

FEI Helios NanoLab - Operation Instructions

For additional assistance, please contact the facility manager.

Please contact in an emergency:

SEM manager: Mr. Ben Myers, 1-3439 (O), 312-593-8298 (cell)
b-myers3@northwestern.edu

EPIC manager: Dr. Shuyou Li, 1-7807 (O), 847-675-7387(h),
syli@northwestern.edu

EPIC director: Prof. Vinayak P Dravid, 7-1363 (O), 847-486-1705 (h),
v-dravid@northwestern.edu

Quanta reservations are made using the EPIC FOM online reservation system. Please follow all EPIC facility rules for using this system.

Note: It is imperative that gloves be worn during all sample exchange procedures. If you cannot find any gloves, please ask!

Data may be stored directly to the SEM file server via the desktop shortcut. You should never retrieve any data directly from the computers attached to the instrument, but rather save your data over the network and retrieve it from the file server.

System Startup and Sample Loading

1. Log in to FOM and log in to your reservation.

Note: The previous user should leave the system logged in and software running. If the computers have been logged off or the software is not running, follow steps 2-5.

2. Log in to each of the three computers (from left to right, EDS PC, Support PC and Helios Control PC) – Username: supervisor, Password: heliosd413
3. Double-click on the **FeiSystemControl** icon on the desktop and hit the **Start** button.
4. Once the server is running, click the **Start UI** button and enter the same username/password.
5. Click **OK** at the prompt to home the stage.
6. Verify the Vacuum status – all three chambers in the diagram at the bottom-right should be green.
7. If you are the first user of the day, you will need to **Wake Up** the system under the beam control tab.
8. If you will be using one or more GIS, you should heat the desired crucible under the patterning tab.
9. Press the **Vent** button to vent the chamber
10. Once the chamber is vented, mount your sample on the stage. Please note that your sample should be <10mm tall and if you are loading multiple samples, they must all be within 1mm of the same height.
11. Close the chamber door and press the **Pump** button. Wait for the chamber vacuum status to turn green.

Setting Up the Electron Column and Eucentric Height

1. To turn on the electron beam, select the appropriate quadrant (top-left) and select **Beam On** under the beam control tab.
2. Set the desired High Voltage and Beam Current for the electron column.
3. There are 2 different imaging modes:
 - a) Mode 1 – Field-free mode (Spy Mode), useful for low magnification imaging and imaging during ion milling
 - b) Mode 1 – Immersion mode, useful for high resolution/high magnification imaging
4. There are several different detectors that can be used with the electron beam
 - a) ETD – Everhart-Thornley detector – secondary electron detector that can be used in either Mode 1 or 2 and provides good 3-D imaging
 - b) TLD – through-the-lens detector – can be used only in Mode 2 and is the high resolution secondary electron detector
 - c) STEM – transmitted electron detector for bright and dark field imaging
5. Locate the sample using Mode 1 and focus on the sample surface. You can navigate by moving the mouse while holding down the middle mouse button (scroll wheel).
6. Couple the Z-axis of the stage to the working distance.
7. Send the stage to a 5mm working distance under the navigation tab.
8. Align a feature on the sample to the center cross on the screen.
9. Tilt the stage to 5 degrees.
10. Adjust the Z-axis of the stage to bring the feature back to the same position.
11. Focus on the sample and couple the Z-axis to the working distance.
12. Tilt back to 0 degrees and repeat steps 8-12 until you have minimal shift of the feature when tilting.

Setting Up the Ion Column and Beam Coincidence

1. To turn on the ion beam, select the appropriate quadrant (top-right) and select **Beam On** under the beam control tab.
2. Set the desired High Voltage and Beam Current for the ion column.
 - a) For ion imaging, choose moderate to high voltage and low currents to minimize sample damage
 - b) For milling, higher voltage will produce a finer probe at the surface with higher current, but more sub-surface damage and Ga implantation. Higher currents will allow for better throughput, but result in a larger beam size.
3. There are 2 detectors for ion imaging:
 - a) ETD – general purpose detector to detect ion-induced secondary electrons
 - b) CDEM – for high S/N secondary ion images (do not use for general imaging during alignment, etc.)
4. Zero the beam shift for the electron column.
5. Align a feature in the electron image with the center cross.
6. Tilt the stage to 52 degrees in the navigation tab.
7. If there is a significant shift of the feature position, tilt back to 0 and repeat steps 8-12 under *Setting up the Electron Column* above.
8. Re-align the feature to the center cross in the electron image.

9. Switch to the ion column image and adjust the image shift to re-align the same feature to the center cross – the electron and ion beams are now coincident.

Alignment of the Electron and Ion Columns

Note: The alignments in this section are for electron/ion imaging or simple milling procedures. If you will be milling with multiple beam currents/voltages, contact the lab manager for a more rigorous alignment scheme.

1. Make sure all conditions are set (high voltage, beam current, WD, etc.).
2. Select the appropriate quadrant for the electron beam.
3. **Focus** on a small particle on the sample surface with magnification >20,000X.
4. Adjust the **Beam Tilt** to achieve the brightest image.
Turn on the **Modulator** to activate the focus wobble.
5. Adjust the **Lens Alignment** to minimize translation of the image.
6. Focus again on the small particle.
7. Adjust the **Stigmator** to achieve the sharpest image and to minimize stretching during focusing.
8. For ion column alignment, select the appropriate quadrant and adjust the **Stigmator** to achieve the sharpest image and minimize stretching during focusing.

General Patterning Instructions

1. There are simple patterning tools accessible under the patterning tab.
2. A different operation (ion/electron exposure, deposition, etc.) and set of parameters (current, voltage, dwell times, etc.) can be assigned to each shape.
3. You may set up a sequence of different shapes and operations.
4. More complex geometry and exposure control can be achieved by importing bitmaps or generating scripts.
5. More to come...

GIS system operation

1. There are 5 GIS systems on the Helios
 - a) TEOS deposition
 - b) C deposition
 - c) Pt deposition
 - d) Enhanced etch
 - e) Delineation etch
2. The crucibles should be warmed for a minimum of 30 minutes prior to deposition.
3. You may heat multiple crucibles, but only one GIS may be inserted at any given time.
4. Deposition can be carried out with either the electron or ion beam. Electron beam induced deposition will typically provide higher resolution features, but with lower efficiency and less complete precursor dissociation. Ion beam deposition is more common for most applications.
5. Etch enhancements are designed for use with the ion beam.
6. Insert the desired GIS needle by clicking the check box under the patterning tab.

7. Refer to the *General Patterning Instructions* to use the GIS (this will open and close the gas valve automatically). Otherwise, once the gas valve is open and the beam is on, deposition/etching will occur in the area being viewed – some precursors are very expensive, so be careful.
8. Retract the GIS needle.
9. When you are completely done with a GIS, turn off the crucible heating.

Shut Down and Sample Removal

1. Shut off both electron and ion beams.
2. Retract all GIS and manipulators.
3. Send the stage to the **Center Position**.
4. Press the **Vent** button to vent the chamber.
5. When the chamber vents, open the door and remove your samples.
6. Close the chamber and press the **Pump** button to evacuate the chamber.
7. Wait for the chamber to pump down (vacuum status is green).
8. **Only if you are the last user** of the day (check FOM), you should put the system to **Sleep**.
9. Shut off heating for all GIS.
10. Clean up any mess you made in the room.
11. Log into FOM and log out of your reservation.