Operating Instructions for

Helios NanoLab 600

Dualbeam Focused Ion Beam
&
Scanning Electron Microscope

RULES OF USE

1) DO NOT TOUCH A CONTROL IF YOU DON'T KNOW EXACTLY WHAT IT DOES.

2) NEVER, EVER FORCE ANYTHING BEYOND FINGER STRENGTH.

3) IF IN DOUBT - ASK FOR HELP.

Please note: This instruction can only be used by trained users as a reference. It is not intended to be the textbook on DIY purposes for the unauthorized personnel to use the machine without training and direct supervision.

ANFF@ANU

Front note

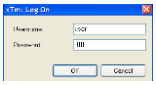
- The right hand side computer is used to run operating software of Helios, which should be setup and ready to use
- The left hand side computer has the software for Genesis EDS system and TSL EBSD data collection and analysis system
- The computer in the middle is the node connected to the ANFF server. All the data collected on Helios are saved in local director “SharedData/users” at first, and then uploaded to the server through the node by the user
- Usage will be monitored with both login information and system log files

Task 1: Start a FIB session

- Check list:

➢ The sample size is suitable for the machine
➢ The sample is flat and locked onto a pin stub
➢ The sample is dry and clean
➢ The surface is conductive and well earthed
➢ The silver paint is fully solidified, if applied
➢ The sitemap is available for multiple samples mounted on the same stub

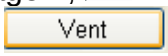
- Double click system control software 

- Click on Start UI 
- Login your user account 

- If the user interface is hided off the scene on the right hand side computer, click on Show UI on the screen,

Task 2: Load sample and get E beam image

- Vent the chamber

➢ Go to page 1, 
➢ Click on 

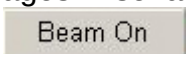
and confirm the action in pop-up window
➢ Wait for ~ 4 min, then try to open the chamber by pulling the handle bar gently

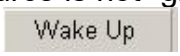
- Lock the stub onto the stage with the Allen key, and check the overall height with the gauge, make sure the height lower than the **max line**.

- Pump the chamber

➢ Gently close the door
➢ Click on 

➢ Wait for ~ 5 min, until the vacuum icon  turn green 

- Select both electron and ion beam images in serial, and click on 

for both columns. If the ion source is not “green”, click on 

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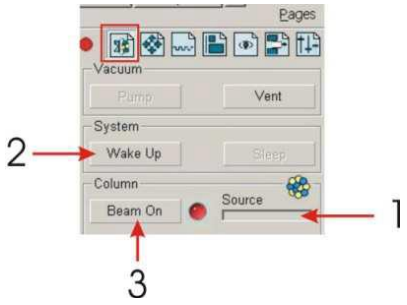


- Locate region of interest (ROI)

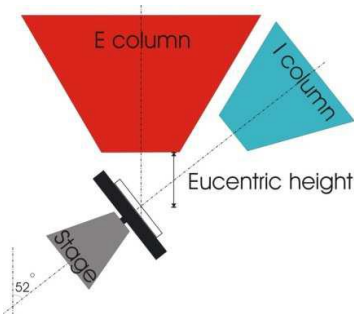
➢ Select E beam image, e.g. top left quad window
➢ Click on pause button  to start E beam scan
➢ Reduce the magnification to <100x, and have an overview of whole sample
➢ Align the working area if necessary
➢ Locate a small feature, e.g. dust, near ROI as the reference
➢ Achieve a focused image

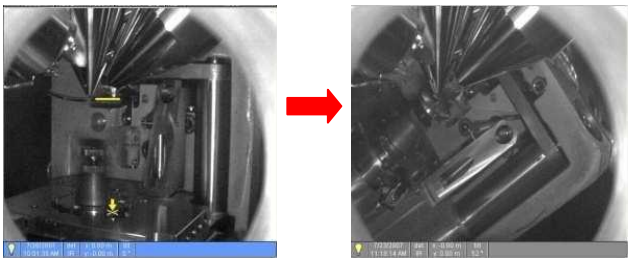
- Link Z to WD

➢ Go to page 2, 
➢ Click on the link icon  on the top of the window

Task 3: Setup Eucentric height and beam coincidence

- ❖ Standard working conditions are all based on the Eucentric height (~4.0 mm)
- ❖ Pt deposition can only be done at the Eucentric height





- Move stage upwards

  - ➢ Increase magnification of E beam image to above 1000×
  - ➢ Achieve a fine focus and update Z measurement by click on the icon 
  - ➢ Input Z of 8 mm, check focus and update Z measurement with the button 
  - ➢ Input Z of 6 mm, check focus and update Z with 
  - ➢ Input Z of 4.0 mm, check focus and update Z with 

- Title stage

  - ➢ Select “Zero beam shift” from the drop down menu of “stage” for both E beam and I beam image respectively
  - ➢ Set a small feature in the centre cross of the E beam image.
  - ➢ Input title, T of 15 degrees.
  - ➢ Make the feature back to the centre with Z adjustment by the mouse.
  - ➢ Input T of 30 degrees, and re-adjust Z to centre the feature.
  - ➢ Input T of 52 degrees, and re-adjust Z, if necessary.

- Setup beam coincidence

  - ➢ Centre a reference feature on E beam image at 3500×
  - ➢ Select I beam image in another window, e.g. top right quad window
  - ➢ Check if the I beam current is small, then get a snapshot with the icon 
  - ➢ Centre the feature with beam shift knobs if necessary, and update the image with snapshot

Task 4: Cover ROI with Pt deposition

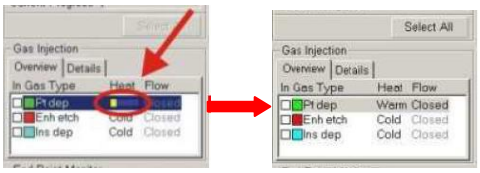
- Select an appropriate ion beam current

➢ 2-6 pA/um^2 is recommended for general application
➢ Update the image after 10 seconds if changing the aperture – sleep time to stabilise the beam

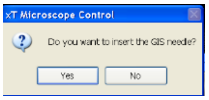
- Insert GIS needle

❖ **Make sure that eucentric height has been set up correctly before doing this!**
❖ **Make sure there is nothing higher than ROI nearby!!**

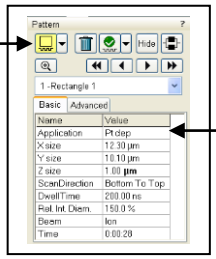
➢ Go to page 3, 
➢ Locate the “Pt dep” line, double click on the word “cold” in “Heat” column
➢ Wait until the yellow timing bar turn to the word “Warm”



➢ Insert the needle by tick the box “in”
➢ Confirm the action within the pop up window by click “Yes”



- Define a pattern



➢ Select rectangular pattern
➢ Draw a box on the I beam image
  - Green color box for deposition
  - Yellow color box for milling
➢ Change the Application to “Pt dep”

- Start/stop deposition

➢ Click on the triangle button  to start deposition
➢ The same set of buttons will allow the user to pause and stop 
➢ When finish, remove the tick within the box under “in” to retreat the GIS needle

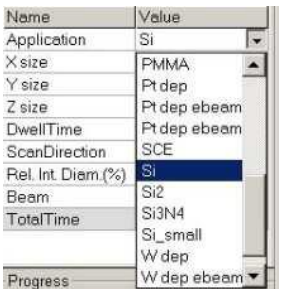
Task 5: Mill cross section and record image

- Select an appropriate ion beam current

➢ 6.5 - 21nA are recommended for rough milling
➢ For the same pattern, smaller beam current leads to sharper images but in longer milling time

- Define a pattern

➢ Select/activate “Regular cross section” pattern for rough milling
➢ Draw a box on the ion beam image
➢ Confirm Application file as “Si”
  ▪ Other material files are also available in the click/drop-down menu



➢ Update parameters and location of the pattern if necessary

- Start/stop milling process

➢ Click on triangle button  to start milling
➢ The same set of buttons will allow the user to pause and stop 

- Clean surface

➢ Select a smaller ion beam current, 9.7 – 93 pA are recommended
➢ Update the image
➢ Select/activate “Cleaning cross section” pattern
➢ Draw a narrow box on the ion beam image
➢ Update parameters and location of the pattern if necessary
➢ Click on triangle button  to start milling
➢ The same set of buttons will allow the user to pause and stop 
➢ Monitor the progress with snapshot 

- Take a photo

➢ Select/activate the quad desired – E beam imaging is in common, but I beam imaging may show extra information for certain materials, such as channelling contrast for polycrystalline metals
➢ Check magnification, location and fine focus if necessary
➢ Press F2 -- pre-set scan speed for photo can be modified within Preferences/Scanning

Task 6: End a session

- Return to Page 1, 
- Turn beam off by clicking on “beam on” for both E beam and Ion beam
- Vent the chamber

➢ Click on Vent and confirm the action within the pop-up window
➢ Wait for ~4min, then try to open the chamber by pulling the handle bar gently

- Pump the empty chamber

➢ Gently close the door
➢ Click on Pump
➢ Wait for ~4min, the vacuum icon  should turn green 

- If you are the last user on the day, turn off the ion source

➢ Select/activate ion beam image
➢ Click on Sleep to turn off the ion source

- Logout your account

Advanced task: TEM lamella sample preparation

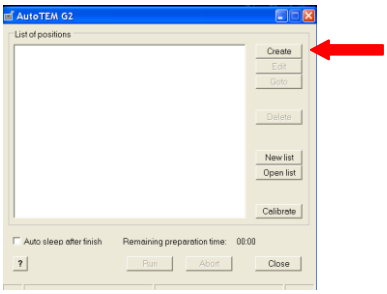
- AutoTEM G2 Software

- Preconditions:

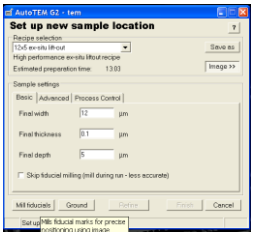
➢ Stage Tilt: 52 °
➢ High voltage: 30 kV
➢ Working distance: Eucentric (defined with E Column)
➢ Magnification: 1,000x

- Define the membrane

  ➢ Start the AutoTEM G2 Software
  ➢ Press 'Create' to start the recipe definition process.



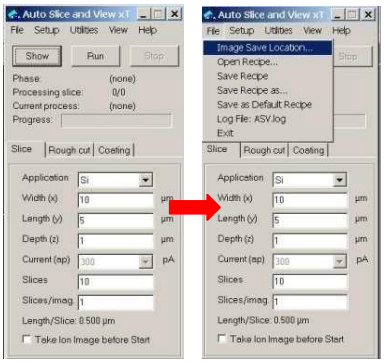
  ➢ Save the project
  ➢ Select the following recipe '12x5 ex-situ lift-out'
  ➢ Verify the current parameters:
  ➢ Deselect 'skip fiducial milling'
  ➢ Select 'Mill Fiducials' to create fiducials for image recognition.
  ➢ Select 'Refine' to enable accurate lamella positioning
  ➢ Select 'Finish' closing the recipe definition process.



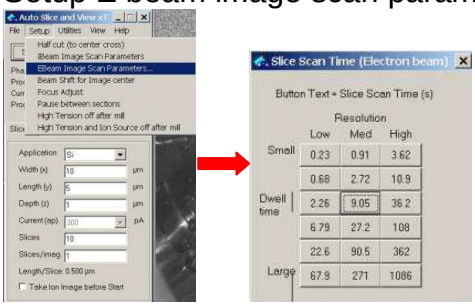
- Run the sites
  ➢ Press the 'Run' button in the position list window.

Advanced task: 3D imaging – Auto Slice & View

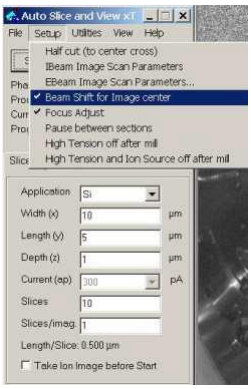
- Setup Eucentric height
- Locate ROI and cover it with Pt deposition (with the ion beam current of 2-6pA/um^2) – defined a thickness less than 0.5um (recommended)
- Make a regular cross section with high beam current, e.g. 9.3 - 21nA, at the leading edge of the ROI – a bit deeper and wider than ROI
- Make trenches on both sides of ROI to avoid shading on images
- Clean up the side edges as the reference for 3D reconstruction
- Select an appropriate beam current for ion beam image, e.g. 93pA or higher
- Using cleaning cross section to clean the viewing area
- Tick the tilt correction in automatic mode
- Hide UI and create a folder in SharedData to store the image files
- Start AutoSlice&View G2 (click on the icon on the desktop)
- Direct image save location to the predefined folder, and change the prefix for data set

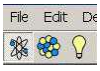


- Setup E beam image scan parameter, e.g. 9.05s

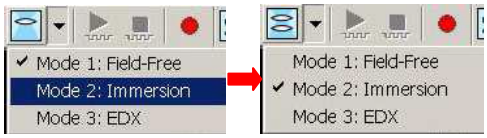


- Select Focus Adjust from Setup menu

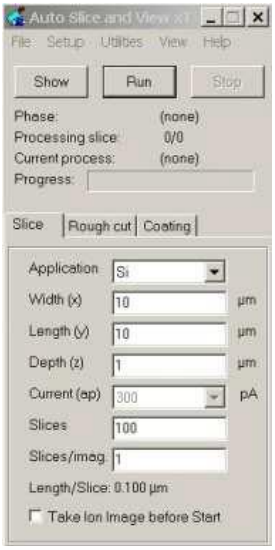


- Beam Shift for Image Centre is optional
- Select E beam image within the same quad of I beam image by clicking the icon  on the top left corner of the screen
- Optional step - If high resolution imaging is desired, switch to mode 2 with drop down menu

➢ a range of working conditions including limited kV, nA and WD required to activate mode 2



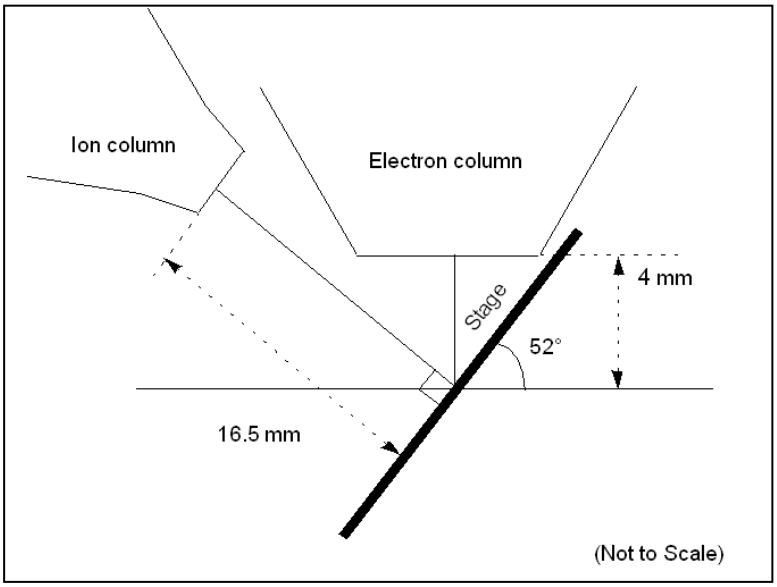
- From the menu bar, select stage/Zero beam shift
- Double click on the image to centre the viewing area for E beam image
- Return to I beam image, and use beam shift knobs to centre the ROI
- Input parameters for the slice (without Enter)
- Click on Show to see the overlay of the pattern on the ion beam image
- Modify the location with beam shift – do not move the patterns
- Capture/print screen or record important parameters for 3D reconstruction



➢ HFW for the final E beam image
➢ Image resolution for E beam image
➢ Slice length y
➢ Slice number

- Click on Run and work out the total time
- If there is a pop-up warning for over limitation of image shift, reduce the magnification of E beam image and retry
- If everything is OK, go home!

- *Relationship of the Two Columns*



**PLEASE NOT
REMOVE THIS
INSTRUCTION FROM
THE MACHINE ANYTIME!**