

JEOL 2000FX

Basic operating instructions

You have to be trained on the instrument prior to operating it on your own!

Always check the instrument log-book to determine the status of the microscope.
Check the following microscope settings:

ACCEL VOLTAGE READY light is lit.

FILAMENT READY light is lit.

BEAM CURRENT reader displays 100.

(If both READY lights are lit, but BEAM CURRENT reader displays 000, then press the red HT switch twice. The ACCEL VOLTAGE READY light will flicker indicating that the voltage is ramping up to 200kV. Wait until the flickering stops.)

FILAMENT is set to OFF.

Goniometer is at 0 and locked.

Objective and SAD apertures are out.

Adjust the brightness and contrast knobs to view the CRT.

Sample insertion

Fill the liquid nitrogen trap. Make sure that the viewing screen is covered!

FILAMENT EMISSION should be off, goniometer at 0.

With the pin at 9 o'clock position, insert the holder until it stops and push in slightly. This will engage the pump that will evacuate the specimen chamber. The goniometer light will become red. Wait for at least two pumping cycles to be completed (light goes off twice). Then turn the holder away from you (clockwise) until it stops and guide it in (it will be pulled inside the microscope by the vacuum, don't just let it go!).

Check that the ACCEL VOLTAGE and FILAMENT READY lights remain on.

Microscope alignment and astigmatism correction

DO NOT ATTEMPT ANY OF THE ALIGNMENT PROCEDURES IF YOU HAVE NOT BEEN TRAINED FOR IT!!!

For beam sensitive materials, first perform alignments 2; 3; and 4 that do not require the presence of the sample without a holder. Other alignments can be done far away from the area of interest or skipped entirely. You might sacrifice the microscope performance but will be able to take images of your sample before it is destroyed by the electron beam.

All alignment procedures are done in MAG 1 or MAG 2 modes.

Press the corresponding CRS switch to change from fine to coarse controls.

Turn on the FILAMENT slowly.

Switch to LOW MAG mode.

Expand the beam with BRIGHTNESS knob (if necessary) until you see the sample/grid.

Choose an area for alignment (like an edge of the sample with sufficiently large hole nearby) and bring it to the center.

Switch to MAG1 or MAG2 mode.

Expand the beam with BRIGHTNESS knob if necessary. (If you don't see anything, move the sample a little bit, you might be right on the grid).

Focus the image roughly using OBJ FOCUS knob (obtain minimum contrast condition).

Use OBJ FOCUS STEP switch to change the current variation per notch, 1 is the smallest increment.

If at crossover (converged beam) the beam is not in the center of the screen, to bring it to the center use the SHIFT: X and Y knobs.

Do not adjust the condenser aperture yourself, ask Lou or Evgenia.

The following alignment requires presence of the sample.

1. Goniometer alignment (eucentric height)

Set MAGNIFICATION to about 20-40 K. Move some recognizable feature of the sample towards the center of the screen. Adjust the OBJ FOCUS knob to obtain the value of 7.1 (OBJ on page 4 on the CRT screen). Using Z control lower or raise the sample until it is in focus. This will be very close to the eucentric height. You can check it by tilting the sample using foot pedals by about 5-10 degrees in both directions, the sample should remain in the center of the screen. Make sure to tilt the sample back to 0 degree when you are done.

Note: If you find it difficult to focus the sample using Z-control, set eucentric height in the following way: set magnification to 10-20K. Tilt the sample using foot pedals by about 5-10 degrees in both directions. The sample will move from the center. Tilt the sample back to 0. Using Z control lower or raise the sample. Repeat tilting procedure and Z adjustments until no specimen movement is observed during tilting. Repeat this procedure at higher magnification (e.g. 40-50K). When finished, tilt the sample back to 0 degree. Focus the image. Check page 4 of the CRT screen, OBJ should have a value close to 7.1.

The following alignments are done outside the specimen area.

2. Gun alignment (tilt) and condenser lens astigmatism correction

Set MAGNIFICATION to about 40K - 50K. Switch to spot size 1. Converge the beam using the BRIGHTNESS knob to obtain the smallest possible illumination spot (crossover point). Undersaturate the filament slightly until you see a dark halo (filament image). Focus the image of the filament with the BRIGHTNESS control.

Turn on the COND STIG switch (the build-in lamp brightens). Using the left and right DEF: X and Y controls, make the image of the filament as sharp as possible. Expand the beam with the BRIGHTNESS control clockwise and counterclockwise to check if it

expands uniformly. Repeat the condenser stigmatism procedure if needed. Turn off the COND STIG switch when finished

If the filament image (the dark halo) is not symmetrical, turn on the DEFLECTOR: GUN switch (in the drawer, the build-in lamp lights up), use DEF: X and Y knobs (in the drawer) to center the filament image (not the beam itself). Turn off the DEFLECTOR: GUN switch. If the beam has shifted from the center, use SHIFT: X and Y knobs to bring the beam to the center.

Slowly increase FILAMENT EMISSION only until the point when the filament image disappears (**DO NOT OVERSATURATE THE FILAMENT!**).

Every time you change the spot size (using the SPOT SIZE switch), you will have to adjust condenser astigmatism. You can do it either by observing the shape of the beam as you go through the crossover point and then expand the beam using the BRIGHTNESS knob or focusing the undersaturated image of the filament (as described above). The beam should be circular and should expand and converge uniformly around the center.

3. Condenser lens system alignment

Set MAG to about 10-20 K. Switch to spot size 1. Converge the beam with BRIGHTNESS to obtain the smallest possible illumination spot (crossover). Depress the DEFLECTOR: GUN button in the drawer (the built-in lamp will light up). Center the beam with the SHIFT: X and Y knobs (in the drawer). Switch to spot size 7-8. Converge the beam with BRIGHTNESS. Depress the DEFLECTOR: COND button in the drawer (the built-in lamp will light up). Center the beam with the SHIFT: X and Y knobs (in the drawer). Repeat this sequence until the beam doesn't shift from the center when you switch between spot size 1 and 5. Turn OFF DEFLECTOR: GUN and COND switches.

4. Image wobbler alignment

Set MAGNIFICATION to about 20-40K. Using BRIGHTNESS control converge the beam and center it with the SHIFT: X and Y knobs. Depress the COND DEF ADJ - **TILT** button in the drawer. Set the COND DEF ADJ - **TILT** switch to X. The beam will split into two. Merge the two beams together and minimize wobbling using SHIFT: X and DEF: X knobs. Set the COND DEF ADJ - **TILT** switch to Y. Merge the two beams together and minimize wobbling using SHIFT: Y and DEF: Y knobs. Set the switch to neutral position and turn OFF the COND DEF ADJ - **TILT** button. Center the beam with the SHIFT: X and Y knobs.

The following alignment requires presence of the sample.

5. Current center alignment

Bring some recognizable feature of the sample to the center of the screen. Set MAG to about 50K and expand the beam with the BRIGHTNESS control to cover the entire screen. Focus the image roughly. Turn on the WOBBLER - OBJ switch (in the drawer). The image now rotates clockwise and counterclockwise periodically. Depress the DEFLECTOR-BRIGHT TILT switch on the left panel (the built-in lamp will light up). Operate the left and right DEF: X and Y knobs to minimize the image movement. Turn OFF the WOBBLER - OBJ switch. Turn OFF the DEFLECTOR-BRIGHT TILT switch.

6. Voltage center alignment

Bring some recognizable feature of the sample to the center of the screen. Increase MAGNIFICATION to about 120K. Focus the image roughly. Expand the beam, to cover the entire viewing screen. Turn on the WOBBLER - HT switch (on the right panel). The image will enlarge and contract periodically. Depress the DEFLECTOR-BRIGHT TILT switch (the built-in lamp will light up). Operate the left and right DEF: X and Y knobs to minimize the image movement. Turn OFF the WOBBLER - HT switch and the DEFLECTOR-BRIGHT TILT switch.

7. Objective lens astigmatism correction

Before adjusting the objective astigmatism, write down the values of O-STIG: X and Y on page 6 of the CRT screen. If you the image worsens after your adjustments, adjust stigmators to the original values.

First method: Bring the thin edge of the sample to the center of the screen. Increase MAG TO >200K. Insert objective aperture. Focus the sample. Use binoculars as you obtain over-, in- and under-focused image. If you observe streaking in the image (unidirectional focusing), then objective astigmatism needs to be corrected. Obtain in-focus condition. Depress the DEFLECTOR - OBJ STIG switch on the left panel (the built-in lamp will light up). Use DEF: X and Y knobs to minimize the unidirectional features in the image. Check it by changing OBJ - FOCUS. Repeat the focusing and astigmatism correction steps as needed. Turn OFF the DEFLECTOR - OBJ STIG switch.

Second method: Find a circular hole in your sample or in the carbon film and bring it to the center of the screen. Adjust MAG to about 20-80K. Focus the sample. Obtain over-, in and under-focus conditions using the OBJ-FOCUS control. Observe a Fresnel fringe around the hole in the under- (bright fringe) and over-focused (dark fringe) conditions. If the fringe width is not uniform around the hole, you need to adjust objective astigmatism. Depress the DEFLECTOR - OBJ STIG switch on the left panel (the built-in lamp will light up). Use DEF: X and Y knobs to make Fresnel fringe width uniform around the hole. Turn OFF the DEFLECTOR - OBJ STIG switch.

Microscope operation

Turn on the FILAMENT slowly.

Switch to LOW MAG mode.

Expand the beam with BRIGHTNESS knob (if necessary) until you see the sample/grid.

Choose an area of interest or an area for focusing away from the area of interest (for beam sensitive materials) and bring it to the center.

Switch to MAG1 or MAG2 mode.

Expand the beam with BRIGHTNESS knob if necessary. (If you don't see anything, move the sample a little bit, you might be right on the grid). Check MAG on the CRT display. Adjust it to the value around 10-20 K for initial observation using the SELECTOR switch.

Check what spot size you are using, the spot size is displayed on the CRT screen (smaller spot size is needed to minimize beam damage). To change the spot size, use the SPOT SIZE switch.

Focus the image roughly using OBJ FOCUS knob (obtain minimum contrast condition).

Use OBJ FOCUS STEP switch to change the current variation per notch, 1 is the smallest increment.

If at crossover (converged beam) the beam is not in the center of the screen, to bring it to the center use the SHIFT: X and Y knobs.

If at anytime during your session you are lost and can't see anything, do the following. Take out objective and SAD apertures. Decrease MAG to about 5 -10K or go to LOW MAG mode. Spread the beam using BRIGHTNESS. Move the sample to the center: X and Y reading 0 on page 2 of the CRT screen. If you still can't see anything, get help.

Bright field image formation

Spread the beam with the BRIGHTNESS knob to cover the entire screen.

Focus the sample roughly (obtain minimum contrast condition) using the OBJ FOCUS knob.

Put in SAD aperture (this step is not necessary if you are planning to use a large objective aperture).

Switch to DIFF mode.

Put in objective aperture. For conventional bright field images, use one of the small apertures. The outline of the aperture should be sharp (do not confuse it with the outline of the central beam that is bright, the outline of the aperture is dark). Focus the outline of the aperture if needed with the DIFF FOCUS knob.

Center the objective aperture around the central beam.

Switch to MAG 1 or MAG 2 mode.

Take out SAD aperture (if you put it in).

*For beam sensitive materials, put in the objective aperture directly in MAG mode to avoid prolong exposures. However, in this case only small adjustments of the aperture position should be done! If you don't see anything when you insert the objective aperture in the image mode, do not adjust its position, but follow the instructions above. For beam sensitive materials, focusing should also be done away from the area of interest. Use a smaller spot size, 3-8. To change the spot size (displayed on the CRT screen) use the SPOT SIZE switch. You can also undersaturate the filament, use smaller condenser aperture (**do not change the condenser aperture yourself!**), STEM mode or MDS mode.*

Selected area diffraction (SAD)

Spread the beam using the BRIGHTNESS knob.

Insert SAD aperture and position it as needed.

Switch to DIFF mode.

To focus diffraction pattern properly, insert an objective aperture and focus the outline of the objective aperture using the DIFF FOCUS knob.

Remove the objective aperture.

To center diffraction pattern: depress the DEFLECTOR: PROJ button in the drawer (the built-in lamp will light up). Use SHIFT: X and Y knobs to center diffraction pattern. Turn off the DEFLECTOR: PROJ button.

Spread the beam further using the BRIGHTNESS knob, so that the central beam becomes a very sharp spot.

Using IMAGE WOBBLER for focusing

Note that image wobbler alignment needs to be performed before using this feature.

Find the area of interest. Expand the beam to cover the entire screen. Turn on the WOBBLER - IMAGE: X or/and Y switches. The image will split into two. Using OBJ-FOCUS controls merge the two images together. Turn OFF the WOBBLER - IMAGE: X and Y switches.

Taking pictures

Select automatic or manual exposure time on Page 1 of the CRT screen by pressing the SHUTTER button (A or M is displayed). The full screen or the small screen can be used to estimate the exposure time. For automatic film advance press FILM ADVANCE AUTO button (the built-in lamp will light up). Cover the screen and turn off lights.

For automatic film advance: press PHOTO button once, wait for the green exposure light to come on and off.

For manual plate advance: press PHOTO button, wait until it lights up, then press it again and observe the green exposure light to come on and off.

If the camera is jammed, check both magazines. Avoid putting your hands inside the camera!

Shut down procedure

Either switch to LOW MAG mode or leave it in MAG 1 or 2 mode at around 10-20 K. Expand the beam to cover the entire screen. Take out objective and SAD apertures. Turn FILAMENT to OFF slowly. Position goniometer at 0. Make sure it is locked.

Take out your sample: pull the sample holder until it stops. Turn towards you (counterclockwise) until it stops. Pull it out, pressing a finger against the goniometer.

Fill out the log book.

Change the camera and **reset the number of negatives to 50.**

Turn off brightness and contrast controls of the CRT screen.

See separate instructions for camera change.