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HIM - Orion Nanofab

Standard Operating Procedure

Revision: 1.0 — Last Updated: Nov. 1/2018, Revised by Christoph Hermann

Overview

This document will provide a detailed operation procedure of the Helium Ion Microscope. Formal Training is required for all users prior to using the system.

Revision History

#	Revised by:	Date	Modification
1	Mohamed Boucherit	02/12/2016	First version
2	Christoph Herrmann	11/01/2018	general update
3			
4			
5			

Document No. 4DSOP000X

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General Information

With imaging resolution of 0.5 nm, ORION NanoFab generates high resolution images of your sample. This equipment especially excels in imaging non-conductive samples due to charge compensation technology. Gain new insight from images with a 5 to 10 times greater depth of field compared to images acquired with FE-SEMs.

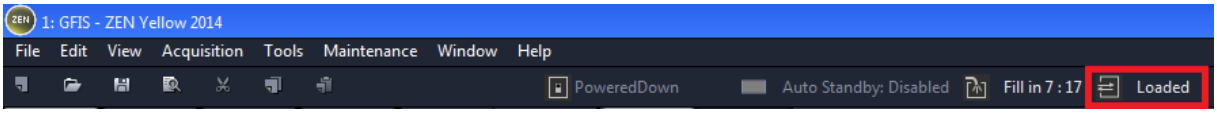
Operation

I- Unloading the sample holder

NOTICE: Unloading the sample holder is necessary if you want to insert or remove your sample.

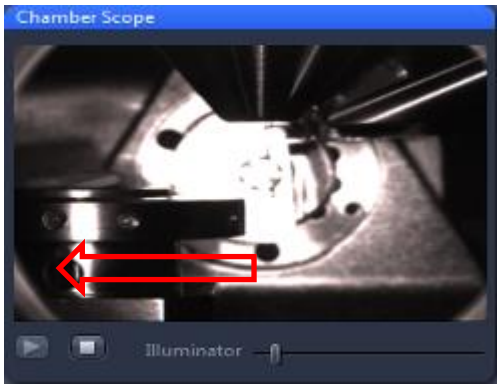
A) Prepare the microscope

1. On the Tool Bar, click the ‘Sample Management’ button. Status is usually ‘Loaded’



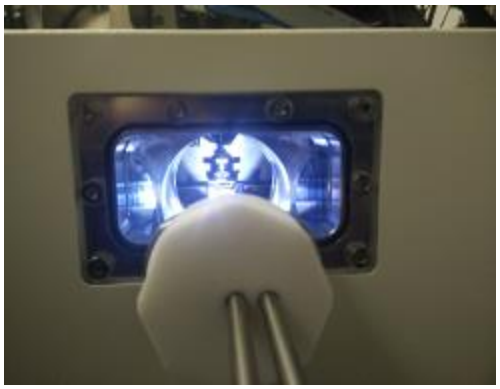
2. The ‘Sample Management’ control panel appears, click the ‘Exchange’ button.

NOTICE: The stage moves from the ‘Resume’ to the ‘Exchange’ position. You can observe the stage movement through the ‘Chamber Scope’ camera window. If the ‘Chamber Scope’ camera is off (green image), click "Image Start" Icon. (The Chamber scope freezes sometimes, i.e. it shows an image of the stage, but it does not update. If you hear the stage moving, but do not see the movement please contact the tool owner.)



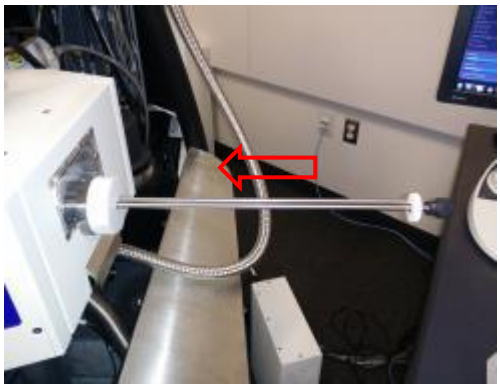
3. The ‘Stage Ready’ indicator lights up. The software automatically starts ‘Transfer’.

NOTICE: The gate valve opens. You can observe this process through the airlock window.



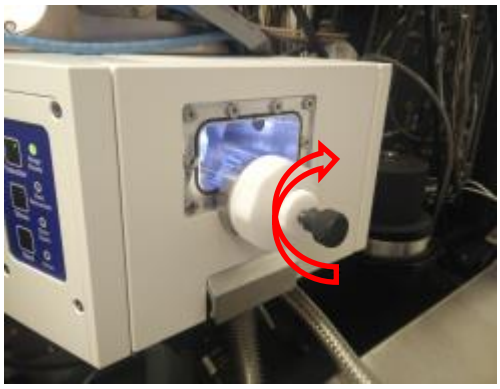
B) Transfer the sample holder from the main chamber into the airlock.

1. Carefully slide the rod into the main chamber until connecting with the sample holder.

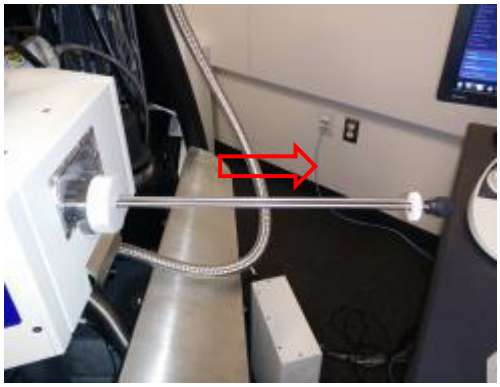



2. To attach the sample holder to the airlock rod, turn the fixing knob clockwise while observing the process through the airlock window. You can feel if the thread engages. Tighten until it stops.

NOTICE: Do not overtighten the airlock rod with force.



3. Retract the airlock rod while observing the process through the airlock window.

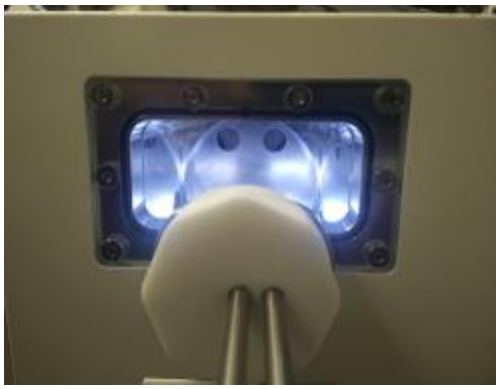



NOTICE: Retract the airlock rod all the way, until the ‘Rod Retracted’ indicator lights up. You can feel it clicking into position.

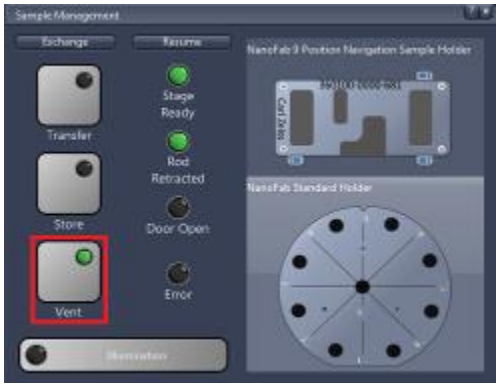
C) Vent the airlock.

1. On the ‘Sample Management’ control panel, click the ‘Store’ button.

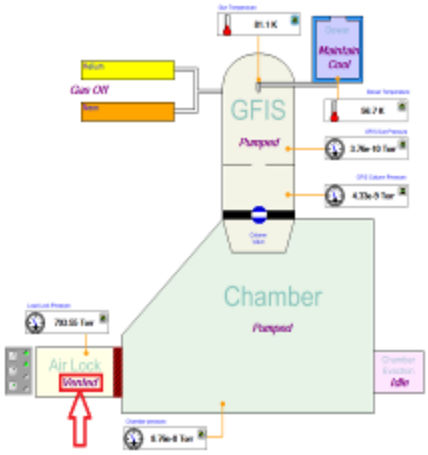
NOTICE: The gate valve closes. You can observe this process through the airlock window.



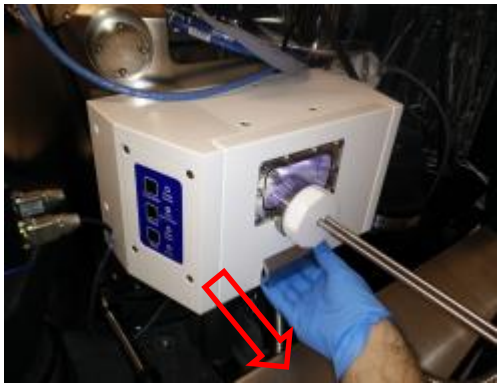
2. Click ‘Vent’ button. The airlock chamber is vented with nitrogen.



3. On the ‘Vacuum Dashboard’ screen, wait until the ‘Vented’ message displays in the ‘Air Lock’ schematic.



D) Grab the handle and pull open the airlock door.

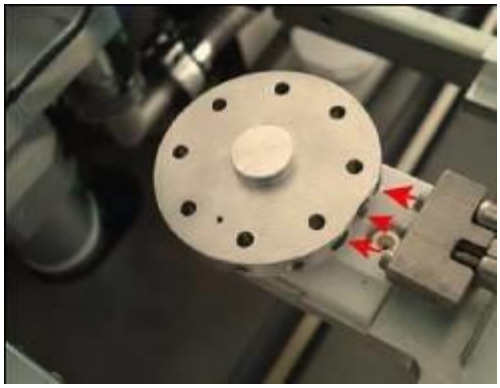


E) Remove the sample holder.

NOTICE: Wearing powder-free gloves is mandatory for the subsequent steps.

1. To detach the sample holder from the airlock rod, turn the fixing knob counter-clockwise.

2. To remove the sample holder from the dovetail fitting, carefully pull towards the sample chamber.



II- Loading the sample holder

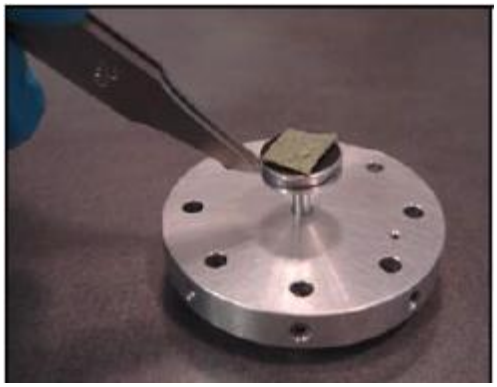
NOTICE: Always wear powder-free gloves when touching sample, sample holder or stage. Fingerprints contain hydrocarbons that can cause vacuum deterioration or prolonged pumping times.

A) Prepare the sample holder.

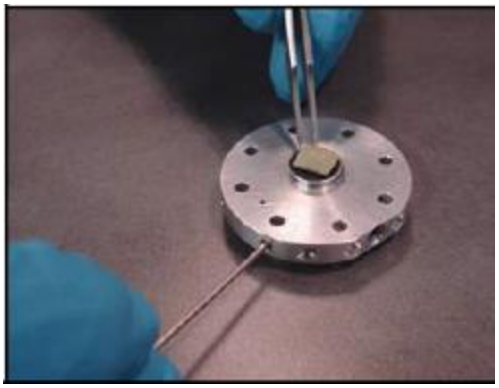
1. Use carbon tape or similar, to attach your sample to the stub.

NOTICE: Ensure that the sample is in proper contact with the stub and does not fall off.

2. Insert the stub into the sample holder.



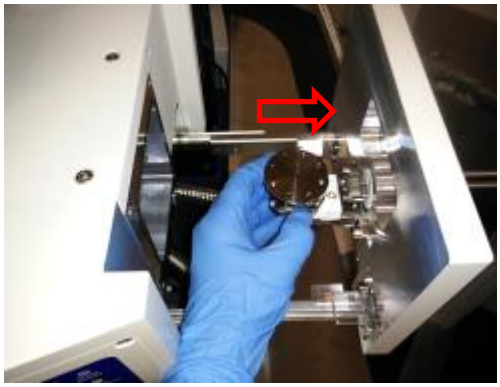
3. To fasten the stub to the specimen holder, tighten the set screw with the Allen wrench.



B) Mount the specimen holder.

1. To mount the prepared sample holder onto the dovetail fitting, carefully push towards the airlock door.

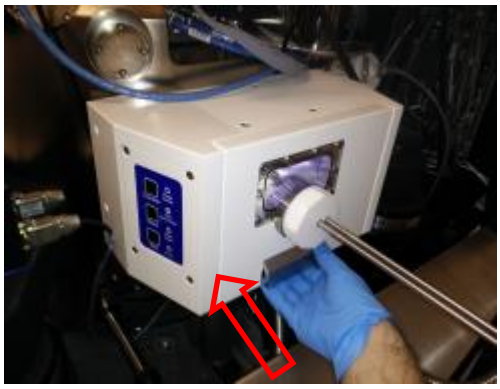
NOTICE: The airlock rod must align with the fixing holes of the sample holder.



2. Turn the fixing knob clockwise to attach the specimen holder to the airlock rod. You can feel if the thread engages. Tighten until it stops.

NOTICE: Do not overtighten the airlock rod with force.

3. Close the airlock door.

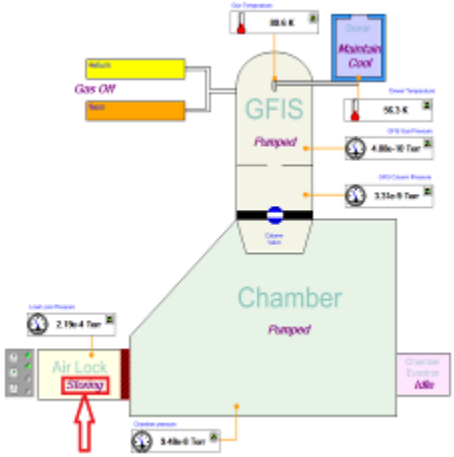


NOTICE: On the Airlock Control Panel, make sure the "Door Open" orange LED switches off.

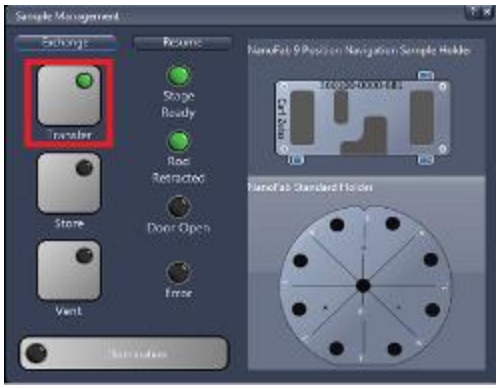
C) Evacuate the airlock.

1. On the ‘Sample Management’ control panel, click the ‘Store’ button.

2. On the ‘Vacuum Dashboard’ screen wait until ‘Storing’ is displayed in the ‘Air Lock’ schematic. Wait until the ‘Air Lock’ pressure reads < 5 x 10^{-3} torr.



3. On the 'Sample Management' control panel, click the 'Transfer' button.
Wait until the 'Transfer' indicator lights up.

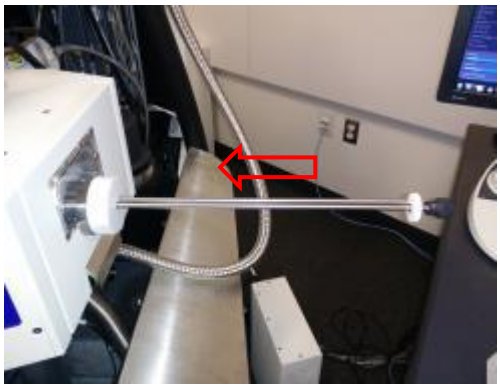


NOTICE: The gate valve opens. You can observe this process through the airlock window.

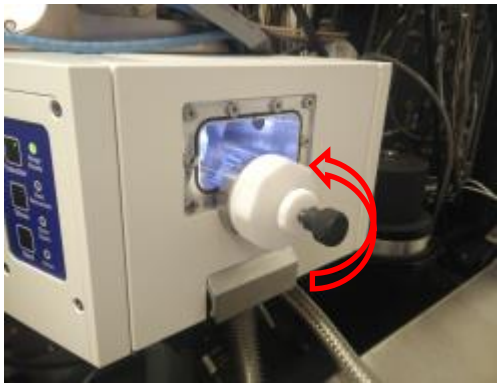
D) Transfer the sample holder from the airlock into the main chamber.

1. To mount the sample holder onto the dovetail fitting of the stage, carefully slide the airlock rod into the main chamber while observing the process through the airlock window. You can

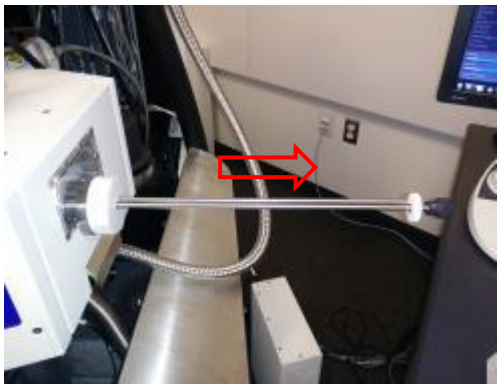
feel the resistance when the specimen holder slides into the dovetail fitting. You might need to rotate the rod slightly to guide it onto the dovetail. Carefully push in the airlock rod until it stops.




2. To detach the specimen holder from the airlock rod, turn the fixing knob counter-clockwise. To make sure that the airlock rod is free, observe the process through the airlock window.



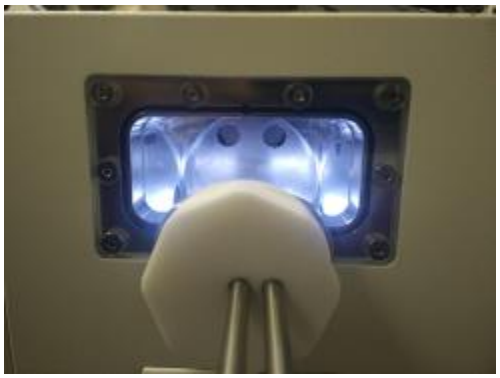
3. Retract the airlock rod while observing the process through the airlock window.



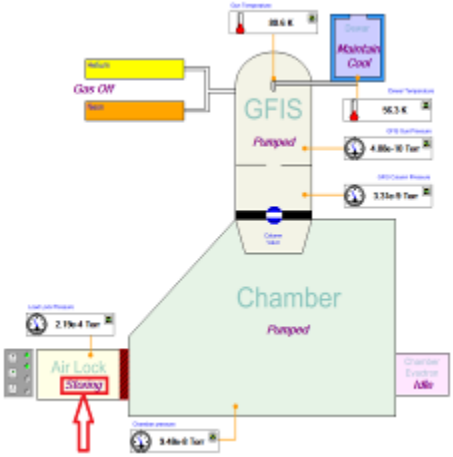

NOTICE: Retract the airlock rod until it stops, and the ‘Rod Retracted’ indicator lights up.

4. On the 'Sample Management' control panel, click the 'Store' button.

NOTICE: The gate valve closes. You can observe the process through the airlock window.

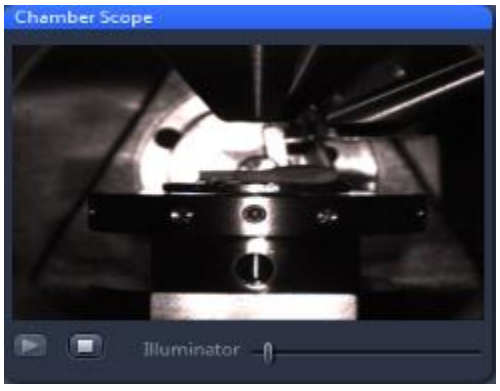


5. On the 'Vacuum Dashboard' screen, wait until 'Storing' is displayed in the 'Air Lock' schematic. Wait until the main chamber pressure is $< 5 \times 10^{-7}$ torr before proceeding.



6. On the ‘Sample Management’ control panel click on the ‘Resume’ button.

NOTICE: The stage moves from the ‘Exchange’ to the ‘Resume’ to position. You can observe the stage movement through the ‘Chamber Scope’ camera window. Clicking ‘Resume’ turns on most microscope functions.

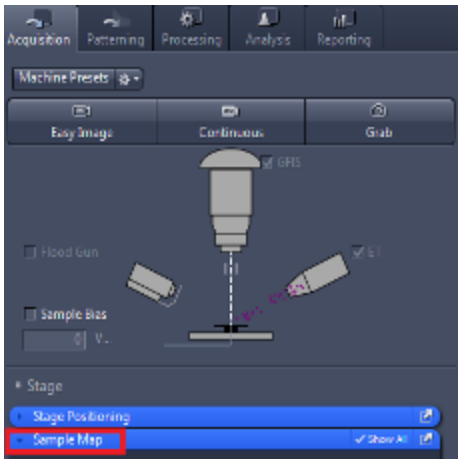


7. Close the ‘Sample Management’ control panel.

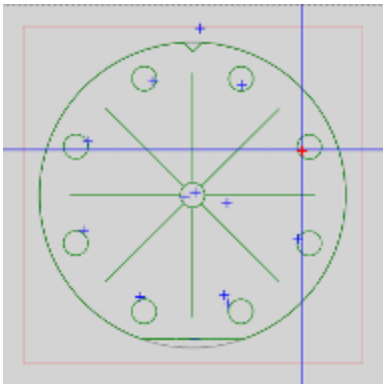
III- Locating the Stub

NOTICE: The 'Sample Map' tool allows sample holder navigation.

1. From the Left panel, select the 'Acquisition' tab and expand the 'Sample Map' section.



3. To move the stage to a stub position, double click on the 'sample holder' map.



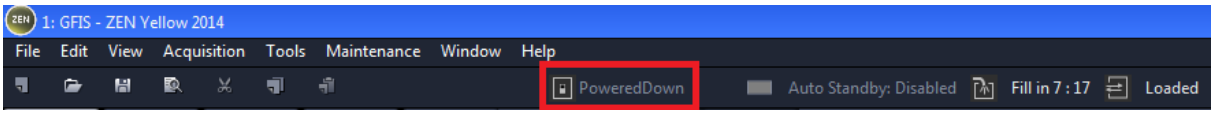
NOTICE: You can observe the stage movement through the 'Chamber Scope' camera window.

4. Reduce the 'Sample Map' section.

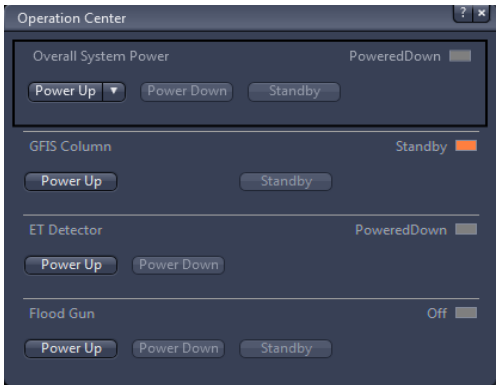
IV) Powering up the Microscope

NOTICE: The Helium Ion Microscope remains in Standby state at all times, except when imaging.

1. On the Tool Bar, click 'Operation Center' button, usually indicating 'Powered Down'.

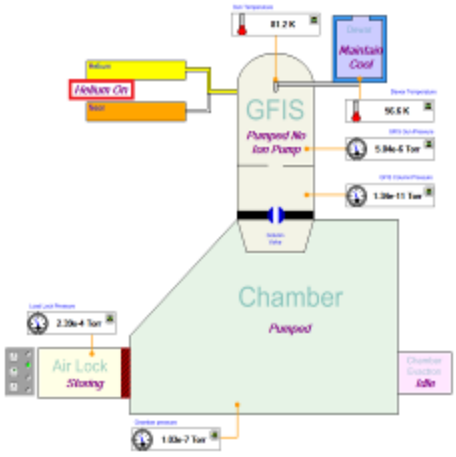


NOTICE: The ‘Operation Center’ dialog opens.



2. In the ‘Overall System Power’ section, press the ‘Power Up’ button to begin the power up sequence.

3. Go back to the ‘Vacuum Dashboard’ screen, and wait until the ‘Helium On'' message displays in the schematic.



4. Verify that all the indicators light up.

NOTICE: The 'Flood Gun' usually remains off. If you have a non-conductive sample the tool owner will provide instructions on flood gun usage.

5. Close the 'Operation Center' dialog.

V) Generate an image

A) Verify ET Detector is ON

1. From the Acquisition tab, expand the 'ET Detector' tool.

2. Check that the Power Status indicator is green and reduce the 'ET Detector' tool.

NOTICE: If this is not the case, go to the 'Operation Center' in the Tool Bar and click 'Power up' in the 'ET Detector' section (see section IV). After pressing 'Resume' the ET detector should automatically be on.

B) Verify GFIS Column is ON

1. From the 'Acquisition' tab, expand the 'GFIS Column' tool.

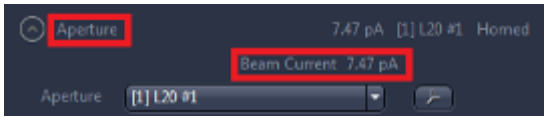
2. Check that the Power Status indicator is green.

NOTICE: If this is not the case, go to the 'Operation Center' in the Tool Bar and click 'Power up' in the 'GFIS Column' section (see section IV).

C) Verify the beam current

Expend the 'Aperture' section and check if the 'Beam current' is above 5 pA.

NOTICE: If not, please contact the tool owner. It is possible that tip maintenance is required. Beam current might be significantly lower due to the aperture, helium pressure, beam settings, etc.



D) Verify Normal Imaging mode is ON

1. Expand the 'Imaging Mode' section and check if the Imaging Mode displays 'Normal Imaging'.

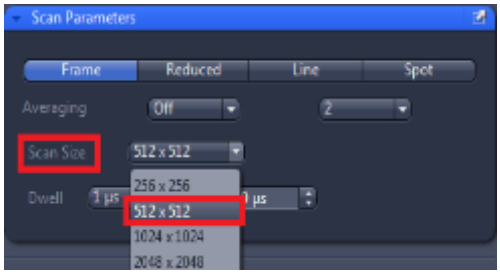
NOTICE: If not, click the 'View Sample' button to switch back to 'Normal Imaging' mode.

2. Reduce the 'GFIS Column' tool.

E) Adjust image size

1. From the 'Acquisition' tab, expand the 'Scan Parameters' tool.

2. In the 'Scan Size' drop-down list select the desired image size (usually 1024x1024).



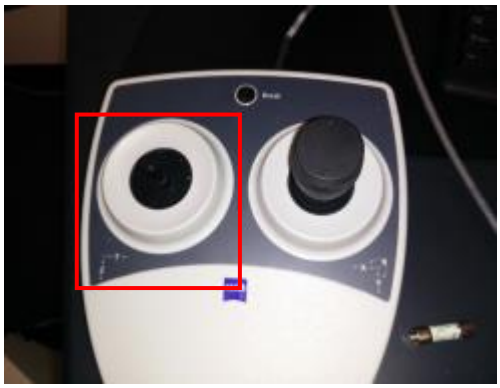
F) Start imaging

1. From the keyboard panel, press the Start/Stop button to start imaging.

NOTICE: The ion beam starts scanning across the specimen. A live image is displayed in the imaging window.

2. If necessary, adjust the 'Z' height to control the distance between the Column and the sample with the T/Z dual joystick while observing the process through the 'Chamber Scope' camera window in order to avoid any collision.

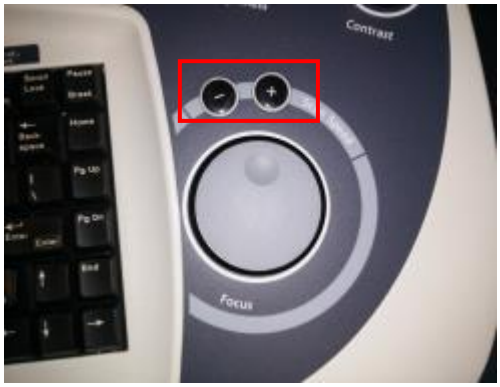
NOTICE: If the stage/sample is too high the HIM column can be damaged!



G) Adjust scan speed

Adjust scan speed using the - / + 'Scan Speed' buttons on the keyboard panel.

NOTICE: Scan speed is shown as 'Scan Dwell Time' in the imaging window, which is the inverse of scan speed. Pushing the (-) button slows the scan rate and increases the dwell time, while pushing the (+) button increases the scan rate and lowers the dwell time.



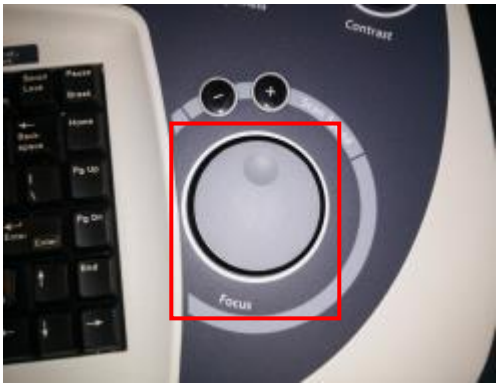
H) Adjust magnification and focus

1. Adjust the magnification using the 'Magnification' turning knob on the keyboard panel.

NOTICE: The current magnification is indicated as 'GFIS Field of view' in the imaging window.

2. Adjust the focus using the ‘Focus’ turning knob on the keyboard panel.

NOTICE: The current working distance is indicated as ‘Working Distance’ in the imaging window. ‘GFIS Field of view’ may update according to focus position.

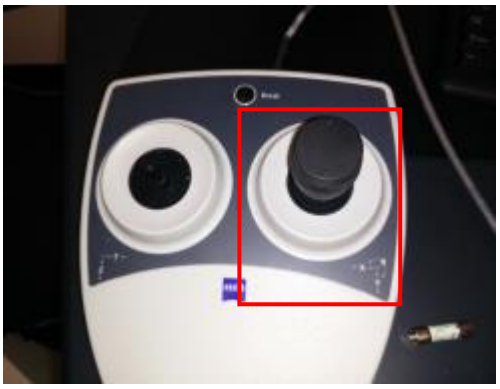


I) Adjust contrast and brightness

Adjust the image contrast using the ‘Contrast’ turning knob on the keyboard panel. Adjust the image brightness using the ‘Brightness’ turning knob on the keyboard panel.

J) Optimizing the Image

1. Move the stage in 'X and Y' directions using X/Y dual joystick to find a detail on your sample surface.



NOTICE: Fine stage movement in X and Y direction can be achieved using 'Pan X' and 'Pan Y' turning knobs on the keyboard panel.

2. Magnify and focus a detail of your sample using the respective turning knobs on the keyboard panel.

3. Adjust the contrast and brightness of the detail using the respective turning knobs on the keyboard panel.

4. Correct astigmatism using the 'Stigmator X' and 'Stigmator Y' turning knobs on the keyboard panel until you obtain the sharpest image.

5. To grab a picture, press the ‘Grab’ button on the keyboard panel.

VI) Save an image

1. From the Menu Bar, select File/Save As

NOTICE: The Save As dialog opens.

2. Enter a path and a file name.

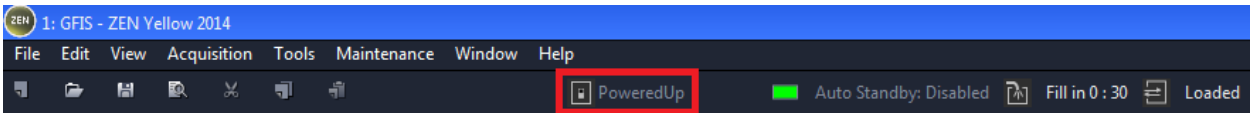
3. Click Save.

IV) Powering Down the Microscope

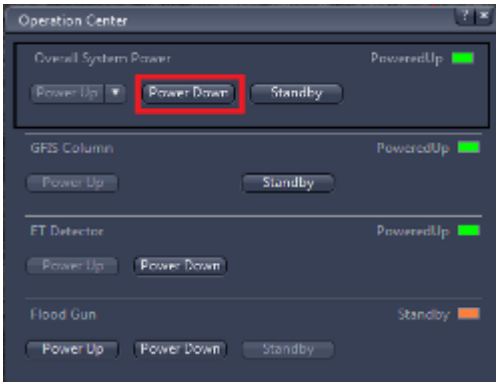
NOTICE: The Helium Ion Microscope must be switch to Standby state when you finish your experiment.

1. On the Tool Bar, click the ‘Operation Center’ button, indicating ‘Powered Up’.

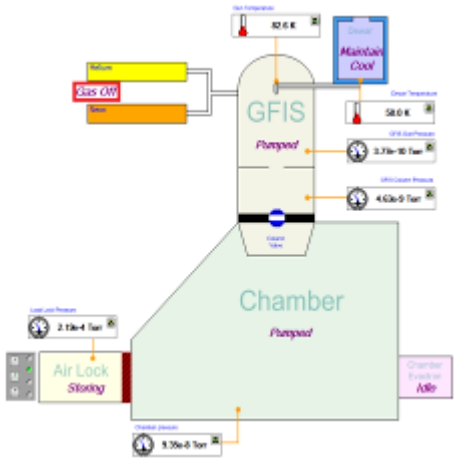
NOTICE: The ‘Operation Center’ dialog opens.



2. In the 'Overall System Power' section, press the 'Power Down' button to begin the power down sequence.

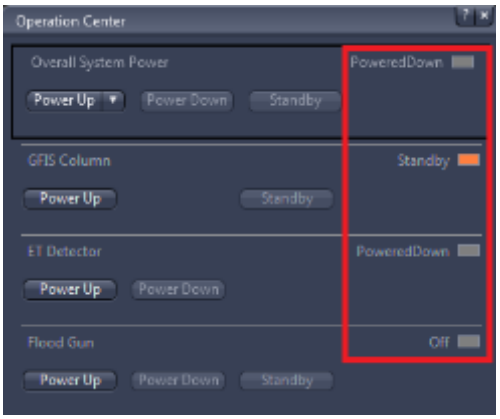


3. Go back to the 'Vacuum Dashboard' screen, and wait until 'Gas Off' displays in the schematic.



4. Verify that all indicators have switched off.

NOTICE: Each of the configured devices have been instructed to go to their power down state, except for the GFIS Column which needs to remain in standby state.



5. Close the 'Operation Center' dialog.

References and Files

Carl Zeiss help and training notes.

Contact Information

Questions or comments in regard to this document should be directed towards Christoph Herrmann (cherrman@sfu.ca) in 4D LABS at Simon Fraser University, Burnaby, BC, Canada.