

Brief Manual for JEOLJSM-6480 SEM:

Starting Up

1. **Log in the SEM on FOM.** Log in to the SEM computer.
 2. Start JEOL program of **[SEM Main Menu]** on the desktop.
 3. **Check** status of the SEM system:
 - On the Column Control Panel, the **[EVAC]** button should be green.
 - In the SEM program, the **[HT]** icon on the toolbar should be **[HT OFF]**.
 - The default stage position should be at the exchange position: **X=0 mm, Y=0 mm, R=0 deg, T=0 deg, Z=20 mm.** (Click the **[Stage]** icon to check)
- Note:** If the SEM system is left at a wrong status by previous user, please record on the Usage Record worksheet and report to the manager.
4. Open the **[IR Camera]** on the desktop. During the operation, always use the camera to monitor the distance between the sample/stage and the optical column/detectors.

Sample Loading

5. Load samples onto a Specimen Holder. Record Sample Height above the holder surface.
6. If the Sample Height is large, increase the **[Z]** position to “20+sample height” before loading.
7. Vent the specimen chamber (Press the **[VENT]** button on the Column Control Panel).
8. Unlock and open the chamber door after the chamber reach to atmosphere pressure.
Don't force to open it.
9. Load the Specimen Holder onto the Specimen Stage using the Specimen Exchange Tool.
10. Close and lock the chamber door. Evacuate the chamber by pressing the **[EVAC]** button.
11. Specify the Specimen Holder in the Stage Control window.
12. Specify Specimen Height in Fundamental Setup if necessary.
13. Wait until the **[HT]** icon becomes **[HT OFF]**. System vacuum is ready for image observation.

Image Observation

14. Set desired parameters for SEM: Accelerating Voltage, Working Distance (WD), and Spot Size.
15. Select desired Objective Aperture on the Electron Optical Column. **Adjust the aperture stepwise.**
16. Bring the sample surface into focus by adjusting **[Z]** position value to “WD+ Sample Height”.
17. Turn on the electron beam by clicking the **[HT]** icon. The icon changes to **[HT ON]** and a SEM image should show up.
18. Find features on samples, adjusting Magnification and Focus, Contrast and Brightness to get best image.
19. Perform aperture alignment with the magnification at about $\times 10,000$.
20. Perform astigmatism correction at higher magnifications.
21. Repeat steps 19-21 to improve image quality if necessary.
22. Save your images to C:\Data\. You can create your folder **ONLY** under this directory.

Turning Off

23. Turn off the electron beam by clicking **[HT]** icon and the icon changes to **[HT OFF]**.
24. Return the stage to exchange position. For high samples, manually set positions to zero except the **[Z]** position to “20+sample height”.
25. Vent the specimen chamber, open the door, and unload the Specimen Holder.
26. Close and lock the door of the specimen chamber tightly.
27. **Evacuate the specimen chamber (making sure the green Evac light switches on and the pumps begin pumping!). Wait until the [HT] icon change from [HT WAIT] to [HT OFF].**
28. Set the specimen height in **Fundamental Setup** back to zero if you specified the specimen height, and return **[Z]** position to 20mm. The **Scan Rotation** function should be turned off if used.
29. Turn off the program, and click [OK] to confirm. Turn off the IR camera.
30. Logoff the computer and leave the computer on.
31. Unload your samples from the holder. Clean the holder and the workspace.
32. Record your usage and write down any problem you encountered.
33. **Log out SEM on FOM.** Report on FOM if there are problems with the SEM system.

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Rules (You will be listed on the “stupid” list or be banned from using SEM if you do not follow these emphasized rules.)

- The SEM/EDS system can ONLY be operated by trained people.
- Read and follow the instruction manual carefully, especially the notes. *If you are not confident of the consequences resulted from you action, please ask permissions before your action.*
- You are required to sign in the login sheet every time you use the SEM. It is your responsibility to report any problems encountered during your experimental session.
- It is imperative that gloves be worn during all sample exchange procedures.
- **NEVER** adjust the stage without attending the spacing between the stage/sample and the back scattering detector. Always use the IR camera monitoring the spacing.
- **NEVER** leave the system without being attended. Make sure you turn off the electron beam, take your samples out, evacuate the chamber, close the software, turn off the IR camera, and log off the computer before you leave.
- Please keep the working space clean. No food and beverages are allowed in SEM area.
- You are asked to make a copy of your data on your own disk IMMEDIATELY after your session is finished. You may save your data on a DVD or CD R/RW, USB flash drive or floppy disk. The data on the hard disk may be deleted at any time without notice. SEM lab is not responsible for any data loss.
- **NEVER** finish your session in a hurry. You must follow the “unloading and turning off” procedures properly and completely before you leave the lab.

Reservation

Reservations are made using FOM software (Facility On-line Manager, <http://fom.uncc.edu/>). User must apply an FOM account and use FOM to make reservations and log in/out online. **ONLY** trained users have permissions to make reservations and operate this SEM.

System Startup

1. **Log in SEM on FOM.** Log in the SEM computer.
2. Start JEOL program by double-clicking the **[SEM Main Menu]** icon on the desktop.
3. Check that the **[HT]** icon (the first one from left) on the toolbar should be **[HT OFF]**, and on the Column Control Panel the **[EVAC]** button is green.
4. Open the IR camera by double-clicking the **[IR Camera]** icon on the desktop. Use the monitor window to check the distance between the stage and the back scattering detector. When adjust the stage, always use this camera to monitor this distance, in case that the sample or stage hits the detector. The camera can be turned off by minimizing or closing the monitor window.

Sample loading

5. Prepare sample(s) onto an appropriate Specimen Holder (Please follow the Sample Preparation Instructions). Record the Sample Height if the sample surface protrudes above the Specimen Holder surface.

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6. Click the **[Stage]** icon on the toolbar to open the Stage Control window. Check the Current Position of the stage: **X=0 mm, Y=0 mm, R=0 deg, T=0 deg, Z=20 mm**. If not, click **[File]** menu of the Stage Control window → select “Exchange” in the Stage Position File window → click **[Go]** button to move the stage to the default exchange position.
Note: *When you have a high specimen, please increase Z value accordingly for sample loading:* click **[Positioning]** menu of the Stage Control window → input a larger **[Z]** position value, making sure choose the **[Absolute Mode]** → click **[Go]** button to lower the stage.
7. Press the **[VENT]** button on the Column Control Panel to vent the specimen chamber. The **[EVAC]** button turns off, and the **[VENT]** button starts to flash. Note the **[HT]** icon on the toolbar now becomes **[HT Wait]**.
8. Unlock the chamber door. Let the chamber vent on its own (*i.e.* do not force the door open). After the pressure inside the chamber rises to atmospheric pressure, the **[VENT]** button stops flashing and is orange. Then open the specimen chamber door.
9. Before loading the Specimen Holder into the chamber, make sure there is enough spacing between the Specimen Stage and the Backscattered Electron Detector. Load the Specimen Holder onto the Specimen Stage using the Specimen Exchange Tool.
10. Close and lock the chamber door tightly, then press **[EVAC]** button to evacuate the specimen chamber. The **[EVAC]** button begins to flash.
11. Specify the Specimen Holder on the Stage Control window (click the **[Stage]** icon to open): select the **[Holder]** menu → select the holder you are using from the Specimen Holder List → click the **[OK]** button.
Note: if a special holder not in the holder list is used or your samples are larger than the regular holder you are using, select a holder no smaller than your holder and samples.
12. Specify Specimen Height if the specimen is protruded above the Specimen Holder surface: choose the **[Setup]-[Fundamental Setup]** menu → select the **[Auto Function]** tab → input the Specimen Height.
13. When the **[HT]** icon becomes **[HT OFF]**, system vacuum is ready for image observation.
14. Report immediately if there are any emergencies or major problems with the SEM system.

General Operation and Alignment

15. Set Accelerating Voltage: Click the active data display **[Acc. Volt]**, and double-click to select the desired Accelerating Voltage from the Acc. Volt list. *In general, a higher Accelerating Voltage will provide better resolution at the expense of some loss in surface sensitivity and increased charging and surface damage effects. Higher accelerating voltages (15-30kV) are good for metallurgical samples, and the lower accelerating voltages (1-15kV) are good for non-conductive samples.*
16. Set Spot Size: Click the active data display **[Spotsize]** and select the desired Spot Size. *A smaller Spot Size allows a higher resolution, but decreases the signal/noise ratio of the image. Normally size 30 is used for routine imaging, and higher for EDS analysis and other large probe current condition.*
17. Select desired Objective Aperture on the Electron Optical Column: 1 (smallest) for high resolution imaging, 2 for routine imaging and EDS analysis, and 3 (largest) for EDS analysis or other large probe current condition. **Adjust the aperture stepwise:** when increase the aperture size (1→2→3), hold and rotate the knob clockwise to stop and then release it; when

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decrease the aperture (3→2→1), pull the knob outward and then rotate it counterclockwise to stop and then release it.

18. Choose Signal: Click the active data display **[Signal]**, double-click to select **[SEI]** (second electron image) or **[BEIW]** (backscattering electron image). For backscattering image, three different signal types can be chosen from the **[BEIW]** menu: **[Compo]** composition image, **[Topo]** topography image, and **[Shadow]** stereoscopic image.
19. Click **[HT]** icon to turn on the electron beam and the icon changes to **[HT ON]**. SEM image shows up.
20. Select Working Distance (WD): Click the active data display **[WD]** → select a desired value from the list (6-48 mm) by double-clicking. *A shorter WD has a higher resolution, but its depth of field is shallow. Larger WD has better topography due to the larger depth of field but a lower resolution. Normally use WD of 10 mm for routine imaging and EDS analysis.*
21. Bring the sample surface into focus: Click the **[Stage]** icon → click **[Positioning]** menu of the Stage Control window → input the **[Z]** position value ($Z = WD + \text{sample height}$), make sure choose the Absolute **[Mode]** → click **[Go]** button to move the stage. After you see the fuzzy image of the sample surface using low magnification, use **[FOCUS]** knob to get the image finely focused. *Always monitor the motion of the stage use IR camera. If the stage does not stop at desired height and keeps moving up, click **[Stop]** button on **[Stage Control]** window to stop the stage.*

Note: The Z position of the stage is the distance between the sample holder surface and the detector. So the Z position is the desired WD plus the sample height protruded from the holder surface. If you have a high sample, or have several samples with different heights mounted on the stage, moving the stage carefully that no sample will collide with backscattered electron detector.
22. Locate your sample: Activate **[Stage X/Y]** button on the control panel, use the Joy Stick to move the sample. Activate **[FINE SHIFT]** button to make fine control.
23. Choose a scan mode.
 - (a) **[View]** (Field view mode): using minimum magnification under current working condition.
 - (b) **[Scan 1]** (Brightness and contrast adjust mode): fast scanning speed and small window with CNT/BRT scalar bars for adjustments.
 - (c) **[Scan 2]** (Observation mode): fast scanning speed for observing the sample.
 - (d) **[Scan 3]** (High quality mode): medium scanning speed for imaging. (Recommended for less conductive sample)
 - (e) **[Scan 4]** (Super quality 80s mode): slow scanning speed for higher quality imaging, automatically freeze the image after finish the whole frame. (Recommended for conductive sample)
 - (f) **[Freeze]** (Freeze mode): click to freeze the frame for image saving.
 - (g) **[Photo]** (Super quality 160s mode): slowest scanning speed for super quality imaging. (Not recommended)
24. Contrast and brightness adjustments:
 - (a) Press **[ACB]** (auto contrast and brightness) button on the control panel for quick correction.
 - (b) On the control panel deactivate the **[STIG]** button, and then use the **[BRT]** and **[CONT]** knobs for fine adjustments.

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25. Magnification and focus: Use the **[MAGNIFICATION]** and **[FOCUS]** knobs on the control panel to adjust the magnification and the focus of an image. Always begin with a low magnification, focus the small features on the sample surface, and then gradually increase the magnification and adjust the focus. Activate or deactivate the **[COARSE]** button to select coarse or fine focus.
26. Aperture alignment: Set the magnification to about $\times 10,000$, focus the image and find a small feature for alignment → Select **[Tools]-[OL Wobbler]** on the menu bar, scan mode becomes [scan 1] → adjust the X/Y direction fine adjustment knobs on the Objective aperture to minimize the image shift → Select **[Tools]-[OL Wobbler]** to stop the OL Wobbler.
27. Astigmatism correction: Focus the sample feature so that no significant stretching along certain direction, then with the **[STIG]** button activated adjust **X/Y** knobs on the control panel respectively to obtain the sharpest image. Repeat the focus → stigmator adjustment several times until no stretching of image when out of focus.
28. Repeat steps 24-26 under higher magnifications if necessary.
29. After getting a good image, freeze the image frame, and click the **[Save]** icon (or select **[File]-[Save image as]** menu) to save the image to C:\Data\. You can create your own folder **ONLY** under this directory.
30. Measurements: after freezing an image or loading a saved image, select **[Image]-[Scaler]** menu → select **[X]**, **[Y]** or **[D]** to do the horizontal, vertical or diagonal measurements; select **[Image]-[Multi Point Measurement]** menu → select **[Line]** or **[Circle]**, and use the cursor to draw line or circle for measurements.

Sample unloading and system turning off

31. Click **[HT]** icon to turn off the electron beam and the icon changes to **[HT OFF]**.
32. Click the **[Stage]** icon on the toolbar to open the Stage Control window → click the **[File]** menu → select “Exchange” in the Stage Position File window → click **[Go]** button to move the stage to default exchange position.
33. Press the **[VENT]** button on the Column Control Panel to vent the Specimen Chamber.
34. Unlock the Specimen Chamber door. Let the chamber vent on its own (i.e. do not force the door open). After the pressure inside the chamber rises to atmospheric pressure, open the specimen chamber door and unload the Specimen Holder from the Specimen Stage using the Specimen Exchange Tool.
- 35. Close and lock the door of the specimen chamber tightly, then press [EVAC] button to evacuate the specimen chamber (making sure the light switches on and the pumps begin pumping!). Must wait until the [HT] icon change from [HT WAIT] to [HT OFF].**
36. Make sure to set the specimen height in **Fundamental Setup** back to zero if you specified the specimen height. Make sure the **Scan Rotation** function is turned off.
37. Turn off the program, and click [OK] to confirm. Turn off the IR camera by close the monitor window.
38. Logoff the computer and leave the computer on.
39. Record your usage and write down any problem you encountered.
40. **Log out SEM on FOM.** Report on FOM if there are problems with the SEM system.

Note: Please be **careful** when you want to stop and unplug your USB driver. Please **DO NOT** mistakenly stop the NETGEAR Adapter which is for communications between SEM and EDS computers.