

Tescan EBL/SEM
Standard Operating Procedure
AggieFab
Texas A&M University
Update: 8/12/2025

1. Login
2. E-beam alignment
3. UV coordinate system
4. Exposure
5. Shutdown
6. Appendix
 1. Sample stage handling
 2. SEM screen explanation
 3. DrawBeam explanation

☐ SCOPE

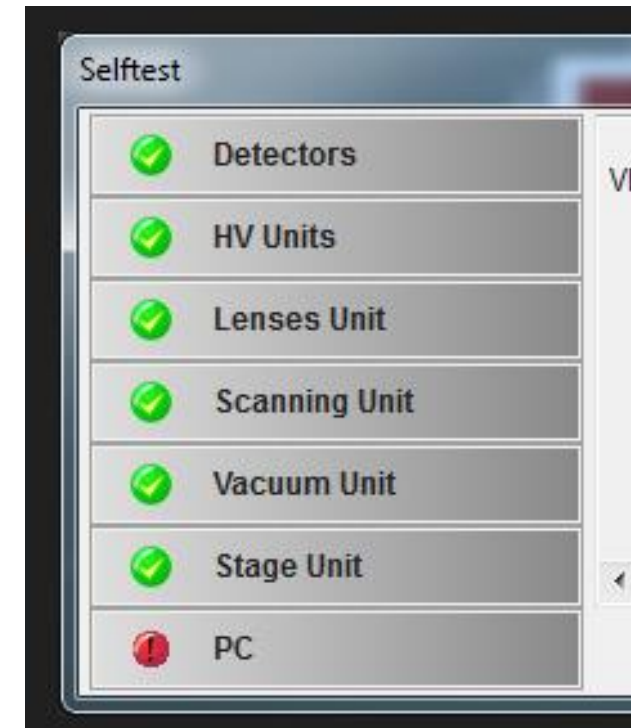
- The purpose of this document is to describe requirements and basic operating instructions for the Tescan SEM/EBL System. The use of this tool is limited to approved processes only.

☐ SAFETY

- Be sure that you are trained and signed off to use this equipment.
- Use care when operating around high voltage or high current.
- If you are unsure about any procedure or indication while operating this equipment be sure to contact a staff member or trainer for assistance.
 - Primary contact: Sung Oh Woo, sung.woo@tamu.edu

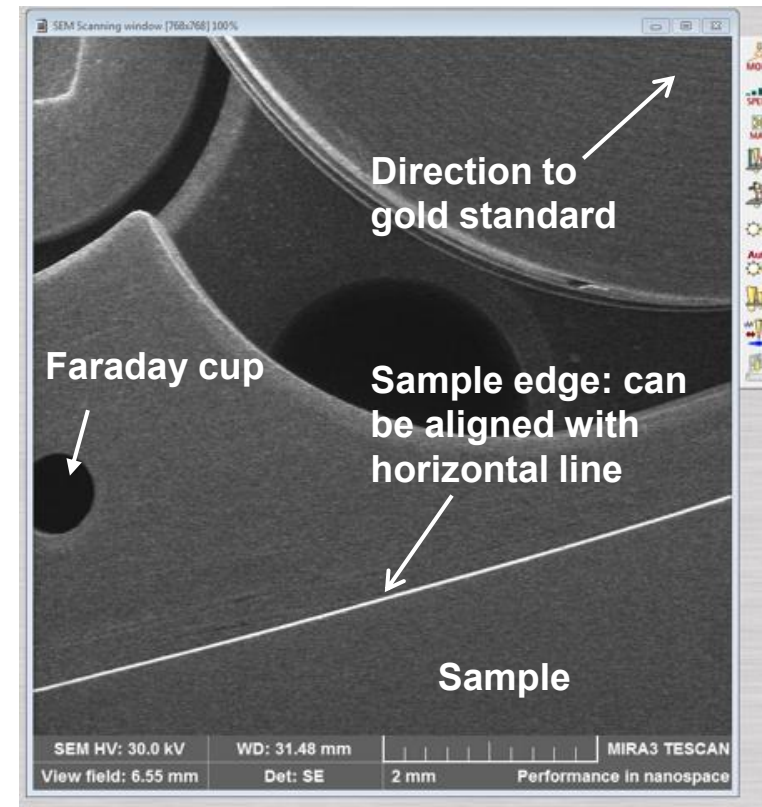
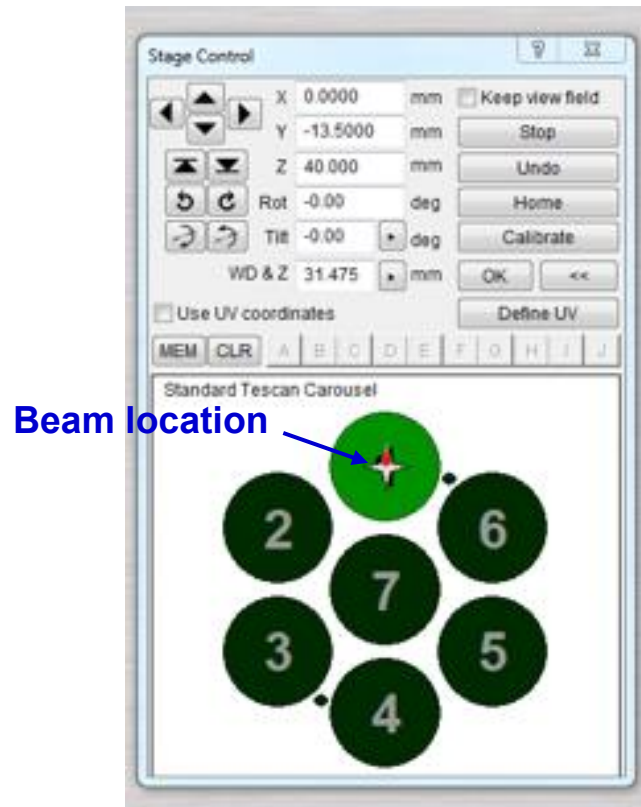
Start

- Login with your account
- The MIRA3 control software always appears. Otherwise, click the MiraTC icon.
- Self test will be performed upon login



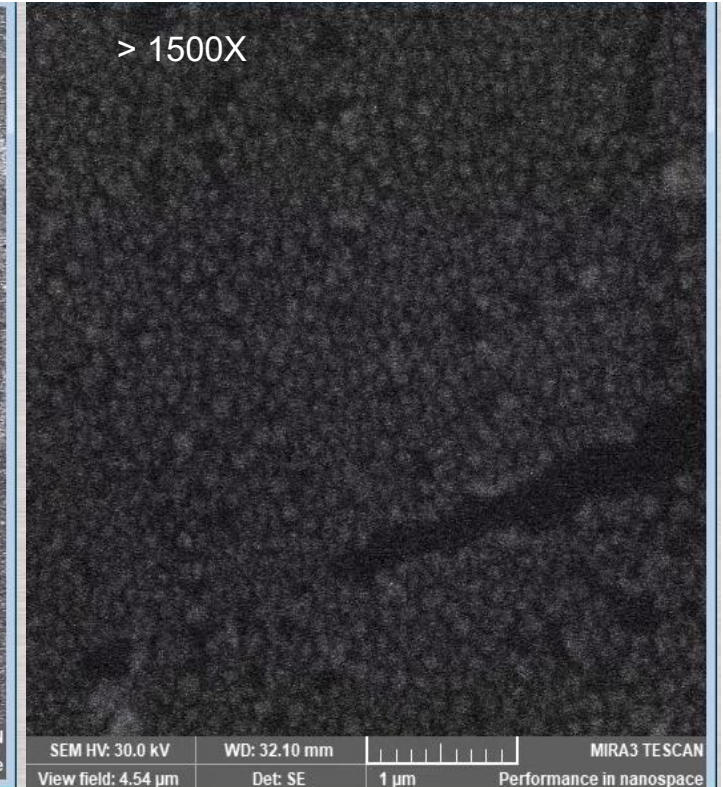
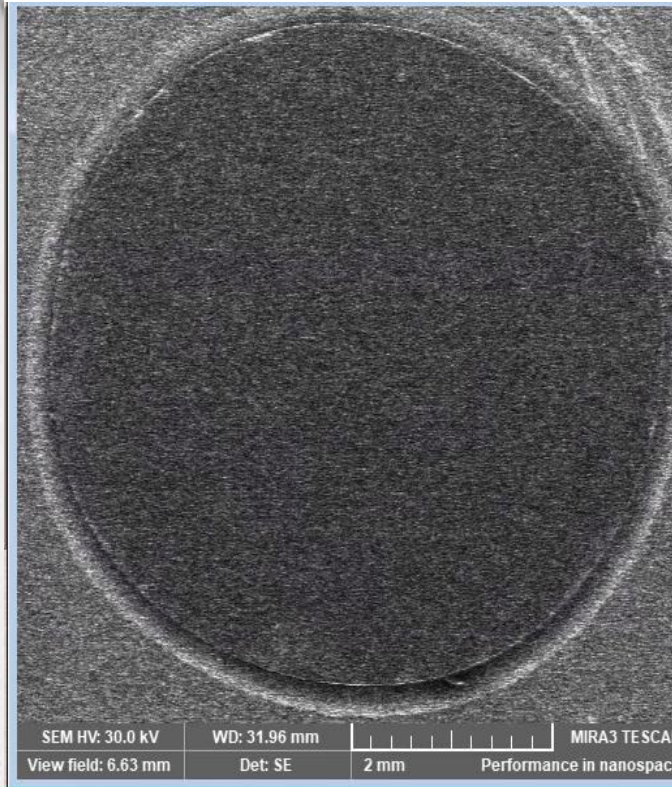
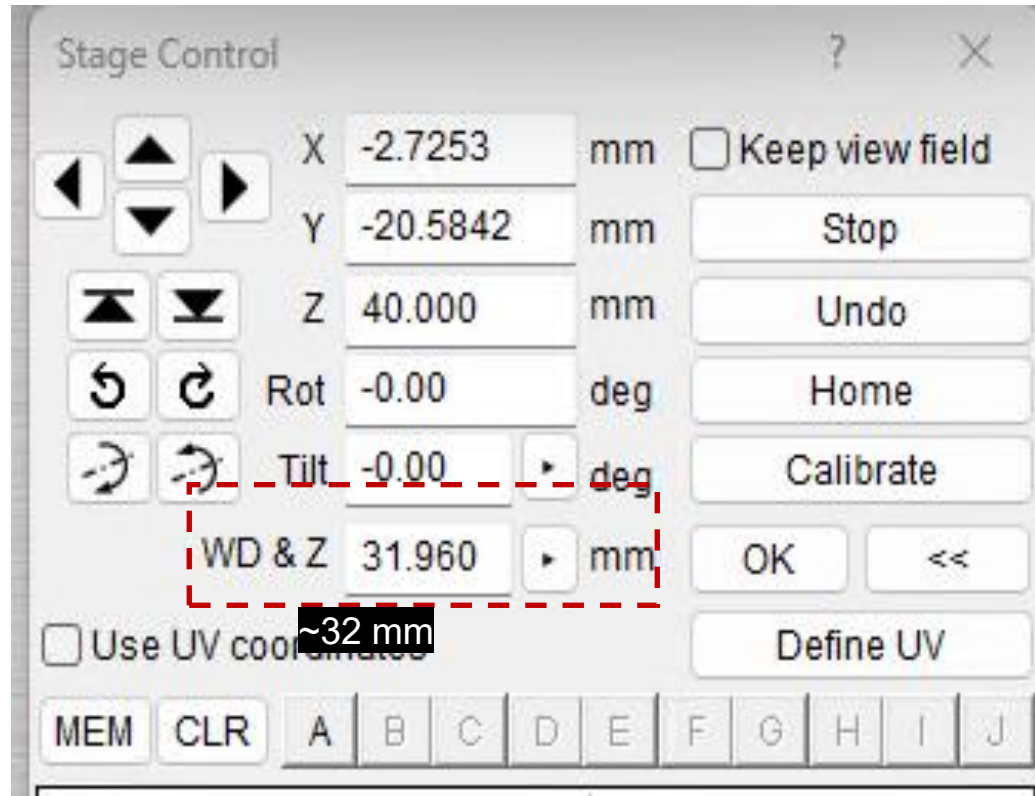
Beam alignment (1/4)

1. Click **'1'** on the SEM control to avoid exposure at the center of sample
2. Start e-beam: 'Beam On' button
 - The screen shows similar image with the following SEM picture
 - Set magnification low, < 100X
3. Select proper BI (BI=10 for smallest beam spot size)



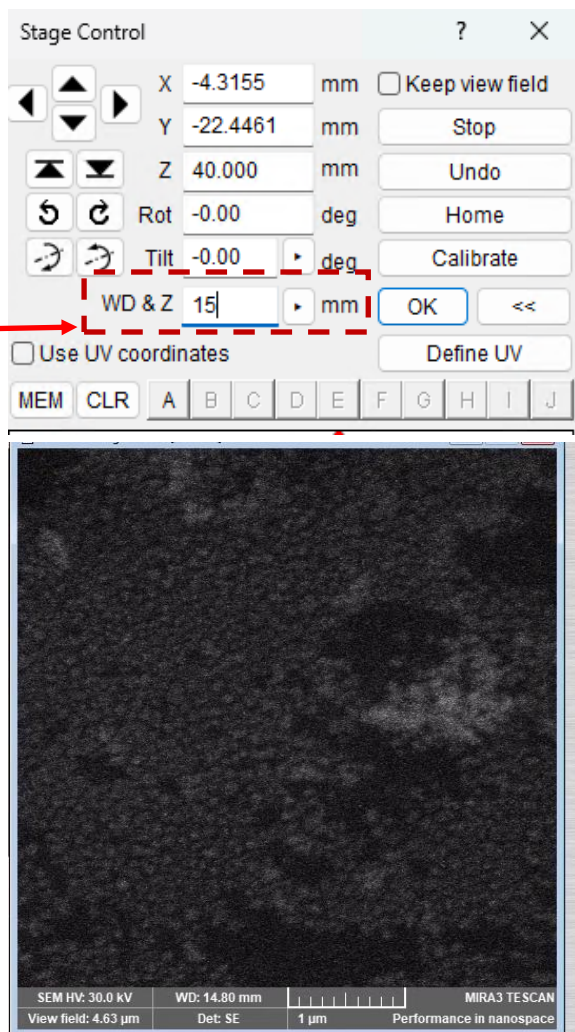
Beam alignment: (2/4)

1. Locate the gold standard (direction can be found from previous slide)
2. Focus the surface at the magnification of 1000X or higher
 - At this moment, Z&WD (working distance) > 30 mm
 - Focus on the gold standard, like right image
 - No fine focus is needed at this moment



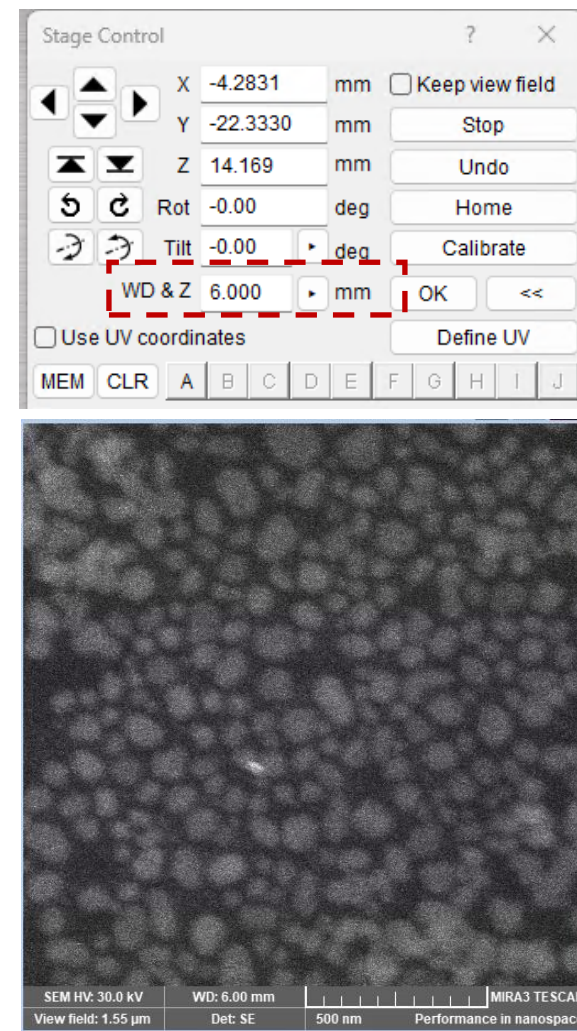
Beam alignment (3/4): bring WD to 6 mm

Type &
Enter or click
'ok'



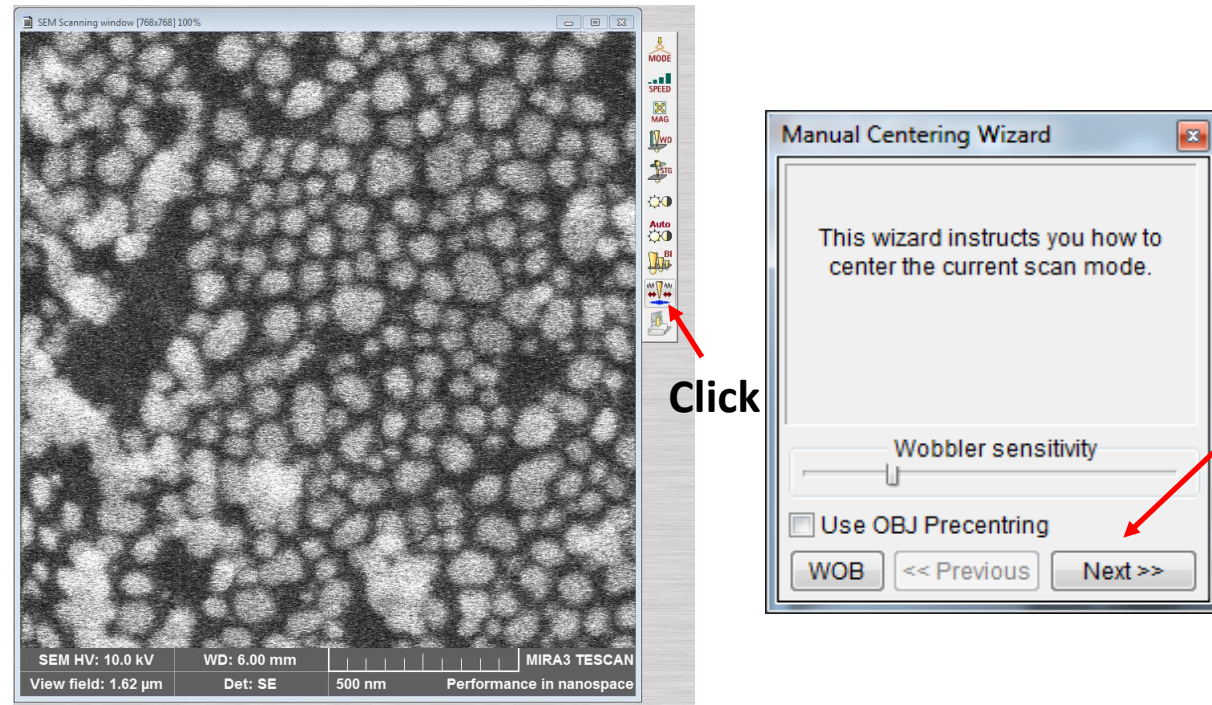
Three steps

- WD 15 mm & focus
- 10 mm & focus
- 6 mm & focus & stigma



Beam alignment: 4/4

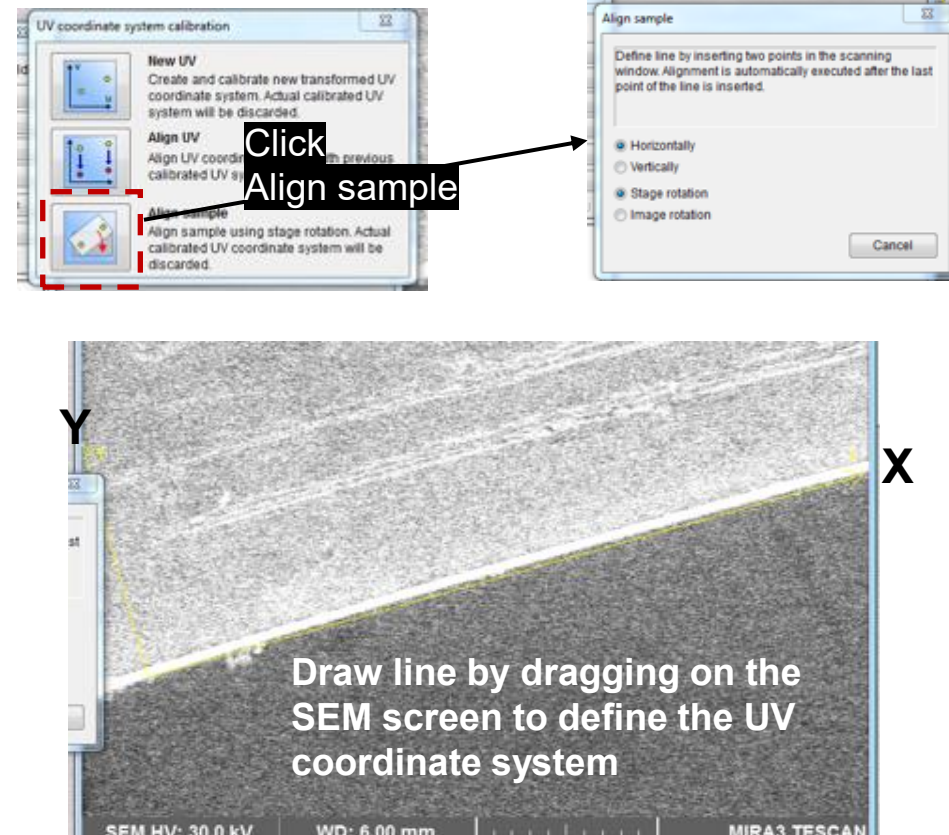
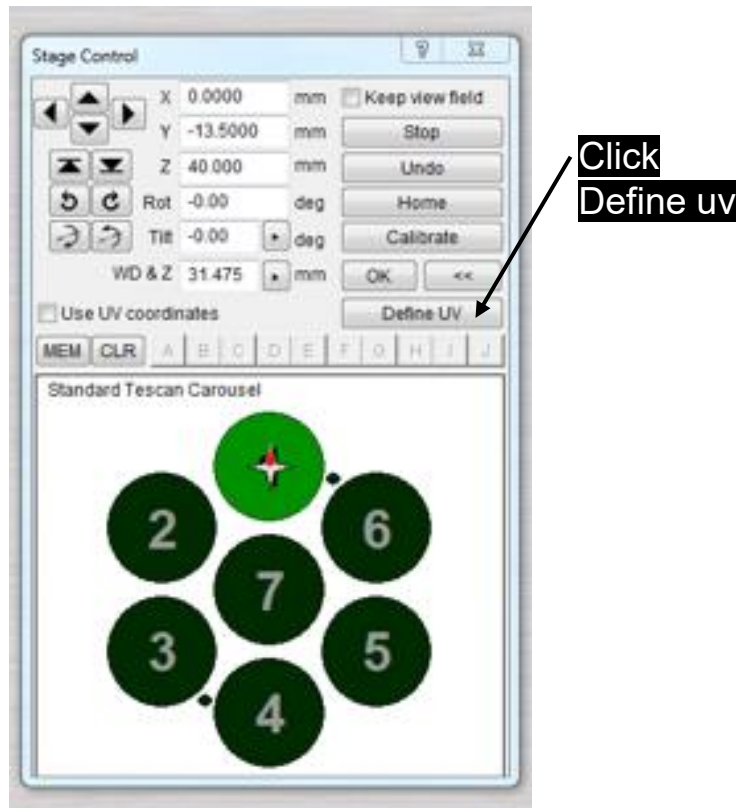
- Do focus & stigma
- Do wobbling correction at magnification of 100,000 X or higher



- **Click Next**
- **Do the wobbling**
 - If the images are shaking laterally while WOB activated, correct it until any particles shows only focus-defocus mode.
- **Click finish**

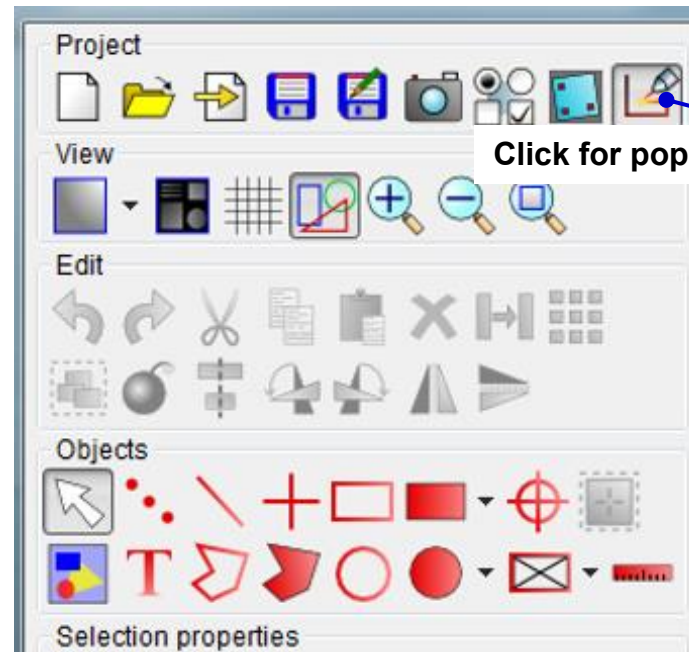
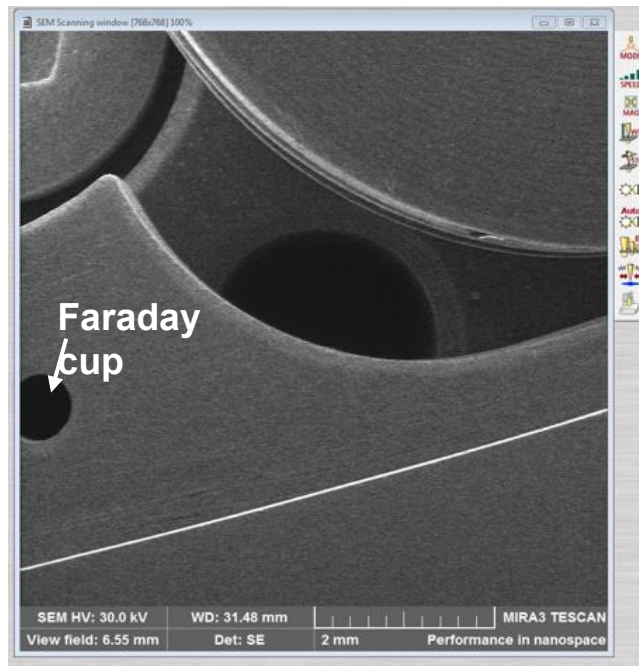
Sample alignment

1. Come back to '1' position
2. Sample alignment: click 'Define UV'

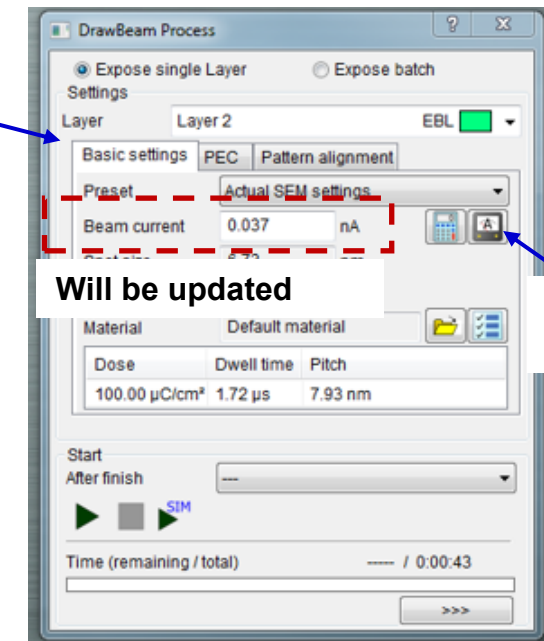


Electron beam current measurement

1. Move to Faraday cup & Zoom in completely
2. Select proper BI (beam intensity)
 - For multiple BIs, measure all the currents corresponding to BIs
 - Beam alignment should be done with the BI corresponding to smallest beam current
3. Open the DrawBeam Process
4. Measure the beam current → update the 'Beam current' value



Click for popup

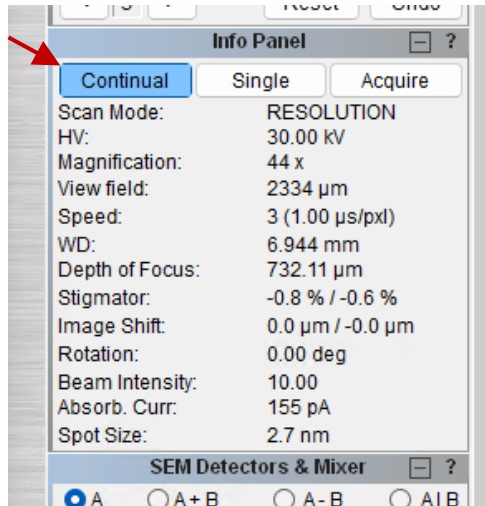


Will be updated

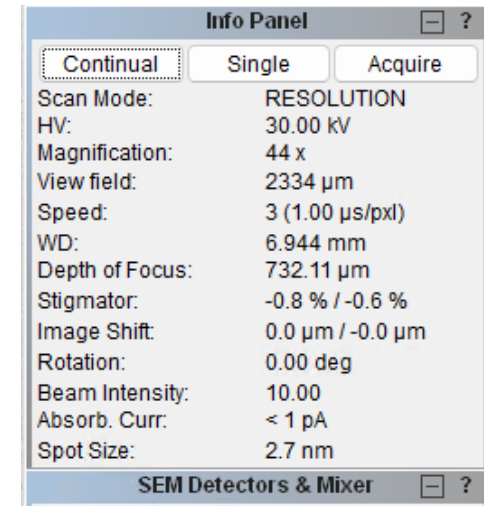
Click for measurement

Exposure on the substrate (1/4)

1. Locate at the sample area
 1. Find a location where focus can be made
 2. Or, a scratch has been made, locate the end of the scratch
2. Focus & stigma at high magnification (e.g. 100,000X) – during focusing, PMMA will be damaged
3. Move to unexposed location
 1. Turn off the beam – click 'Continual'

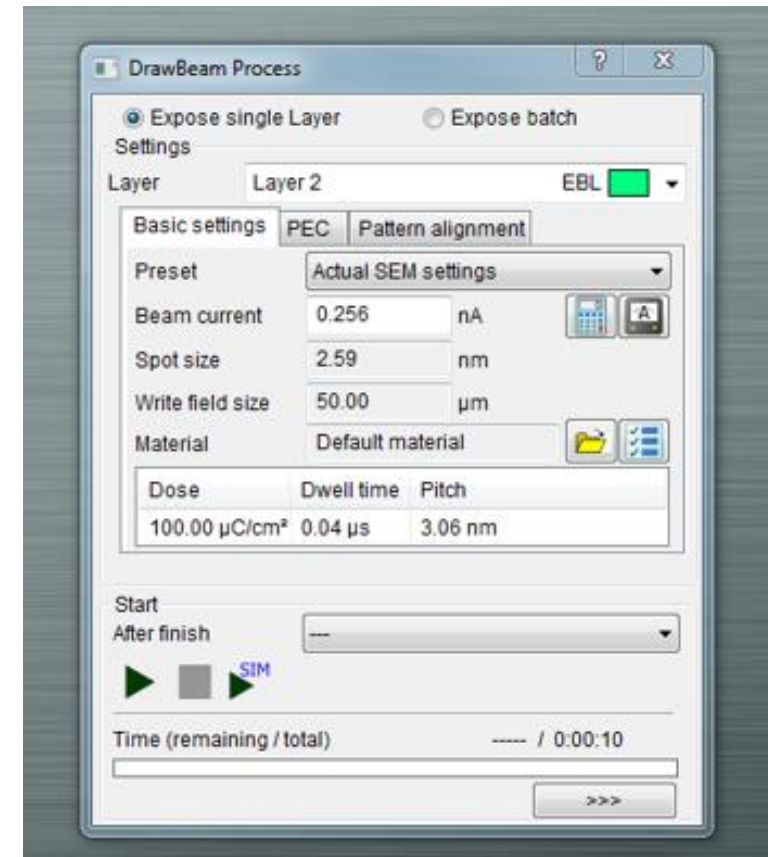
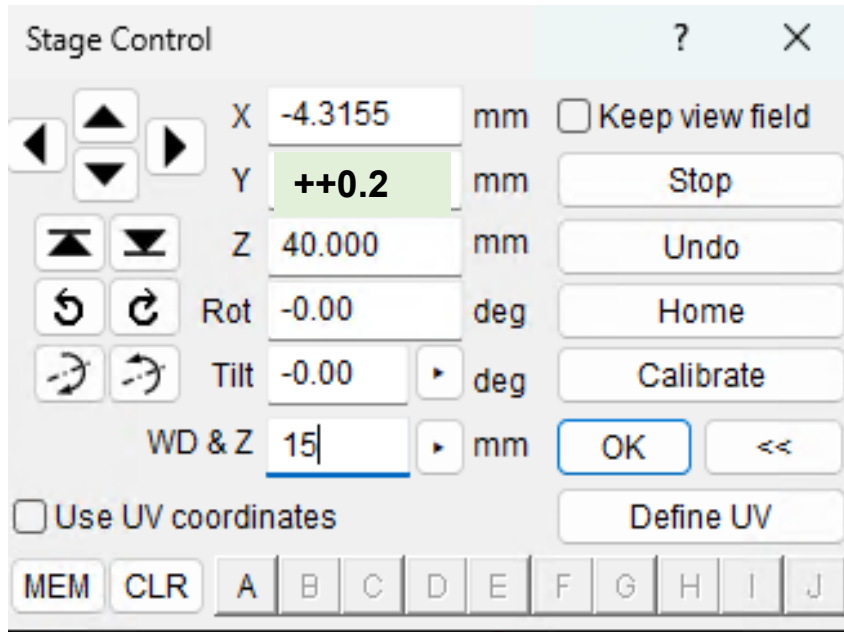


Stop beam scanning



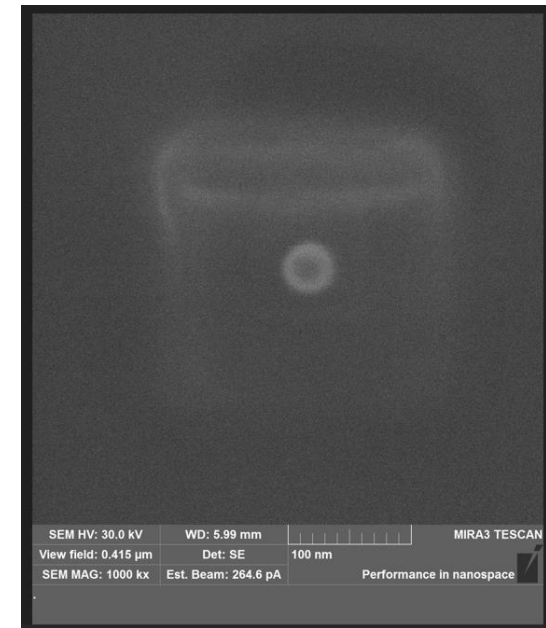
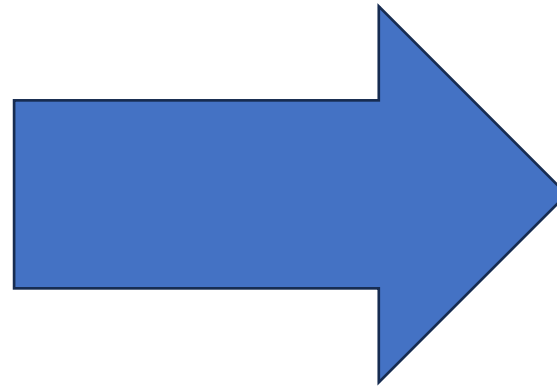
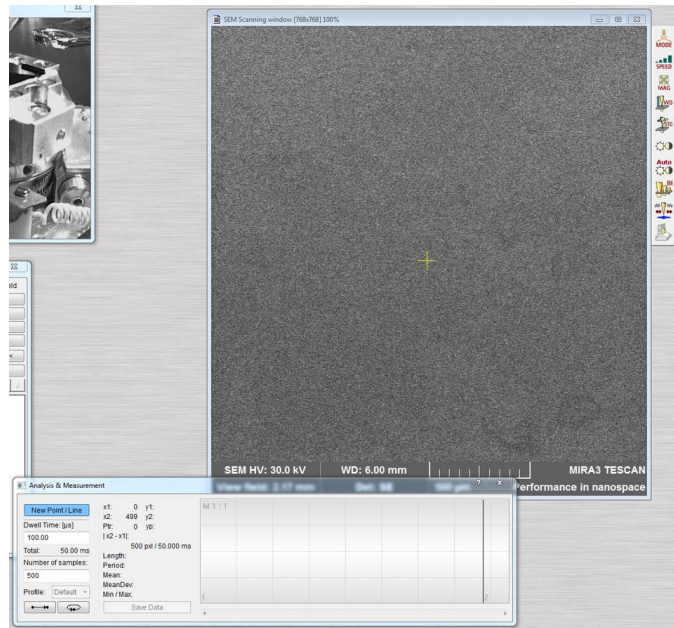
Exposure on the substrate (2/4)

1. Move 100 ~ 200 μm away (downward) to avoid e-beam exposed area
 - E.g., “++0.2” → send the stage 200 μm along positive direction
2. Start exposure



Exposure on the substrate (3/4)

1. Making a beam spot: checking the beam shape (stigma) & focus
 - Max magnification → Analysis & Measurement → click at the center of SEM window → yellow cross
 - Click 'Start button'
 - This takes 30 – 60s depending on current stigma & focus
2. Beam shape
 - Perfect circular shape (right image): move forward for exposure
 - Not clear oval or linear shapes: adjust stigma & focus
 - Nothing appeared: go back to previous location and do focus and stigma, then repeat making beam spot



Exposure (4/4) – set the exposure parameters

The image shows two overlapping software windows: "DrawBeam Process" and "Exposure settings".

DrawBeam Process Window:

- Buttons: ☒ Expose single Layer, ☐ Expose batch
- Settings tab: Layer 1, EBL
- Actual SEM settings table:

Beam current	Spot size	Write field size	Material
0.500 nA	2.73 nm	70.00 μm	Default material
- Parameters table:

Dose	Dwell time	Pitch
350.00 μC/cm²	0.06 μs	2.73 nm
- Start button (green play icon)
- Time (remaining / total): --- / 0:00:---

Exposure settings Window:

- Material parameters section:

Parameter	Value	Unit
Dose	350.00	μC/cm²
Dwell time	0.06	μs
Spacing	1.000	
Exp. pitch	2.73	nm
DAC resolution	1.19	nm
Base settle time	15.00	μs
Accuracy	Medium	34.2 nm
Objects overlaps	Multiple exposure	
- Buttons: Cancel, Ok

Annotations:

- "Check layers for exposure" points to Layer 1.
- "Measured value here. 0.5 is dummy" points to 0.500 nA.
- "Double click" points to the Pitch value (2.73 nm) in the parameters table.
- "Set the dose" points to 350.00 μC/cm².
- "Exp pitch > 4 X DAC resolution" points to Exp. pitch (2.73 nm) and DAC resolution (1.19 nm).
- "Click" points to the Ok button.
- "Everything is okay, Click start button for exposure" points to the Start button.

Shutdown

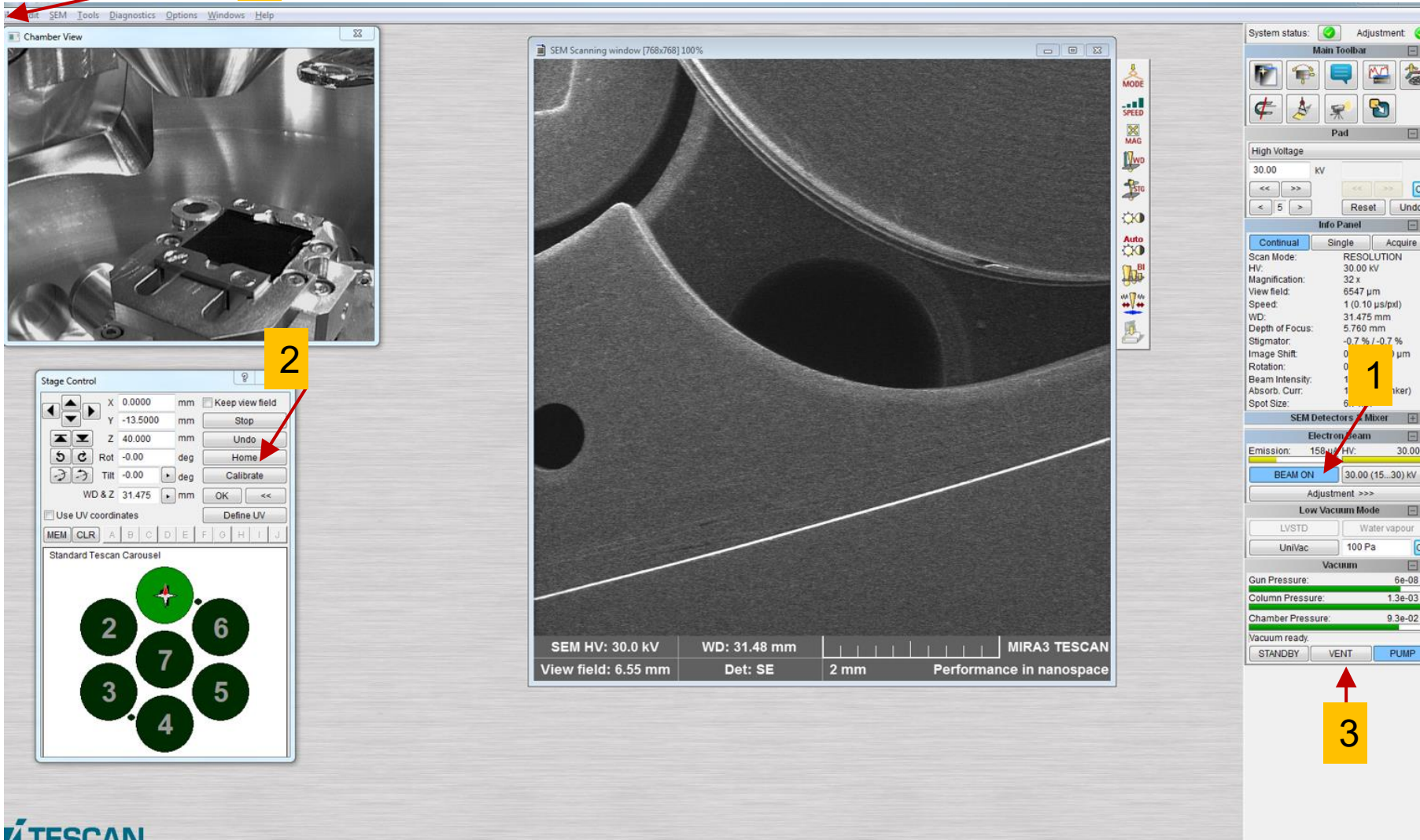
6

2

1

3

1. Shut off Beam
2. Home stage
3. Vent
4. Unload sample
5. Pump – wait until the pressures turn to green
6. File – log off
7. No for Standby mode

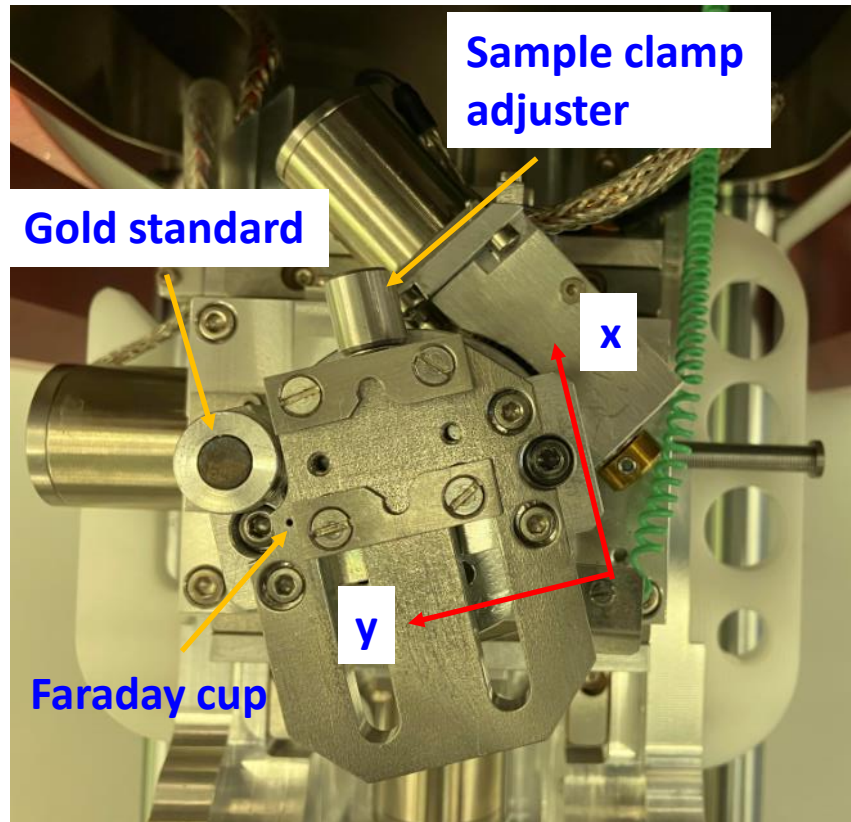


Appendix

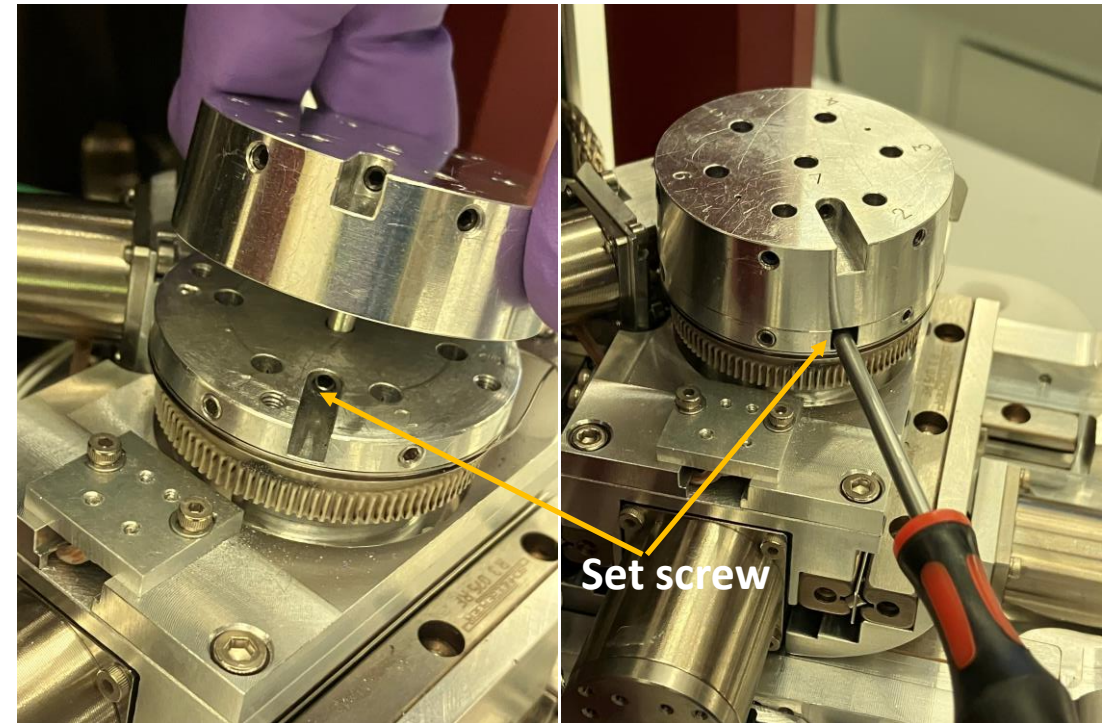
Sample stage

- If another stage needs for the operation, switch one to the other

EBL stage



SEM stage



Login screens: two screens

SEM

Lithography (DrawBeam)

The screenshot displays the Mira3 SEM software interface. The main window shows a 'Blanked' SEM image. On the left, there is a 'Stage Control' panel with a circular navigation pad. The top right shows system status and adjustment parameters. The bottom right shows a 'DrawBeam' window with a diagram of a beam and a list of objects. A blue callout box highlights the 'SEM' menu, which is open, showing 'DrawBeam' checked. A yellow callout box points to the 'Tools' menu, which is also open, showing 'DrawBeam' checked.

SEM HV: 30.0 kV WD: 31.48 mm MIRAS TESCAN
View field: 0.209 μm Det: SE 50 nm Performance in nano

SEM menu items:
Analysis & Measurement
Chamber View
Histogram
Measurement
3D Scanning
DrawBeam
Image Processing
Multi Image Calibrator
Object Area
Switch-off Timer
Tolerance
X-Positioner

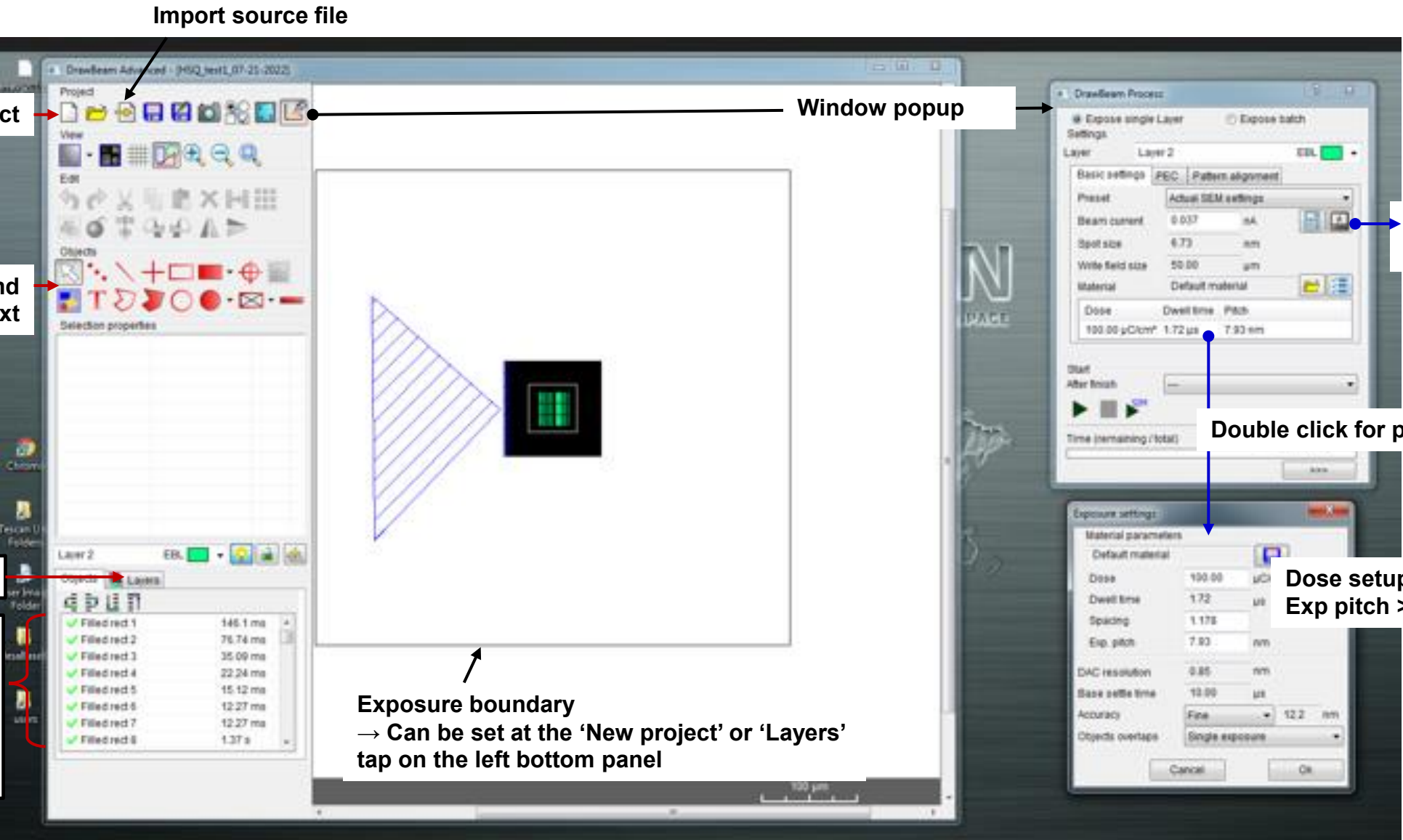
Tools menu items:
Analysis & Measurement
Chamber View
Histogram
Measurement
3D Scanning
DrawBeam
Image Processing
Multi Image Calibrator
Object Area
Switch-off Timer
Tolerance
X-Positioner

SEM functions

The image shows a screenshot of the SEM software interface with several labeled components:

- Chamber view camera**: Points to the top-left window showing a live video feed of the sample chamber.
- Gold standard**: Points to a specific feature on the sample in the chamber view.
- Faraday cup**: Points to a component within the sample assembly in the chamber view.
- Stage operation**: Points to the 'Stage Control' panel on the bottom left, which includes controls for X, Y, Z, Rotation, Tilt, and WD & Z.
- E-beam location**: Points to a circular diagram with six numbered positions (1-6) in the 'Stage Control' panel. A note states: "Click '1' is suggested to avoid e-beam exposure".
- SEM screen**: Points to the large central display area.
- Scan speed**: Points to a control on the right side of the SEM screen.
- Stigma**: Points to a control on the right side of the SEM screen.
- Auto. Brightness & contrast**: Points to a control on the right side of the SEM screen.
- Wobbling correction**: Points to a control on the right side of the SEM screen.
- E-beam scan option**: Points to the 'Continue' button in the 'Acquire' panel on the right.
- E-beam on/off**: Points to the 'BEAM ON' button in the 'Electron Beam' panel on the right.
- Analysis & measurement ; circular test spot**: Points to the 'Analysis' icon in the 'Main Toolbar' on the right.
- Adjust the selected parameter**: Points to the 'Adjustment' button in the 'Main Toolbar' on the right.
- Control panel; Select parameter for control**: Points to the 'Adjustment' panel on the right, which contains various system parameters like High Voltage, Magnification, and Speed.
- Chamber pump & vent**: Points to the 'PUMP' button at the bottom right of the interface.

EBL: DrawBeam



Revision history

SIGNATURES AND REVISION HISTORY

- 1. Original author of this document: Mitchell Roselius
 - Original author Title or Role: Student worker
 - Date of original: 2/25/2021
- 2. Revision B notes: Update of the graphical procedures.
- 3. Revision C notes: Photos and description added

Approvals:

Technical Manager Signature: *Sandra G Malhotra*

Date: 7/11/2025

Revision	Author	Date
Original Issue	Manouchehr Teimouri	3/5/2018
Rev A	Mitchell Roselius	2/25/2021
Rev B	Sung Oh Woo	7/1/2025
Rev C	Sung Oh Woo	8/12/2025