



IIT Bombay Nanofabrication Facility

Tool Name: VOYAGER

IITBNF is responsible only for maintaining and providing baseline processes. If a baseline process is working, the tool is considered functional. Development, modification, and optimization of individual user processes are the sole responsibility of the respective users.

Standard Operating procedure (SOP)

(Version 1- August 2024)

Raith Voyager -IITB

STEP-1: Facility Check

Outside

- Check all the facilities connected to the system in a service corridor
- Status of compressor air (CDA): [8 bar- on the black scale or 100 on the red scale]
- Status of the UPS: [Line Mode] - normal cases; otherwise, [Battery Mode] during a power cut.
- PN2 cylinder: Check the Cylinder pressure if it is below 20 bar request facility team to change the cylinder, Line pressure should be ~1 bar
- Status of Backing pump The Display should show 0.0 mbar and Turbo Mode
- Check the chiller status (System chiller temp ~ 19.0 deg C and Cover chiller temp ~ 16 deg C)

Inside

- Enter the Nano-2 lab room with proper gowning - wearing gloves and goggles ● Check the dehumidifiers - empty the buckets if full.
- Check the compressor pressure gauge (~ 7 bar) and PN2 pressure gauge (~1 bar)
- Check the Temperature (should be in the range of 19 - 22°C) and Humidity (45-55%) of the lab

STEP-2: Sample Preparation

Prepare your sample with an e-beam resist coat and bake it using the appropriate recipe required for the sample.

STEP-3: Starting the Raith NanoSuite software

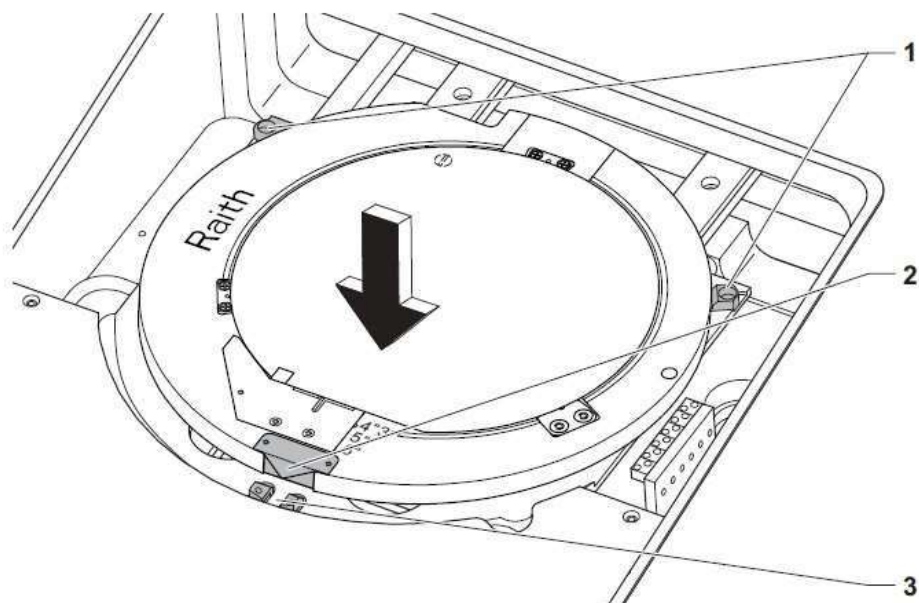
Start the Raith NanoSuite software with a double-click on the icon  on your desktop. The VOYAGER Login dialog will open.



- Enter your login data (User & Password).
- Go to Project and select New from the dropdown list to start a new project.
- Click on Login.

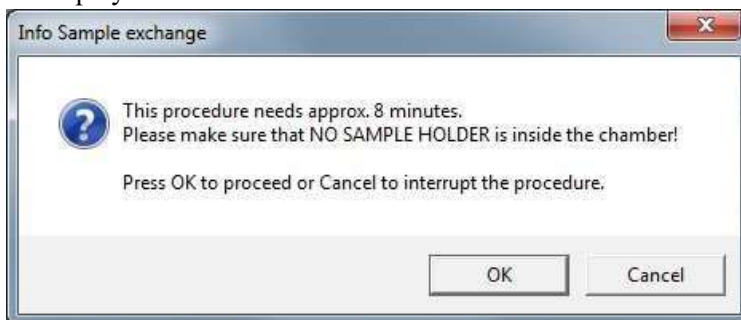
STEP-4: Loading the sample holder

- Take out the universal sample holder from the side box
- Take a lint-free cloth and place the sample holder on the Voyager working table
- Put your sample on the sample holder using a plastic or wafer tweezer only. For the larger sample size (> 1 cm), you can use a spring clip for sample fixation.
- Put a drop of nanoparticles (from a latek or Nanoparticle bottle in the EBL starter kit) at one corner of the sample for focus and alignment.
- Open the Load Lock access door on the right hand of the system housing
- Place the sample holder onto the transport guide of the load lock so that the plastic nose (2) of the holder sits firmly in the guiding nut (3) and ensure that the sample holder is placed between the two holding positions (1). • Close the load lock lid.



STEP-5: Performing the Load procedure

- Use the Load- Icon  in the setup  of the Raith NanoSuite software, or Use the Load Button beside the Load Lock.
- If the Load procedure was initiated via the Raith NanoSuite software, the following prompt message will be displayed



- On the monitor, click on OK to start the load procedure.

The load procedure will be started and the Load Sample dialog will be opened:

Load via load lock

Initialize	_____
☒	
Close load lock door	_____
☒	
Driving to lower exchange position	_____
☒	
Pumping the load lock	_____
☒	
Moving transfer rod into the chamber	_____
☒	
Driving to upper exchange position	_____
☒	
Moving transfer rod into the load lock	_____
☒	
Venting the load lock	_____
☐	
Finalize	_____
☐	Drive to position 'USH_CaliS01_align'

Activation progress



Optional actions after load

☒ Reset UV adjustment

☒ Drive to position: USH_CaliS01_align

☐ Reactivate last column mode

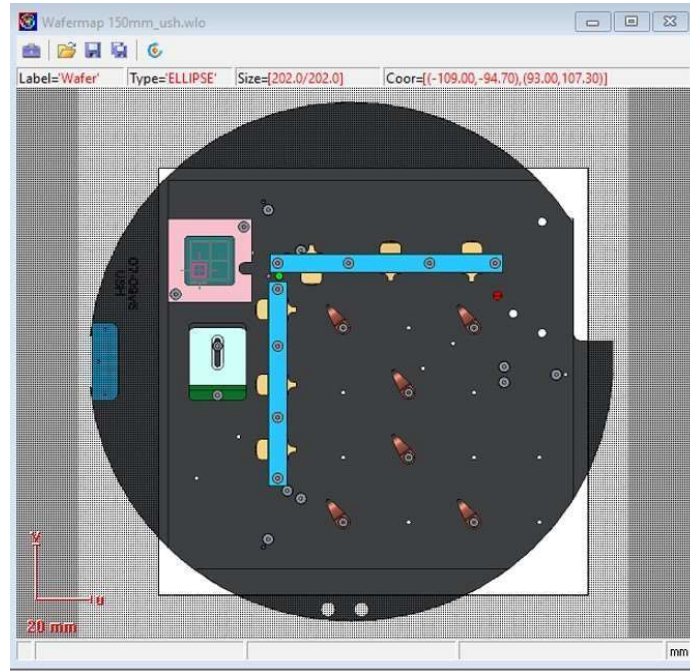
☐ Select sample holder:

- Select Drive to position and go to the USH_CaliS01_align.

STEP-6: EBL Process / SEM Imaging

EBL Process

- After successful sample loading,
- open the wafer map(file — Sample Holder Map — USH-150 mm)



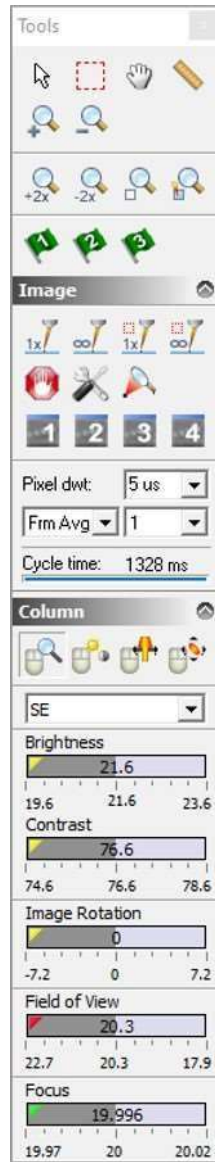
window by

- Open the new image clicking the new image icon
- Go to the xy/uv — Position — USH_CaliS01_align (Standard Calibration Sample) If you didn't enable it to move automatically during sample loading.
- Activate the desired column in Voyager user mode only.

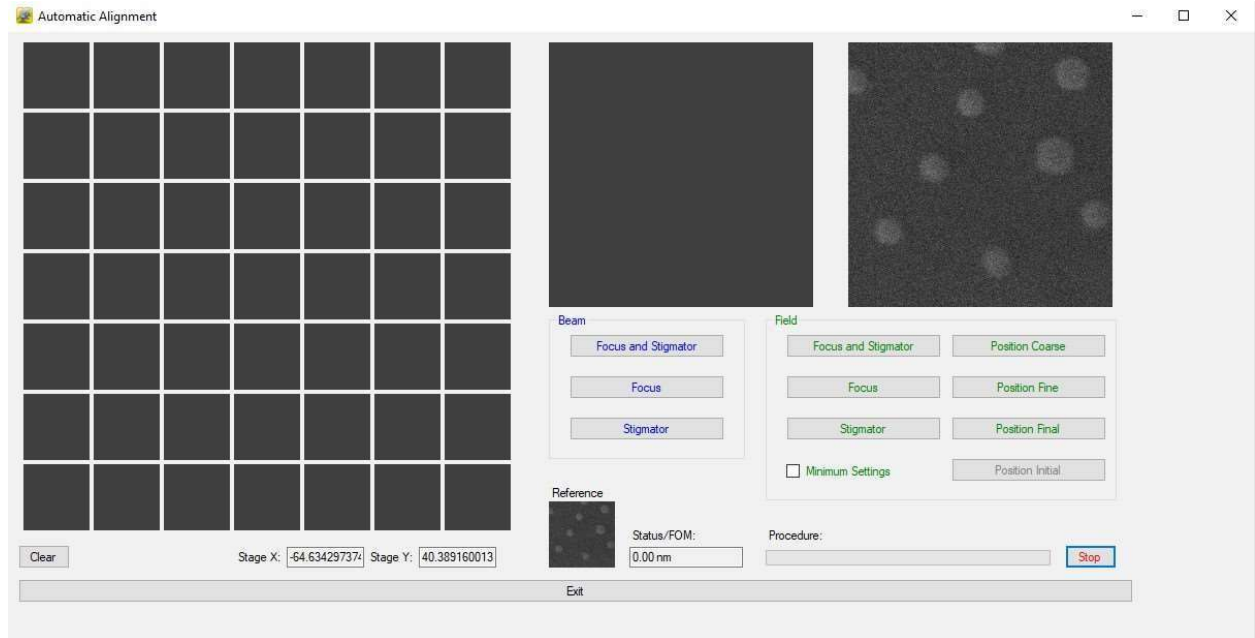
6(a) Focus and Stigmatism Correction on Voyager calibration sample



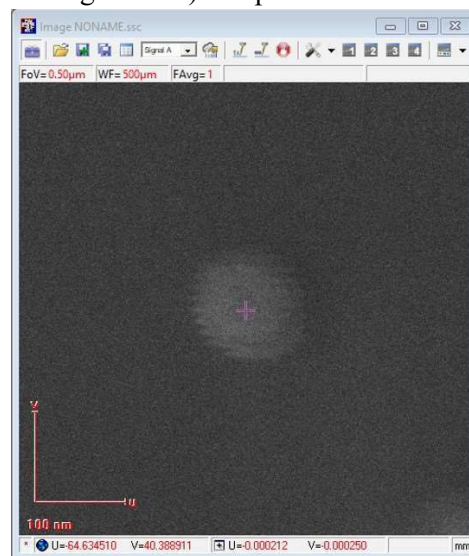
- Click on the toolbox icon  in the new image window



- Set the field of view to 0.5 μm (by pressing the 'E' key and entering the value 0.5) • Set the pixel dwell time to initially 100-300 nsec to get a fast continuous image scan.
- Scan the image continuously using icon  in the new image window.
- After scanning, an array of circles (dia – 100 -150 nm) patterns will be observed.
- Stop the continuous image scan using the icon  in the new image window
- Go to 'Script-1  Automatic Alignment.py' after clicking an automatic alignment window will appear.

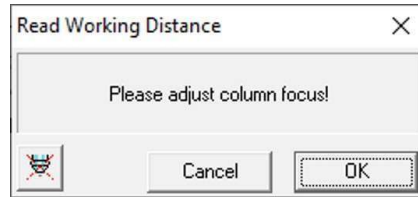


- Click focus in the beam-column
- Once the focus procedure is completed minimize the window.
- Perform a continuous scan in the new image window (with dwell time 100-500 nsec) to get a more focused circle pattern image.
- Select any one circle (Ctrl + Right Click) and place it at the center of the new image window.



- Stop the continuous scan, go to the automatic alignment window, and perform 'focus and Stigmation' for fine focusing.
- Again do a single image scan (with dwell time 2-4 µsec) using icon  to get the bestfocused image.

- Check the focus value and adjust the working distance (W) by going to the icon  XY/UV – Adjust W – Read the WD – a dialog will appear – Click ok – Press adjust.



- Now the WD is adjusted to the current focus value
- The best focusing WD should be 20 mm as per the standard column mode calibration.
- Perform a single scan and check the focus. If it has changed go to automatic alignment ('Script-1') and perform focus and stigmation.
- Check the image by doing a single scan.
- Now focus and stigmation should be best aligned for the calibration sample. 6(b) Beam

Current Measurement

Go to the Faraday Cup:

- XY/UV – Stage control – Position – Faraday cup on the holder For measurement:
- Go to Patterning icon  – Beam current – current position – Measure

6(c) Origin and Angle Correction on user sample

- Move to your sample on the wafer map (Ctrl + Right Click) • Set the FOV to max 500 um (by pressing 'E' and entering the value)
- Scan the image continuously using icon  in the new image window. • Use the joystick to locate the corner of your sample.

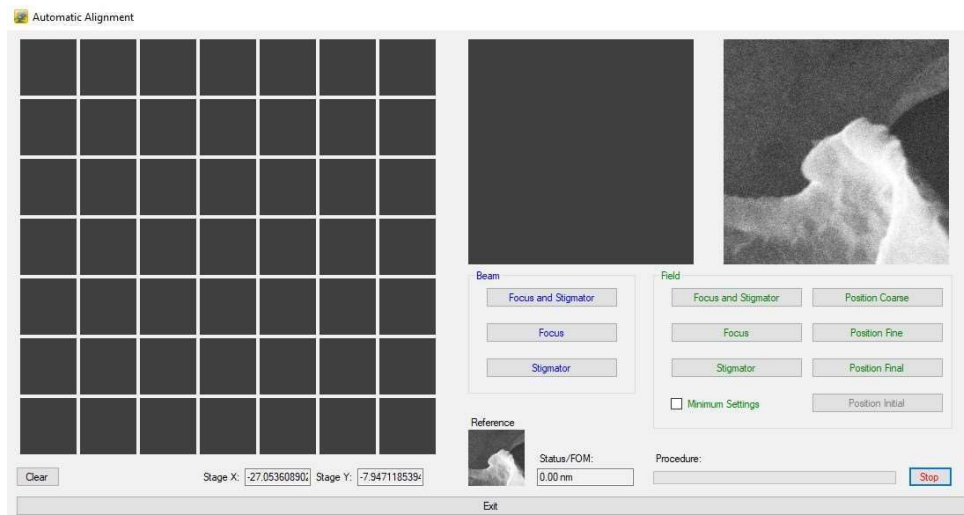


- Select any corner point on your sample (Ctrl + Right Click).
- Stop the continuous scanning and do origin correction: XY/UV – Origin Correction – Adjust
- Go to Angle correction – Read the P1 (same as Origin) – Adjust.
- For P2, move to the other end of the sample: Stop the continuous image scan — Stage Control – Drive – Set U, V as per the sample size – Start
- Perform a continuous image scan and locate the end point of the sample, then stop the scan.
- XY/UV – Angle correction – Read the P2 – Adjust
- Go back to the origin (by clicking the drive icon )

6(d) Focus and Stigmation Correction on User Sample

1. Using the joystick move to the sample and locate the brightest smaller sharp edge particle.
2. After locating the particle, use the magnification icon  to reduce the FOV (by pressing a left button) until the chosen particle is within the scanning window and focus with the right click of the mouse.
3. After manual rough focusing, again decrease the FOV to 0.5 µm by centering any sharp edge of the particle in the FOV.
4. Go to 'Script-1  Automatic Alignment', and start auto-focusing in the beam column.
5. Again adjust and focus the particle edge at the center of the FOV.
6. Stop the continuous scan, go to the automatic alignment window, and perform 'focus and Stigmation' in the beam-column for fine focusing.

7. Now do a single image scan (with dwell time 2-4 μsec) using icon  to get the best focused image.
8. Check the focus value and adjust the working distance (W) by going to the icon  XY/UV – Adjust W – Read the WD – a dialog will appear – Click ok – Press adjust
9. Now the WD is adjusted to the current focus value
10. The best focusing WD should be 20 mm as per the standard column mode calibration.
11. If the current WD is not at 20 mm, Reset the WD to 20mm using Drive – Set W = 20 mm – start
12. Do a single scan and check the particle position and focus. If it is changed then Repeat steps 5-11.
13. The final aligned focus value should be 1-4 μm range around 20 mm WD.



14. Close the Script 1.

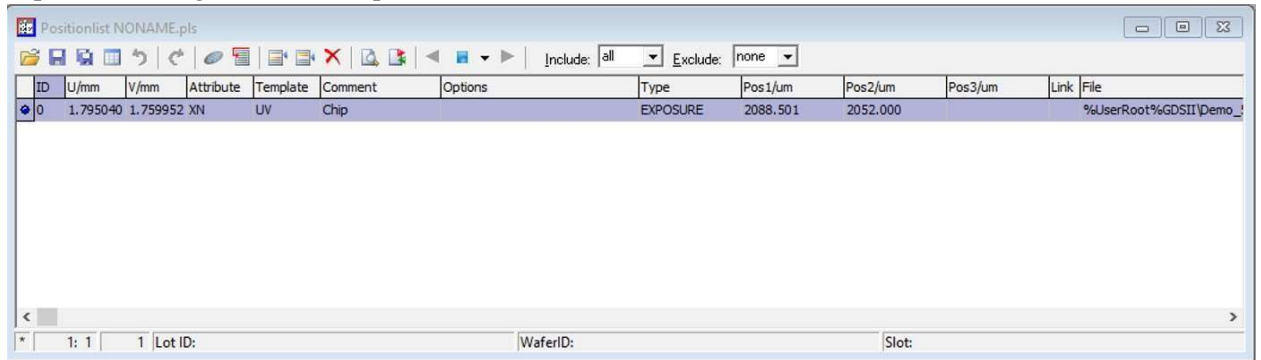
6(e) Write field Alignment

- Select any sharp edge of the focused particle and position it at the center of the FOV.
- Go to XY/UV – Scan Manager – WF alignment procedure – Manual
- Start with manual ALWF 5 μm mark (right click – execute) followed by ALWF 1 μm mark scan.
- Now go to automatic alignment with the image.
- Start with Auto ALWF 5 μm mark (right click – execute) followed by Auto ALWF 2 μm mark scan.
- After alignment, go to the Raith Protocol tool – WF alignment and check the zoom factor (U, V), which should be corrected up to four decimal points. • If it is not corrected, repeat the WF alignment procedure.

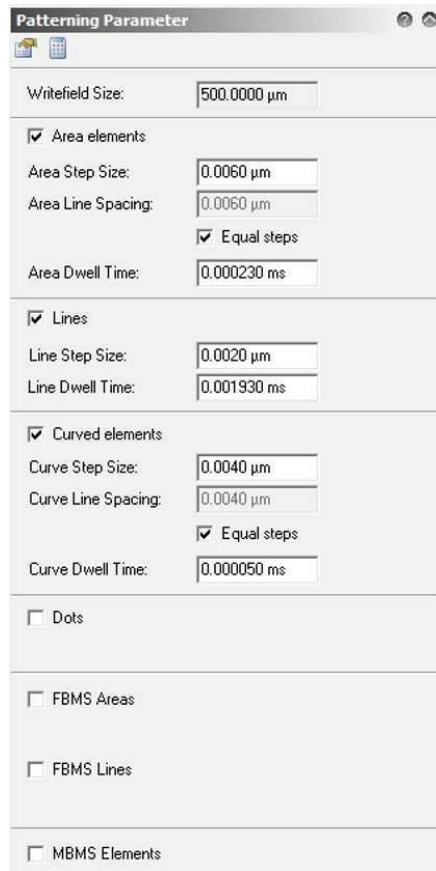
6(f) Pattern Writing

- Open the position list using  icon
- Open the GDS-II file and drag and drop it into the position list.

- Right-click on the position list file – go to the properties – set the U and V values for the start of the pattern writing location, and press Ok.



- Go to the patterning window  – Patterning parameter – select the desired options as per your pattern design.



- Go to patterning parameter calculator  – enter your required parameter depending on your pattern feature size – press Ok

Patterning Parameter Calculation

Areas	Curved Elements	Lines
Write Field Size: 500.0000 μm	Area Step Size: 0.0060 μm	☒ Equal steps
Min. Step Size: 2.00 nm	Area Line Spacing: 0.0060 μm	
Beam Current: 0.154905 nA	Area Dwell Time: 0.000230 ms	
	Area Dose: 100.000000 $\mu\text{C}/\text{cm}^2$	
	Beam Speed: 26.0869565 mm/s	

Area Dose = (Beam Current * Area Dwell Time) / (Step Size * Line Spacing)

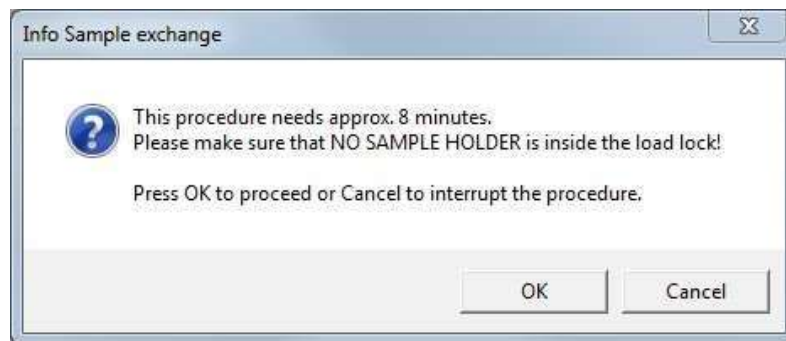
Cancel OK

- Turn off your motor control XY and Start writing using the  icon in the position list.
- After patterning, close the position list and write all the system parameters in the log book.

STEP-7: Sample Unloading

Initiate the Unload procedure by one of the following:

- Use the Unload- Icon  in the Raith nanosuit software or use the Unload Button beside the Load Lock.
- If the Unload procedure was initiated via the PC the following prompt message will be displayed on the PC monitor:



- On the monitor, click Ok to confirm and start the Unload procedure.
- The Unload procedure will be started and the Unload Sample dialog will be opened:

