.

5.1.3b Restarting the EPMA menu

1. When you press the SC RESET button on the main panel, wait for 30 seconds. When you press OPE RESET button or set the OPE PWR/OFF switch to the up position, wait until the Basic screen appears on the Scanning-image viewing display.
2. Click the **EPMA column** icon in the window displayed at the lower part on the screen.
   The EPMA menu will appear.

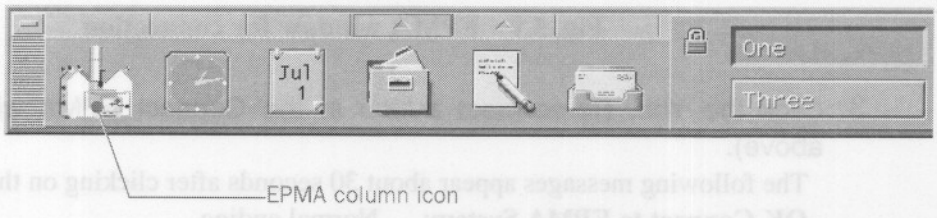


Fig. 5.8 Window displayed at the lower part on the screen

✍ If you have not waited at least 30 seconds after you pressed the SC RESET button, or if the EPMA menu starts before the Basic screen appears on the Scanning-image observation display, the system controller might not be connected to the host computer via the network. If this occurs, a message window will appear. Click the End of Menu button to close the window; then open the EPMA menu again.

5.1.3c Operating the OPE PWR/OFF switch without terminating the EPMA menu

The procedure described below allows the OPE PWR/OFF switch on the power supply panel to be manipulated, without finishing the EPMA menu operation.

✍ This procedure cannot be used when restarting the system after a reset-button operation. Also, it may not be used depending on your type of network system. If you cannot use the procedure described in this section, follow the procedures described in Sects. 5.1.3a and 5.1.3b.

✍ If you have not waited at least 30 seconds after you pressed the SC RESET button, or if the EPMA menu starts before the Basic screen appears on the Scanning-image viewing display, the system controller might not be connected to the host computer via the network. If this occurs, the message window shown below will appear. Click the **End of Menu** button to close the window and reopen the EPMA menu.

1. Close all windows (including iconified windows) other than those opened from the EPMA menu; then set the OPE PWR/OFF switch on the main panel to the OFF position.

   ✍ Be sure to close all the windows opened from the Monitor, Analysis, EDS, and Initialize icons.

2. When you restart a window operation after you have set the OPE PWR/OFF switch to the OPE PWR position, wait about 30 seconds, then click the **JEOL** icon in the EPMA menu. A pull-down menu will be displayed. Select **Connect EPMA system** from this menu.

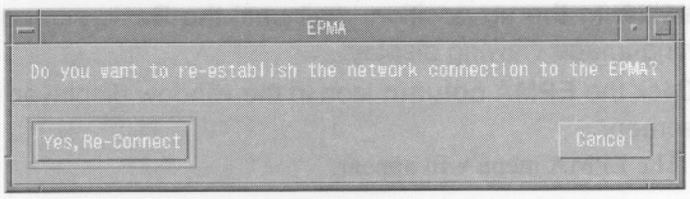


Fig. 5.9 EPMA window for connection

3. Click the **Yes, Re-connect** button in the Connect EPMA window (Figure above).

   The following messages appear about 30 seconds after clicking on the button:

   OK Connect to EPMA System: Normal ending

   Connect Failed: Abnormal ending

4. If the **Connect Failed** message appears, follow the steps in Sects. 5.1.3a and 5.1.3b.

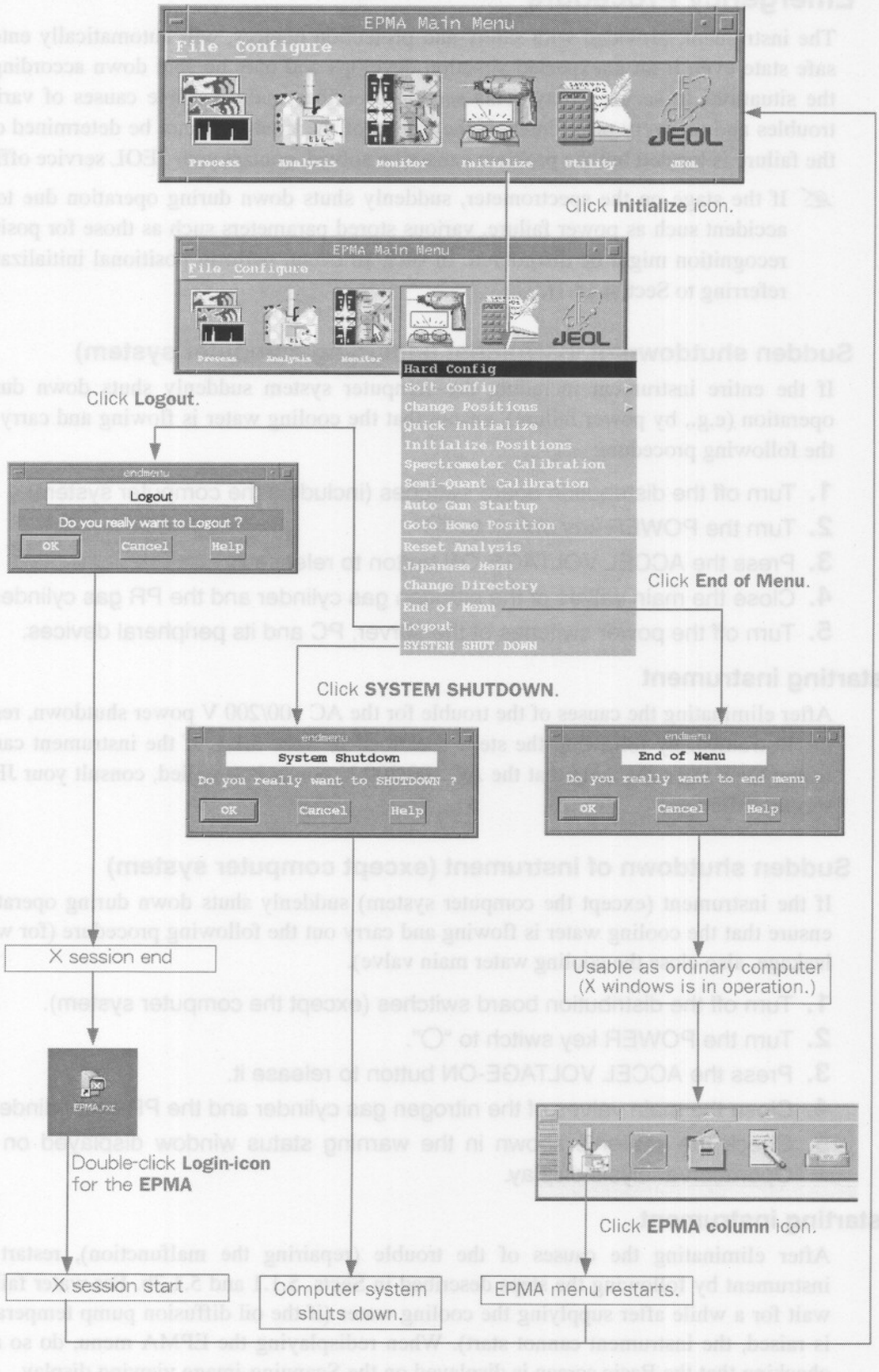


Fig. 5.10 Computer system shutdown flow chart

5.1.4 Emergency Procedure

The instrument, provided with safety and protection devices, will automatically enter a safe state even if an unexpected situation develops and may be shut down according to the situations to secure safety. This section describes main possible causes of various troubles and recovery procedures. If the causes of the trouble cannot be determined or if the failure is located but the problem cannot be solved, contact your JEOL service office.

✍ If the stage on the spectrometer, suddenly shuts down during operation due to an accident such as power failure, various stored parameters such as those for position recognition might be disordered. In such an event, perform positional initialization referring to Sect. 4.14.1f.

5.1.4a Sudden shutdown of instrument (including computer system)

If the entire instrument including the computer system suddenly shuts down during operation (e.g., by power failure), ensure that the cooling water is flowing and carry out the following procedure:

1. Turn off the distribution board switches (including the computer system).
2. Turn the POWER key switch to "○".
3. Press the ACCEL VOLTAGE-ON button to release it.
4. Close the main valves of the nitrogen gas cylinder and the PR gas cylinder.
5. Turn off the power switches of the server, PC and its peripheral devices.

■ Restarting instrument

After eliminating the causes of the trouble for the AC 100/200 V power shutdown, restart the instrument by following the steps described in Sect. 5.1.1. If the instrument cannot restart even after checking that the AC 100/200 V power is supplied, consult your JEOL service office.

5.1.4b Sudden shutdown of instrument (except computer system)

If the instrument (except the computer system) suddenly shuts down during operation, ensure that the cooling water is flowing and carry out the following procedure (for water leakage, also close the cooling water main valve).

1. Turn off the distribution board switches (except the computer system).
2. Turn the POWER key switch to "○".
3. Press the ACCEL VOLTAGE-ON button to release it.
4. Close the main valves of the nitrogen gas cylinder and the PR gas cylinder.
5. Check the contents shown in the warning status window displayed on the Operation/analysis display.

■ Restarting instrument

After eliminating the causes of the trouble (repairing the malfunction), restart the instrument by following the steps described in Sects. 5.1.1 and 5.1.3b. For water failure, wait for a while after supplying the cooling water (if the oil diffusion pump temperature is raised, the instrument cannot start). When redisplaying the EPMA menu, do so after checking that the Basic screen is displayed on the Scanning-image viewing display.

5.1.4c When high voltage (accelerating voltage) shuts off and all vacuum valves are closed except V7

When the accelerating voltage suddenly shuts off during X-ray analysis or microscopy and when all vacuum system indicators (except V7) on the main panel go out, carry out the following steps:

1. Press the ACCEL VOLTAGE-ON button to release it.
2. Close the main valves of the nitrogen gas cylinder and the PR gas cylinder.

If the column inside increases in pressure for some reason while it is kept under high vacuum, all vacuum valves except V7 will close.

- Vacuum system indicators go out:
  Leakage in column and evacuation system.

■ Restarting instrument

To check for vacuum leak and repair it, two methods are available.

- **Repair without shutting down the instrument**

  Press the SPEC VENT (to vent only the specimen chamber) button or GUN VENT button (to vent only the electron gun chamber) on the main panel, or press both the GUN Vent and SPEC Vent button (to vent the entire column). Locate the leak and repair it, then press the button(s) that you pressed to reevacuate the vacuum system.

- **Repair after shutting down the instrument**

  If pumping noise continues for several minutes or if the main panel indicator lamp V4, V3A, or V3B does not go on after a certain period (the vacuum valves do not open), shut down the instrument as described in Sect. 5.1.2 and contact your JEOL service office.

5.1.4d When power to the control and display system shuts off

When the power to the control and display system suddenly shuts off during operation though the evacuation system operates normally, perform the following steps:

1. Set the OPE PWR/OFF switch on the main panel to the OFF position.
2. Press the ACCEL VOLTAGE-ON button to release it.
3. End the EPMA menu (☞ refer to Sect. 5.1.3a).

While the main panel OPE PWR/OFF switch is set at the OPE PWR position, if a protection circuit in the control on observation system is activated for some reason, any one of the DEFECT indicators on the main panel goes on and the power to the control and observation system will automatically shut down.

- COOLING BOX indicator goes on:
  A temperature rise in the control system power amplifiers (insufficient cooling water).

■ Restarting instrument

Described below is a procedure for the trouble above.

● When the temperature in the control system power amplifier has risen

Wait until the circuits are cool down (the COOLING BOX indicator lamp will go out). Check whether there is any problem in the water supply system such as a water shortage or the closed main valve, and remove the problem; then set the OPE PWR/OFF switch to the OPE PWR position. Make sure that the flow rate of the cooling water of two water supply systems at the drain is totally 3 to 3.5 L/min.

5.2 SPECIMEN EXCHANGE

This chapter explains method of changing the specimen for each specimen stage. Normally, specimen exchange is performed using the airlock system, with the specimen chamber kept under high vacuum. Therefore, specimen exchange by the stage-drawout system, which requires that the stage is to be pulled out from the specimen chamber, is not required in routine operations. The stage-drawout system specimen exchange is briefly described here as an ancillary means to be used in special cases, e.g., when a special specimen holder is used, when the specimen becomes detached in the specimen chamber, and when the specimen chamber must be opened for loading or unloading optional accessories or for maintenance of the instrument.

5.2.1 High Speed Large Specimen Stage (HSLSS)

The High Speed Large Specimen Stage Z (HSLSZ), High Precision Specimen Stage (HPSS), High Precision Specimen Stage Z (HPSZ) and High Speed Large Specimen Stage (HSLSS) described here use the same airlock system and the same stage-drawout system. Therefore, this section describes the systems for the HSLSS as models for all types of specimen stages.

5.2.1a Airlock system

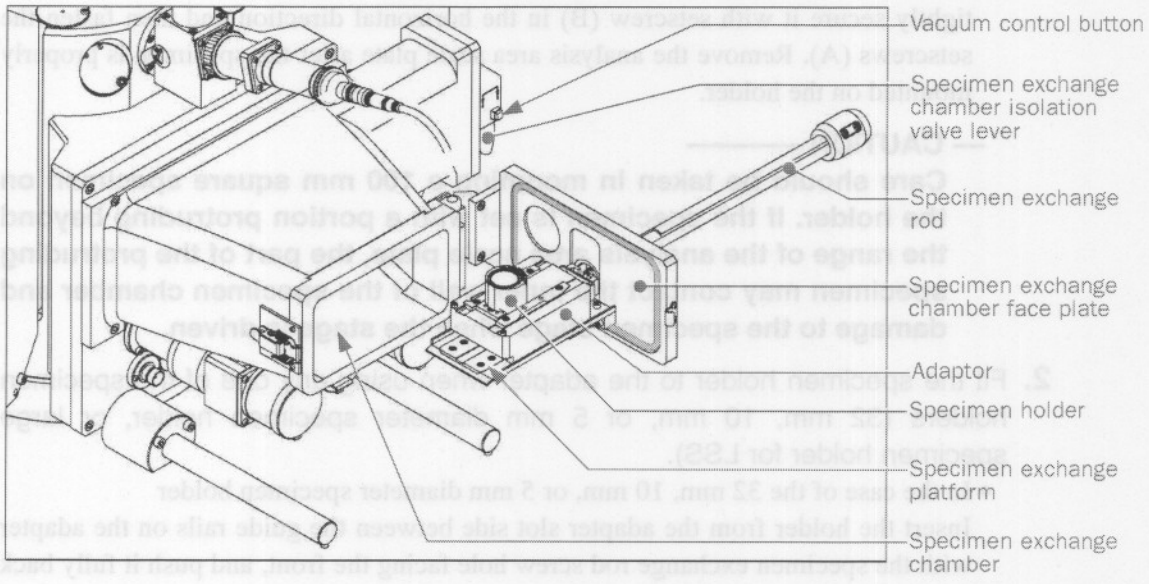


Fig. 5.11 Specimen exchange by airlock system (HSLSS)

Insertion of the specimen holder is described here.

1. Mount the specimen on the specimen holder.
   - 32 mm diameter specimen holder (with standard specimens), 10 mm diameter specimen holder, and 5 mm diameter specimen holder (☞ refer to Fig. 5.12 and Fig. 5.16)

     Insert the specimen into the cylinder (with the 32 mm diameter specimen holder, stick the specimen on the height adjust screw with conductive paint). Make the specimen surface flush with the cylinder top face by turning the height adjusting screw (with the 5 mm and 10 mm diameter specimen holders, secure the specimen and the cylinder with a screw). Then insert the cylinder into the holder (with the 32 mm diameter specimen holder, secure them with a screw).

     ✍ With the 5 mm and 10 mm diameter specimen holders, use a stub as necessary. With individual holders, use conductive paint to avoid specimen charge-up, as necessary.
   - Large specimen holder for LSS (☞ refer to Fig. 5.16)

     Load a specimen on the large specimen holder according to the procedure in Sect. 5.2.2.
   - Large specimen holder for HSLSS (☞ refer to Fig. 5.12)

     With the 100 mm square specimen holder (for XM-81320: Large specimen holder), mount a 100 mm square specimen on the holder by inserting it from the side and fit the analysis area scale plate to the holder, with its pins put in the holder guide holes. Take care to position the specimen to be involved within the range of the scale plate. Lightly secure the specimen with two setscrews (A), tightly secure it with setscrew (B) in the horizontal direction and then fasten the setscrews (A). Remove the analysis area scale plate after the specimen is properly mounted on the holder.

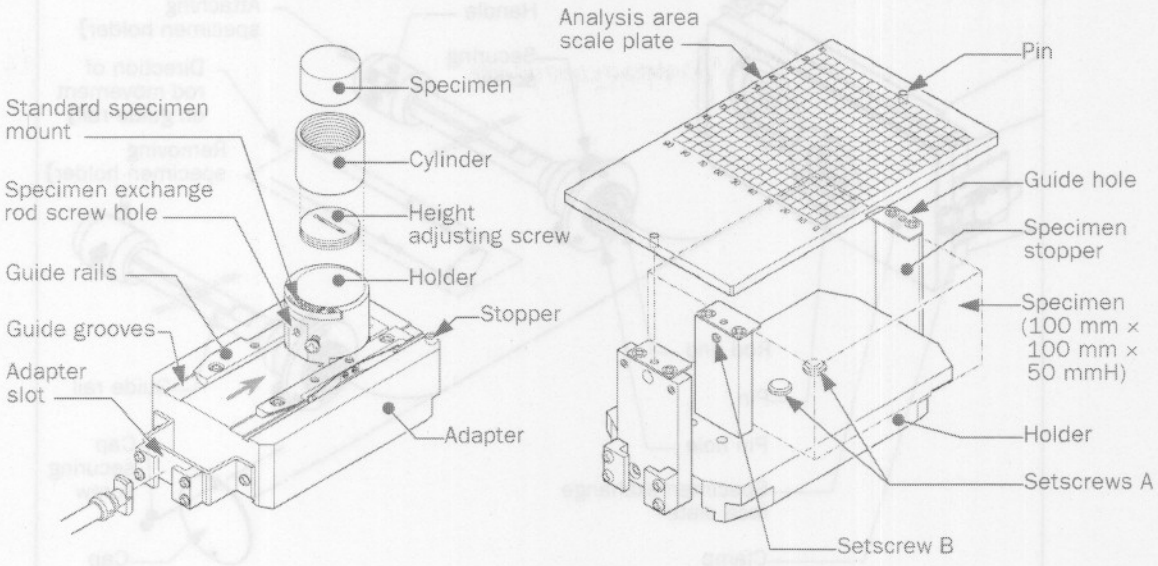
   — CAUTION ———

   Care should be taken in mounting a 100 mm square specimen on the holder. If the specimen is set with a portion protruding beyond the range of the analysis area scale plate, the part of the protruding specimen may contact the inner wall of the specimen chamber and damage to the specimen stage when the stage is driven.

2. Fit the specimen holder to the adapter when using any one of the specimen holders (32 mm, 10 mm, or 5 mm diameter specimen holder, or large specimen holder for LSS).
   - In the case of the 32 mm, 10 mm, or 5 mm diameter specimen holder

     Insert the holder from the adapter slot side between the guide rails on the adapter with the specimen exchange rod screw hole facing the front, and push it fully back (☞ refer to Fig. 5.12).
   - In the case of the large specimen holder for LSS

     Place the holder from the adapter slot side following the guide grooves on the adapter with the specimen exchange rod screw hole facing the front, and push it to the stopper(☞ refer to Fig. 5.16).



[32 mm diameter specimen holder (with standard specimen)]

[100 mm square large specimen holder for HSLSS]

Fig. 5.12 Mounting the specimen and adapter

3. Press the ACCEL VOLTAGE-ON button on the main panel to turn off the button lamp and to shut off the accelerating voltage.

> **⚠ CAUTION**
>
> **To avoid any electrical accidents, be sure to turn off the accelerating voltage and follow the following procedures.**

4. Open the Stage Monitor window (☞ refer to Sect. 4.13.6) on the Operation/analysis display.
5. Set the specimen stage to the specimen exchange position (45 mm for X, 1 mm for Y, and 11 mm for Z)* by clicking the **Sample Change** button in the Stage Monitor window; then click the **OK** button in the Sample Change window.
6. Remove the cap on the specimen exchange chamber face plate by unscrewing the securing screw and fit the specimen exchange rod in the port that becomes available (☞ refer to Fig. 5.13).

   Pull out the specimen exchange rod handle to make the rod end portion as short as possible, insert the rod into the specimen stage with its T-shaped rod end directed horizontally (☞ refer to Fig. 5.12), put the rod pin into the pin hole in the exchange rod mount on the specimen exchange chamber face plate and turn the three securing screws clockwise to secure the rod and the specimen exchange chamber face plate.

* The specified specimen exchange position represents the default values to be set from the Stage Configuration window (refer to Sect. 4.14.1c).

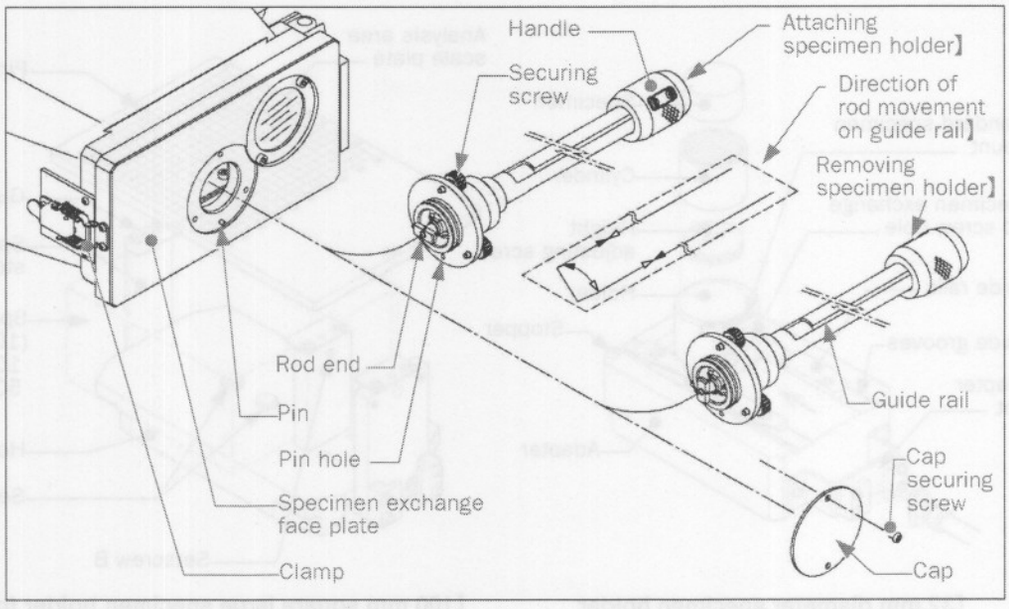


Fig. 5.13 Installing the specimen exchange rod

7. After the specimen exchange rod is attached to the specimen exchange chamber face plate, unlatch the clamp and open the face plate; then insert the holder (adapter) slot into the T-shaped exchange rod end and mount the specimen holder on the specimen exchange platform (☞ refer to Fig. 5.11).
8. To evacuate the specimen exchange chamber, close the specimen exchange chamber face plate and latch it with the clamp; then press the vacuum control button (☞ refer to Fig. 5.11).

   After about two minutes, the vacuum control button lamp goes out to indicate the finish of evacuation.
9. After confirming that the specimen exchange chamber is evacuated, turn the specimen exchange chamber isolation valve lever fully clockwise and pull it completely out rightward to open the isolation valve. Then turn the lever fully counterclockwise and secure it to keep the isolation valve open (the specimen chamber lamp lights) (☞ refer to Fig. 4.6).
10. While viewing the interior of the specimen chamber through the viewing window, push the specimen exchange rod handle completely forward so that the specimen holder is placed in the specimen chamber. Then turn the rod handle clockwise and fully pull it out.

    The specimen exchange rod handle moves as indicated by the ▶ marks in Fig. 5.13 【Direction of rod movement on guide rail】.
11. After checking that the specimen exchange rod handle is completely pulled out, turn the specimen exchange chamber isolation valve lever fully clockwise and push it back to close the isolation valve and turn the lever counterclockwise to secure it.
12. To vent the specimen exchange chamber, press the vacuum control button (the button lamp goes on).
13. Detach the specimen exchange rod from the specimen exchange chamber face plate and place the cap on the face plate and secure it with the screw.

> **⚠ CAUTION**
>
> **Be sure to remove the specimen exchange rod to avoid hitting it and attach the cap.**

The foregoing procedure describes insertion of the specimen holder. Taking out the specimen holder can be performed in almost the same manner.

■ Taking out the specimen holder

1. Follow the previous steps 3 to 5 as preparative steps.
2. According to the previous step 6, fit the specimen exchange rod to the specimen exchange chamber face plate, with the T-shaped rod end set vertically (☞ refer to Fig. 5.13 【Removing the specimen holder】).
3. Press the vacuum control button, check that the evacuation of the specimen exchange chamber is completed, and then open the isolation valve according to the previous step 9.
4. While viewing the interior of the specimen chamber through the viewing window, push the specimen exchange rod handle fully forward, insert the T-shaped rod end into the adapter slot, turn the rod handle counterclockwise and then pull it completely out to move the specimen holder to the specimen exchange chamber (☞ refer to the ▷ marks in Fig. 5.13 【Direction of rod movement on guide rail】).
5. Vent the specimen chamber according to the previous steps 11 and 12. Then unlatch the clamp, open the specimen exchange chamber face plate, and remove the specimen holder from the specimen exchange platform.
6. Close the specimen exchange chamber face plate and latch it with the clamp; then replace the specimen exchange rod with the cap.

5.2.1b Stage drawout system (drawing out the specimen stage)

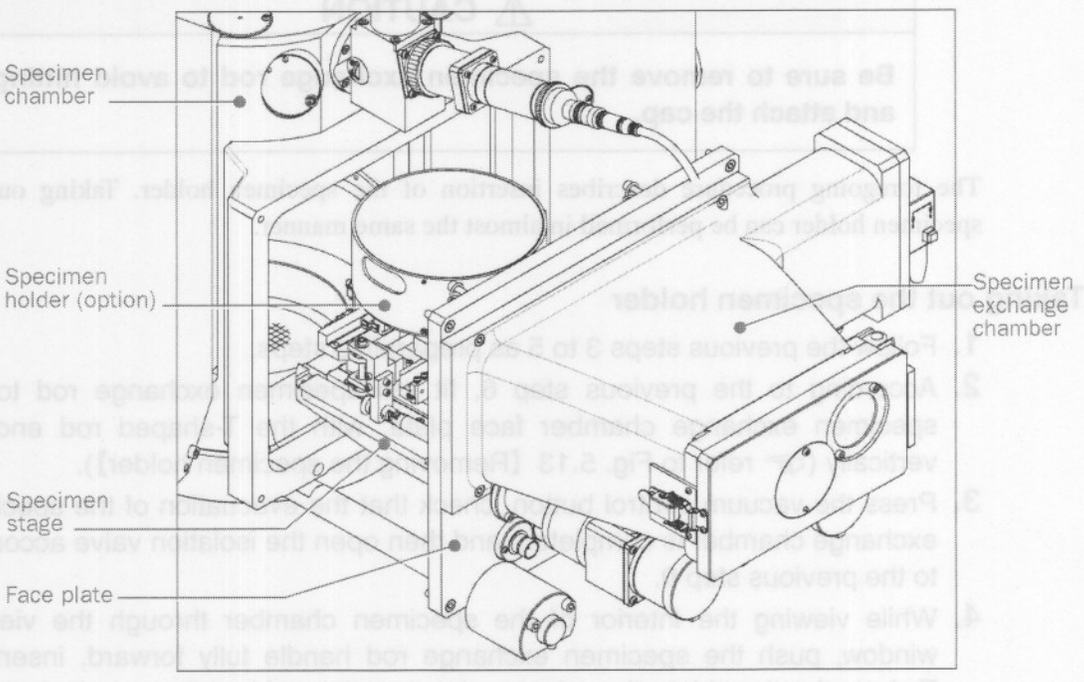


Fig. 5.14 Drawing out specimen stage (HSLSS)

The procedure below allows the specimen stage to be drawn out (☞ refer to Fig. 5.14).

1. Press the ACCEL VOLTAGE-ON button on the main panel to turn off the button lamp and to shut off the accelerating voltage.
2. Open the Stage Monitor window on the Operation/analysis display according to the step 4 in Sect. 5.2.1a. Place the pointer in the X, Y, and Z input boxes and enter the stage position (45 mm for X, 1 mm for Y, and 12 mm for Z) and set the stage to this position.
3. Turn off the OPE PWR/OFF switch on the main panel according to the procedure in Sect. 5.1.3c.
4. Loosen the specimen exchange chamber evacuation pipe nut and remove the evacuation pipe (☞ refer to Fig. 4.8) and evacuation pipe O-ring from the specimen exchange chamber.
5. Remove four screws that secure the specimen stage face plate on the specimen chamber and press the SPEC VENT button on the main panel to vent the specimen chamber inside according to Sect. 1.1, "Bringing the Column to Atmospheric Pressure" in the maintenance manual (the button lamp brightens).

   Nitrogen gas will be introduced into the specimen chamber inside, and the chamber will reach atmospheric pressure after about 15 minutes.
6. Gently draw out the specimen stage from the specimen chamber.

   The specimen stage has now been drawn outside and access to the specimen chamber inside is available. When the desired job is completed, follow the procedure below to return the stage to its place, to close the specimen chamber and to evacuate the specimen chamber.

7. After you return the specimen stage gently to its place, fit the face plate to the specimen chamber and secure them with the screws.

> **⚠ CAUTION**
>
> **When pushing the specimen stage back into place, take care that your fingers do not get caught in the clearances between the specimen chamber and the specimen stage face plate.**

8. Reconnect the specimen exchange chamber evacuation pipe.
   After checking that the O-ling does not have foreign particles and scratches on it, replace it on the specimen exchange chamber evacuation pipe mount and connect the pipe to the mount; then secure it by turning the nut.
9. Set on the OPE PWR/OFF switch on the main panel to the OPE PWR position and make the operation using windows possible according to Sect. 5.1.3c.
10. Evacuate the specimen chamber inside by pressing the SPEC VENT button according to Sect. 1.2, "Re-evacuating the Column" in the maintenance manual (the button lamp dims).
    After evacuation is complete, the HV button on the Scanning-image viewing display turns blue.

5.2.2 Large Specimen Stage (LSS)

5.2.2a Airlock system

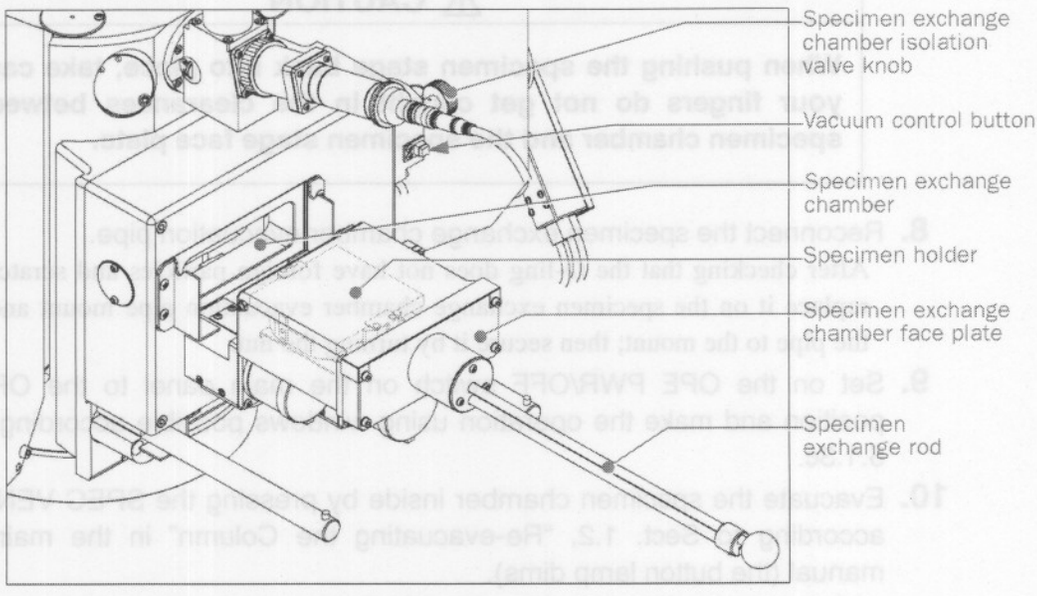


Fig. 5.15 Specimen exchange using airlock system (LSS)

The procedure for loading the specimen is described here (☞ refer to Fig. 5.15 and Fig. 5.16).

1. Mount the specimen on the specimen holder as follows:
   - 32 mm diameter specimen holder with a standard specimen
     Insert the specimen into the cylinder (stick the specimen on the height adjust screw with conductive paint), make the specimen surface flush with the cylinder top face with the height adjusting screw, insert the cylinder into the holder and then secure them with a screw.
   - 100 mm square specimen holder (XM-86LH100: optional)
     Mount the specimen on the holder by inserting it from the side and fix it by pushing it up with the height adjust screw.

   ✍ Use conductive paint to avoid charge-up on the specimen as necessary.

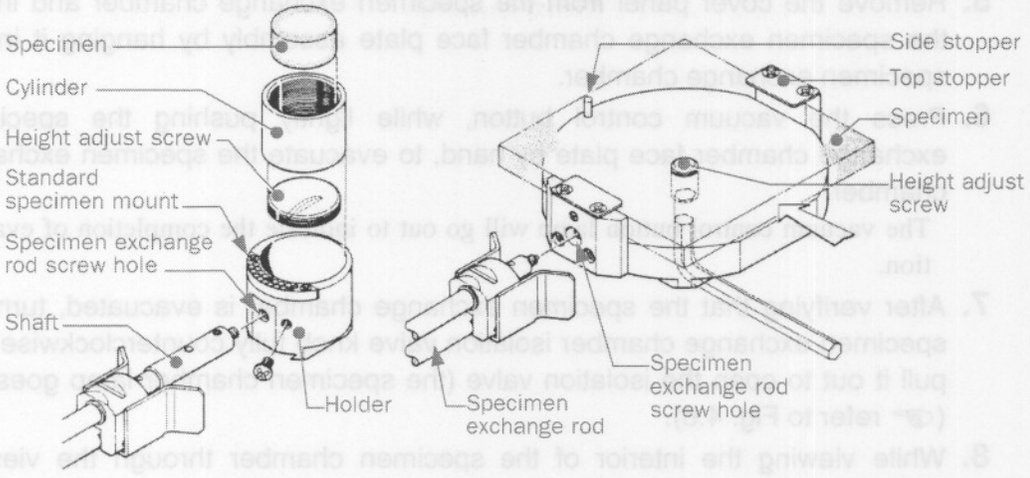


Fig. 5.16 Specimen holders (for LSS)

2. Press the ACCEL VOLTAGE-ON button on the main panel to turn off the button lamp and to shut off the accelerating voltage.

> **⚠ CAUTION**
>
> **To avoid any electrical accidents, be sure to turn off the accelerating voltage and follow the following procedures.**

3. Open the Stage Monitor window (☞ refer to Sect. 4.13.6) on the Operation/analysis display and click the **Sample Change** button. Then set the stage to the specimen exchange position (0.5 mm for X, 40 mm for Y, and 11 mm for Z).*
4. After you screw the specimen exchange rod into the specimen exchange rod screw hole of the specimen holder securely, completely pull out the specimen exchange rod combined with the specimen exchange chamber face plate, and insert the specimen holder into the exchange chamber face plate assembly.

   ✍ When using the 32 mm diameter specimen holder, securely screw the shaft into the specimen exchange rod beforehand (☞ refer to Fig. 5.16).

   — CAUTION ———

   Be sure to screw the specimen exchange rod into the specimen holder securely, otherwise the specimen holder can be disconnected from the rod and dropped.

* The specified specimen exchange position represents the default values to be set from the Stage Configuration window (refer to Sect. 4.14.1c).

5. Remove the cover panel from the specimen exchange chamber and install the specimen exchange chamber face plate assembly by hanging it in the specimen exchange chamber.
6. Press the vacuum control button, while lightly pushing the specimen exchange chamber face plate by hand, to evacuate the specimen exchange chamber.

   The vacuum control button lamp will go out to indicate the completion of evacuation.
7. After verifying that the specimen exchange chamber is evacuated, turn the specimen exchange chamber isolation valve knob fully counterclockwise and pull it out to open the isolation valve (the specimen chamber lamp goes on) (☞ refer to Fig. 4.6).
8. While viewing the interior of the specimen chamber through the viewing window, manipulate the specimen exchange rod so that the specimen holder is positioned completely on the specimen stage holder mount, turn the rod counterclockwise to disconnect it from the holder, and pull it out.
9. After verifying that the specimen exchange rod is pulled out completely, push the specimen exchange chamber isolation knob to its stop and turn it fully clockwise to close the isolation valve.
10. Press the vacuum control button (the button lamp goes on) to vent the specimen exchange chamber.
11. Remove the specimen exchange chamber face plate and specimen exchange rod assembly.

⚠ CAUTION

Be sure to remove the specimen exchange chamber face plate and specimen exchange rod assembly to avoid unexpected accidents.

12. Attach the cover panel to the specimen exchange chamber (☞ refer to Fig. 5.17).

Described above is the procedure for inserting the specimen holder. Taking out the holder can be performed in almost the same manner.

■ Taking out the specimen holder

1. Follow the previous steps 2 and 3 as preparative steps, fully pull out the specimen exchange rod.
2. Fit the specimen exchange chamber face plate to the specimen exchange chamber and open the isolation valve, according to the previous steps 5 to 7.
3. Screw the specimen exchange rod into the specimen exchange rod screw hole of the specimen holder and pull it completely out.
4. Close the isolation valve, remove the specimen exchange chamber face plate and specimen exchange rod assembly from the exchange chamber, and attach the cover panel instead of the face plate, according to the previous steps 9 to 12.
5. Disconnect the specimen holder from the specimen exchange rod.

5.2.2b Stage drawout system (drawing out the specimen stage)

1. Press the ACCEL VOLTAGE-ON button on the main panel to turn off the button lamp and to shut off the accelerating voltage.
2. Open the Stage Monitor window on the Operation/analysis display and place the mouse pointer in the X, Y, and Z input boxes in the Stage Monitor window (☞ refer to Sect. 4.13.6) and enter the following values using the keyboard and set the stage to this position (☞ refer to Fig. 4.108).
   - X [mm] ····· 40
   - Y [mm] ····· 40
   - Z [mm] ····· 12
3. Turn off the OPE PWR/OFF switch on the main panel according to the procedure in Sect. 5.1.3c.
4. Remove four screws that secure the specimen stage front cover on the specimen chamber and press the SPEC VENT button on the main panel according to Sect 1.1, "Bringing the Column to Atmospheric Pressure" in the maintenance manual to introduce the nitrogen gas into the specimen chamber (the button lamp brightens). The specimen chamber inside will reach atmospheric pressure after about 15 minutes.
5. Gently draw out the specimen stage from the specimen chamber (☞ refer to Fig. 5.17).

The specimen stage has now been drawn outside and access to the specimen chamber inside is available. When the desired job is completed, follow the procedure below to replace the stage, to close the specimen chamber and to evacuate the specimen chamber.

6. Gently push back the specimen stage into the specimen chamber, fit the specimen stage front cover to the chamber and secure them with the screws.

> **⚠ CAUTION**
>
> **When pushing the specimen stage back into the specimen chamber, take care that your fingers do not get caught in the clearances between the specimen chamber and the specimen stage front cover.**

7. Set the OPE PWR/OFF switch on the main panel to the OPE PWR position and make the operation using windows possible according to the procedure in Sect. 5.1.3c.
8. According to Sect. 1.2, "Re-evacuating the Column" in the maintenance manual, press the SPEC VENT button to evacuate the specimen chamber (the button lamp dims).

   After evacuation is complete, the HV button on the Scanning-image viewing display turns blue.

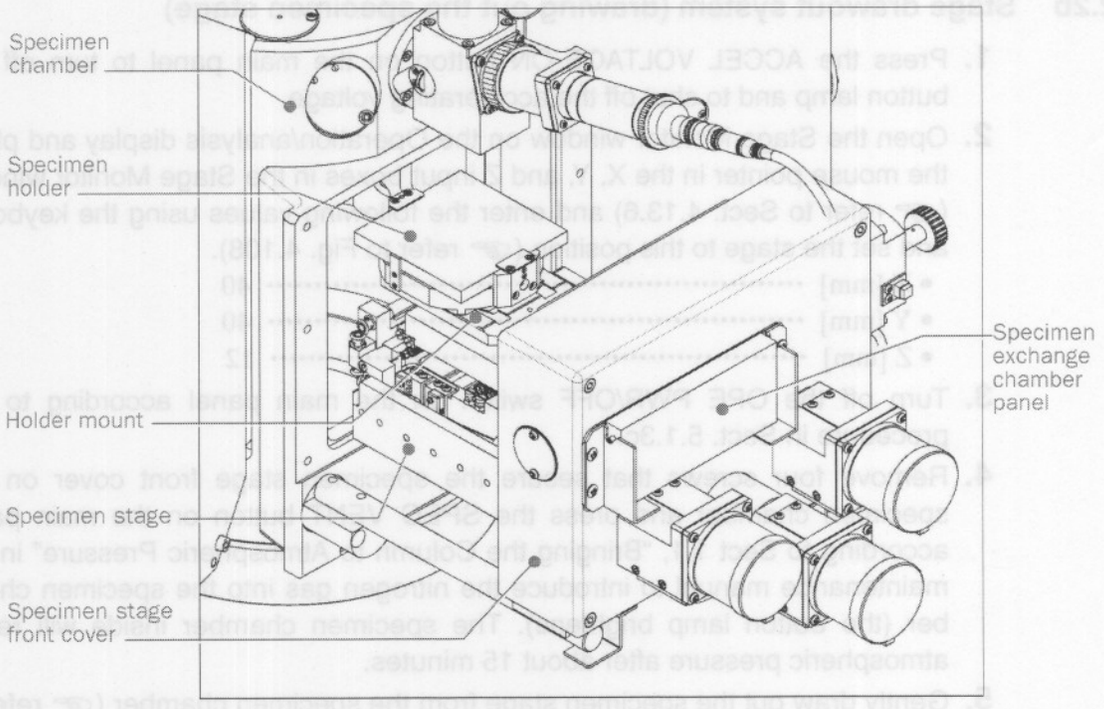


Fig. 5.17 Drawing out the specimen stage (LSS)

5.2.3 Goniometer Stage (GS)

5.2.3a Airlock system

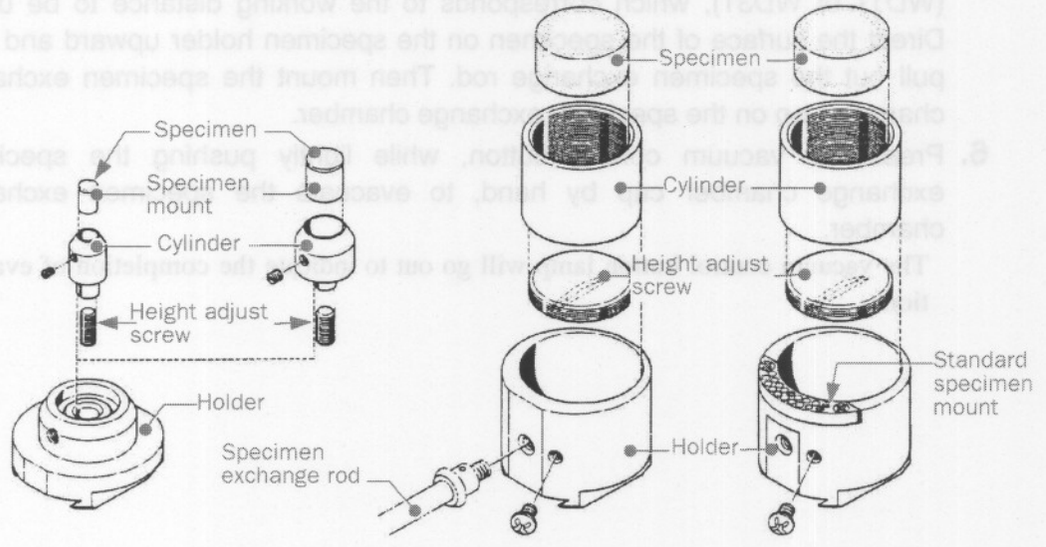
1. Insert the specimen into the cylinder (with the 32 mm diameter specimen holder, stick the specimen on the height adjust screw with conductive paint). Make the specimen surface flush with the cylinder top face by turning the height adjust screw (with the 5 mm and 10 mm diameter holders, secure the specimen and the cylinder with a screw). Then insert the cylinder into the holder (with the 32 mm diameter specimen holder, secure them with a screw).

   ✍ With the 5 mm and 10 mm diameter specimen holders, use a specimen mount as necessary. With individual holders, use conductive paint as necessary to avoid charge-up on the specimen.

2. Press the ACCEL VOLTAGE-ON button on the main panel to turn off the button lamp and to shut off the accelerating voltage.

⚠ CAUTION

Be sure to turn off the accelerating voltage to avoid any electrical accidents.



【5 mm diameter holder】 【10 mm diameter holder】 【32 mm diameter holder】 【32 mm diameter holder (with standard specimens)】

Fig. 5.18 Specimen holders (for GS)

3. Open the Stage Monitor window on the Operation/analysis display (☞ refer to Sect. 4.13.6); using the window and the specimen stage tilt and rotation controls, set the specimen stage positions as directed below.

■ Stage setting by Stage Monitor window

- When a working distance (WD) of 11 mm is used
  Click the **Sample Change** button (the specimen stage will be set to: 16 mm for X, 25 mm for Y, and 11 mm for Z)*.
- When a working distance (WD) of 31 mm is used
  Place the pointer in the X, Y and Z key input boxes and enter, from the keyboard, 16 for X [mm], 25 for Y [mm], and 31 for Z [mm] and set the stage to this position.

■ Stage setting with stage controls

- Tilt control..... 000 (0°)
- Rotation control..... 000 (0°)

4. Screw the specimen exchange rod into the specimen exchange rod screw hole of the specimen holder until it is secured.

— CAUTION ———

Be sure to screw the specimen exchange rod into the specimen holder securely, otherwise the specimen holder can be disconnected from the rod and dropped.

5. Set, to the upper position, the specimen exchange chamber cap's mark (WD11 or WD31), which corresponds to the working distance to be used. Direct the surface of the specimen on the specimen holder upward and fully pull out the specimen exchange rod. Then mount the specimen exchange chamber cap on the specimen exchange chamber.
6. Press the vacuum control button, while lightly pushing the specimen exchange chamber cap by hand, to evacuate the specimen exchange chamber.
   The vacuum control button lamp will go out to indicate the completion of evacuation.

* The specified specimen exchange position represents the default values to be set from the Stage Configuration window (refer to Sect. 4.14.1c).

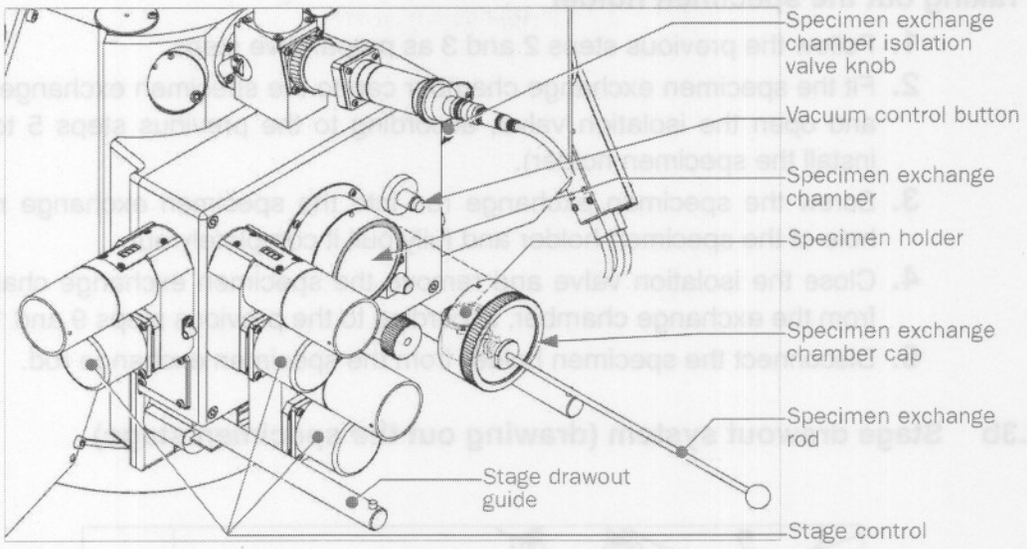


Fig. 5.19 Airlock system specimen exchange (for GS)

7. After verifying that the specimen exchange chamber is evacuated, fully pull out the specimen exchange chamber isolation valve knob to open the isolation valve (the specimen chamber lamp goes on) (☞ refer to Fig. 4.6).
8. While viewing the interior of the specimen chamber through the viewing window of the specimen exchange rod assembly, manipulate the rod so that the specimen holder is positioned completely on the specimen stage holder mount. After that, turn the rod counterclockwise to disconnect it from the holder and pull it fully out.
9. After verifying that the specimen exchange rod is fully pulled out, push the specimen exchange chamber isolation knob to its stop to close the isolation valve.

   The specimen exchange chamber will be automatically vented and will reach atmospheric pressure.
10. Press the vacuum control button (the button goes on) to vent the specimen exchange chamber.
11. Remove the specimen exchange chamber cap and exchange rod assembly from the specimen exchange chamber.

⚠ CAUTION

Be sure to remove the specimen exchange chamber cap to avoid hitting it.

Described above is the procedure for inserting the specimen holder. Taking out the holder can be performed in almost the same manner.

■ Taking out the specimen holder

1. Follow the previous steps 2 and 3 as preparative steps.
2. Fit the specimen exchange chamber cap to the specimen exchange chamber and open the isolation valve, according to the previous steps 5 to 7 (don't install the specimen holder).
3. Screw the specimen exchange rod into the specimen exchange rod screw hole of the specimen holder and fully pull it completely out.
4. Close the isolation valve and remove the specimen exchange chamber cap from the exchange chamber, according to the previous steps 9 and 10.
5. Disconnect the specimen holder from the specimen exchange rod.

5.2.3b Stage drawout system (drawing out the specimen stage)

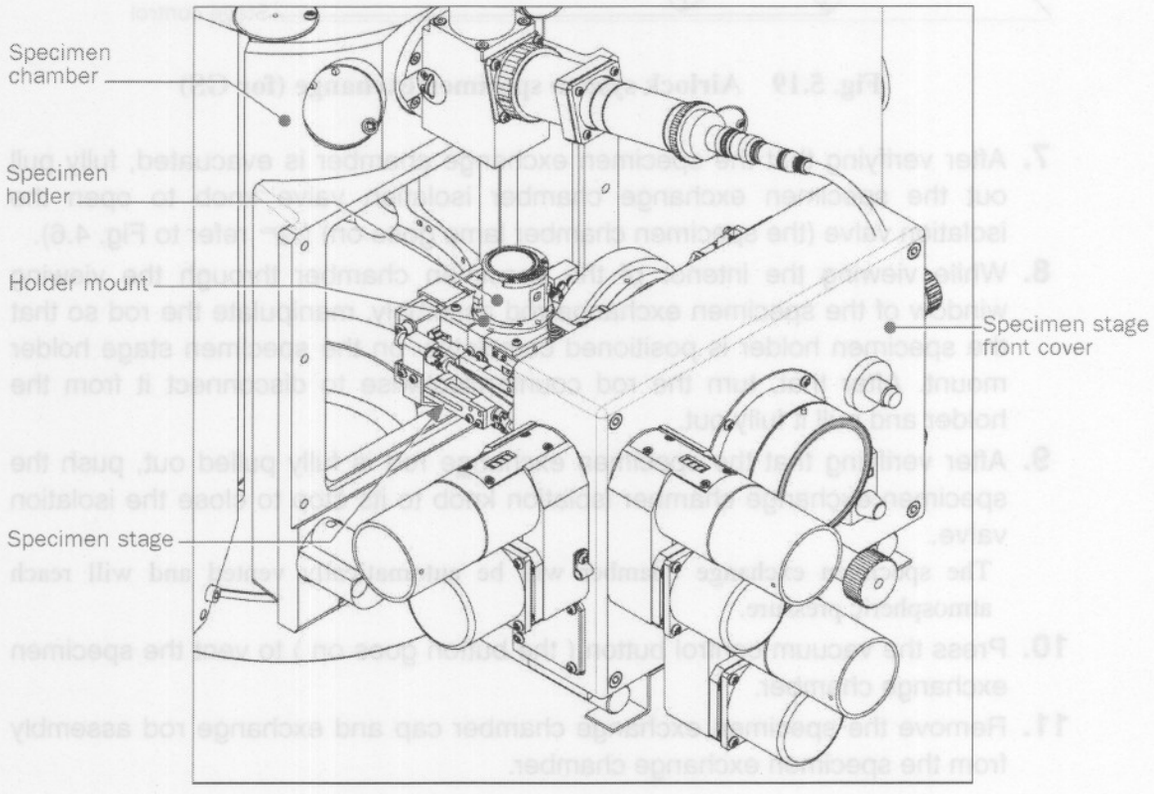


Fig. 5.20 Drawing out the specimen stage (GS)

1. Press the ACCEL VOLTAGE-ON button on the main panel to turn off the button lamp and to shut off the accelerating voltage.
2. Using the Stage Monitor window opened on the Operation/analysis display, and manipulating the specimen stage tilt and rotation controls, set the specimen stage positions as directed below (☞ refer to Sect. 4.13.6).

■ Stage setting by Stage Monitor window

Place the pointer in the X, Y and Z key input boxes and enter, from the keyboard, 16 for X [mm], 25 for Y [mm] and 30 for Z [mm] in order, and set the stage to this position.

■ Stage setting with stage controls
- Tilt control ..... 000 (0°)
- Rotation control ..... 000 (0°) or as desired

3. Turn off the OPE PWR/OFF switch on the main panel according to the procedure in Sect. 5.1.3c.
4. Remove four screws that secure the specimen stage front cover on the specimen chamber and press the SPEC VENT button on the main panel according to Sect. 1.1, "Bringing the Column to Atmospheric Pressure" in the maintenance manual to introduce the nitrogen gas into the specimen chamber (the button lamp brightens).

   The specimen chamber inside will reach atmospheric pressure after about 15 minutes.
5. Gentry draw out the specimen stage from the specimen chamber.

The specimen stage has now been drawn out and access to the specimen chamber inside is available. When the desired job is completed, follow the procedure below to replace the stage, to close the specimen chamber, and to evacuate the specimen chamber.

6. Gentry push the specimen stage back into the specimen chamber, fit the specimen stage front cover to the specimen chamber and secure them with the screws.

> **⚠ CAUTION**
>
> **When pushing the specimen stage back into the specimen chamber, take care that your fingers do not get caught in the clearances between the specimen chamber and the specimen stage front cover.**

7. Set the OPE PWR/OFF switch on the main panel to the OPE PWR position and make the operation using windows possible according to the procedure in Sect. 5.1.3c.
8. According to Sect. 1.2, "Re-evacuating the Column" in the maintenance manual, press the SPEC VENT button to evacuate the specimen chamber (the button lamp dims).

   After evacuation is complete, the HV button on the Scanning image viewing display turns blue.

5.3 OBSERVING OPTICAL MICROSCOPE IMAGES

To perform X-ray analysis by the WDS, the point of analysis on the specimen should be positioned on the focal point of the built-in optical microscope (OM). This requirement can be attained by observing an OM image on the OM Monitor window, which is formed from signals fed from the OMTV camera installed on the optical microscope in the EOS column.

5.3.1 Observing OM images

Follow the procedure below for observation of OM images:

1. Load a specimen on the specimen stage; then move the stage to a position where specimen observation is available by operating the Stage Monitor window and using the JOYSTICK CONTROLLER.
2. Start up OM Monitor referring to Sect. 4.17.
3. Click on the **OM lamp** icon on the OM Monitor window.
   The lamp in the optical microscope lights and an OM image appears on the OM Monitor window.

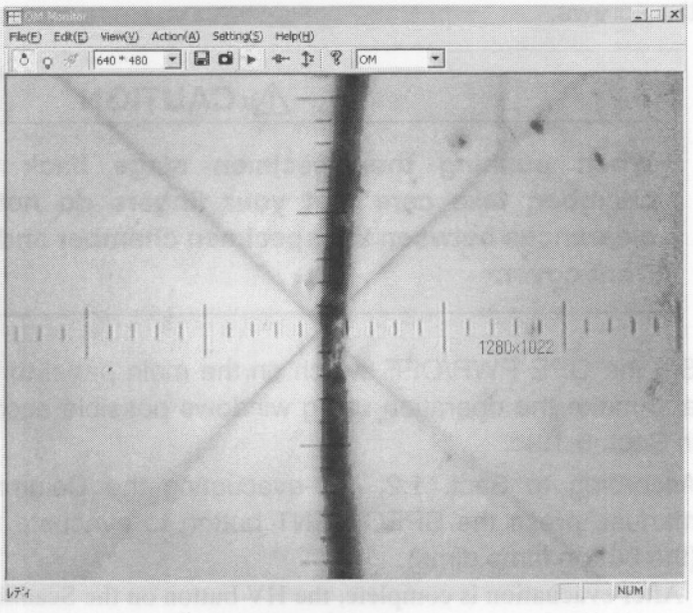


Fig. 5.21 OM Monitor window

4. While observing the OM image, focus the image using the Z-axis buttons on the JOYSTICK CONTROLLER.
   With a specimen having contrast, focus the image so that it may be observed most distinctly. With a specimen whose surface is polished (mirror surface), focus the image so that the cross marker of the optical microscope may be observed most distinctly.
5. When an image under observation is too dark or too bright, or has too little contrast to observe, adjust the lamp brightness and/or the Brightness and Contrast settings on the Video display using the OM Monitor setting dialog.

6. Click the **OM lamp** icon on the OM Monitor window to turn off the illumination lamp.

✍ When you try to measure the signal intensity of the secondary electrons or backscattered electrons quantitatively, the reflection of the illumination light on the specimen surface varies and it affects the signals.

✍ Especially, when you measure the backscattered electrons by scanning the stage in line analysis or area analysis, note that the reflection will be affected by the conditions where the stage is placed.

5.3.2 Storing OM Images

The OM images can be stored as image files.

☞ Refer to Sect. 4.17 to store the OM images.

5.4 OBSERVING SECONDARY ELECTRON IMAGES

Described hereunder are operational procedures from electron probe generation to scanning image observation. These procedures are fundamental for image observation. Usage of various functions is described in Sect. 5.4.2 onward.

5.4.1 Preparation for Observation

This section describes fundamental operations, such as setting of the emission/filament current to the saturation position, adjustment of the GUN ALIGNMENT TILT, SHIFT controls, setting of the objective lens aperture and correction of astigmatism. If these settings and adjustments have already been properly done according to the procedures given below, start with the operation stated in Sect. 5.4.2, "Using Image Selector".

5.4.1a Initial setting

Make the following settings to facilitate the subsequent operations.

1. Insert the specimen into the stage specimen stage. Then open the Present values window and make sure that the Vacuum Ready is indicated in the window to apply the high voltage.
2. Open the Electron Optical System window on the Operation/analysis display. Check the settings in the window, and change them if necessary, referring to the description below:

• Filament:	Last value
• Acc. V:	15 to 20 kV
• CL (Current):	C (for coarse) 45 (1×10^{-8} A), F (for fine) 255 or last value
• Mag (for magnification):	200 to 1000
• OL (Focus):	Last value
• Other settings:	The default settings can be used; however, if you entered into this observation from another operation, set the parameters while referring to the example shown in Fig. 5.22.

The default settings on the main panel can be used without changing them; however, if you entered into this observation from another operation, make sure that the following buttons on the operation panel are set as shown below.

- IMAGE SELECT-INST button: OFF (the button lamp is unlit.)
- DISPLAY & PHOTO-FREEZE button: OFF (the button lamp is unlit.)
- ALIGNMENT-WOBB button: OFF (the button lamp is unlit.)

3. Set the objective lens aperture selector to No. 3 (130 μm).

   ✍ The optimum aperture number for the present probe current is indicated on the Optim Apt. indicator in the Electron Optical System window. However, you may set a different number other than the indicated one except for observation that uses the minimum diameter probe.

4. Make sure that the isolation valve of the specimen exchange chamber is completely closed.

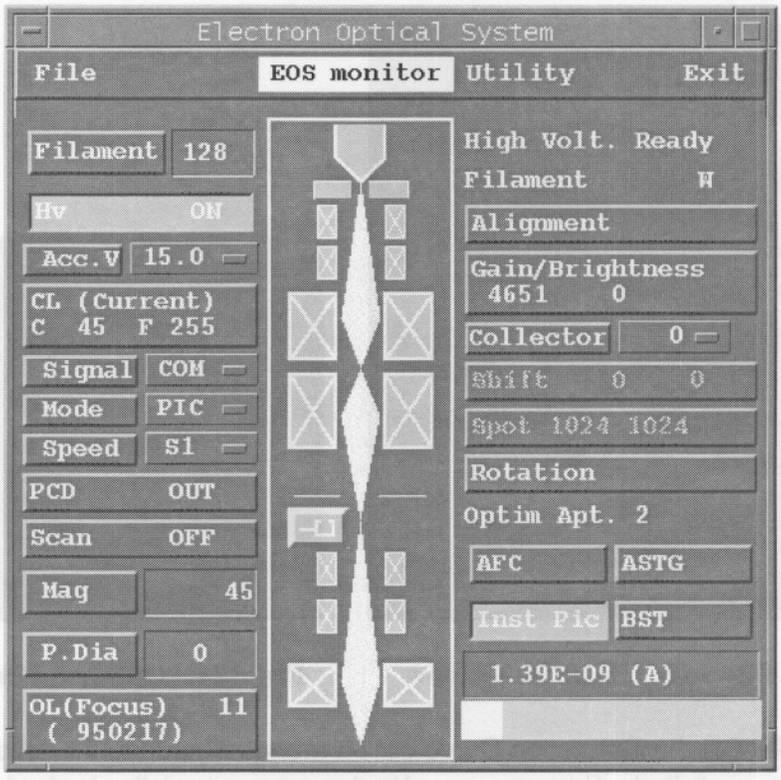


Fig. 5.22 Electron Optical System window: Example

5.4.1b Setting electron gun filament heating current

Described in the first half of this section is mainly the method of using the function of the automatic saturation-point setting of filament heating. Since the method employed in the JXA-8100/8200 series is to examine the change of the emission current occurring when changing the filament heating and judge the saturation point, an automatic heating-current setting is performed, even if the electron gun axis adjustment has not been completed.

For the cases where this automatic function cannot be used (for example, when a LaB_6 electron gun is used), refer to other methods described in the latter half of this section, such as the method of using emission patterns or the method of setting the heating current while observing the change of the probe current value.

✍ However, keep it in mind that when you use the method of observing the change of the probe current value, the electron gun axis adjustment must have been roughly completed.

■ Method of using automatic saturation-point setting function

☞ Refer to the descriptions related to Sect. 4.13.2a, "Filament Window" in Chap. 4, "Description of Each Part" as necessary.

1. Press the HT button on the Basic screen on the Scanning-image viewing display to apply the high voltage (the button turns green).
2. Click the **Filament** button in the Electron Optical System window to open the Filament window.
3. Then, open the Optional Condition window from the Filament window.

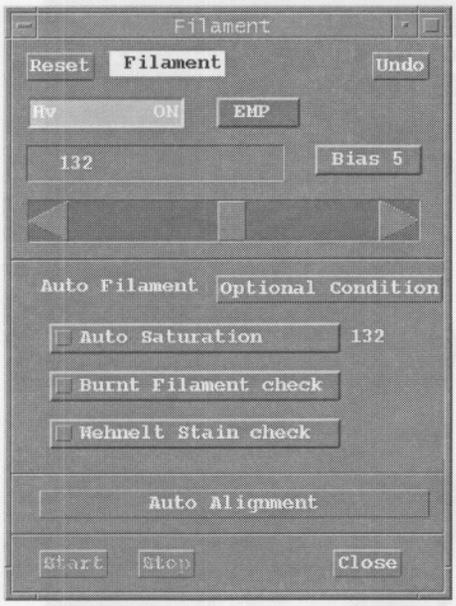


Fig. 5.23 Filament window

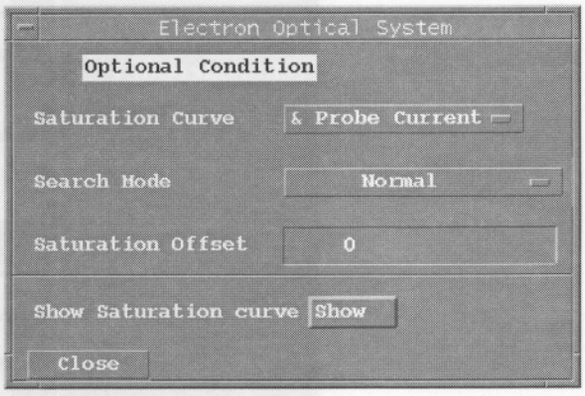


Fig. 5.24 Optional Condition window

4. Set the Saturation Curve option menu referring to the following descriptions.
   - & Probe Current: Used to carry out a daily check of filament heating or to set the saturation point when the electron gun axis adjustment has been completed.

   ✍ '& Probe Current' can be selected even when the gun alignment has not been completed, but the saturation curve produced thereby is not a right curve. No matter which curve it is, however, the saturation point is accurately judged.
5. Set the Search Mode option menu referring to the following descriptions.
   - From Present Value: Used for a daily check of filament heating or when the filament has been in use for a long time.
   - Normal: Used to set the heating of a comparatively new filament soon after filament exchange or when the accelerating voltage or the electron gun bias has been changed.
   - Show wide range: Used to observe or display the saturation curve in a wide range.
6. Set the Saturation Offset to 0 usually.
7. Press the Start button in the Filament window.

   ✍ By this operation, first, a diagnosis is made as to whether the filament has burnt out or not, and then the automatic saturation-point setting is executed.

   ✍ If the OVER EMISSION lamp on the main panel goes on and the high voltage has turned off while the saturation point is being judged, press the ACCEL VOLTAGE-ON button once so that the accelerating voltage is not applied (the OVER EMISSION lamp is unlit). Then, select a large bias number by clicking the **Bias** button in the Filament window. If the OVER LOAD lamp is still lit despite of re-attempts of operation describe above, carry out Wehnelt cap cleaning (☞ refer to the separate MAINTENANCE manual).

✍ If the accelerating voltage has been applied, the following diagnoses can be independently executed regardless of the automatic judgment of the saturation point.

- Burnt Filament check: Diagnosis as to whether the filament has burnt or not.
- Wehnelt Stain check: Diagnosis of the contamination of the Wehnelt unit.

✍ The larger the filament setting value, the larger the filament heating current, and the larger the probe current. However, if the setting value exceeds a value for the saturation point, the probe current does not increase so much and the filament life becomes shorter (☞ refer to Fig. 5.25).

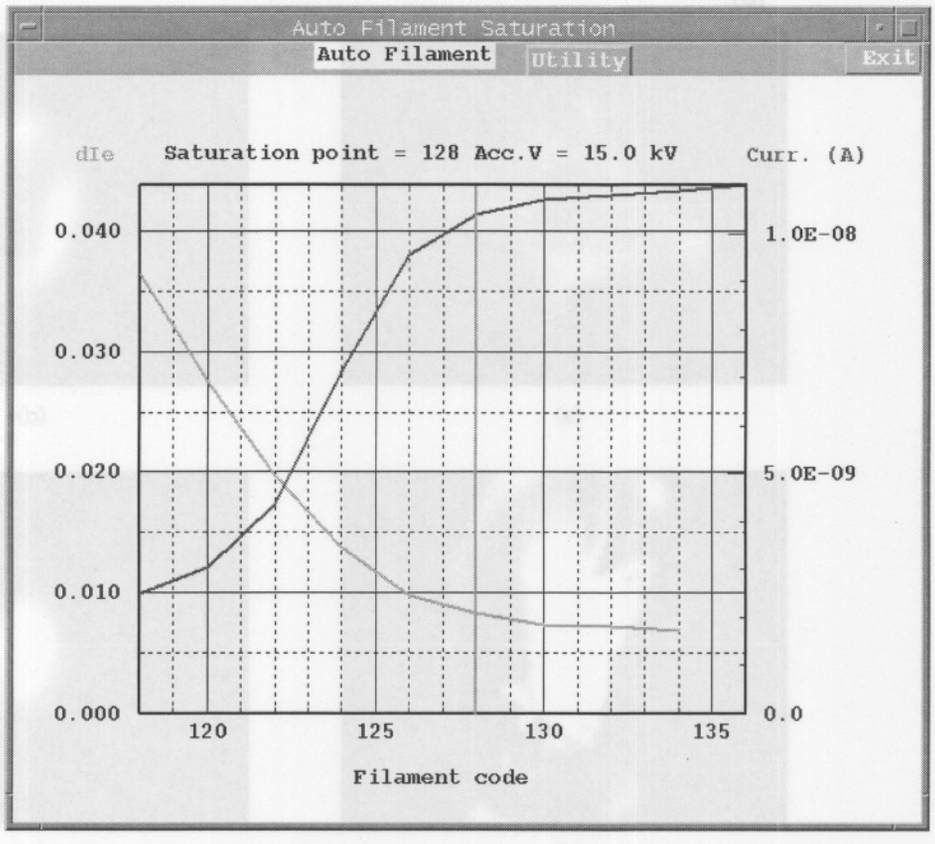


Fig. 5.25 Change in probe current with filament current

8. Since the saturation point of filament heating changes with time during which the filament is used, try to keep the filament heating optimum using "From Present Value" in the Search Mode option menu periodically (if possible, every day or at least once in three days).

✍ If you carry out maintenance in such a manner, you can make the filament life longer. For instance, when the accelerating voltage is 25 kV and the emission current is 30 – 40 μA, the filament code at the saturation point changes from around 140 or so when the filament is new, to around 110 or so when the filament has become old.

■ Method of setting saturation point using emission patterns

1. Click the **Filament** button in the Electron Optical System window to open the Filament window and click the **EMP** button in this window.
   Depending on the state of the electron gun filament being heated, emission patterns will appear on the Scanning-image viewing display as shown in Figs. 5.26 (a) to (f).
2. Click the arrowhead (▶) on the scroll bar in the Filament window to gradually increase the setting number for the filament code, and determine the value (saturation position) so that the center of the circular pattern (d) on the Scanning-image viewing display may become most bright as shown in (e).

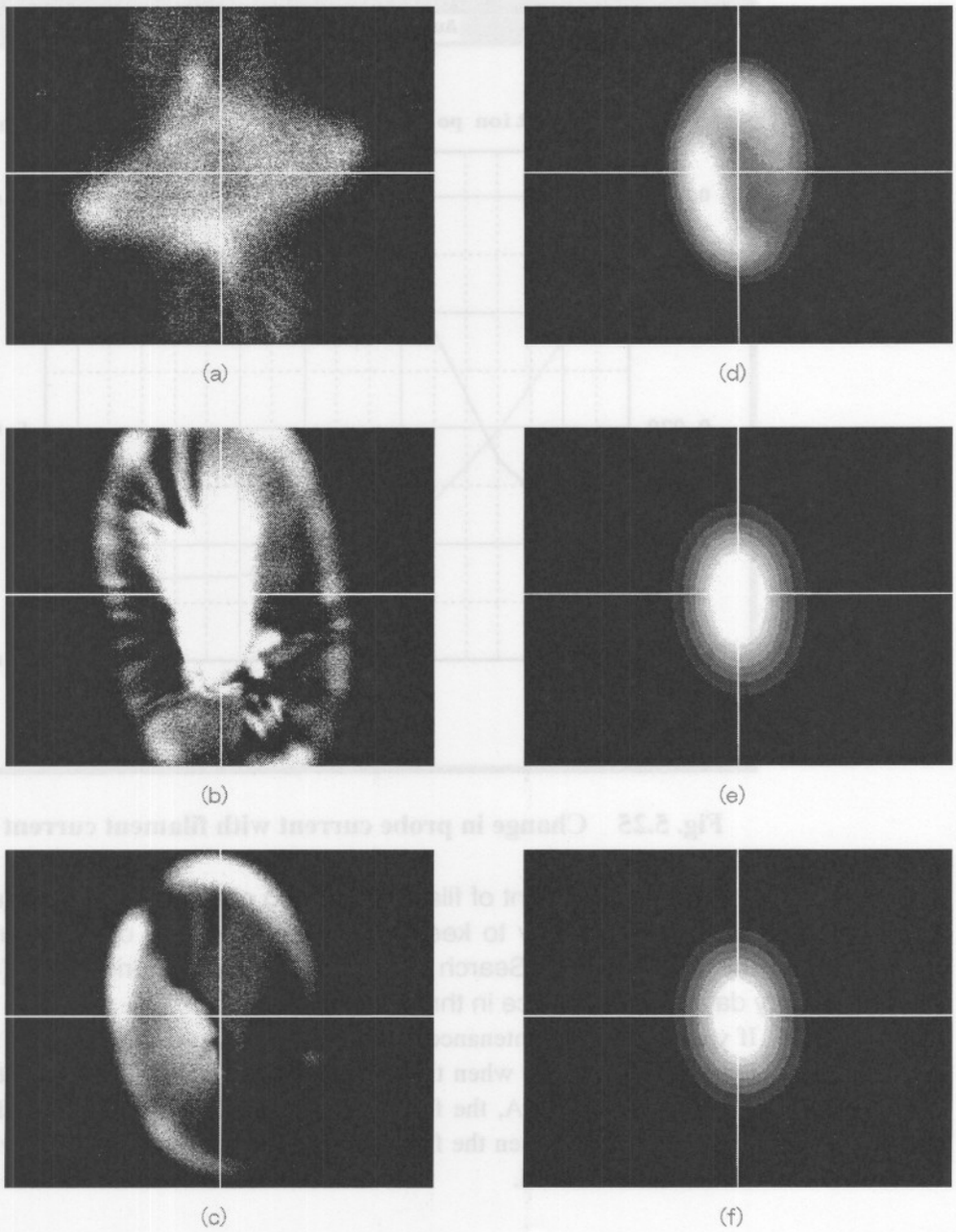


Fig. 5.26 Setting saturation point using emission patterns

■ Method of observing change of probe current value

1. Provisionally set the filament heating (for example, to 140 in the filament code) and adjust the electron gun tilt axis (Gun Tilt) and the electron gun position (Gun Shift), referring to the subsequent sections.
2. Click the **PCD** button to insert the Faraday cup into the electron beam path and measure the probe current.

   ✍ Provisionally set the probe current to approximately 10^{-9} A to 10^{-8} A.
3. Decrease the filament code once until the probe current lowers by 10% to 30%. Then, increase the filament code again. Stop the increase when the probe current changes approximately 0.5% to 1% each time you increase the filament code one.

   ✍ The values of this change are approximate ones usable when the Wehnelt cap position and the gun bias are set to the standard values (☞ refer to separate MAINTENANCE manual).

5.4.1c Adjusting electron gun tilt axis (tilt in alignment)

Adjust the electron gun tilt axis after having set the electron gun filament heating current described in the preceding Section.

1. Click the **Alignment** button in the Electron Optical System window to open the Alignment window; select tilt adjustment by clicking the **Tilt** button.
2. Click the **EMP** button in the Alignment window to display the emission pattern.

   The CL (Current) is automatically set to C (for coarse): 45 (1×10^{-8} A) and F (for fine): 255.

   ✍ When no emission pattern is displayed after the above procedure, set the Contrast to 6000 or more and double-click the five places in the two-dimensional display area in the Alignment window and search for the place where the emission pattern appears.

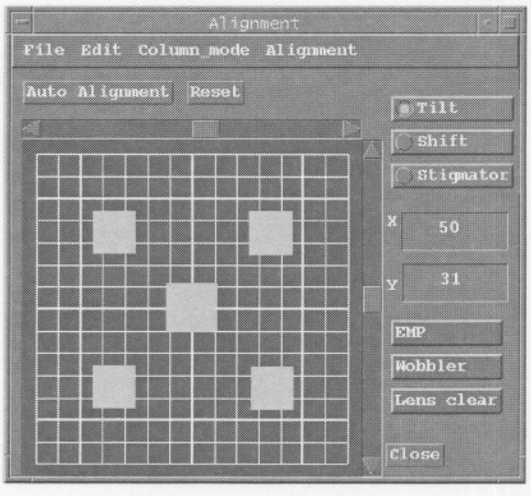
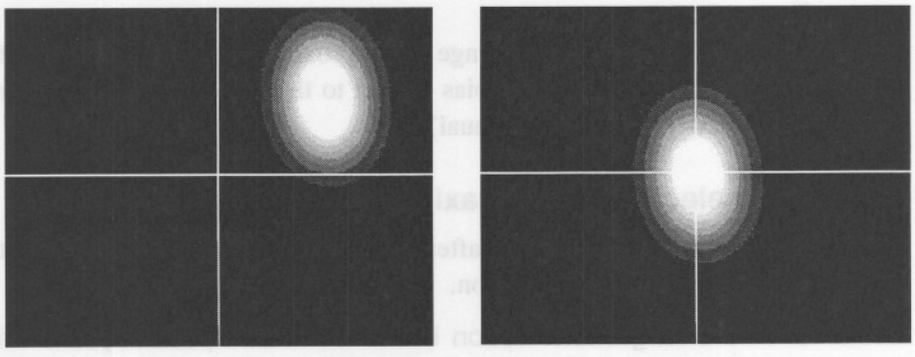


Fig. 5.27 Searching for emission pattern in Alignment window

When no emission pattern appears even with this procedure, check the electron gun filament for being burnt out, referring to the separate MAINTENANCE manual. Adjust the electron gun tilt axis again.

3. Drag the block cursor (■) in the two-dimensional display in the Alignment window and move the center of the emission pattern to the center of the display. When you have roughly set an emission pattern to the center, press the SCANNING MODE-FINE VIEW button on the operation panel to slow down the scanning speed. You can adjust the position more accurately. Click the arrow buttons (▲▼◀ ▶) in the Alignment window for fine adjustment of pattern shift as necessary.



[Before adjustment] [After adjustment]

Fig. 5.28 Tilt adjustment with emission pattern monitor

— CAUTION ———

If the electron gun bias value (the Bias value in the Filament window) is set small, the value for the electron gun filament should be set large accordingly. On this occasion, the filament current increases more than usual. Thus keep it in mind that the filament life will be shortened accordingly.

5.4.1d Adjusting electron gun position (Alignment Shift)

1. Open the Electron Optical System window and click on the **Mag.** button to open the Magnification window; then set the magnification value on the Scanning-image viewing display to 5,000 to 10,000.
2. Move the specimen stage using the JOYSTICK CONTROLLER or other methods and locate a feature image (about 1 cm long on the Scanning-image viewing display) to the center of the Scanning-image viewing display.

   If the feature image is out of focus, adjust the focus using the FOCUS knob or the FOCUS-AUTO button on the operation panel. Pressing the FOCUS-AUTO button adjusts the focus together with the contrast and brightness automatically.
3. Make sure that the COARSE/FINE-FINE button lamp in the PROBE CURRENT box on the operation panel is unlit (COARSE). If it is lit (FINE), press the button to turn the lamp off (COARSE).
4. Open the Alignment window from the Electron Optical System window and click the **Shift** button to select it.
5. Monitor the feature image on the Scanning image viewing display by gradually turning the PROBE CURRENT knob clockwise (the CL (Current) C F button in the Electron Optical System window to increases the C (Coarse) value). If the feature image moves, position the cursor on the block cursor (■) in the two-dimensional display in the window, and drag it so that the feature image on the Scanning-image viewing display returns to previous position.

   — CAUTION —

   If a state where the Coarse value is high continues for a long time, the secondary electron detector may be damaged. Finish the adjustment at this step as soon as possible.

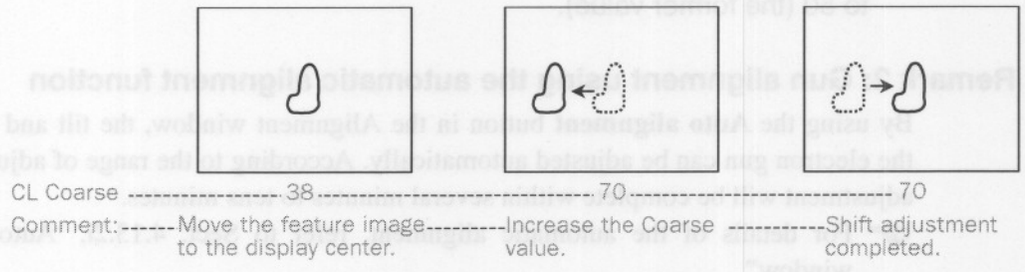


Fig. 5.29 Adjustment of Alignment Shift

6. Correct feature image shift on the Scanning-image viewing display so that the deviation of its shift may be within 1 μm when the Coarse value is increased from 38 to 70 according to step 5.
7. Turn the PROBE CURRENT knob counterclockwise, set the Coarse value to 38 or less (the former value) and click the **Close** button in the Alignment window to close the window.

■ Remark 1: Positional adjustment of electron gun using probe current change

Besides the method of using image shift that occurs when the CL (Current) C value is changed, the method described below is also available, which adjusts the probe current to be maximum when the CL (Current) C value is decreased. With this method, no electron probe illuminates the specimen, causing the specimen and the secondary electron detector to be damaged and obviating focusing and astigmatism correction for secondary-electron image observation.

1. Click the **PCD** button (or on the PCD display in the electron optical system image) in the Electron Optical System window to insert the Faraday cup into the electron beam path.
2. Click the **Alignment** button to open the Alignment window and click the **Shift** button to select it. Also open the Beam Current window by clicking the **CL (Current) C F** button.
3. While monitoring the probe current indicator in the Electron Optical System window and gradually increasing the value in the Coarse input box in the Beam Current window using the scroll bar, stop changing the value at a step where the probe current decreases. Drag the block cursor (■) in the two-dimensional display in the Alignment window so that the probe current becomes maximum.
4. Repeat the adjustment at the previous step until the value in the Coarse input box becomes maximum.

   After completion of this adjustment, executing hysteresis elimination under the following conditions makes a probe current of about 10 μA available:

   Accelerating voltage 25 kV, number of objecting lens aperture 1 (240 μm diameter) and the value in the Coarse input box maximum.
5. Return the value in the Coarse input box in the Beam Current window to 40 to 50 (the former value).

■ Remark 2: Gun alignment using the automatic alignment function

By using the **Auto alignment** button in the Alignment window, the tilt and position of the electron gun can be adjusted automatically. According to the range of adjustment, the adjustment will be complete within several minutes to tens minutes.

☞ For details of the automatic alignment, refer to Sect. 4.13.2i, "Auto alignment window".

■ Remark 3: Elimination of hysteresis

The probe current may not returns to the former value due to the hysteresis of the condenser lens even if you try to return it to the former setting after you have changed the value in the Coarse input box in the Beam Current window largely. If this happens, execute hysteresis elimination by clicking the **Lens Clear** button in the Alignment window.

5.4.1e Method of observing secondary-electron images

This section describes the operations from generation of the electron probe to displaying a secondary-electron image.

The default setting for the accelerating voltage is 15 to 25 kV. Actually, the proper value should be selected, depending on the type of specimens and the purpose of observation (☞ refer to Figs. 5.30a to d).

Generally, observation at low accelerating voltages has the following advantages:

- Secondary electrons increase in the amount of generation, enhancing image quality.
- An uneven fine surface of the specimen can be observed.
- Poor conductive specimens can be avoided from charge-up.

However, use of low accelerating voltages decreases the emission current, resulting in a decrease in the probe current that illuminates the specimen. Since observation at a low accelerating voltage is easily affected by the external magnetic field, care should be taken for the installation room when moving the instrument.

The image quality of a secondary-electron image depends on the amount of electron emission. As the amount of electron emission decreases, the amount of signals to be detected also decreases, lowering the image quality.

Increasing the probe current is thus necessitated for observation of specimens that slightly emit secondary electrons. Figs. 5.30e and f compare secondary-electron images obtained by varying the probe current. As is evident in the figures, the image quality is deteriorated as the probe current decreases. In this event, click the **CL (Current) C/F button** in the Electron Optical System window to open the Beam Current window. Then adjust the values (probe current) in the Coarse input box in this window while monitoring the probe current/absorption current indicator.

1. Load the specimen holder on which a specimen to be observed is mounted to the specimen stage.
2. Display the optical microscope image on the OM monitor; then adjust the Z-axis of the stage using the JOYSTICK CONTROLLER to focus the image.
3. Make sure that the Vacuum indication in the Present values window is Ready; then click on the **HT** button in the Basic screen on the Scanning-image viewing display.

   The HT button turns green and the high voltage (accelerating voltage) will generate and the filament will be heated.
4. Check and set the settings on the operation panel as follows:
   - DISPLAY & PHOTO-FREEZE button: OFF (the button lamp is unlit)
   - ALIGNMENT-WOBB button: OFF (the button lamp is unlit)
5. Press the PCD-IN button on the operation panel to pull out the PCD (the switch lamp goes out) and to display the scanning image on the Scanning-image viewing display.
6. Select field of view using the JOYSTICK CONTROLLER.

   ✍ When observing an image at high magnifications, click the **STAGE** icon on the Basic screen to turn off the stage-shift mode (the icon turns gray) and activate the image-shift mode. After that, you can move the image on the display electrically in the minute range, without moving the stage, by dragging the image on the Basic screen. Moreover, pressing the Shift icon on the Basic screen returns the X and Y shift amounts to 0,0.

7. Adjust the FOCUS knob on the operation panel to focus the image.

   ✍ If you have largely changed the excitation current of the objective lens to adjust the focus, press the Lens clear button in the Alignment window to remove the hysteresis for accurate focusing.

   You can automatically adjust the focuses of secondary-electron images and backscattered-electron images (compositional and topographic images, and their mixture) by pressing the FOCUS-AUTO button on the operation panel. The automatic adjustment functions are described in a separate section; use this AUTO button as an alternative to the FOCUS knob.

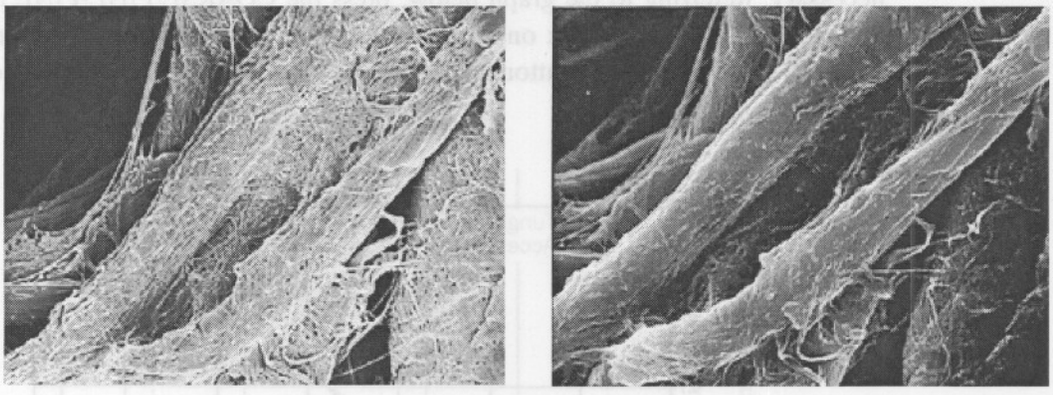
8. Set the magnification to the desired value using the MAGNIFICATION knob on the operation panel; then adjust the focus precisely using the FOCUS knob.

   ✍ The magnification shown in the Scanning-image viewing display is based on one for the picture size (9 cm × 12 cm). When you store the observation images as data, you can print the images having the picture size using optional software such as SmileView.

9. To turn off the high voltage (accelerating voltage) after completion of image observation, click the **HT** button on the Basic screen to turn the button color from green to blue.

✍ In X-ray analysis during observation of secondary-electron image, which requires a high probe current, select **COL** of the LINK function to turn on after selecting **Column – Control** from the menu buttons on the Basic screen so that setting of the collector is automatically changed and the detector will be protected.

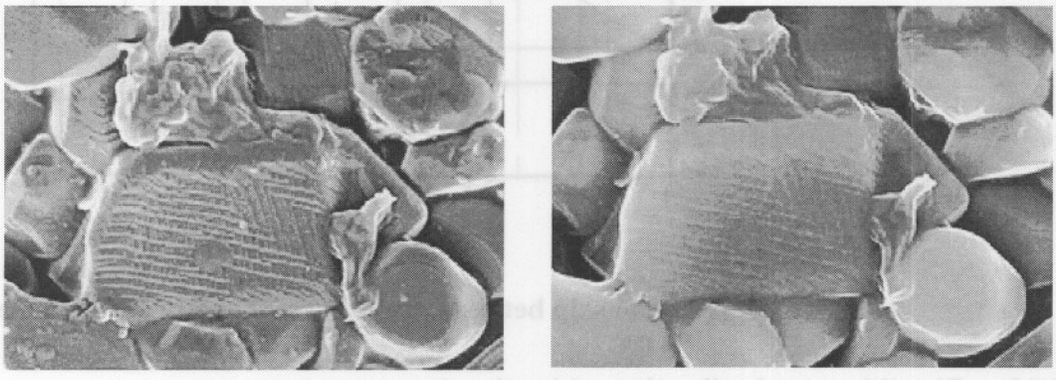
- **Specimen: Filter paper**



Accelerating voltage: 5 kV ---------- Accelerating voltage: 25 kV

(a) (b)

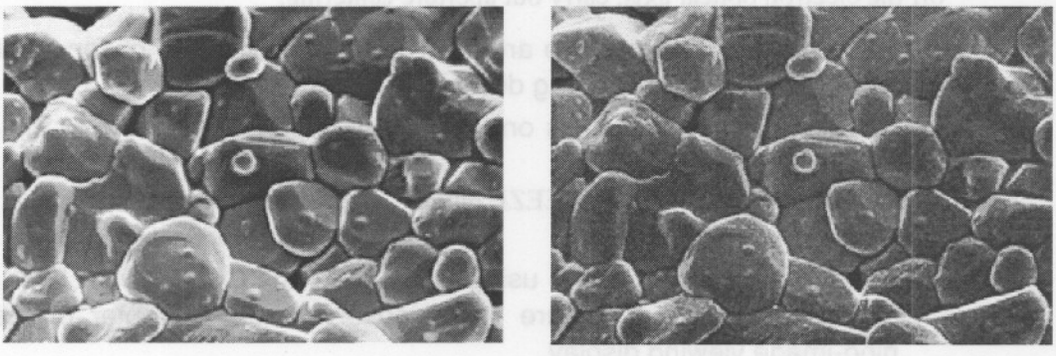
- **Specimen: Sintered compact**



Accelerating voltage: 5 kV ---------- Accelerating voltage: 25 kV

(c) (d)

- **Specimen: Ceramics**



Probe current: 1 nA ---------- Probe current: 10 pA

(e) (f)

Fig. 5.30 Secondary electron images dependent on accelerating voltage and probe current

■ High resolution image

To obtain a high resolution image, setting the probe current as small as possible is necessary. Referring to the graph below, press the COARSE/FINE-FINE button in the PROBE CURRENT box on the operation panel to change over the function of the knob placed under the button and adjust the knob to optimize the probe current.

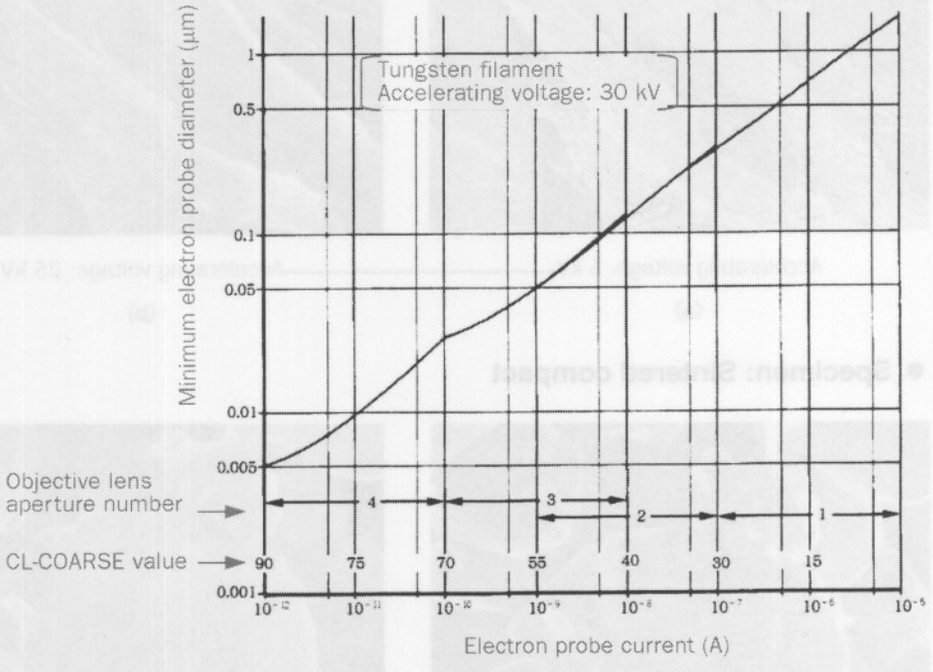


Fig. 5.31 Relationship between probe current and probe diameter

5.4.1f Checking and adjusting objective lens aperture

Checking the aperture centering is necessary when you change the objective lens aperture or when you change the accelerating voltage, the specimen stage working distance, or the settings for the electron gun tilt and positioning largely. If the aperture is off the electron optical axis, carry out aperture centering.

1. Set the magnification value around 1000 so that you can observe images on the Scanning-image viewing display.
2. Check and set the buttons on the operation panel according to the settings below.
   - DISPLAY & PHOTO-FREEZE button: OFF (the switch lamp is unlit)
   - Alignment-WOBB button: OFF (the switch lamp is unlit)
3. Move the specimen stage using the JOYSTICK CONTROLLER or another method to locate a feature to be observed to the center of the Scanning-image viewing display.
4. If the feature image is out of focus, focus the image with the FOCUS knob on the operation panel.
5. Press the WOBB button on the operation panel (ON: the button lamp blinks).

When the aperture is positioned properly, the feature image at the center of the Scanning-image viewing display will not shift. Thus, skip the next step. If the feature image shifts, proceed to the next step.

6. Adjust the X and Y fine adjustment knobs of the objective lens aperture selector to minimize the shift of the feature image.

   ✍ For more precise aperture centering, carry out the centering, with the magnification increased to 5,000× to 20,000×. When the contour of the feature image shifts concentrically toward the display center of the display, the centering of the aperture is completed.

7. Press the WOBB button to release its function (the button lamp goes out).

5.4.1g Checking and correcting astigmatism

If astigmatism exists in the electron optical system, you cannot adjust the focus of the image properly and cannot get a clear image. Therefore, accurate astigmatism correction is required to obtain high-resolution clear images before observing and photographing images.*

Although you cannot clearly distinguish astigmatism when the magnification is 1000× or lower, when you increase the magnification of the image, a directional blurring is clearly distinguished around the focusing point. As shown in the lower row photos of Fig. 5.32, the image-blurring directions are at right angles to each other for underfocus and overfocus. When astigmatism is absent as shown in the upper row photos of Fig. 5.32, the image shows only isotropic blurring due to defocus, but does not shows any directional blurring.

When astigmatism increases or the image-blurring direction (that is, the direction of astigmatism) changes, contamination in the electron beam path is suspected. When this happens, clean the column to remove the cause of astigmatism. Moreover, in the following cases, the amount and direction of astigmatism may be changed. Check and correct them as necessity.

- When you change the accelerating voltage
- When you change the objective lens aperture position or replace the aperture foil
- When you observe a magnetic specimen
- When you change the working distance (WD)
- When you greatly change the probe current
- When you clean the column

1. Set the magnification to the value that you used for image observation or slightly higher.
2. Check and set the settings on the operation panel as follows:
   - DISPLAY & PHOTO-FREEZE button: OFF (the button lamp is unlit)
   - ALIGNMENT-WOBB button: OFF (the button lamp is unlit)
3. Move the specimen stage using the JOYSTICK CONTROLLER or another method to locate a feature to be observed to the center of the Scanning-image viewing display.

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* You can carry out astigmatism correction of secondary-electron images automatically by pressing the STIG button in the ALIGNMENT box on the operation panel. The automatic adjustment functions are described in a separate section; use this STIG button as an alternative to the X and Y knobs.

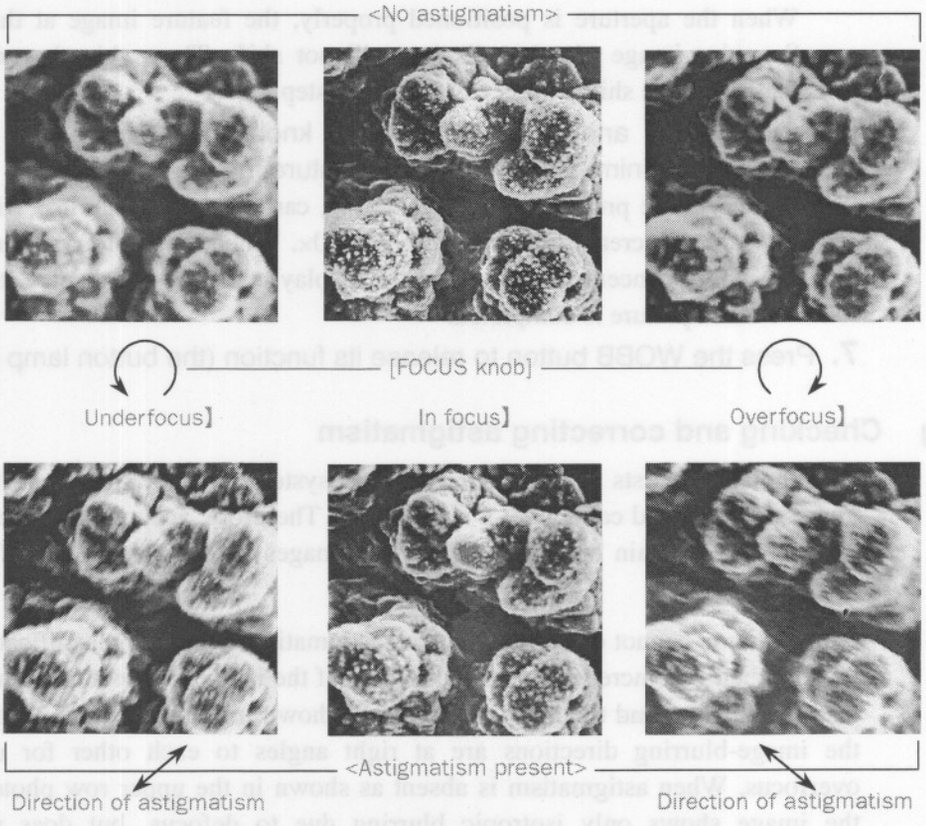


Fig. 5.32 Focusing and astigmatism

4. Focus the image using the FOCUS knob on the operation panel.
   If the image shows only isotropic blurring at the underfocus and overfocus positions near the focus point as shown in the upper row photos of Fig. 5.32, you can omit the following steps because the image shows no astigmatism.
   However, if the image shows directional blurring in right angle each other at the underfocus and overfocus positions near the focus point as shown in the lower row photos of Fig. 5.32, you have to proceed the following steps because the image shows astigmatism.
5. Check and set that the lamp of the ALIGNMENT-STIG button is lit (that is, the operation is in the astigmatism correction mode).
6. Adjust the ALIGNMENT X and Y knobs on the operation panel to obtain the clearest image.
   ✍ If you cannot carry out the above operation smoothly, return the positions of the X and Y knobs to the center (STIG-X, -Y = 0, 0) and proceed from step 4 again.
7. Repeat steps 4 and 6 so that no astigmatism (the phenomena that shows directional blurring of the image) appears as shown in the upper row photos of Fig. 5.32 when you change the focusing position.

■ Astigmatism correction by observing optical microscope (OM) image

By carrying out the following steps, you can roughly correct the astigmatism without observing secondary-electron images.

1. Load the standard specimen holder on which the 32 mm diameter standard specimen is mounted to the specimen stage. Bring the stage to the position of the standard specimen ZrO_2 using the JOYSTICK CONTROLLER (☞ refer to Table 4.2).
2. Open the OM Monitor window; then click on the OM lamp icon to turn on the lamp of the optical microscope. After that, display the OM image on the OM monitor by adjusting the Z-axis using the JOYSTICK CONTROLLER.
3. Press the SCANNING MODE-PRB SCAN button on the operation panel to make it inactive (button lamp goes out): then press the PCD-IN button to pull out the Faraday cup from the electron beam path (the button lamp goes out) so that the electron probe illuminates the specimen.

   The cathodeluminescence on the surface of the standard specimen ZrO_2 by electron probe illumination can be observed on the OM Monitor window.
4. Adjust the probe current by manipulating the PROBE CURRENT COARSE/ FINE button and the knob on the operation panel so that you can observe the luminescence spot clearly.
5. While observing the luminescence spot, adjust the FOCUS knob on the operation panel to minimize the spot. This carries out focus adjustment of the electron optical system.
6. If the cathodoluminescence spot is elliptic during focus adjustment, press the ALIGNMENT-STIG button on the operation panel and manipulate the X and Y knobs so that the spot becomes circular for astigmatism correction. Also, adjust the FOCUS knob to minimize the spot.

5.4.1h Automatic adjustment functions for image observation

Focus, astigmatism, and contrast and brightness of images can be adjusted using the automatic adjustment functions of the AUTO button on the operation panel. The automatic functions (for focusing, astigmatism correction, and contrast and brightness of images) that are performed by pressing the AUTO button can be selected in advance using the settings specified in the AUTO box in the Operation window that is opened by selecting **Setup – Operation** from the menu buttons in the Basic window.

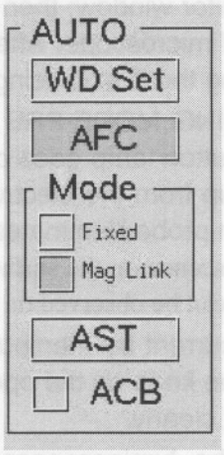


Fig. 5.33 AUTO box in Operation window

AUTO box: Set the functions related to the AUTO button on the operation panel.

- WD Set: Calculates the focus value from the position of the working distance and set the focus using that value.
- AFC: Selecting this button enables the AUTO button to perform automatic focusing.
- Mode
  - Fixed: Selecting this button fixes the search area.
  - Mag Link: Selecting this button links the search area to the magnification value.
- AST: Selecting this button enables the AUTO button to perform both automatic focusing and automatic stigmator.
- ABC: Selecting this button enables the AUTO button to perform automatic adjustment of contrast and brightness of the image in combinations with the other selected automatic functions.

1. Carry out the operations for displaying a secondary-electron image or backscattered-electron image.
2. Change the settings in the AUTO box if necessary.
3. Press the AUTO button on the operation panel.
   Automatic corrections are performed within several to tens seconds depending on the settings in the AUTO box.

✍ For specimens of some shapes, the automatic adjustment may not work. If this happens, carry out the adjustment in the previous sections.

5.4.2 Using Image Selector

Mixed images (added images) can be displayed by setting the image selector in the observation condition display buttons on the Basic screen. The methods for displaying the images of various input signals that are optionally selected from the menu items and using the image selector button that are described in the separate section and those are not described here.

In the selected items, an AUXn is used when you use an optional detector.

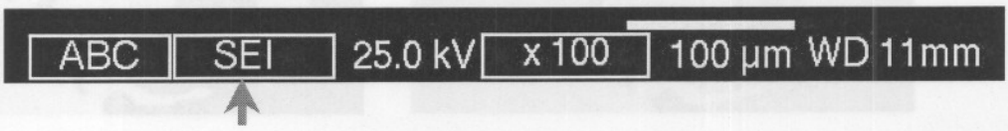


Fig. 5.34 Image selector button

■ Displaying the mixed (added) images

The method for displaying added images (ADD IMAGEs) by mixing two or more different video signals is described here.

Various combinations of video signals are available for added images, for examples, addition of a secondary-electron image and a backscattered-electron image (composition image: COMP), and an X-ray image, addition of a backscattered-electron image and an X-ray image, and addition of X-ray images obtained from different channels of spectrometers (☞ refer to the photos of Fig. 5.35 Examples of added images).

The contrast and brightness of an added image are determined by settings of the IMAGE-CONTRAST and BRIGHTNESS knobs on the operation panel for the secondary-electron image, and settings of the corresponding knobs for other images.

1. Adjust the contrast and brightness of the images to be added to prepare the conditions for displaying.
2. Select **Setup – Add Image** from the menu buttons on the Basic screen to open the Add Image window; then specify two or more images to be added in the window.
3. Display **ADD** by clicking the Image selector button to display the added image.

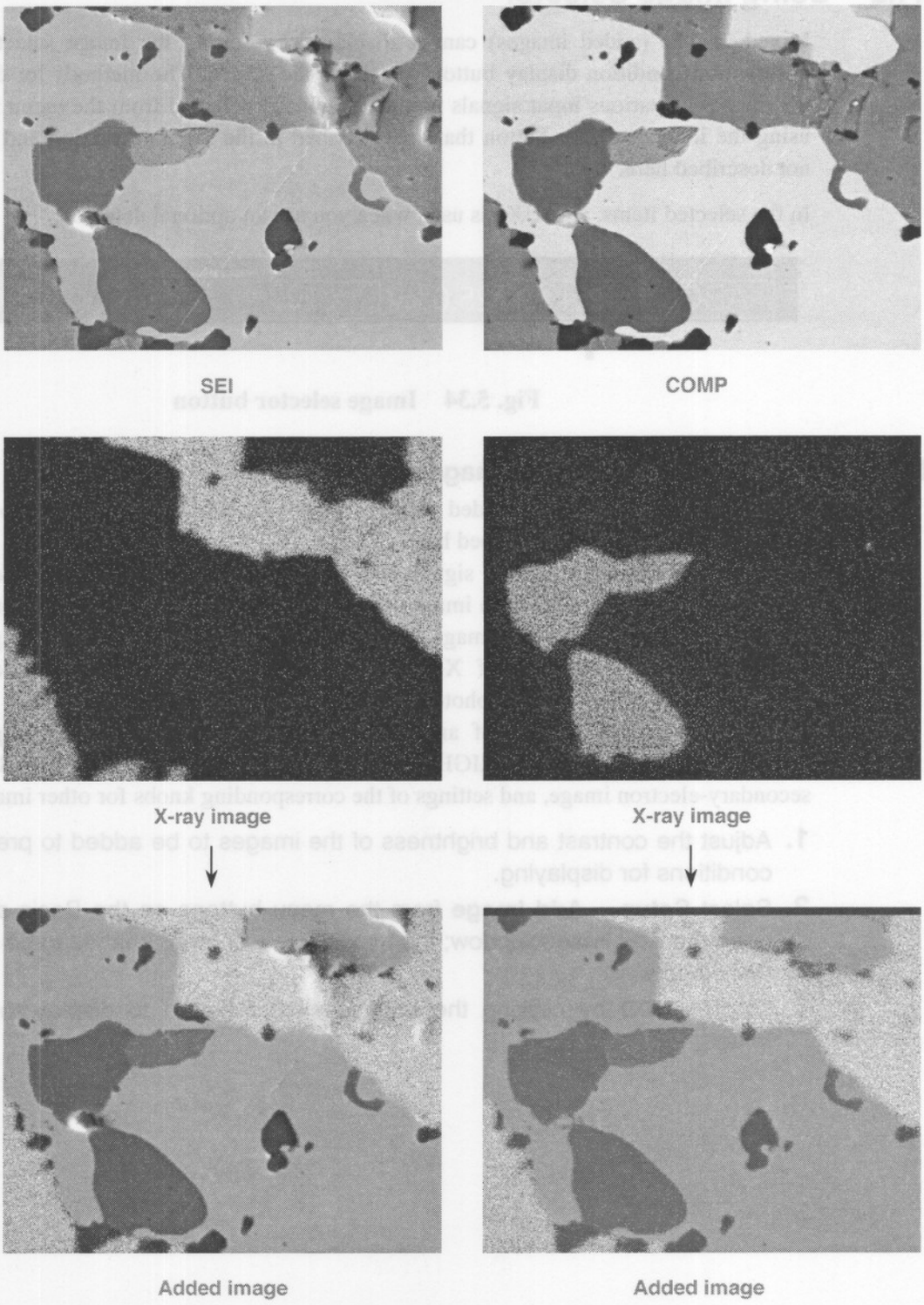


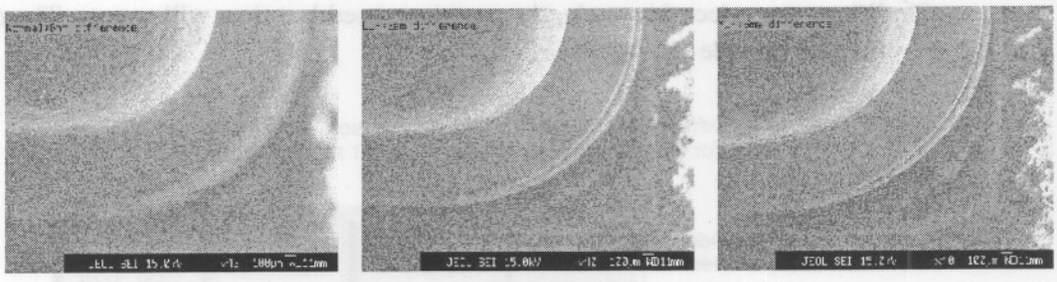
Fig. 5.35 Examples of added images

5.4.3 Using large Depth-of-Focus (LDF) Mode and Maximum Depth-of-Focus (MDF) Mode

In observing rugged or highly-tilted specimens, the depth of focus tends to be insufficient in the normal (NOR) mode. Especially, it is very difficult to focus the entire observation area on the specimen if the angles of the tilted surfaces in the observation area is not uniform.

The LDF mode allows observation at 5 times the normal depth of focus without changing the objective lens aperture and the working distance. Therefore, this mode is very effective for observation of those specimens (a depth-of-focus of ±1 mm is available when the objective lens aperture number is set to 4 (70 μm diameter), the accelerating voltage to 25 kV, and the probe current to 1 nA). The MDF mode allows image observation with the maximum depth-of-focus in specified electron optical system conditions. Furthermore, use of the LDF mode or MDF mode in the energy dispersive X-ray spectrometer (option), which has higher analysis capabilities in a low magnification range and undergoes less affection by rugged specimens than the wavelength dispersive X-ray spectrometer, ensures higher precision analysis of rugged specimens at low magnifications than ever.

1. Select **Column-Control** from the menu buttons on the Basic screen to open the Control window; then specify **NOR** (normal) in the Column Mode box, and display the image of a specimen.
   ✍ To deepen the focus in image observation, select the objective lens aperture with a smaller diameter.
2. Change the column mode in the Column Mode box from the NOR to LDF or MDF mode.
   ✍ In the LDF or MDF mode, the instrument sets the conditions to get the largest depth-of-focus according to the accelerating voltage and probe current that you specified. For this reason, setting ranges for the probe current and the probe diameter are limited in those modes. That is, you should set the image observation conditions before you select the LDF or MDF mode.
3. Adjust the focus on the image using the FOCUS knob on the operation panel as necessity.
4. To return to the normal (NOR) mode from the LDF or MDF mode, specify **NOR** on the Column Mode box in the Control window.



NOR LDF MDF

Fig. 5.36 Differences of images between NOR, LDF, and MDF modes

5.4.4 Various Image Observation Modes

The image observation modes can be roughly divided to four. You can select these modes from the icons on the menu bar of the Basic screen.

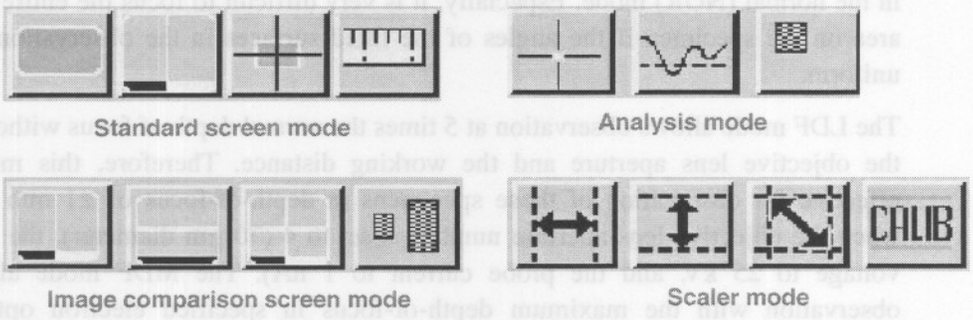
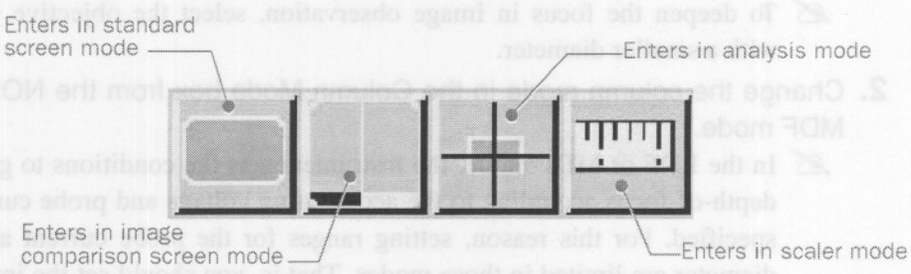


Fig. 5.37 Image observation icons

Details of each mode are as follows.

5.4.4a Standard screen mode

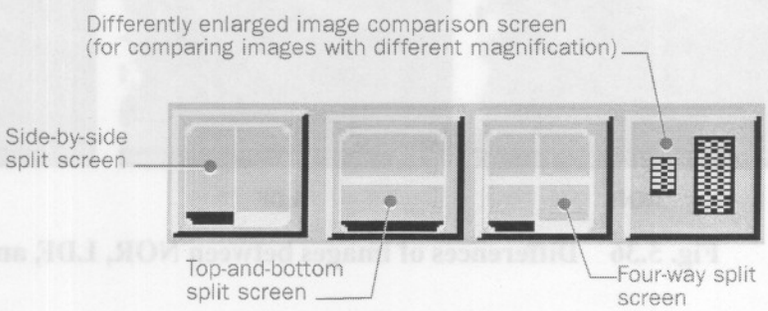
The standard screen mode is used in normal image observation. When you start the instrument, the icons of this mode will appear.



5.4.4b Image comparison screen mode

The image comparison screen mode divided the screen of the Scanning-image observation display into two or four, and display images in the partitions individually. This can be used to compare images.

✍ When you select this mode, the partitions used last time will appear. The default is the side-by-side split screen.



■ Display of side-by-side split screen

This is used to compare two different images (for example, a secondary-electron image and a backscattered-electron image). When you click this icon, the icon turns green and the screen is partitioned into two parts (left and right). The operation in this mode is the same as that in the normal mode.

● Operations in this mode

- Manipulating images

  You can manipulate the left and right images independently. By clicking the observation condition display area located at the bottom of the observing image as shown in Fig. 5.38, the screen becomes active. When the screen is active, the background of the observation condition display area turns black and you can manipulate the image. When the screen is not active, the area turns white.

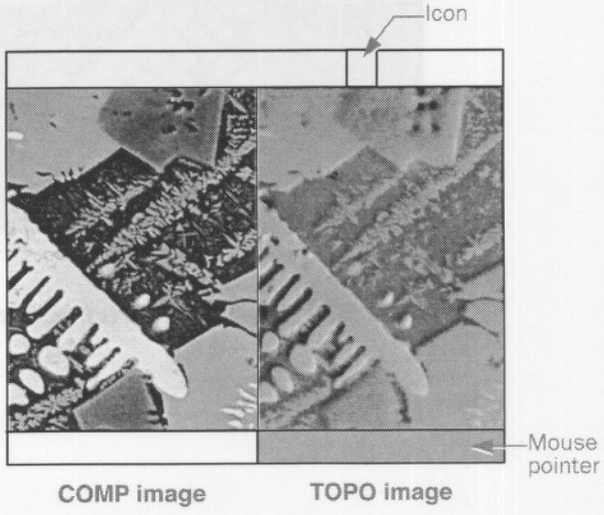


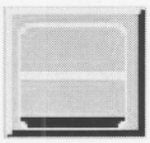
Fig. 5.38 Switching over active window

✍ You can operate the DISPLAY & PHOTO-FREEZE button on the operation panel and items in the observation condition display such as Image shift while the screen is active.

- FREEZE button

  You can freeze the left and right images independently.

■ Display of top-and-bottom split screen



This displays top-and-bottom split screen and is used to compare laterally long different images. Especially, this is effective when you compare cross-section images.

When you click this icon, the icon turns green and the screen is partitioned into two parts (one above the other). The basic operation in this mode is the same as that in the side-by-side screen mode.

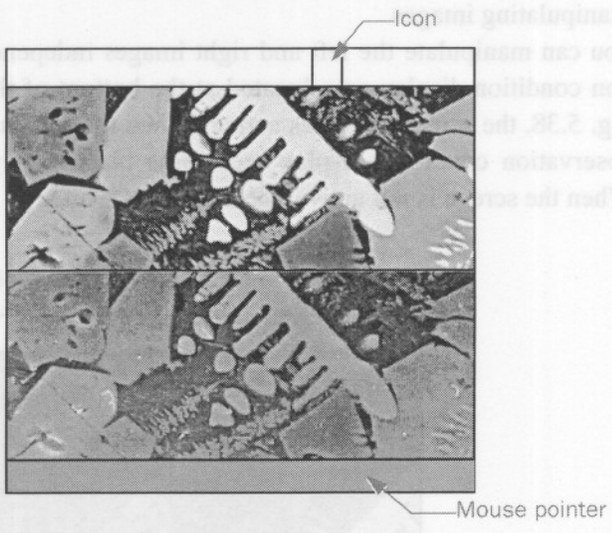


Fig. 5.39 Switching over active window

■ Display of four-way split screen

This is used to compare different images.

When you click this icon, the icon turns green and the screen is vertically and laterally partitioned into four parts. The basic operation in this mode is the same as that in the side-by-side screen mode.

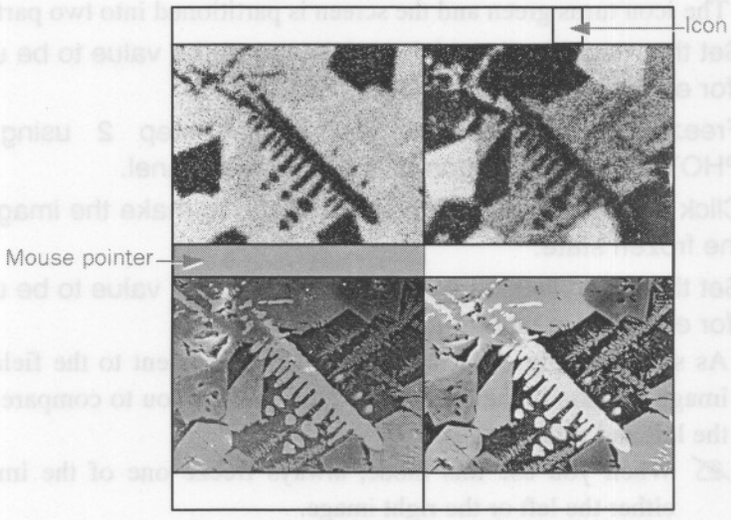
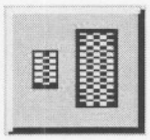


Fig. 5.40 Switching over active window

■ Display of differently enlarged image comparison screen



This differs from the display of the side-by-side or the top-and-bottom split screen and is used to compare the two images by changing the magnification independently.

● Operations in this mode

1. Click the **Differently enlarged image comparison screen** icon
   The icon turns green and the screen is partitioned into two parts (left and right).
2. Set the magnification of the left image to the value to be used for comparison (for example, a low magnification).
3. Freeze the image that you set in step 2 using the DISPLAY & PHOTO-FREEZE button on the operation panel.
4. Click the bottom part of the right image to make the image active and cancel the frozen state.
5. Set the magnification of the left image to the value to be used for comparison (for example, a high magnification).
   As shown in Fig. 5.41, a frame that is equivalent to the field-of-view of the right image appears in the left image. This enables you to compare the magnifications of the left and right images.
   - When you use this mode, always freeze one of the images. You can freeze either the left or the right image.
   - When photographing this screen, the color of the frame for magnification comparison will change.

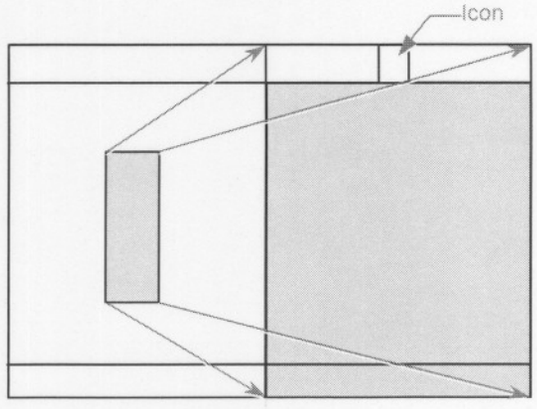
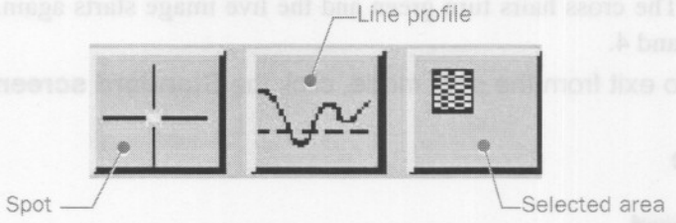


Fig. 5.41 Differently enlarged image comparison mode

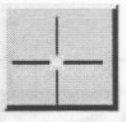
5.4.4c Analysis mode

The analysis mode is mainly used to control the scanning system of the electron probe when you use an X-ray spectrometer to analyze specimens.



When you select this mode, the analysis screen that is set to display used in the previous analysis mode will appear. The default is the spot display.

■ Spot



The Spot function stops electron probe scanning. It is mainly used in point analysis. When you use this function, the electron probe illuminates the position where you specified on the observation screen using the cross hairs.

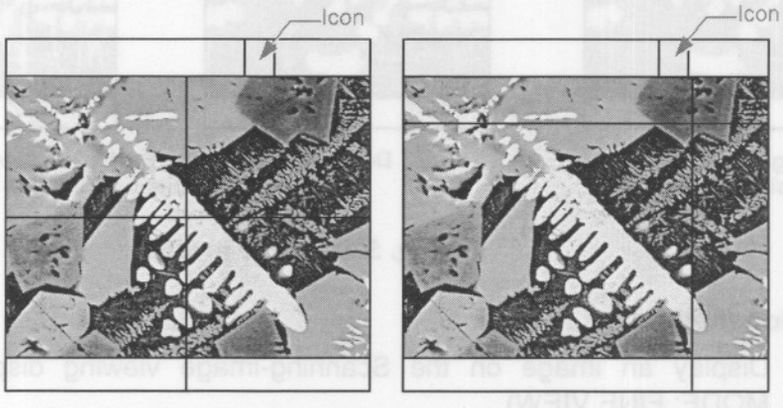


Fig. 5.42 Spot

- **Operation method**

1. Display an image on the Scanning-image viewing display (SCANNING MODE: FINE VIEW).
2. Click the **Spot** icon to change the operation mode to the spot mode.
   Green cross hairs will appear on the observation image.
3. Drag the cross hairs to move the intersection to the position (analysis point) to be illuminated by the electron probe.

4. After you have determined the analysis point, click the **Spot** icon again.
   The cross hairs turn orange and the image displayed in step 3 is frozen. Simultaneously, spot illumination starts.
5. When you want to change the illumination point, click the **Spot** icon again.
   The cross hairs turn green and the live image starts again. After that, repeat steps 3 and 4.
6. To exit from the spot mode, click the **Standard screen mode** icon.

■ Line profile

The Line profile function scans the electron probe over a horizontal line on the image. It is mainly used in line analysis. In this mode, the line profile can also be displayed.

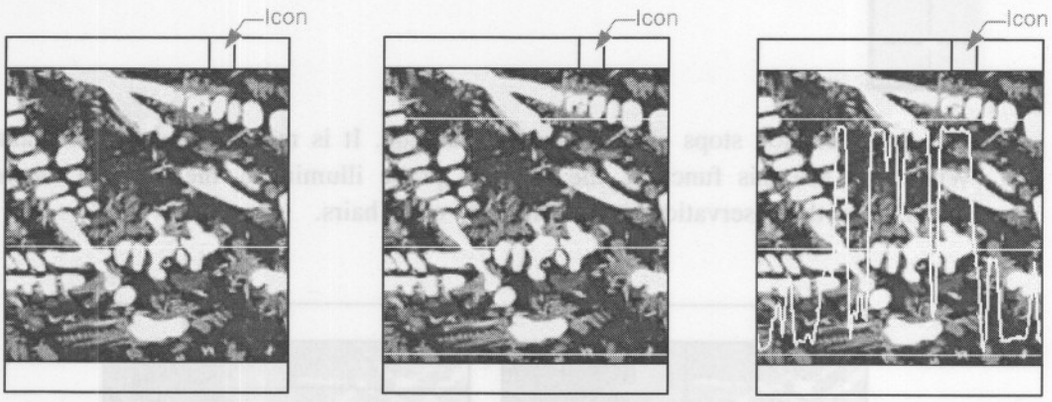


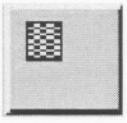
Fig. 5.43 Line profile

• Operation method

1. Display an image on the Scanning-image viewing display (SCANNING MODE: FINE VIEW).
2. Click the **Line profile** icon to change the operation mode to the line profile mode.
   A green line cursor appears on the observation image.
3. Drag the line cursor to the position to be illuminated by scanning the electron probe.
4. After you have determined the position to be scanned, click the **Line profile** icon again.
   The line cursor turns orange and the image displayed in step 3 is frozen. Simultaneously, the line illumination starts. Then the line profile at the line cursor position appears between two upper and lower green lines.

5. When you want to change the scanning position of the probe, click the **Line profile** icon again.
   The line cursor turns green and the live image starts again. After that, repeat steps 3 to 4.
6. To exit from the line profile mode, click the **Standard screen mode** icon.

■ Selected area



The Selected area function scans the electron probe over an area specified on the image.

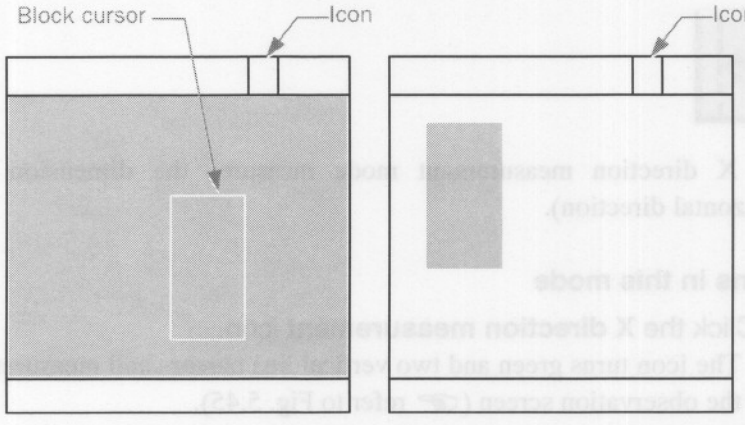


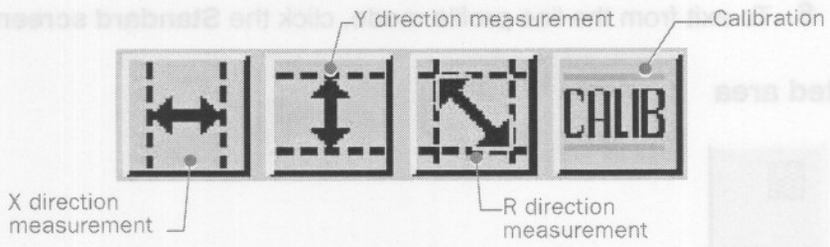
Fig. 5.44 Selected area

● Operation method

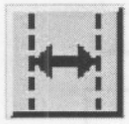
1. Display an image on the Scanning-image viewing display (SCANNING MODE: FINE VIEW).
2. Click the **Selected area** icon to change the operation mode to the selected area mode.
   A green block cursor appears on the observation image.
3. Drag the line cursor to determine the area to be illuminated by scanning the electron probe.
4. After you have determined the area, click the **Selected area** icon again.
   The block cursor turns orange and the image displayed in step 3 is frozen. Simultaneously, probe scanning on the selected area starts.
5. When you want to change the area to be illuminated, click the **Selected area** icon again.
   The block cursor turns green and the live image starts again. After that, repeat steps 3 and 4.
6. To exit from the selected area mode, click the **Standard screen** mode icon.

5.4.4d Scaler mode

The scaler mode measures the dimensions of the image displayed on the observation screen.



■ X direction measurement



The X direction measurement mode measures the dimension in the X direction (horizontal direction).

- **Operations in this mode**

1. Click the **X direction measurement** icon.
   The icon turns green and two vertical line cursors and measurement value appear on the observation screen (☞ refer to Fig. 5.45).
2. Drag the cursors to move the position to be measured.
3. To exit from the scaler mode, click the **Standard screen mode** icon.

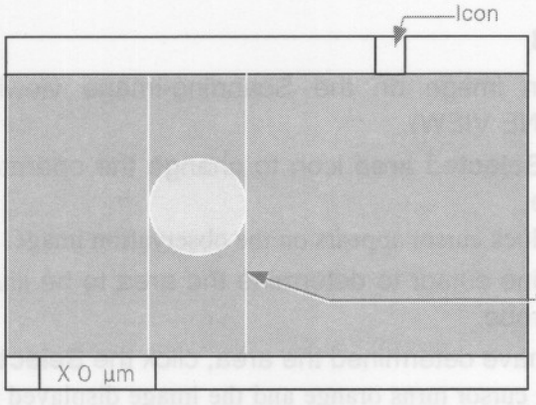


Fig. 5.45 X direction measurement

■ Y direction measurement

The Y direction measurement mode measures the dimension in the Y direction (vertical direction).

● Operations in this mode

1. Click the **Y direction measurement** icon.
   The icon turns green and two horizontal line cursors and measurement value appear on the observation screen (☞ refer to Fig. 5.46).
2. Drag the cursors to move them to the position to be measured.
3. To exit from the scaler mode, click the **Standard screen mode** icon.

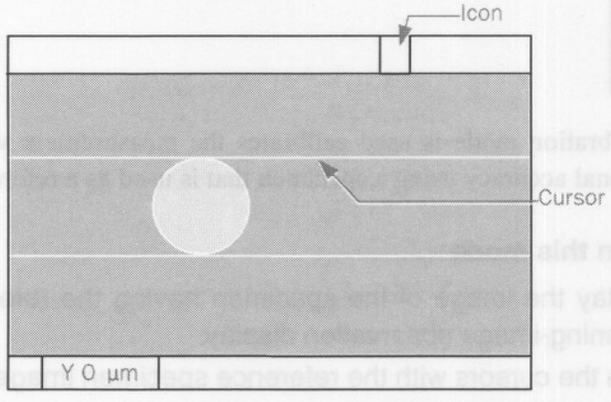


Fig. 5.46 Y direction measurement

■ R direction measurement

The R direction measurement mode measures the dimensions in the X, Y, and R directions (horizontal, vertical, and diagonal).

● Operations in this mode

1. Click the **R direction measurement** icon.
   The icon turns green and two horizontal and two vertical line cursors and measurement values appear on the observation screen (☞ refer to Fig. 5.47).
2. Drag the cursors to move them to the position to be measured.
3. To exit from the scaler mode, click the **Standard screen mode** icon.

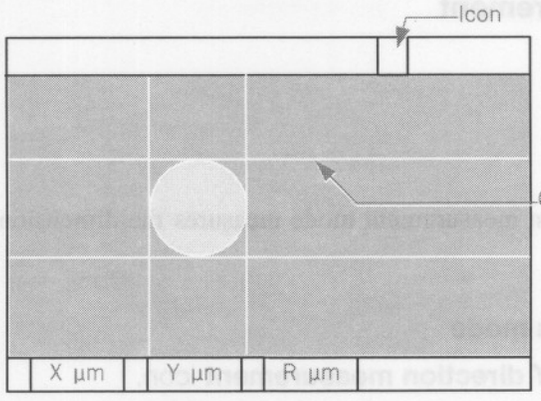


Fig. 5.47 R direction measurement

5.4.4e Calibration

The Calibration mode is used calibrates the measurement value. You can calibrate the dimensional accuracy using a specimen that is used as a reference.

- **Operations in this mode**

1. Display the image of the specimen having the reference dimensions on the Scanning-image observation display.
2. Align the cursors with the reference specimen image.
3. Click the **Calibration** icon.
   The icon turns green and four line cursors, measurement values, and the calibration panel will appear on the observation screen (☞ refer to Fig. 5.48).
4. Enter the reference dimensions into the X and Y Length input boxes in the Calibration panel.
5. Make sure that the entered values are correct; then click the **OK** button in the Calibration panel.

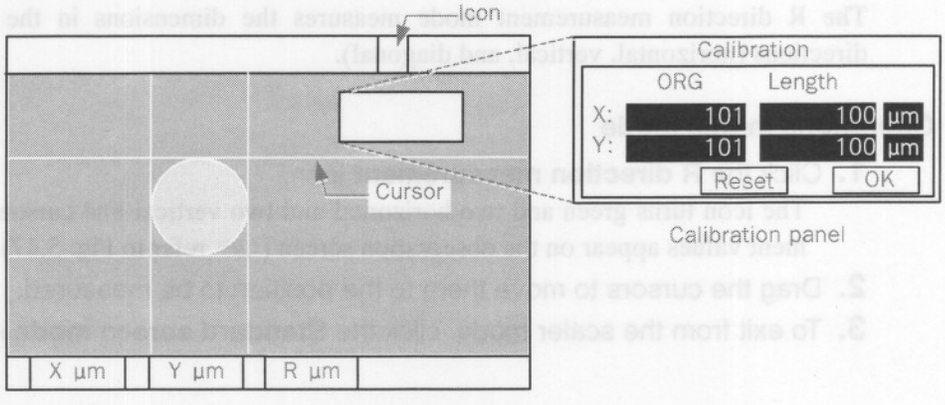


Fig. 5.48 Calibration

5.4.5 Halting Probe Scanning

When you carry out line analysis or area analysis by scanning the stage, you can halt probe scanning by electrically disconnecting the deflection coil (scanning coil and image fine shift coil) from the circuit. The procedure is described below.

5.4.5a Halting and starting probe scanning

■ Halting probe scanning

Press the SCANNING MODE-PRB SCAN button on the operation panel to halt probe scanning (the button lamp goes out).

■ Starting probe scanning

Press the SCANNING MODE-PRB SCAN button on the operation panel to start probe scanning (the button lamp goes on).

5.4.5b Checking probe illumination position

You can find out the accurate probe illumination position when you stopped probe scanning by following the procedure below.

■ Using secondary-electron image or backscattered-electron image

1. Click the **SHIFT (0,0)** icon on the Basic screen on the Scanning-image viewing display to remove the fine image shift (the icon turns green).
2. Open the Electron Optical System window from the EPMA menu; then click the **Speed** button to open the Scan control window and click the **speed 7** button to select it.
3. Click the **Analysis** icon on the Basic screen on the Scanning-image viewing display.
4. Click the **Spot** icon.

   Cross hairs appear. The intersection of the cross hairs (the center of the screen) is the probe position while probe scanning is being halted.

■ Using OM image

When you check the probe position by using an OM image, a specimen, which causes cathodoluminescence by electron beam illumination, should be used. Given below is a procedure when the standard specimen (ZrO_2: zirconium oxide) on the standard specimen holder is used as a luminescent specimen.

1. Load the standard specimen holder into the specimen stage and display the OM image on the OM monitor.
2. Locate the stage at the ZrO_2 position (☞ see Table 4.2) and focus the OM image.
3. Illuminate the electron probe on the specimen.
4. Display a secondary-electron image on the Scanning-image viewing display and focus the image.

5. Set the probe current to 1×10^{-9} to 10^{-8} A; then press the SCANNING IMAGE-PRB SCAN button on the operation panel to halt probe scanning (the button lamp goes out).
6. While monitoring the cathodoluminescence spot caused by electron probe on the OM monitor, adjust the probe current so that the spot has appropriate brightness.

   The position of the cathodoluminescence spot represents the position of probe illumination.

5.4.6 Adjusting and Checking Probe Diameter

When you measure an average concentration of the desired area on a rugged specimen surface, you can get a good result by performing analysis with setting the probe diameter to one or more micrometers. Described below is a procedure for adjusting the probe diameter in such a case.

1. Set the number of the objective lens aperture to 1 (240 mm diameter).

   ✍ Setting the OL aperture to a number other than 1 makes the probe diameter smaller than the displayed value, depending on the aperture diameter (☞ refer to Table 4.1).
2. Set the probe current to the desired value using the knob in the PROBE CURRENT box on the operation panel.
3. Display a secondary-electron image on the Scanning-image viewing display and focus the image.
4. Open the Electron Optics System window and click the **P.Dia** button to open the Probe diameter window; then specify the probe diameter to be used.

   ✍ If the probe diameter is set to a value other than 0 (μm), the FOCUS knob on the operation panel is disabled. Also, when you set the Column Mode of the Control window to MDF, LDF, or ECP, the probe diameter cannot be set to a value other than 0.

The present probe diameter will be displayed at the bottom of the Scanning-image viewing display.

✍ When the OL aperture is set to a number other than 1, you can get the probe diameter by measuring the dimension of the cathodoluminescence spot displayed on the OM monitor using the scales of the cursors on the OM monitor. To display the cathodoluminescence spot, you can use the same procedure that is used for checking the probe illumination position using the standard specimen (such as ZrO_2) on the standard specimen holder. In this case, the measured size of the spot may be larger than the displayed value for the probe diameter. This is because the displayed value is set to an approximate value for the full width at half maximum (FWHM) with respect to the current density distribution in the probe.

5.4.7 Using Instant Picture

The function of instant picture is used to display a secondary-electron image on the Scanning-image viewing display by changing over the current image display conditions to the predetermined display conditions. This function is useful for brief observation of scanning images by changing different images alternately. The procedure is given below.

1. Press the ACCEL VOLTAGE-ON button on the main panel (the button lamp goes on) to generate the electron probe.
2. Press the IMAGE SELECT-INST button on the operation panel (the button lamp goes on).

   The operating conditions immediately before pressing the button, for the electron optical system, are stored, and a secondary-electron image is displayed on the Scanning-image viewing display under the predetermined conditions (☞ refer to the description about "IMAGE SELECT-INST" button in Sect. 4.5.1).
3. Adjust, as necessary the CONTRAST and BRIGHTNESS in the IMAGE box and FOCUS knobs to display the appropriate image.

   ✍ If the previous operating conditions (specified by the instant picture function) have been unknown due to changing over the conditions during instant picture operation, press the IMAGE SELECT-INST button to release the instant picture function momentarily (the button lamp goes out). Then press the button again (the button lamp goes on) and the previous operating conditions will be restored.
4. Press the IMAGE SELECT-INST button (the button lamp goes out) to release the instant picture function. The electron optical system will return to the previous operating conditions stored at step 2.

■ When the instant picture function does not work, check the settings below

- OM lamp button on OM Monitor window: OFF
- Specimen exchange chamber isolation valve lever (or knob): Completely closed

5.5 BACKSCATTERED-ELECTRON MICROSCOPY

Since this instrument uses a paired semiconductor detection devices to detect backscattered-electrons, you can selectively display a compositional (COMP) image or a topographic (TOPO) image. The compositional image shows the contrast that is caused by the difference of atomic numbers of the specimens and is useful for surveying the entire specimen surface prior to X-ray analysis. The topographic image shows the contrast that is caused by the topographic appearance of the specimen surface and the specimen is seen as if the specimen is illuminated by light from a given direction.

In backscattered-electron microscopy, the higher the accelerating voltage, the higher the signal intensity and the better the image quality. Generally, the accelerating voltage is set to 5 kV or more and the probe current is set to 1×10^{-11} A or more. Fig 5.49 shows the schematic diagram of backscattered-electron microscopy for obtaining compositional and topographic images.

A backscattered-electron image is usually observed after observation of a secondary-electron image; it is therefore assumed that operations such as "checking and correction of the astigmatism" have already been completed.

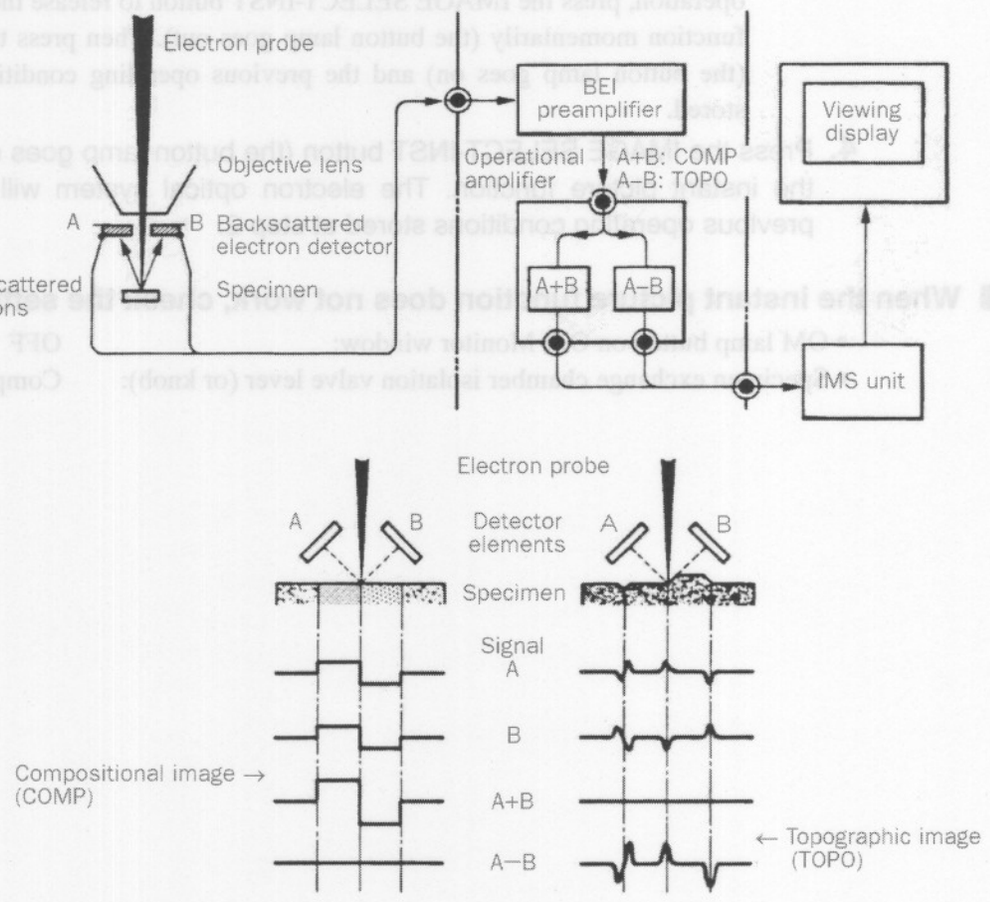


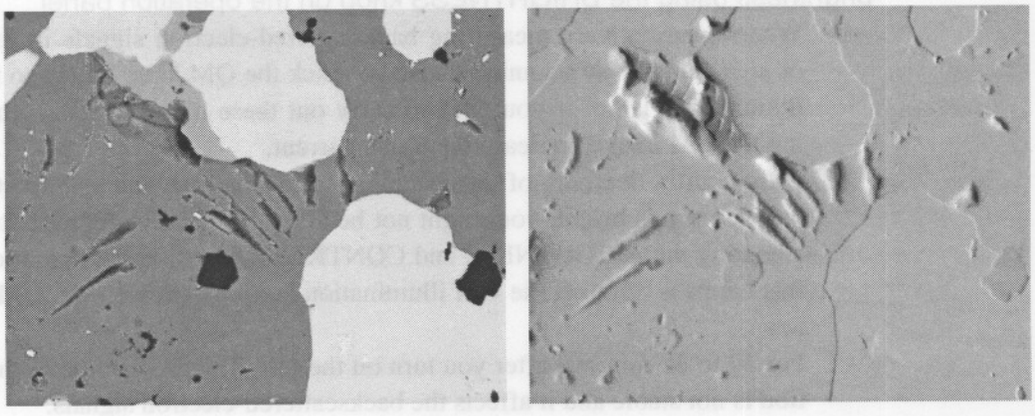
Fig. 5.49 Principle for compositional and topographic imaging

1. Make sure that the light-tight cap is put in the spectrometer viewing window and set the Spectrometer. Lamp button in the SPC window to off.

☞ Refer to Sect. 4.13.3.a for opening method of the Spectrometer window.

✍ If light enters the backscattered electron detection devices, the image quality deteriorates and the image becomes noisy.

2. Press the IMAGE SELECT-VIEW button on the operation panel and set the observation mode to COMP or TOPO.



Compositional image (COMP) Topographic image (TOPO)

Fig. 5.50 Backscattered electron images

3. Adjust the brightness of the image using the BRIGHTNESS knob on the operation panel.

   In this operation, the backscattered-electron image can be observed on the Scanning-image viewing display.

   ✍ If the image has too small contrast to observe the image, increase the probe current by adjusting the knob in the PROBE CURRENT box on the operation panel; then correct the astigmatism using the secondary-electron image again and display the backscattered-electron image. After that, repeat the procedure in step 3 and after.

4. Set the magnification to the value to be used using the MAGNIFICATION knob; then focus the backscattered-electron image properly.

5. Adjust the contrast of the backscattered-electron image (the COMP or TOPO image) using the CONTRAST knob on the operation panel; then adjust the brightness using the BRIGHTNESS knob again.

   ✍ Normally, when you lower the accelerating voltage, you have to increase the probe current. Also increase the probe current and readjust the contrast and brightness of the image when the image quality is poor.

   ✍ When you use a specimen that yields a lot of backscattered electrons and has poor image contrast, you may not observe the backscattered-electron image with the appropriate brightness.

6. When you observe the backscattered-electron image and the OM image simultaneously (that is, when you turn on the OM lamp by clicking the OM lamp button on the OM monitor), the illumination lamp of the optical microscope (OM) brightens and the amount of the incident light for the backscattered electron detector will be changed. If this happens, adjust the image brightness using the BRIGHTNESS knob on the operation panel

   ✍ When quantitatively measuring backscattered-electron signals in line analysis or area analysis by scanning the stage, click the OM lamp button to turn off the illumination lamp. If you need to carry out these measurements while observing the OM image, increase the probe current.

   ✍ If the light reflectivity of the specimen surface is high and also the OM illumination lamp is bright, you might not be able to obtain an appropriate image by adjusting the BRIGHTNESS and CONTRAST knobs on the operation panel. If this happens, turn off the OM illumination lamp by clicking the **OM lamp** button.

   ✍ For 10 to 30 min just after you turn on the OM illumination lamp, the illumination is not stable and it affects the backscattered-electron signals.

✍ Backscattered-electron images can be recorded in the same way as secondary-electron images.

✍ Pressing the IMAGE SELECT-VIEW button on the operation panel during the COMP or TOPO image observation changes to the secondary-electron image observation.

5.6 OPERATING BEAM STABILIZER (BST)

5.6.1 Starting up the BST

Here is the procedure for starting the BST. Refer also to Sect. 4.13.2n.

✍ After setting the filament heating current, wait enough time before you use the BST,. In addition, precisely align the electron gun.

1. Turn on the accelerating voltage, then set the electron-gun filament heating current.
   Confirm that the emission current is 20 to 40 μA.
   ☞ If the emission current is low, the CL-BST might not operate properly.
2. After setting the electron-gun filament heating current, wait about 30 minutes.
   ☞ While the filament temperature is changing just after the heating, you might not obtain the specified performance.
3. Align the electron gun.
   Select **Narrow** for Auto tilt/shift adjust in Auto alignment, and execute it.
4. Readjust the electron gun as follows.
   a. Set PCD-IN and PROBE SCAN OFF, and open the Chart recorder window to display the irradiation current, setting the chart speed to 1 min/scan.
   b. Enlarge the Y-axis so that you can easily observe the current variation, and manually readjust the electron-gun alignment to obtain the maximum current.
   c. Adjust the alignment tilt, alignment position and mechanical position of the objective aperture, repeatedly 2 or 3 times.
5. Set the probe current to analysis conditions and clear the lenses using the Alignment window.
6. Adjust focus and stigma for a secondary-electron image.
7. Display the Beam Stabilizer window in the EOS monitor, and turn on the BST by clicking on the **Manual** button in Tilt-BST while watching the chart recorder.

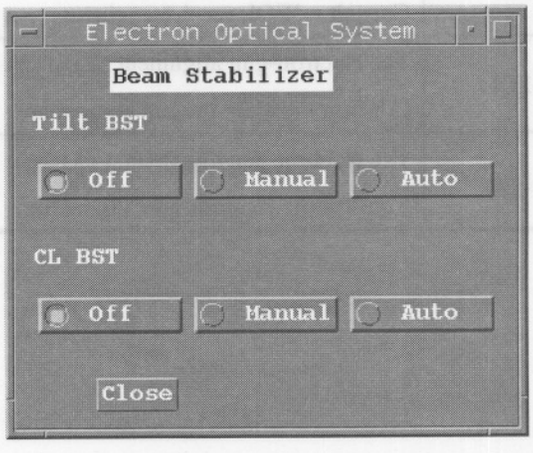


Fig. 5.51 Beam stabilizer window

✍ Observe the current variation about 30 seconds, and if the variation is large, readjust the alignment.

8. If the situation under the Tilt-BST ON is good, turn on the BST by clicking on the **Manual** button in CL-BST.
9. Observe the current variation for about 5 minutes. Sometimes, just after turning on the CL-BST from the OFF state, the current may decrease a little bit. In such a case, after turning off both Tilt- and CL-BST, precisely adjust the probe current, then turn on the Tilt-BST and CL-BST in sequence again, and confirm that the current becomes stable at the specified current value.
10. Confirm that the focus and stigma did not change. If they changed, repeat this procedure beginning with step 6.

✍ After this, do not change the settings.

☞ Be sure to start the Tilt-BST first. If you start the CL-BST first, the BST might operate unstably.

☞ If the Tilt- and CL-BST do not operate properly even after you reexamine the saturation position of the filament heating or alignment of the gun, clean the Wehnelt or other parts.

5.6.2 Error Messages

If one of the following messages appears, set appropriate conditions referring to the content.

Table 1 Error messages

Error number	Contents
-110	The probe current might be out of range. Confirm the probe current.
-111	The detector (objective) aperture number might be wrong. Confirm the aperture number.
-112	the BST circuit might be abnormal. Consult a JEOL service engineer.
-113	The electron-gun alignment (X) might not be properly adjusted. Confirm the electron-gun alignment.
-114	The electron-gun alignment (Y) might not be properly adjusted. Confirm the electron-gun alignment.

5.6.3 Setting the Analysis Conditions

This section explains how to set the EOS conditions for each analysis in the application software. Set the EOS conditions as follows:

1. Finish operating the BST (☞ Sect. 5.6.1).
2. Open the EOS Condition window.
3. Click on the **Read** button to read the present conditions.
   ✍ When you use the BST, do not click on the **Apply** button. In addition, do not use the automatic probe-current setting.
4. Press the **Stabilizer** button in the Scan Conditions to select a kind of the BST.

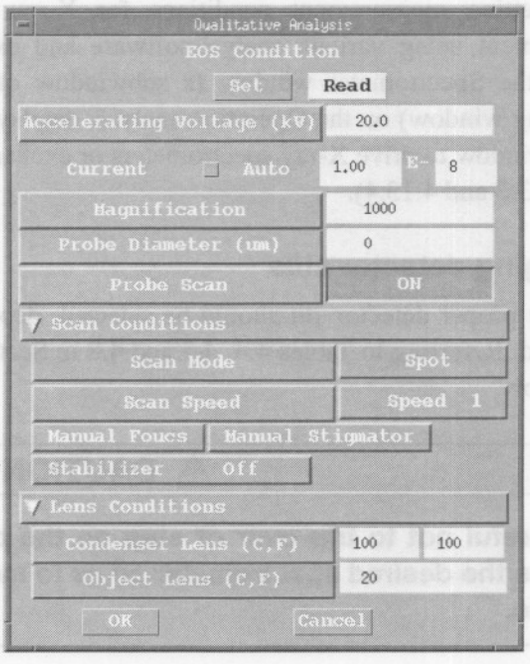


Fig. 5.52 Beam stabilizer subwindow

- Stabilizer Tilt — To start only Tilt-BST (manual mode)
- Stabilizer CL — To start only CL-BST (manual mode)
- Stabilizer CL & Tilt — To start both CL/Tilt-BST (manual mode) (Normally, select this mode.)
- Stabilizer off — When not using the BST functions

✍ While you have already started up the BST, the present conditions are not reflected when you read them. Confirm the condition settings every time.

✍ The operation mode of the BST that is set in the application software is always manual mode.

That completes the BST setting in the analysis-condition settings. Complete other settings; then start measurement.

✍ After starting measurement, do not perform such operations as changing the probe current that might require stopping the BST.

5.7 BASIC OPERATIONS FOR X-RAY ANALYSIS

Described below are the basic operations for X-ray spectrometers and an introductory method for X-ray analysis.

☞ For the X-ray analyses using various analysis software, refer to the separate manuals.

✍ The descriptions about the operations in the subsequent sections are mainly directed for users who are well acquainted with the operations described so far.

5.7.1 Basic Operations for X-ray Spectrometer

5.7.1a Driving X-ray spectrometers and exchanging analyzing crystals

When setting measurement conditions for X-ray analysis, performing preparatory measurement using various analysissoftware and exchanging analyzing crystals, first display the Spectrometer window (a subwindow of the Ratemeter window or Chart Recording window) on the Operation/analysis display and then manipulate the mouse in the subwindow to drive X-ray spectrometers or exchange analyzing crystals (☞ refer to Sect. 4.13.3 and 4.13.4).

5.7.1b Exchanging detector slits

☞ The proper detector slit should be selected, depending on analyzing crystals to be used. Referring to Tables 4.4, 4.5 and 4.8 in Sect. 4.3, exchange the slits as directed below.

⚠ CAUTION

Be careful not to trip over or step on the cables and hoses when you access the desired spectrometer so as to avoid any injury or instrument trouble.

1. Open the Ratemeter window on the Operation/analysis display, and click the **HV** button with the mouse to make the indication on the button "HV OFF" and to stop the high voltage applied to the detector.

⚠ WARNING

To avoid an electric shock, be sure to switch off the high voltage to the detector prior to proceeding to the subsequent steps.

2. Click any of the **CH-1** to **5** buttons in the Ratemeter window to open the Spectrometer window, then click the spectrometer lamp **(Spc. LAMP)** button to turn on the spectrometer illumination lamp (the lamp button is depressed).
3. By manipulating the scroll bar or △, ▽ buttons in the Spectrometer window or entering numerals from the keyboard, set the proper value, which allows slit exchange, in the detection position (L (mm)) input box, referring to Table 4.8.
4. Fit the groove of crystal-alignment/slit-change rod end to the tongue of the drive shaft end of the spectrometer and turn the connecting pipe counter-

clockwise to join them securely. In this manual, this joined rod is now called the "rod assembly" for convenience.

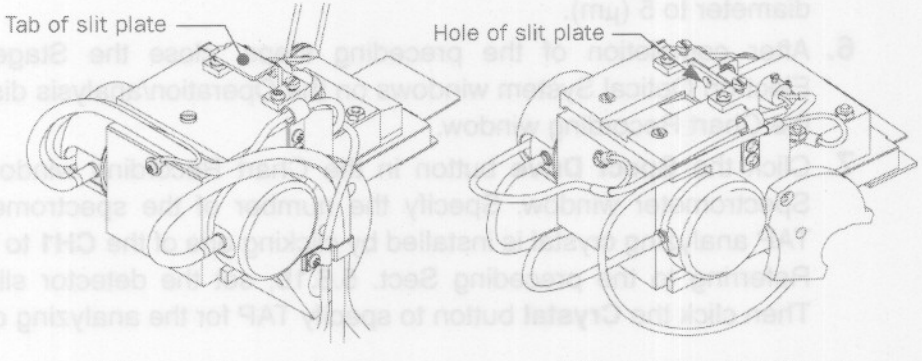
5. Remove the light-tight cap from the spectrometer viewing window (with the H-type X-ray spectrometer, remove the top cover). While monitoring the spectrometer interior through the viewing window, turn the rod assembly clockwise to release the lock of the shaft and slightly push it in.
6. When you are using the XCE, TXE, or FCS type X-ray spectrometer, touch the tip of the rod assembly to the tab of the detector slit plate and push up/down the tab to exchange the detector slit. When you are using the H type X-ray spectrometer, insert the tip of the rod assembly into the hole of the detector slit plate and pry it up/down to exchange the detector slit. (☞ Refer to Fig. 5.53 and Table 4.8 for slit settings.)
7. Pull out the rod assembly completely and turn it counterclockwise to lock the screwdriver blade.

— **CAUTION** ———

If the screwdriver blade is improperly locked, the drive shaft may be sucked into the spectrometer when you disconnected the rod. Care should be taken to avoid such an accident.

8. Turn the connecting pipe clockwise to loosen it, disconnect the crystal-alignment/slit-change rod from its drive shaft and return the light-tight cap on the spectrometer viewing window.
9. Click the **HV** button in the Ratemeter window to make the indication on the button "HV ON" and to apply high voltage to the detector.

   ✍ When performing X-ray analysis, be sure to apply high voltage to the detector by clicking the HV button.
10. Click the **Spc. LAMP** button on the Spectrometer window again to turn off the spectrometer illumination lamp (the depressed lamp button comes up).



Detector slit assembly of XCE/TXE/FCS-type X-ray spectrometer

Detector slit assembly of H-type X-ray spectrometer

Fig. 5.53 Adjustment of detection slit

5.7.2 Operations for Analyses

The following section describes, as an example, the X-ray analysis of a standard specimen, Mg, on the standard specimen holder, using the TAP analyzing crystal.

5.7.2a Setting stages and spectrometers

1. Open the Stage Monitor window on the Operation/analysis display (☞ refer to Sect. 4.13.6) and install the standard specimen holder on the specimen stage, referring to Sect. 5.2 "Specimen Exchange".
2. Manipulate the mouse in the Stage Monitor window to set the specimen stage to a position where the secondary-electron image of the standard specimen, Mg, on the specimen holder can be observed. Observe the image.
3. Open the OM Monitor window and click the **OM lamp** button to make it depressed state; then display the OM image on the Operation/analysis display and focus the image using the Z buttons on the JOYSTICK CONTROLLER.
4. First open the Electron Optical System window on the Operation/analysis display. Then click the **Acc. V** button and the **CL (Current) C–F** button in the window to open the windows and set the accelerating voltage to 15 kV and the probe current to 1×10^{-8} (A); focus the secondary-electron image.

   ✍ When performing X-ray analysis at a probe current of 10^{-8} (A) or more or simultaneously performing mapping and X-ray analysis, with the electron probe scanned, click the **Collector** button on the Electron Optical System window to open the Collector window and specify a value except 0 to protect the scintillator of the secondary-electron detector from deterioration.
5. Click the **Scan** button and the **PCD** button in the Electron Optical System window to make the indications on the buttons "Scan OFF" and "PCD IN," respectively (the probe current detector is inserted into the optical axis). Then, click the **P. Dia** button to open the Probe diameter window and set the probe diameter to 5 (μm).
6. After completion of the preceding steps, close the Stage Monitor and Electron Optical System windows on the Operation/analysis display and open the Chart Recording window.
7. Click the **Spect Drive** button in the Chart Recording window to open the Spectrometer window. Specify the number of the spectrometer where the TAP analyzing crystal is installed by clicking one of the **CH1** to **CH5** button. Referring to the preceding Sect. 5.6.1b, set the detector slit to 300 (μm). Then click the **Crystal** button to specify TAP for the analyzing crystal.

5.7.2b Setting pulse height analyzer

This section describes a way of provisionally setting the pulse height analyzer (SCA).

1. Click the **SCA** button in the Spectrometer window to open the SCA Control window and set the items in the window as directed below.
   - SCA mode ..... Int
   - High V (V) ..... Default or 1700 (V)

   ✍ The default is set in the SCA Configuration window. This window can be opened by clicking the SCA condition button in the Hardware Configuration window.

- Gain 32
- Base (V) ..... 0.7 (V)
- Window (V) ..... 9.3 (V)

2. After completion of the preceding setting, close the SCA Control window.

5.7.2c Chart recording and peak profile

After completion of the preceding operations, perform X-ray counting for the specimen and display its peak profile.

1. Open Spectrometer window from the Chart Recorder window and click on a spectrometer number (CH1 to CH5) that installs TAP. Then click the **Element** button in the window to open the Periodic Table window.
2. Select the element, Mg, from the periodic table in the window and click it and the **Set** button. Then click the **Close** button to close the Periodic Table window.

   The X-ray spectrometer will be set to the MgKα detection position for the TAP analyzing crystal.

   ✍ After calibration of the X-ray spectrometer, the spectrometer will be set to the corrected position.
3. Click the ▶ button in the Chart Recorder window and press the PCD-IN button on the operation panel (the button lamp goes out) to pull out the Faraday cup as the probe current detector from the electron beam path.

   The X-ray count rate varying with time will be displayed as a waveform in the Chart Recorder window.

   ✍ In this operation, turning off the waveforms that are not necessary to display by clicking the corresponding buttons (**WDS CH-1** to **WDS CH-5**) makes easier to observe the desired waveform.
4. Enter 100.0 (mm) in the L (mm) input box in the Spectrometer window and set the spectrometer to 100.0 mm. Click the **drive speed setting** button to open the Spect Speed [mm/sec] window and set the spectrometer drive speed to 0.100 (mm/sec), then close the Spect Speed [mm/sec] window.
5. Click the **Speed** button in the Chart Recorder window to open the Chart Speed window. Set the waveform record speed to 2 min in this window; then close the window.
6. Click the **Cont** button and click the ▲ button in the Spectrometer window to drive the spectrometer. Then click the **Clear** button in the Chart Recorder window.

   Peak profiles in a detection position (L) range between about 100 mm and 112 mm will be displayed on the chart, allowing the peak position and peak count rate to be read out.

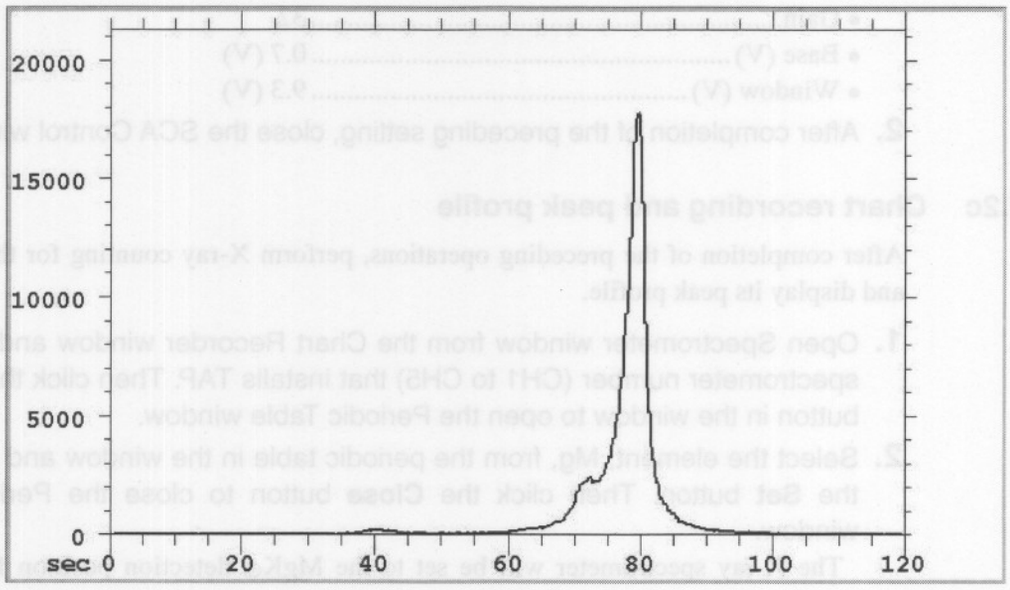


Fig. 5.54 Peak profile

7. To stop waveform recording, click the ▮▮ button at a position where the recording bar moves close to the end of the chart.

   ✍ Use of the color hardcopy (optional) allows a peak profile on the screen to be output on paper.

8. Click the **To Max** button (which is located at the lower right part in the Chart Recorder window,) corresponding to the spectrometer being used to set the spectrometer to the peak position of the peak profile.

   ✍ When displaying the pulse height distribution described in the following section, leave the spectrometer at the peak position.

9. Close the Chart Recorder window (the Spectrometer window will close, too). Press the PCD-IN button on the operation panel (the button lamp goes on) to insert the Faraday cup as the probe current detector into the electron beam path when specimen illumination by electron beam is not required.

5.7.3 Measuring X-ray Pulse Height Distribution

Described hereunder is a way of displaying the X-ray pulse height distribution obtained after the Mg-Kα peak profile is displayed (☞ refer to Sect. 5.7.2c).

1. Make sure that the spectrometer is set at the peak position (that is, the position set at the preceding step 8).
2. Open the SCA Scan window on the Operation/analysis display (☞ refer to Fig. 4.113). Make sure that the spectrometer channel number indicated at the Signal button corresponds to the spectrometer being used to detect Mg-Kα of the analyzing crystal TAP. If the number is different, click the **Signal** button to change it to the same channel number as the spectrometer being used.
3. Click the **Base L** button in the SCA scan window to open the Base L Scan window. Set the items in this window as directed below.
   - Lower (V) 0.4
   - Upper (V) 10
   - Step (V) 0.2
   - Stime (msec) 500
4. Click the **Start** button in Base L Scan window to draw a waveform of the pulse height distribution.

   ✍ As shown in Figs. 5.55 (a) and (b), either a single peak (E_M) or two peaks — a peak (E_M) and an escape peak (E_E) — are normally observed in the waveforms of the X-ray pulse height distribution. The reason the escape peak appears is that the energy of the incident X-rays is higher than that of the absorption end of the proportional counter detection gas (ArK absorption end energy in gas flow type proportional counter: 3.20 keV). Thus it will not appear if the energy of the incident X-rays is lower than the absorption end energy of the proportional counter detection gas.
   For the case of Mg-Kα, this waveform is shown as (a) without appearing the escape peak.

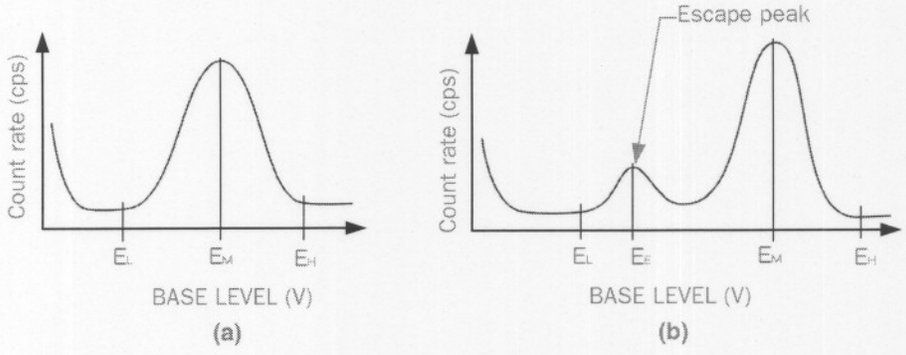


Fig. 5.55 X-ray pulse height distribution

5. Depending on the pulse height analysis mode, set the SCA operating conditions for the Spectrometer window and for individual analysis software as directed below.

	Pulse height analysis mode	
	Int mode	Diff mode
• SCA Mode-Int/Diff buttons	Int	Diff
• Base (V)	E_L	E_L
• Window (V)	Optional	$E_H - E_L$

✍ The SCA Mode should be selected, depending on the analyzing crystals to be used. For example, in an analysis using analyzing crystals such as LIF and PET, set the SCA Mode to Int (integration). In the analysis of analyzing crystal such as TAP, LDE or STE using for light element analysis, the SCA MODE should be set to Diff (differentiation) to improve the signal-to-background (P/B) ratio and eliminate high-order diffraction X-rays.

5.8 OBSERVING X-RAY IMAGES

X-ray pulses detected by a wavelength dispersive X-ray spectrometer (WDS) or an energy dispersive X-ray spectrometer (EDS) fitted to the instrument with scanning facilities provide an X-ray images on the Scanning-image viewing display, i.e., a picture showing the distribution of a particular element on the specimen surface.

This section describes the procedures to obtain X-ray images, assuming that the preparations for X-ray spectroscopy and scanning electron microscopy (secondary electrons and backscattered electrons) are completed.

1. Display a secondary-electron image or a backscattered-electron image on the Scanning-image viewing display and select the desired area for X-ray imaging using the JOYSTICK CONTROLLER on the Stage Monitor window.
2. Adjust the magnification to the desired value using the MAGNIFICATION knob on the operation panel and focus the image using the FOCUS knob.
3. Referring to the separate manual "Basic Software ", carry out qualitative analysis and set the multichannel analyzer to the energy of the element of interest (EDS). For WDS analysis, set the detection position of the spectrometer to the spectral peak of the characteristic X-rays from the element of interest.
4. Select XR1 to XR5 (for WDS) or EDS (for EDS) by clicking the IMAGE SELECTOR button in the Basic screen on the Scanning-image viewing display.
5. Select the scanning speed using the SCANNING MODE buttons on the operation panel.
6. Observe X-ray images. If necessary, adjust the number of pulses of the X-ray image by changing the probe current using the PROBE CURRENT knob on the operation panel.

SiKα image　　SnLα image　　FeKα image

Fig. 5.56 X-ray images

5.9 STORING SCANNING IMAGES

Images displayed on the Scanning-image observation display can easily be stored as image data.

You can use three methods to store images:

(1) Press the DISPLAY & PHOTO-PHOTO button on the operation panel to carry out photographing and storing of the image simultaneously.
(2) Press the DISPLAY & PHOTO-FREEZE button on the operation panel to freeze the image; then press the PHOTO button to store the image.
(3) Use the Clipboard to store images.

This section describes the setting in the Operation window for the methods (1) and (2) above.

■ Method (1) above

To carry out this method, you need to specify the conditions for Speed, Recording Data, and Output in the PHOTO box in the Operation window, and also, to specify the settings in the Network setting window in advance.

☞ For details, refer to the paragraphs on Operation and the Network setting in Sect. 4.9.2c, "Setup button."

1. Display an image on the Scanning-image viewing display; then adjust the focus and set the magnification.
2. Press the DISPLAY & PHOTO-PHOTO button on the operation panel.

■ Method (2) above

To carry out this method, you need to specify the conditions for Recording Data and Output in the PHOTO box, and conditions in the FREEZE box in the Operation window, and also, to specify the settings in the Network setting window in advance.

1. Display an image on the Scanning-image viewing display; then adjust the focus and set the magnification.
2. Press the DISPLAY & PHOTO-FREEZE button on the operation panel to freeze the image.
3. Press the DISPLAY & PHOTO-PHOTO button on the operation panel.

☞ For details, refer to the paragraphs on Operation and the Network setting in Sect. 4.9.2c, "Setup button."

5.10 SENDING IMAGES TO ANOTHER COMPUTER (HOST)

To transfer images to the PC (host computer), you can use the following three methods:

- Using the Network Save window
  Give a filename to the observation images, and send images and observation conditions. At that time the system append a serial number to each image.
- Using the Network Clip window
  Display the window composed of the 16-image screen and sends the ones you want.
- Using the PHOTO button

These are described below in order.

5.10.1 Using Network Save Window

■ Procedure

1. Click the **Network** icon on the menu bar (or select **Image-Network Save** from the menu bar).
   This opens the Network Save window (☞ see Fig. 5.59).

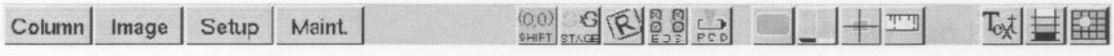


Fig. 5.57 Menu bar

2. Enter the filename for the observation image displaying on the screen in the Image File Name input box (Fig.59–①).
3. Click the **Save** button.
   The image is send to the host computer.
4. Click the close button.
   The Network Save window closes.
5. Select **Image-Network Load** from the menu bar.
   This opens the Network Load window (☞ see Fig. 5.60).

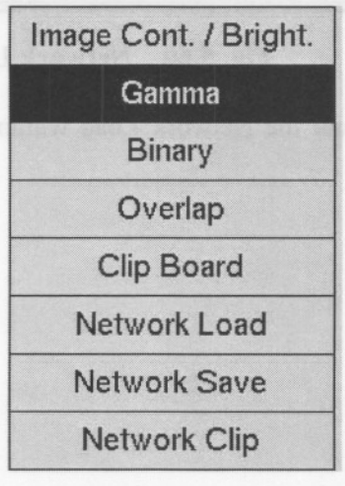


Fig. 5.58 Pull-down menu of Image

6. Make sure that the name of the image file that are send is correct in the filename display area (Fig.60–①). To close the Network Load window, click the **Close** button.

■ Network Save window

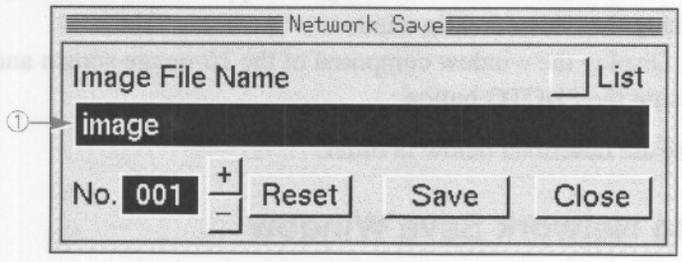


Fig. 5.59 Network Save window

☞ For details about the Network Save window, refer to Sect. 4.9.2b, "Image menu button".

■ Network Load window

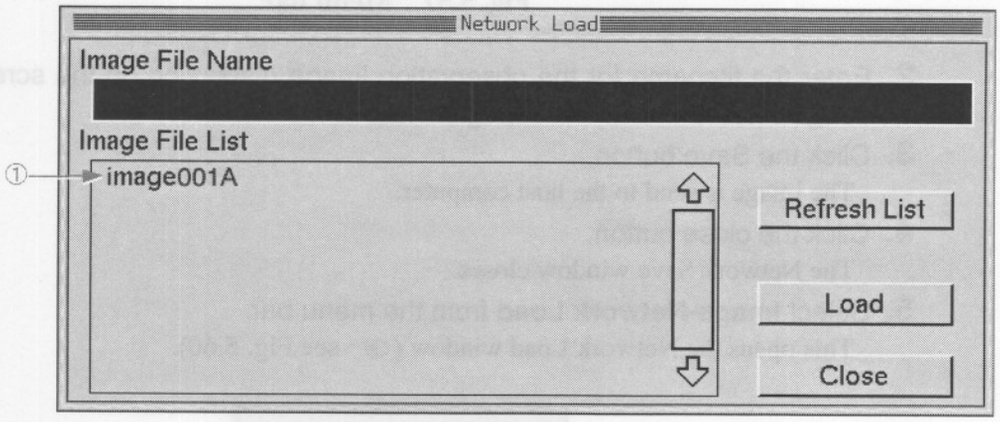


Fig. 5.60 Network Load window

☞ For details about the Network Load window, refer to Sect. 4.9.2b, "Image menu button".

5.10.2 Using Network Clip Window

This displays images stored in the Clipboard in the Network Clip window and sends to the host computer.

■ Procedure

1. Select **Image-Network Clip** from the menu bar.
   This opens the Network Clip window (☞ see Fig. 5.62).

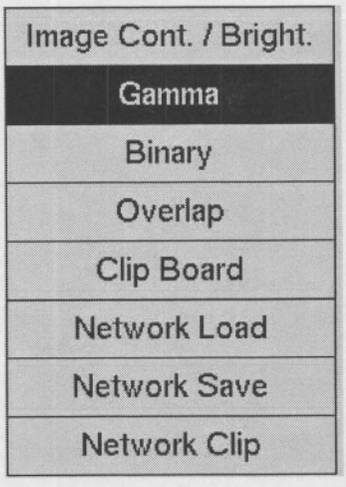


Fig. 5.61 Pull-down menu of Image

2. Select the image to be send to the host computer.
3. Click the **Save** button.
   The selected image is send to the host computer.

■ Network Clip window

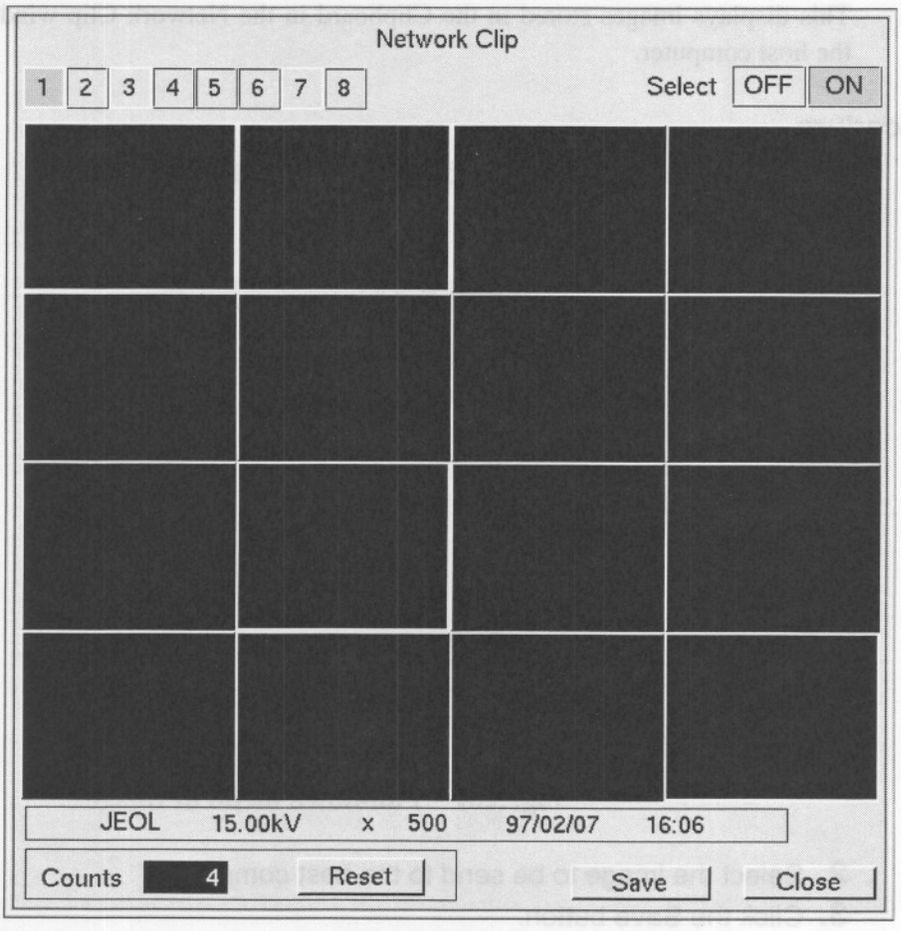


Fig. 5.62 Network Clip window

☞ For details about the Network Clip window, refer to Sect. 4.9.2b, "Image menu button".

5.10.3 Using Photo Button

◆ Click the **Photo** button (**Network1** or **Network2** in the Output box) in the PHOTO box in the Operation window.

The image being displayed is sent.

✍ If the image is a live image, clicking the Photo button loads the image with the speed specified in the PHOTO box and sends it to the host computer. If the image is a frozen image, clicking the Photo button selects the freezing method that has been specified and sends the image as it is.

✍ The system uses the filename that is specified in the Network Save window and the destination that is specified in the Network Setting window.

✍ The counter values are also stored each time the image is sent as individual files.

5.10.4 Message Displayed during Image Transmission

While an image is being sent, the File transmit dialog box appears and it shows the message for image transmission. The dialog box will automatically close when image transmission completes.

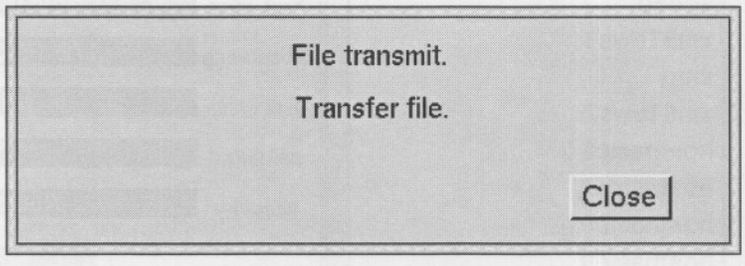


Fig. 5.63 File Transmit dialog box

☞ For details about the Transmit dialog box, refer to Sect. 4.9.2b, "Image menu button".

5.10.5 Specifying Network Parameters

The procedure to specify the network parameters such as host name, IP address, password, and destination directory are as follows:

■ Procedure

1. Select **Setup-Network Set** from the menu bar.
   The Network Setting window will open (☞ see Fig. 5.64).
2. Click the desired host name from the host list box.
   The network parameters related to the host name you selected will appear.
3. Click text boxes that you wish to change the settings and type new settings using keyboard.
4. Click the OK button.
   The settings are finalized and the window will close.

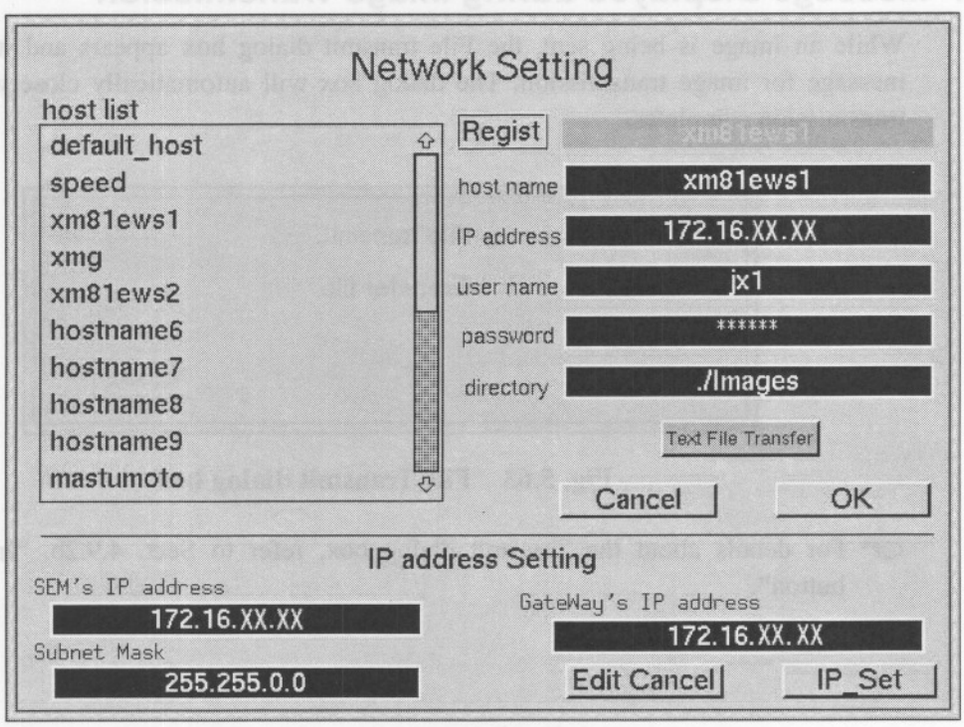


Fig. 5.64 Network Setting window

☞ For details about the Network Setting window, refer to Sect. 4.9.2b, "Image menu button".

5.11 DISPLAYING TEXT

Text can be displayed on the Scanning-image viewing display screen.

- **Operation method**

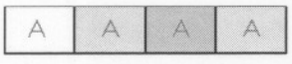
When you wish to display text, click the **Text** icon on the menu bar.

The Text toolbar appears beneath the menu bar.

Fig. 5.65 Text toolbar

5.11.1 Entering Text

1. Select a background color for text from the Text toolbar.



2. Click **EDIT** on the Text toolbar.
3. Move the mouse pointer on the observation screen to the location where you wish to enter text and click that point.
   This allows you to enter text on the observation screen.
4. Type text to be displayed using the keyboard.
5. Press the Return key on the keyboard.
   The text is entered on the screen with the background color that you set in step 1.

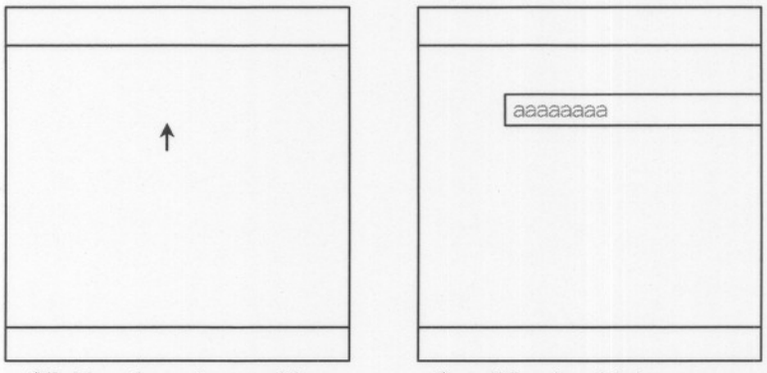
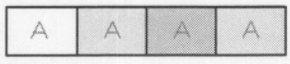


Fig. 5.66 Text entry

5.11.2 Changing Background Color

1. Click **EDIT** on the Text toolbar.
2. Click the character string that you wish to change the background color.
   The character string becomes ready for revision.
3. Select the desired background color from the Text toolbar.



4. Press the Return key on the keyboard.
   The background color of the character string changes to the background color you select in step 3.

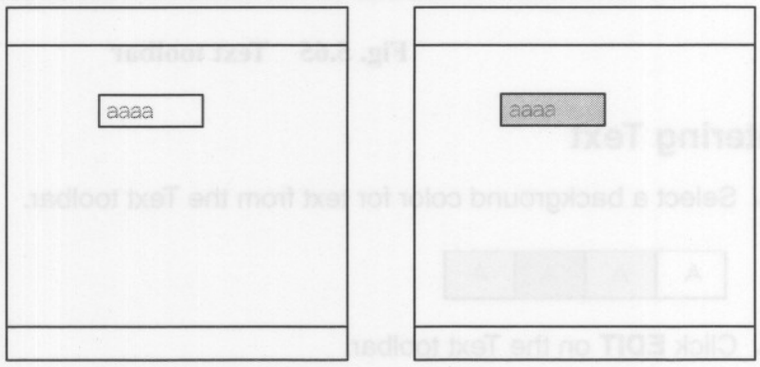


Fig. 5.67 Changing background color

5.11.3 Revising Text

1. Click **EDIT** on the Text toolbar.
2. Click the character string that you wish to revise.
   The character string becomes ready foe revision.
3. Revise characters in the string using the keyboard.
4. Press the Return key on the keyboard.
   This completes the revision of the text.

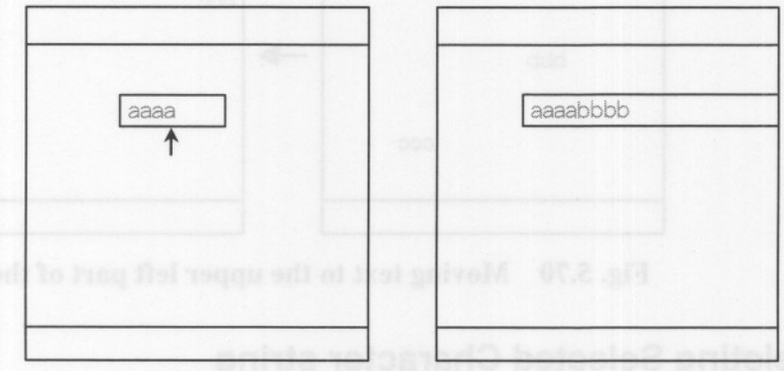


Fig. 5.68 Text revision

5.11.4 Moving Text

1. Click **MOVE** on the Text toolbar.
2. Drag the character string that you wish to move to the desired position.

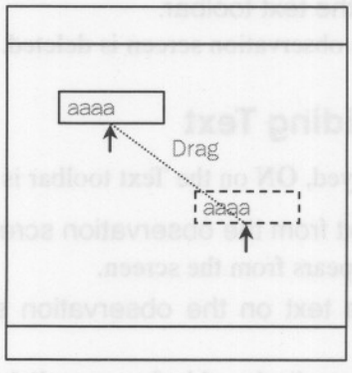


Fig. 5.69 Text movement

3. Release the mouse button at the desired position.
   This completes the movement of the text.

5.11.5 Moving Text to the Upper Left Part of the Screen

◆ Click **ARR** on the Text toolbar.
All the character strings displayed on the observation screen move to the upper left part of the screen.

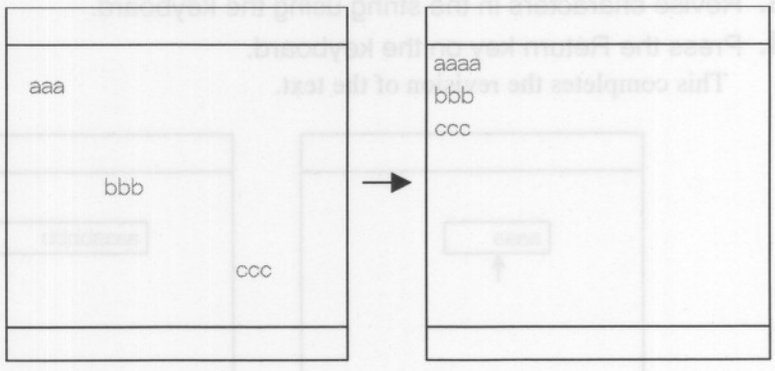


Fig. 5.70 Moving text to the upper left part of the screen

5.11.6 Deleting Selected Character string

1. Click the character string that you wish to delete.
The character string becomes ready for revision.
2. Click **DEL** on the Text toolbar.
The string you selected is deleted.

5.11.7 Deleting All Text

◆ Click **CLS** on the text toolbar.
All text on the observation screen is deleted.

5.11.8 Temporarily Hiding Text

When text is displayed, **ON** on the Text toolbar is green.

1. To hide the text from the observation screen temporarily, click **OFF**.
The text disappears from the screen.
2. To display the text on the observation screen again, click **ON** on the Text toolbar.
The text that was displayed before you click **OFF** reappears on the screen.

5.12 BACKING UP ANALYSIS DATA

The data acquired using the EPMA can be easily copied onto the PC, and also can be backed up to removable media by using a CD-R/RW drive or an optional DVD multi-drive that is attached to the PC.

Perform data backup periodically according to the following procedure.

5.12.1 Backing up the Analysis Data using the PC

1. Double-click on the **Shortcut to jx1** icon on the Desktop, or use Explorer to select the drive (☞ Fig. 5.71, Fig. 5.72) that mounts jx1.

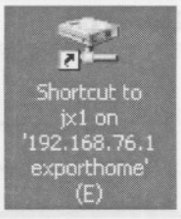


Fig. 5.71 Shortcut icon

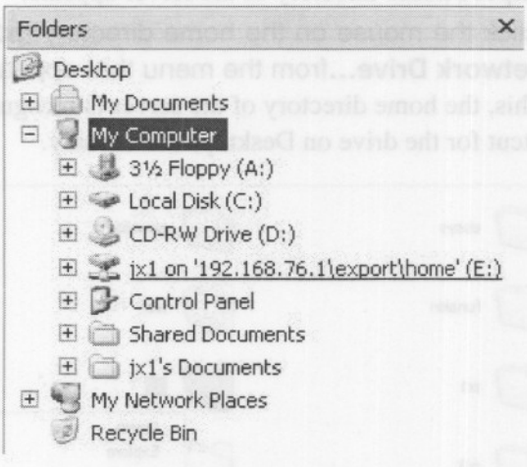


Fig. 5.72 Explorer

The contents of jx1 appear.

2. Copy folders with group names to the hard disk or other device of the PC.
3. Write the copied folders' data onto the removable media, referring to the instruction manual of the writing software for the CD-R/RW drive or DVD multi-drive.

✍ When you copy the analysis data onto the PC, be careful to distinguish capital and small letters. The server distinguishes capital and small letters, but the PC does not. So, change the name of the data before copying data, if necessary.

- **When the user data area is not set as a network drive**

For users other than jx1, such as jx2, the user data area might not be set as a network drive. Set it as a network drive by following this procedure:

1. Select **Start→Run**, input the server IP address (at the factory it is set to 192.168.76.1) after \\, and click on the **OK** button.

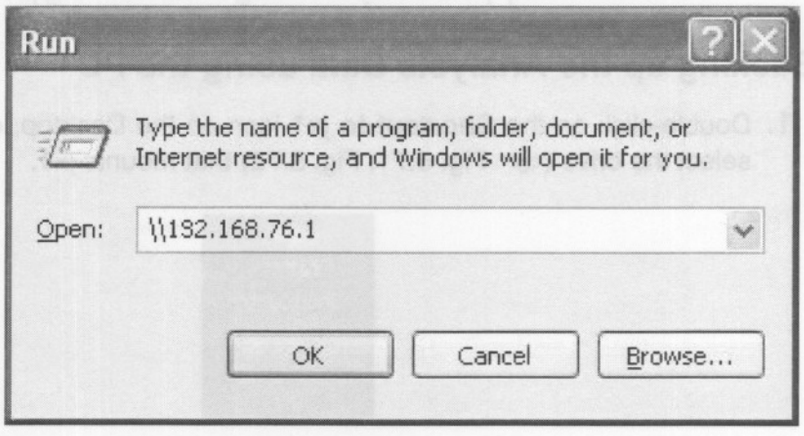


Fig. 5.73 Run

The **/export/home** directory of the server appears.

2. Right-click the mouse on the home directory (jx2 for the user jx2) and select **Map Network Drive...**from the menu that appears (☞ refer to Fig.5.74)

With this, the home directory of the server is recognized as a drive of the PC. Create a shortcut for the drive on Desktop, if necessary.

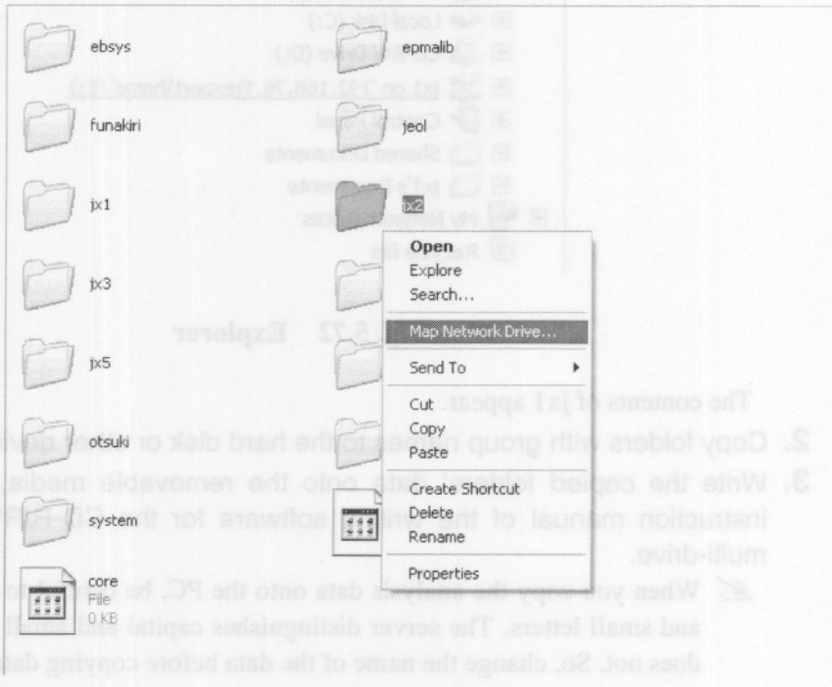


Fig. 5.74 Shortcut

5.12.2 Restoring the Backed up Analysis Data

To display the analysis data that are backed up by the PC using the EPMA, the data must first be returned to the server. Copy the folders of the backed up group name to the home directory such as the mounted jx1 user.

☞ If another data set with the same name exists on the server, be careful not to overwrite the data.