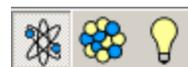


FIB Checklist

- 1) Sign into the log book.
- 2) Prepare your sample (*wear gloves*)
 - a. Coat with metal if necessary, and connect metal layer to sample stub with conductive tape.
- 3) Load your sample (*wear gloves*)
 - a. Ensure both the E-beam and I-beam are off (the Beam On button should be grey in color)
 - b. Using the Navigation tab set the following stage position:
 - X = 0.00 mm
 - Y = 0.00 mm
 - Z = 25 mm* (with black +↓ symbol OR 0.0 mm with red +↑ symbol)
 - T = 0.0 °
 - R = 0.0 °

(* The stage will not get to 25 mm, but it will move to the lowest position possible.)

- c. Press Vent. Wait for the chamber pressure icon to turn grey in the main chamber. Once it does, *gently* try to open the door. If it does not open, press Vent again (typically you'll need to do this 3x), wait ~1 minute, and gently try to open the door again. It will take a few minutes to vent the chamber, and it should not require force to open the door. 
 - d. Place your sample into the sample holder and gently tighten the set screw. Do not over tighten. Make sure your sample will not hit the E-beam pole piece.
 - e. *Gently* close the door, press Pump, and wait for the chamber pressure icon to turn green in the main chamber. 
- 4) If the tool is Asleep, press the Wake-Up button under the Beam Control tab (the I-source progress bar will be grey when asleep and green when awake). The wake-up process will take a few minutes. The progress can be monitored in the Beam Control tab - eventually the I-source progress bar will turn green when the system is fully awake.



Left icon: E-beam;
Middle icon: I-beam;
Right icon: CCD camera

- 5) Turn on the E-beam by pressing Beam On under the Beam Control tab with the E-beam active (the button should turn yellow when on).
- 6) Focus your image (adjust stigmation, brightness and contrast, and scan speed if necessary). Do NOT adjust the height of the sample during this process.
- 7) Link your sample height (Z) to the working distance by pressing the Z-FWD button. After you have linked to an in focus image, it is safe to change the height of the sample.
- 8) If you are only using the FIB for E-beam imaging, you can skip the following steps and move straight onto imaging your sample (Step 14).
- 9) Find the location on your sample where you want to pattern. Move the Z position to 4.1 mm, which should be close to the eucentric position. Refocus and re-link. (If necessary, optimize the image using Modulator/Lens Align, Crossover/Source Tilt and stigmatize your image.)



10) Find the eucentric position:

- a. On the Beam Control tab, ensure the E-beam Beam Shift is set to Zero by right clicking in that window and selecting Zero.
- b. At $T = 0.0^\circ$ find a feature and center it (by double clicking) in the E-beam image. Adjust your magnification to 1,000 - 5,000x.
- c. Tilt the sample to $T = 7.0^\circ$, and use the z-control (middle roller ball) in the CCD window to bring the feature back to the center of the E-beam image. (Refocus if necessary – do not re-link at this tilt angle.)
- d. Tilt back to $T = 0.0^\circ$. (If the feature has shifted more than 5-10 μm , then repeat b-d.) Recenter the feature (by double clicking on it). (Refocus and re-link if necessary.)
- e. Tilt to $T = 52.0^\circ$, and use the z-control in the CCD window to bring the feature back to the center of the E-beam image. (Refocus if necessary – do not re-link at this tilt angle.)
- f. Repeat the tilt from $T = 0.0^\circ$ to $T = 52.0^\circ$ to ensure less than 1 μm vertical shift.

11) Align both beams

- a. Adjust the tilt to $T = 52.0^\circ$, and while imaging with the E-beam, find a feature and center it. Pause the E-beam.
- b. Turn on the I-beam on by pressing Beam On under the Beam Control tab with the I-beam active (button will turn yellow when I-beam is on).
- c. Set the aperture current for the I-beam. Use relatively low beam currents ($\sim 28\text{pA}$ or greater) for imaging to reduce the amount of sample milling, and limit the exposure to the I-beam. Ideally you should use the same beam current you will pattern with.
- d. Unpause the I-beam, and use the Beam Shift in the Beam Control tab to move the same feature to the center of the I-beam image. Focus and stigmatize the image.

12) Patterning:

- a. Make sure $T = 52.0^\circ$, and the I-beam is on.
- b. Warm up the deposition source if necessary.
- c. Take a snapshot with the I-beam, making sure that the image is in focus and stigmatized.
- d. Select a pattern to etch/deposit from the menu in the Patterning tab. Draw this feature on the I-beam snapshot and adjust the position/rotation of the feature. Repeat if necessary for multiple shapes patterned in one step.
- e. Select an Application from the pull down menu to designate the type of etch or deposition you would like to do. Modify the size and depth of your features, and any other parameters in this window as necessary (serial vs parallel). Check the process time and adjust the beam current to modify the process time until it is acceptable.
- f. If you are using a GIS (Gas Injection System), ensure the deposition source is warm, and insert the needle. ****You MUST be at the eucentric point or the GIS needle will hit the sample, and damage both your sample and the needle.****
- g. Press the Play Pattern button to start the patterning process. Record this process in the log book. 
- h. Once patterning is complete, retract the GIS needle and turn the deposition source heater off.
- i. Delete your patterns when finished patterning.

13) For E-beam imaging, select a Lens Mode: Mode 1 for normal imaging, Mode 2 for Immersion / Ultrahigh Resolution imaging. (Mode 2 is only available at certain magnifications, voltages, currents, and working distances, so if it is grayed out, modify your imaging parameters and try again.)



- a. Adjust the beam position by pressing the Crossover button, and then using the Source Tilt adjustment to center the beam in the window. Turn the Crossover off when finished.
- b. In the Beam Control tab, press the Modulator button, and use the Lens Align adjustment window to eliminate any movement in your E-beam image. Turn off the modulator when finished.
- c. Focus and stigmatize your image.
- d. Adjust the contrast and brightness, and the scan parameters for image acquisition.
- e. Take a photo (F2) or a snapshot  and save your data in “support-d0406/images on support-d0406/Faculty Advisor Name/Your Name”.
- f. When you are finished imaging, return to Mode 1 if using Mode 2, and refocus as a courtesy to the next user.

14) Shut down:

- a. Turn both the E-beam and the I-beam off by clicking on the yellow Beam On button in the Beam Control tab while each column is active.
- b. If you are the last user of the day, also press the Sleep button in the Beam Control tab to turn the I-column source off.
- c. Using the Navigation tab set the following stage position:

X = 0.00 mm

Y = 0.00 mm

Z = 25 mm* (with black +↓ symbol OR 0.0 mm with red +↑ symbol)

Do this first!! → T = 0.0 °

R = 0.0 °

(* The stage will not get to 25 mm, but it will move to the lowest position possible.)

- d. To remove your sample, press Vent. Wait for the chamber pressure icon to turn grey in the main chamber. Once it does, *gently* try to open the door. If it does not open, press Vent again (typically you’ll need to do this 3x), and *gently* try to open the door again. It will take a few minutes to vent the chamber, and it should not require force to open the door. 
- e. Loosen the set screw, and remove your sample.
- f. *Gently* close the door, press Pump, and wait for the chamber pressure icon to turn green in the main chamber.
- g. Leave the software running.
- h. Sign out of the log book.

Shut down/Restart Procedure

**** Items in blue are optional. If a typical restart doesn't fix the problem, try also putting the system into standby by including the items in blue. ****

- 1) Instrument Shut Down:
 - a. Turn off both the electron and ion sources.
 - b. Close the software (User Interface – UI)
 - c. Stop the server and wait for all of the lights at the bottom of the window to turn grey.
 - d. **Press the standby button. You should see the light on the front of the instrument switch to standby, and the instrument will become quieter.**
 - e. Exit from the server.
 - f. Shut down the computer.
- 2) Instrument Start Up:
 - a. **Press the button on the front of the instrument to turn the instrument back on.**
 - b. Turn the microscope PC back on, and log on as “supervisor” with a password of “HeliosD0406”.
 - c. Open the FEI software. Once the four lights in the upper right hand corner have turned green, press the start button and wait for all of the lights in the bottom of the window to turn green.
 - d. The user interface should automatically restart.
 - e. Log on as “supervisor” with a password of “HeliosD0406”.
 - f. **Run the Home Stage procedure if requested (after putting the system in standby).**

FIB Mouse Button Functions

1. Focus:
 - a) Click and hold right mouse button. Drag side to side to focus
2. Zoom in and out:
 - a) “+” and “-“ keys OR
 - b) Left click and drag a new region of interest OR
 - c) Double click on the magnification on the right of the page and type in a new value.
3. Move to new position:
 - a) Double click to bring a new feature to the center OR
 - b) Press and hold middle roller ball and drag in direction you want to move
4. Adjust z-position in the CCD window
 - a) Press and hold middle roller ball and drag in the direction you want the feature to move