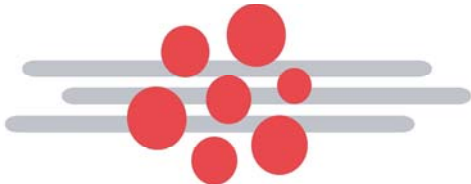


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|  <p>Center for Functional Nanomaterials Brookhaven National Laboratory</p> | NUMBER |
| | REVISION 0.1 |
| Subject: Helios SEM/FIB Basic Instructions | DATE 11/15/2011 |
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This SOP does not replace the detailed training sessions you should receive before being allowed to use the machine independently.

It is your responsibility to avoid any dangerous situations and to understand and follow these instructions. If we observe any negligence from your part, you will not be allowed to use the system anymore.

Under any doubt of any kind contact Fernando Camino (x7606) or Aaron Stein (x3527). If neither of us is around, **STOP YOUR WORK** until we show up. The cost of parts, repairs or tool downtime is certainly worth a day of your project.

STARTING

- 1) Open Helios-log.vi log program, located on the desktop of the support computer, and record the start of your session.
- 2) Hit "FeiSystemControl" icon on desktop of Helios computer to start microscope server.
- 3) In microscope server window, hit "Start UI" to start user interface (UI); then log on using your username and password.
- 4) Loading your sample:
 - Hit "Vent" in beam page of UI. It takes about 5 min to be able to open the chamber. Make sure sample holder is far from SEM final lens. For this you need to see a "live" CCD camera image of the chamber.
 - Open chamber door slowly, while observing chamber image to make sure no accidents occur.

- Figures 1 and 2 show the stub holder mounted on the Helios stage. It has a piece with three holes for stubs. Only use the hole shown in Figure 1. This hole has a corresponding setscrew to hold the stub (see Figure 2).

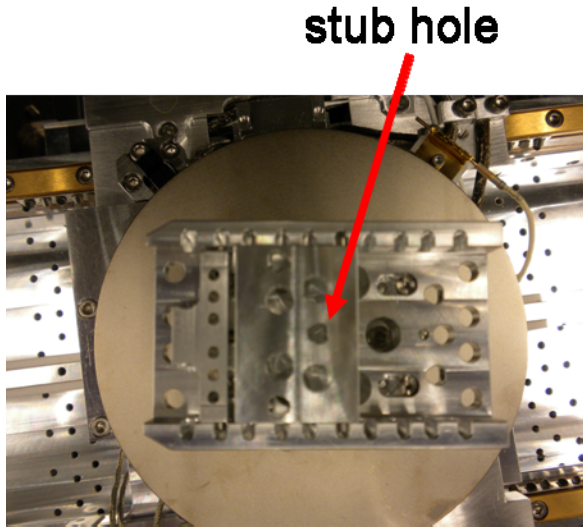


Figure 1. Top view of stub holder.

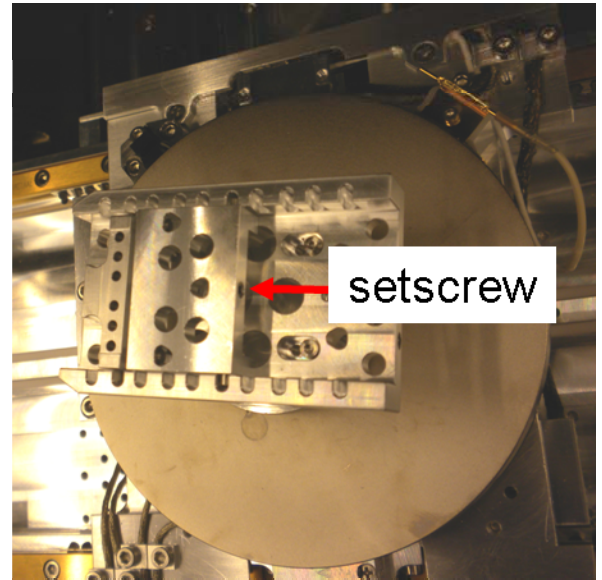


Figure 2. Angle view of stub holder.

- To facilitate adjusting the setscrew (use very little force), you may need to rotate the stage so that the setscrew is to your right when you stand in front of the chamber. You may also need to bring the stage closer to you to make it easier to place the stub and tight the setscrew. You move the stage only from the User Interface (see figure 3). If you have any questions about this step, do not hesitate to call Fernando or Aaron.

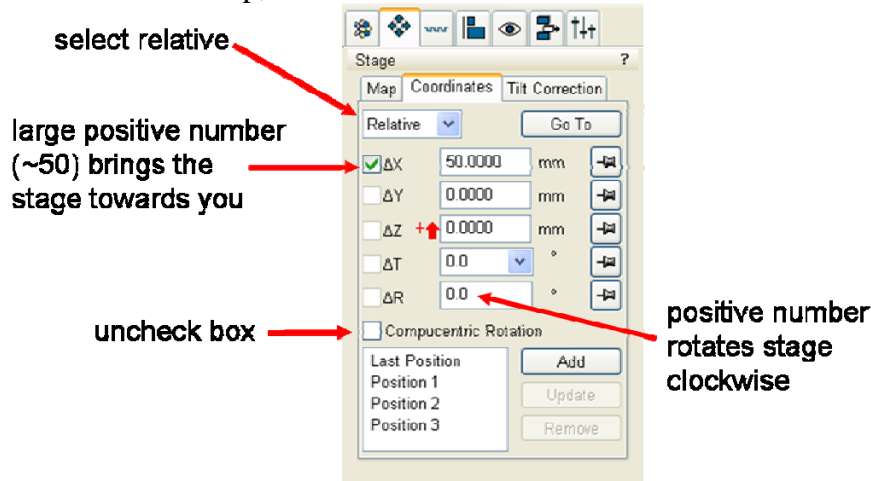


Figure 3. User interface settings for moving the stage in order to facilitate access to stub hole setscrew.

- To rotate the setscrew to secure or to remove your stub, use the hex wrench placed inside a plastic box next to the Helios tool. Do not use any other wrench!

- The holder has another larger hex screw (opposite to the stub setscrew, see figure 4). This needs to be always tight (you should not need to tighten it, it uses a different wrench). In case it is loose, please call Fernando or Aaron.

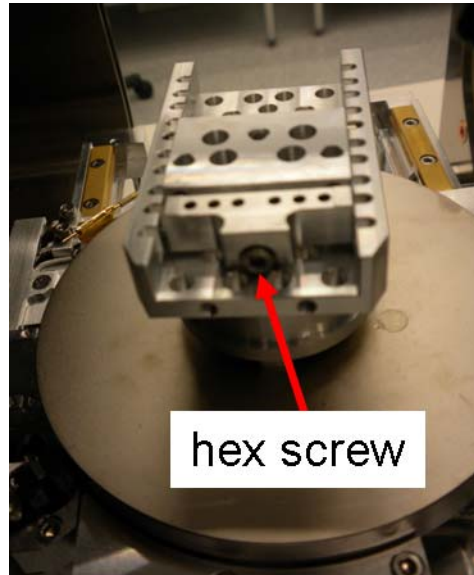


Figure 4. Hex screw that holds stub holder in place. You do not need to tighten this screw.

- There is not height adjustment with this new holder. **Samples should be less than 3-mm thick. If you have thicker samples, first contact Fernando Camino or Aaron Stein. Always check the height using the sample height gauge (inside plastic box next to Helios).** The highest point of your sample should be at the same height or below the top surface of the gauge (ignore max. or min. lines in the height tool). **If your sample is above, STOP your work and call Fernando or Aaron.**
 - Be very careful when you close the chamber door. Always look at the CCD camera quadrant to detect any possibility of crashing the objective lens.
 - Hit "Pump" in UI. Push the door close for the first few seconds until mechanical pump stops making loud sound. Wait until chamber color in bottom SEM icon turns green. It takes about 5 min for this.
- 5) If only using SEM, then hit "Beam On" button for e-beam only. **DO NOT USE "Wake Up"**. Only use "Wake Up" button when you want to use both electron and ion beams.
- 6) Linking Z stage coordinate to the Free Working Distance (Link Z to FWD): This is a most critical part of the tool operation. Before any stage movement in the Z-direction, you should tell the system to update the Z stage coordinate to the actual distance between the final lens and your sample, which is called free working distance (FWD). This updating operation is called "Link Z to FWD".
- In QUAD 1 (e-beam) window, locate a good feature in your sample and focus it. You move the stage by pressing down the mouse thumbwheel (you'll see a yellow dot on QUAD 1) and by moving the mouse. Setting $x=y=0$ using absolute stage coordinates will place the center of the stub approximately at the center of the SEM field of view. Focus

on your sample. You should be able to recognize a mark or feature on your sample to be sure it is the surface of your sample. If you have a pattern this will do it. If not, make scratches at two corners, at least, to be able to correlate the distance between the marks and the size of your sample (you should also know the approx. dimensions of your sample). If you are in doubt, **STOP your work and contact Fernando or Aaron.**

- For regular samples (less than 1-mm thick), after focusing on your sample, the working distance (WD) should fall around 9 mm. For thicker samples, WD can fall in the range of 6-10 mm. **If you get a WD outside the 6-10 mm range, most likely you are not focusing on your sample. THIS IS A POTENTIALLY DANGEROUS SITUATION. DO NOT PROCEED. Contact Fernando or Aaron at this point.**
 - Once the feature is focused, link the stage Z coordinate to the working distance by hitting the "link Z to FWD" icon on top icon bar. This action will pass the FWD value to the Z stage coordinate.
- 7) Move the stage to your desired FWD, making sure you keep the Z stage coordinate updated (linked) after any Z stage movement.
 - 8) If doing FIB work, understand the procedure to find the eucentric point. If in doubt, **STOP your work and contact Fernando or Aaron.**
 - 9) Never attempt to tilt the sample if you have not first correctly determined the eucentric point.

FINISHING:

- 1) Hit "Sleep" if using both beams; otherwise, just hit e-beam "Beam On" button to turn the e-beam off.
- 2) Hit "Vent". Remove sample and pump chamber back down as explained in step 4 above.
- 3) Log off. Record your end of session in Helios-log.vi log program.
- 4) Make sure the Helios room is left clean and in order.

APPENDIX I. HELIOS SYSTEM DATA STORAGE GUIDELINES

The objective of these guidelines is to minimize cyber security threats to the Helios system.

A) EXTREMELY IMPORTANT

- No external data storage device is allowed to be connected to the Helios system computers. This includes USB memories, CDs or DVDs, etc.
- No use of the internet of any kind is allowed (internet browser, FTP sessions, email checking, remote desktop control, etc).

B) HOW TO TRANSFER DATA FILES

- 1) For SEM or FIB images, save files directly into your folder in the SUPPORT computer by opening the "Data on Support" folder in the HELIOS computer. For NPGS files or INCA files, save them directly into your folder in the SUPPORT computer.
- 2) In order to copy your files to a USB memory or send them via the internet, first copy your files from the SUPPORT computer to any of the three general purpose computers in the cleanroom: "Cleanroom 2" and "Cleanroom 3" are the computers by the windows in the thin-film area (Cleanroom 2 is the one closest to the cleanroom main door) and "Cleanroom 4" is the one on the Zeiss microscope in the Lithography room. Copy your files from your folder in the Support computer to the folder named "Cleanroom 2", "Cleanroom 3" or "Cleanroom 4" located on the desktop of the Support computer.
- 3) Your data will be stored in a folder named "HeliosData" in the respective general purpose computer you have chosen. In these general use computers, you can use any storage device or the internet to transfer your files.

C) DATA HOUSEKEEPING

- 1) Once you have successfully transferred your files, you are supposed to erase them from the SUPPORT computer to free up space.
- 2) At the beginning of a new year, if storage space is becoming an issue, we will remind Users to clean their directories. Starting the first week of February, **ALL DATA OF PREVIOUS YEAR WILL BE DELETED!** Please avoid losing precious information by following these simple rules.

D) IN CASE OF A PROBLEM

Either due to network problems or cyber security issues, sometimes there might be a lack of communication between computers in the Helios system. Any of these two cases may occur:

- 1) You cannot send you data from the Support computer to Cleanroom2, 3, or 4 computers.
Solution: If this happens, inform Fernando of the problem and wait until the situation is resolved. You won't have to wait more than one day. Do not break the USB port seals in the Support or Helios computers to get your data out.
- 2) You cannot save images in the Support computer.
Solution: Save you data in a folder with your name on the desktop of the Helios computer and let Fernando know of the problem. Once the issue is resolved, Fernando will copy these folders to your respective folders in the Support computer. Again, do not use any USB ports to get your data out.

APPENDIX II. GUIDELINES FOR MICROMANIPULATOR (OMNIPROBE) USERS

- 1) When logging in the LabView software, check the "Omniprobe" check box.
- 2) You must leave the tip sharpened for the next user. The quality of the tip should be comparable to the one shown in the image below (courtesy of Kim Kisslinger).
- 3) Take an ion beam image of the tip close to the eucentric height using a magnification of 4000x (see image below).
- 4) Save the tip image in the folder "Omniprobe" located in the data folder of the Support computer. Use the format: YYYY-MM-DD-lastname (e.g., 2011-11-15-Camino.tif).
- 5) **DO NOT FORGET** to bring the tip out to the edge of the circular aperture before fully retracting the tip using the pneumatic valve. Serious problems can occur if you do not follow this step. You all have been trained in this procedure, however, if you have any doubts, please do not hesitate to contact me.
- 6) Sometimes, it would be impossible to sharpen the tip to a good quality, for example, after a crash. In these instances: a) take an tip image and save it as described above. b) Leave a comment in the LabView log in software letting users know about the bad tip. c) Let Fernando know about this so that the tip is replaced.

