



אוניברסיטת בן-גוריון בנגב
Ben-Gurion University
of the Negev

מערכת eLINE – מדריך מקוצר למשתמש

eLINE System – a brief operation guide



Nano-fabrication center



General Information

General system description:

- Raith Company
- Leo Gemini Coulomb
- Stage position laser interferometer
- Stage height laser interferometer
- Stationary stage movement
- Gaussian beam shape profile
- Vector scan elements

Specifications:

- Encoder resolution 2nm
- Position repeatability « 50nm
- Dwell time 100nm-8s
- Step size 1nm-1mm
- High tension 0.1 kV to 30kV
- Setting time 0-10ms
- Write field 1nm-2mm
- Beam Current 1pA-10nA
- WD 2mm-15mm
- Spot resolution 20nm



SEM software (right screen)

The screenshot shows the SEM software interface with several callouts pointing to specific features:

- Scan speed**: Points to the first icon in the top toolbar.
- Scan pause**: Points to the second icon in the top toolbar.
- Crosshairs**: Points to the third icon in the top toolbar.
- Brightness & Contrast**: Points to the fourth icon in the top toolbar.
- Magnifications / working distance**: Points to the fifth icon in the top toolbar.
- Crosshairs**: Points to the sixth icon in the top toolbar.
- Dedicated Keypad lock**: Points to the seventh icon in the top toolbar.
- System control bar**: Points to the SEM Controls panel on the right side of the interface.
- Annotation bar**: Points to the information bar at the bottom of the main image area.

The SEM Controls panel on the right includes the following information:

Detectors		Scanning	
Vacuum	Gun	Apertures	
System Vacuum = 3.36e-003 mbar			
Gun Vacuum = 2.81e-009 mbar			
Vent inhibit = None			
Vac Status = Pumping			
Column Chamber valve = Closed			
EHT Vac ready = Yes			
Column pumping = Ready			
Pump		Vent	
<input type="checkbox"/> Partial Vent on Standby			
<input type="checkbox"/> Vac Quiet Mode			

The information bar at the bottom of the main image area displays the following parameters:

BGU Nano Fabrication Center
10 μm^* EHT = 0.000 kV Signal A = InLens Date :17 Nov 2016
WD = 2.7 mm Mag = 1000 X Time :10:38:33



Raith eLINE software (left screen)

Magnifications /
working distance

Stop all motors

Navigators

Desktop
toggles

Beam on / off

Switch patterning/imaging mode

Design

Column control

Write-field control

Adjustment

Patterning

State control

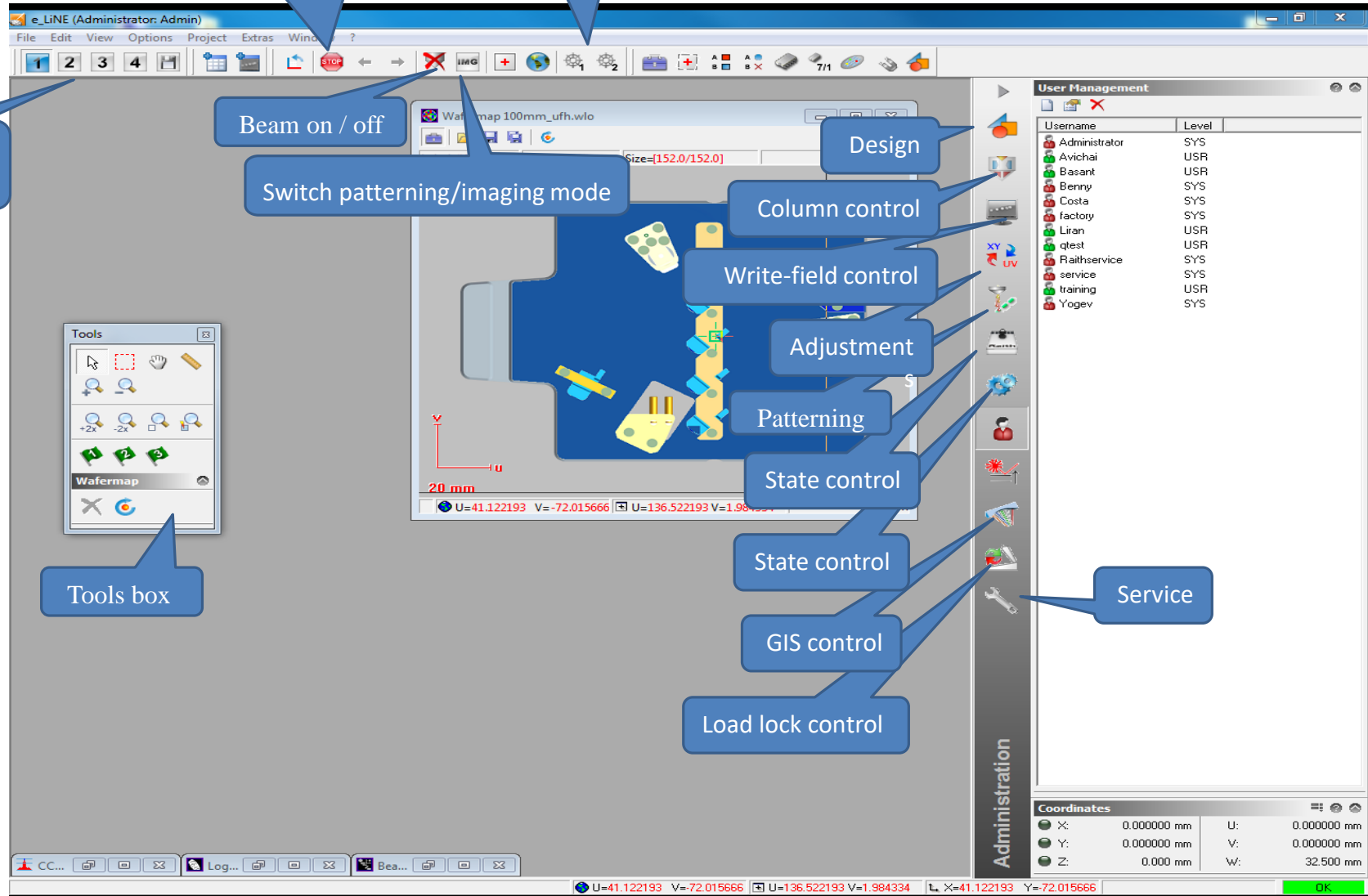
State control

GIS control

Load lock control

Tools box

Service





fundamental steps to successful e-beam lithography:

1. [Loading sample](#)
2. [Set desired EHT, aperture and pattern](#)
3. [Measure current and set suitable dose](#)
4. [Adjust axes](#)
5. [Focus](#)
6. [Write-field alignment](#)
7. [Exposure](#)
8. [Unloading sample and developing](#)



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Enter your user name and password,
choose the project type and click “Login”

14th Workshop #10446
patented by Raith Ltd

e_LiNE

Ultra high resolution electron beam lithography and nano engineering workstation

Licensed to: Ben Gurion University of the Negev
IL-84105 Beer Sheba
No.: 214301

User: Password:

Project:

Konrad-Adenauer-Allee 8, 44263 Dortmund, Germany
Phone: +49 (0)231 95004 499
Email: support@raith.com http://www.raith.com

Raith
INNOVATIVE SOLUTIONS FOR NANOFABRICATION AND SEMICONDUCTOR NAVIGATION

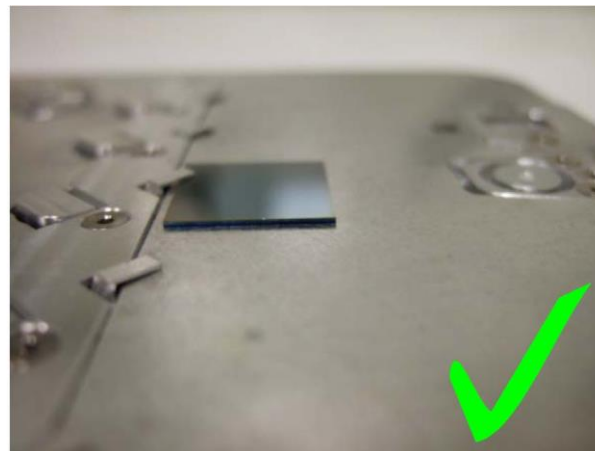
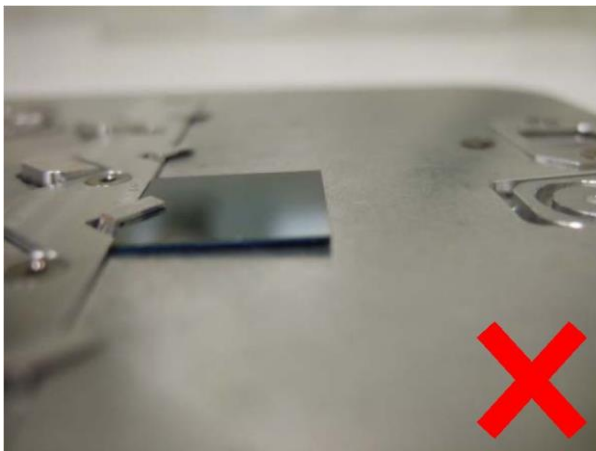
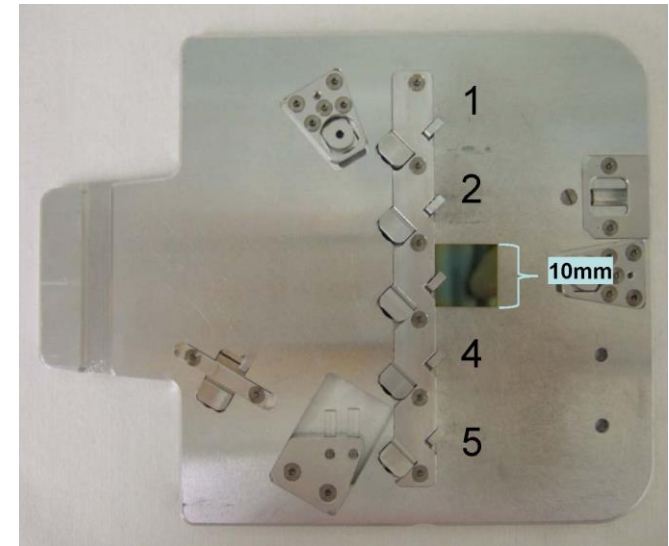
www.raith.com



Loading sample

Placing the sample on holder:

- Select the suitable holder
- Take a note of the sample size and position on holder:
- It is recommended that the sample's bottom left corner is bare
- Make sure the sample is flat:

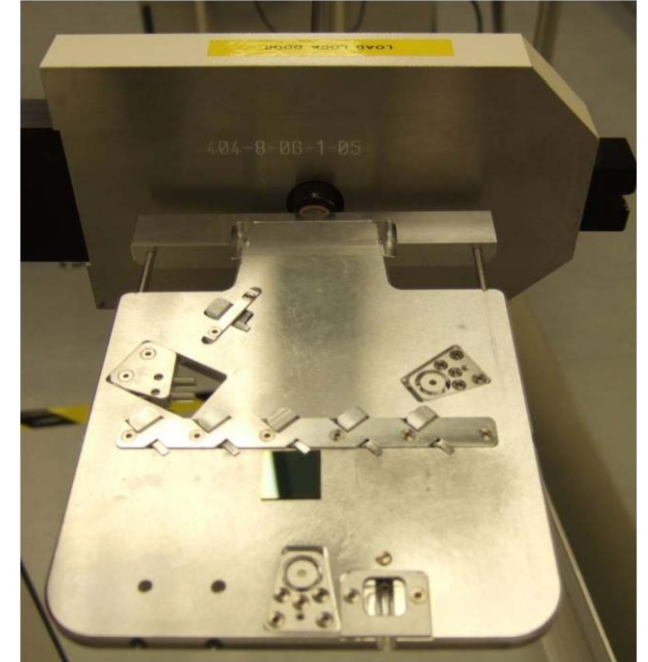
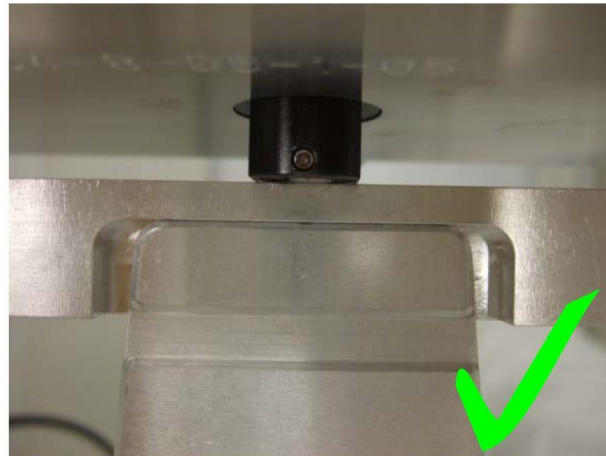
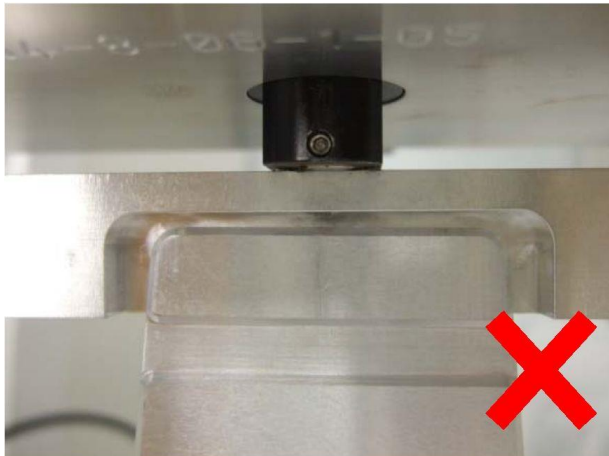




Loading sample

Place holder on transfer rod:

- Make sure it is leveled properly
- Make sure it is anchored correctly
- Close and fasten load-lock door

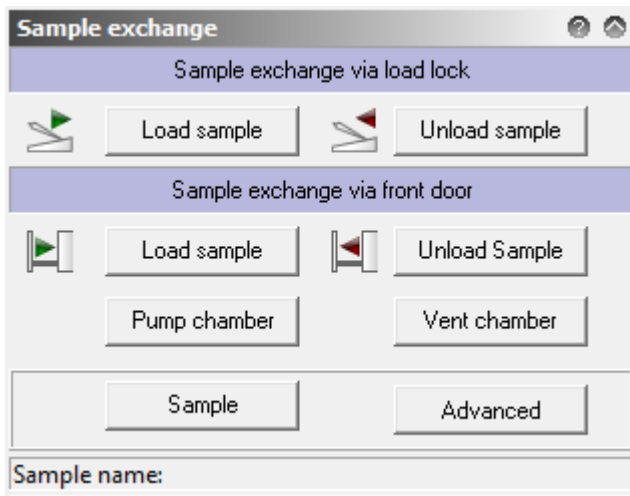




Loading sample

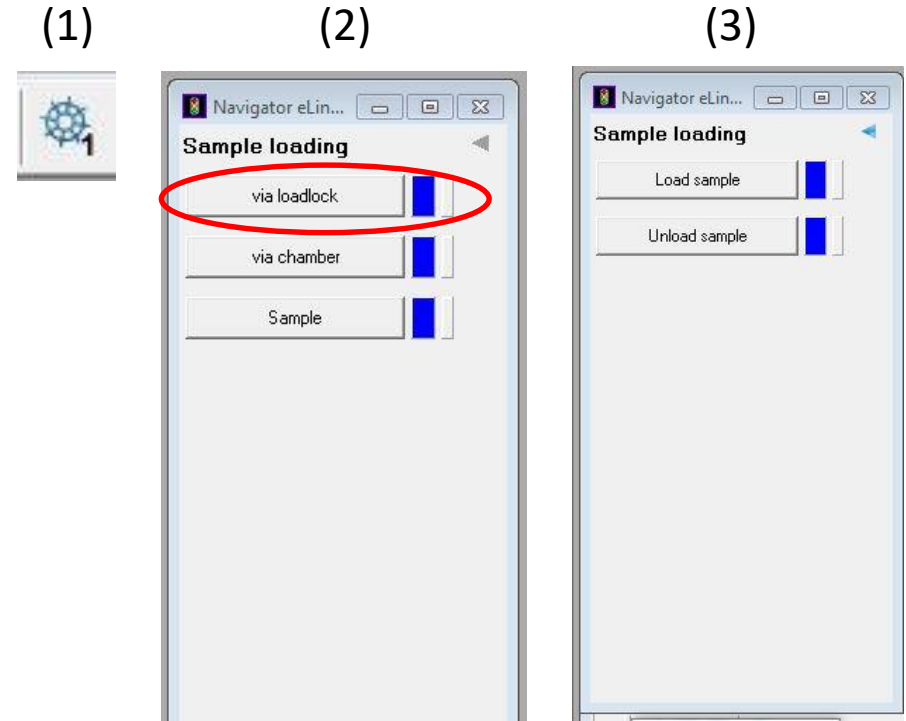
Raith eLINE software:

- Click on **Load-lock** sample exchange menu icon
- Click on **Load sample** on “Sample exchange via load lock” bar



Notice!
Using the “Sample exchange
Via front door” menu will open
The main chamber and lose the
system vacuum!

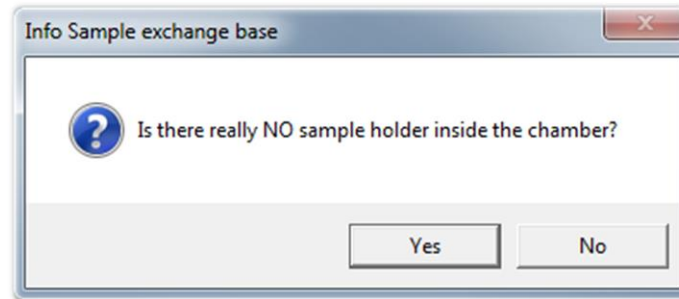
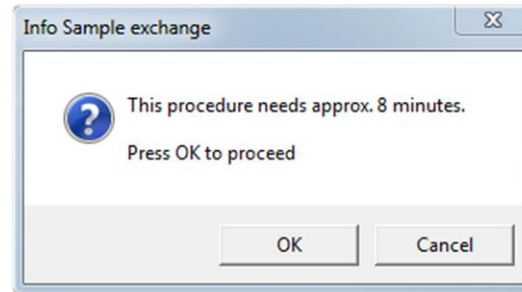
OR



- Click icon (1)
- Choose via loadlock (2)
- Choose “Load sample” (3)

Loading sample

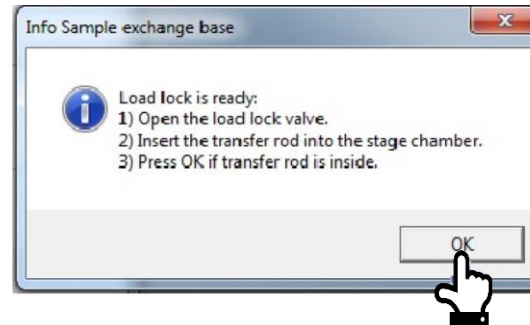
- Click OK to proceed
- Insure that there is no sample holder inside the chamber and the holder is in place and click “Yes”
- Close and fasten the load lock door
- Click OK to proceed
- Wait until next info pop-up window appears





Loading sample

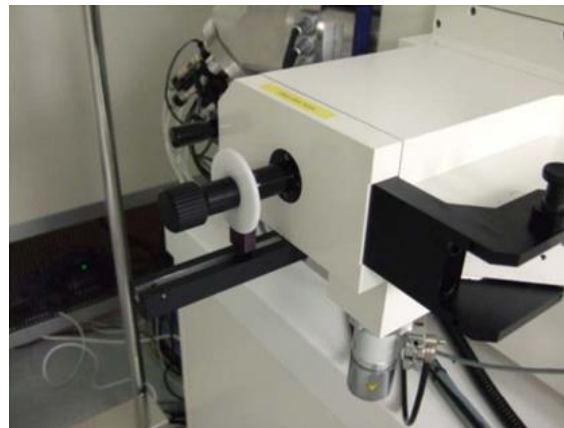
- When this pop-up appears, insure that the load lock vacuum ready indicator is on



- Open the load lock valve



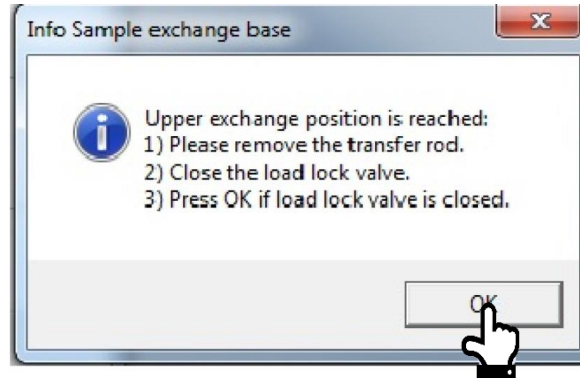
- Insert the transfer rod into the stage chamber and click "OK"





Loading sample

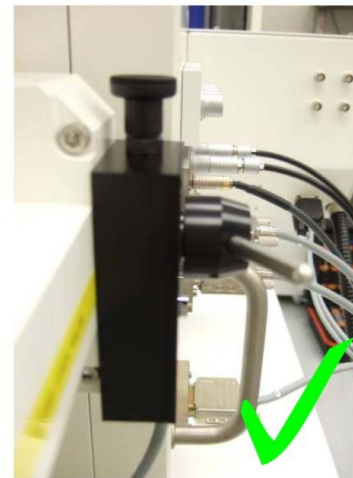
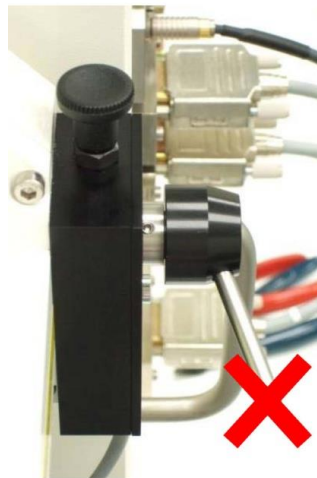
- When this pop-up appears, remove the transfer rod from the stage chamber



- Close the valve. Make sure that it is placed in "Locked" position



- Click OK to proceed

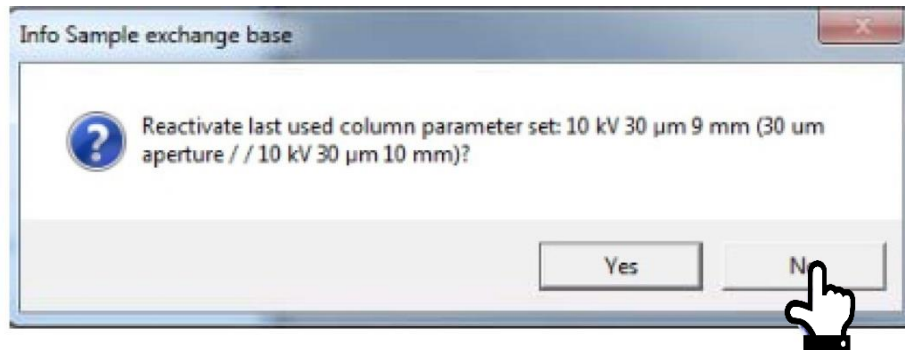


Loading sample

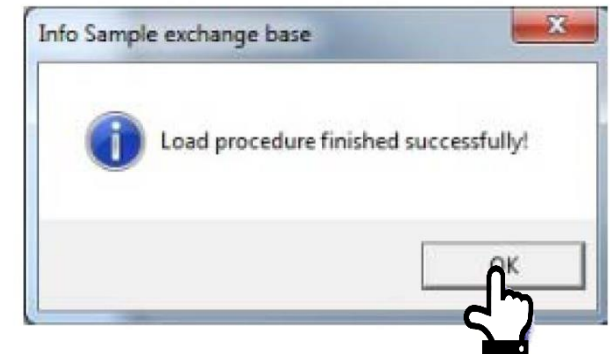
Reset coordinate system? Click as required



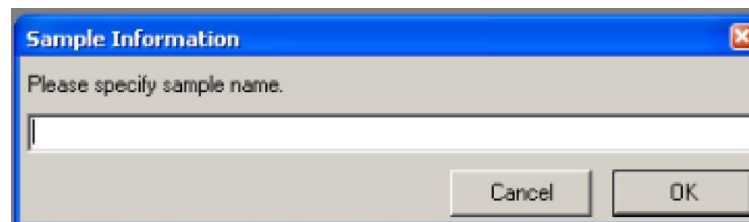
Reactive last used column parameter? Click as required



Load procedure finished successfully ? Click on "OK"



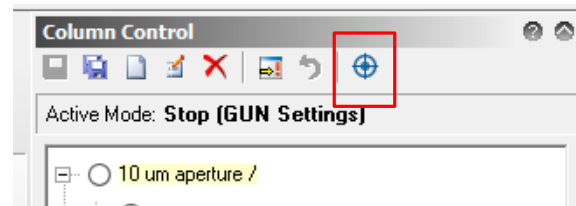
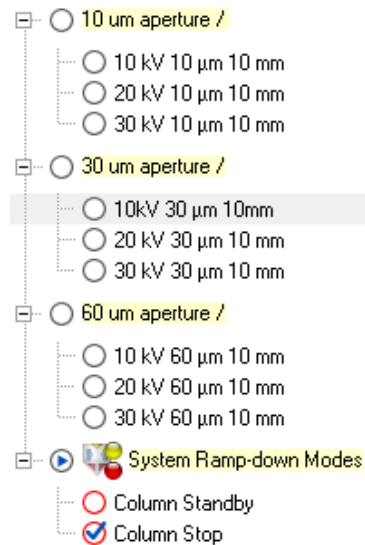
Name the sample






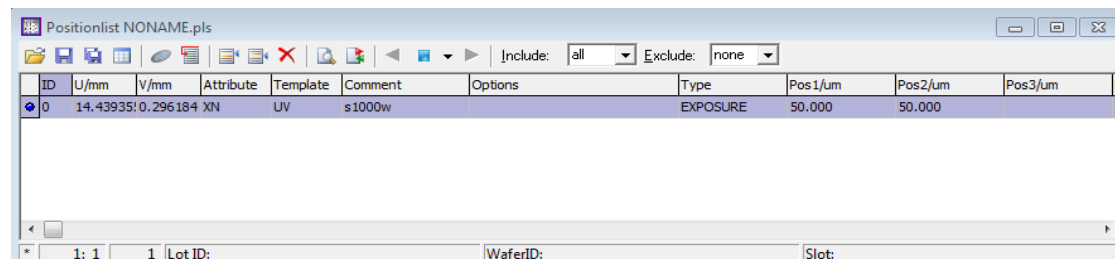
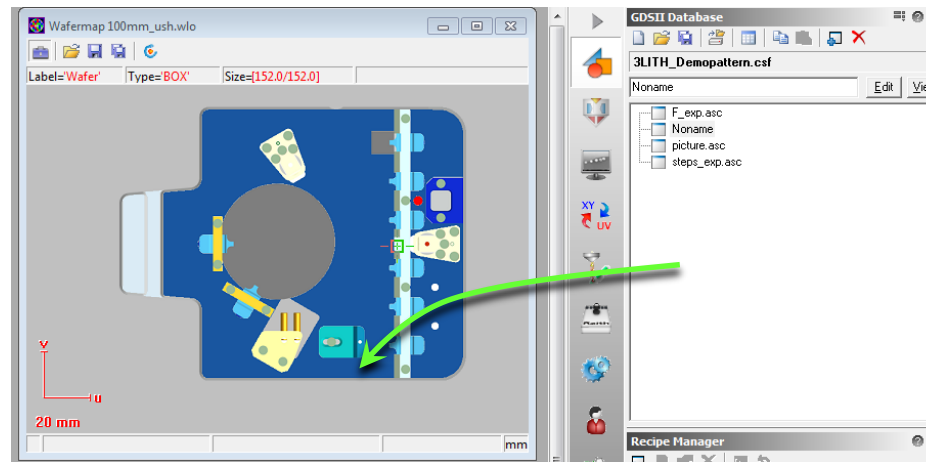
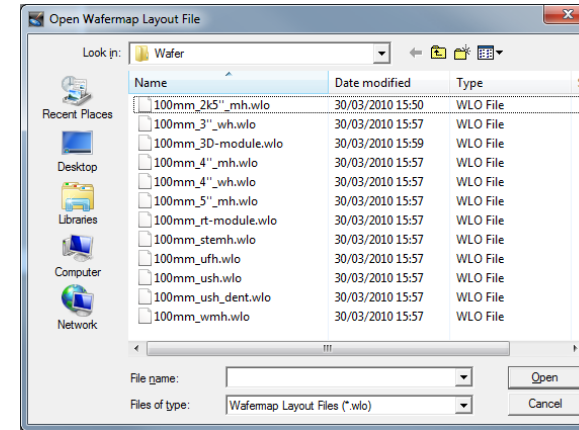
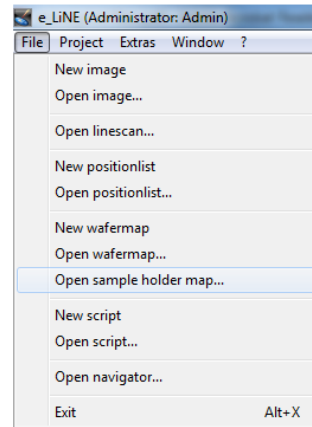
Set desired EHT, aperture and pattern

- Click on “Column control” icon
- Select the desired mode
- Click on “Activate selected mode” icon



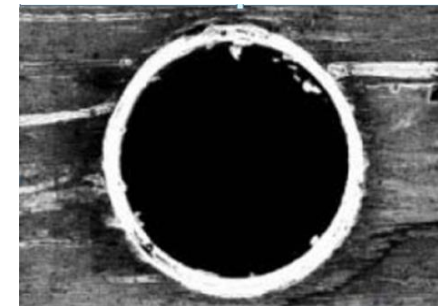
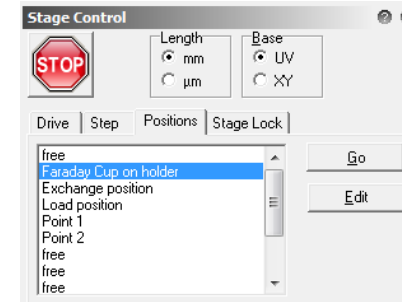
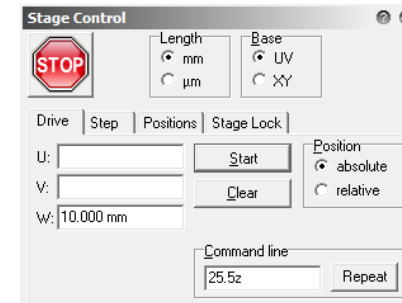
Set desired EHT, aperture and pattern

- Click on "Design" icon 
- Open GDSII database file
- Open the required sample holder map layout
- Choose the desired structure and drag it to the sample position on the wafer-map. A new position list window should appear with the structure position parameters



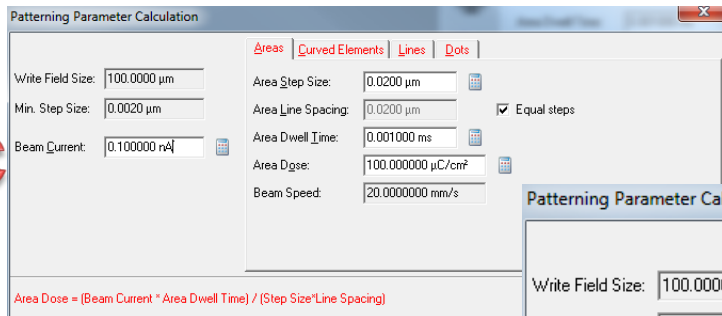
Current measurements and suitable dose set

- Move the stage to be in a working distance of 10mm (use command line **25.5z** or drive to **W=10mm** or to **Z=~25.5mm**)
- Move to the faraday cup position
- Make sure that your on the faraday cup position
- Re-measure the beam current to ensure its stability
- Ensure that the measured current is suite to the official current table



Current measurements and suitable dose set

- In the patterning parameter menu, mark the needed types of elements (Lines, Curved elements, Dots, etc.)
- Click on the patterning parameter calculator icon
- Set the **Step size** and **Dose** for each type of elements
- Calculate the **Dwell time** for each type of elements
- Note that the calculated beam speed should not exceed 15mm/s (otherwise change the parameters or even the EHT and aperture in order to have different beam current)
- Note that the headers and notification area is NOT red



Patterning Parameter Calculation

Write Field Size: 100.0000 μm

Min. Step Size: 0.0020 μm

Beam Current: 0.100000 nA

Area Step Size: 0.0200 μm

Area Line Spacing: 0.0200 μm

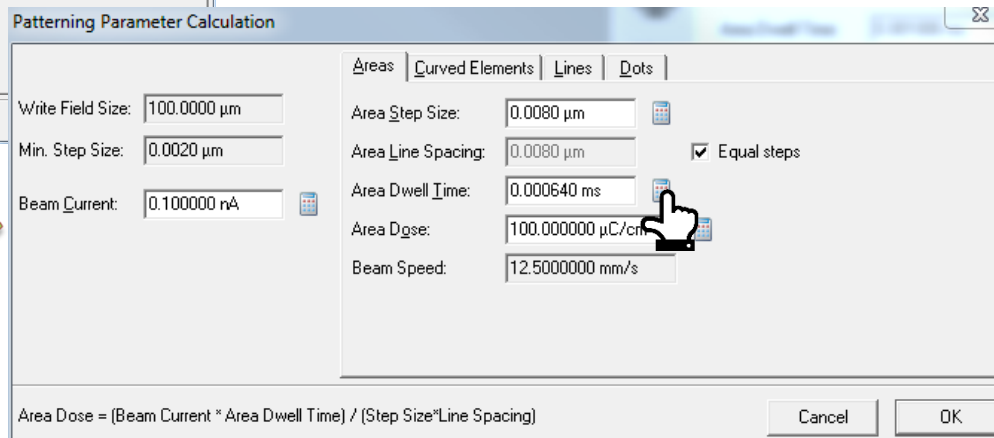
Area Dwell Time: 0.001000 ms

Area Dose: 100.000000 $\mu\text{C}/\text{cm}^2$

Beam Speed: 20.0000000 mm/s

Equal steps

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



Patterning Parameter Calculation

Write Field Size: 100.0000 μm

Min. Step Size: 0.0020 μm

Beam Current: 0.100000 nA

Area Step Size: 0.0080 μm

Area Line Spacing: 0.0080 μm

Area Dwell Time: 0.000640 ms

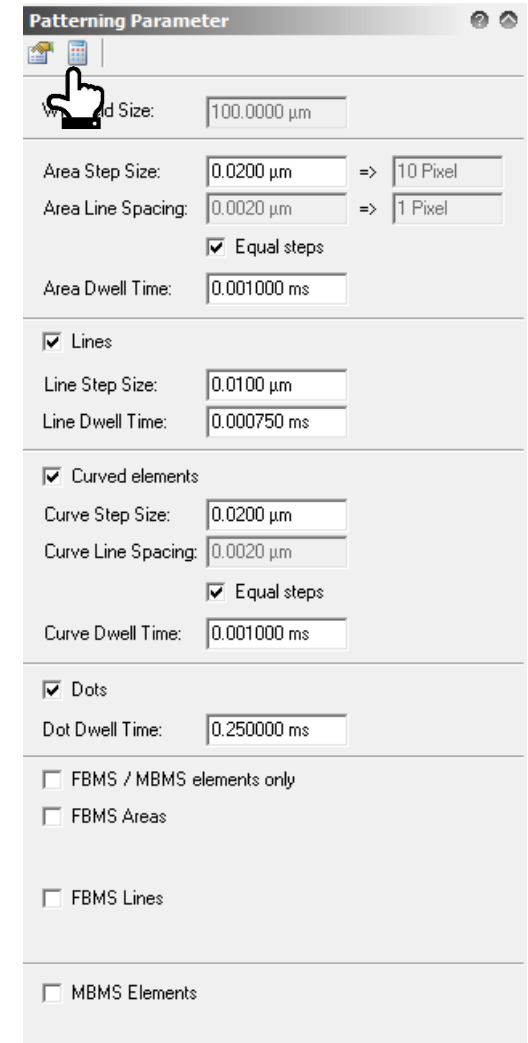
Area Dose: 100.000000 $\mu\text{C}/\text{cm}^2$

Beam Speed: 12.5000000 mm/s

Equal steps

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

Cancel OK



Patterning Parameter

Write Field Size: 100.0000 μm

Area Step Size: 0.0200 μm => 10 Pixel

Area Line Spacing: 0.0020 μm => 1 Pixel

Equal steps

Area Dwell Time: 0.001000 ms

Lines

Line Step Size: 0.0100 μm

Line Dwell Time: 0.000750 ms

Curved elements

Curve Step Size: 0.0200 μm

Curve Line Spacing: 0.0020 μm

Equal steps

Curve Dwell Time: 0.001000 ms

Dots

Dot Dwell Time: 0.250000 ms

FBMS / MBMS elements only

FBMS Areas

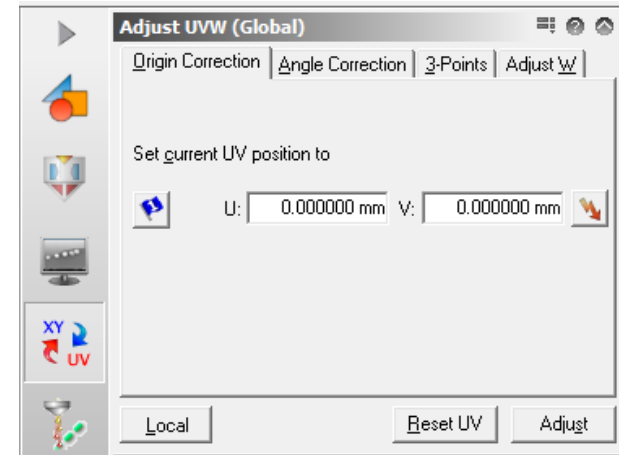
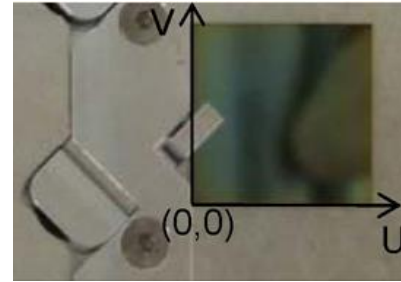
FBMS Lines

MBMS Elements

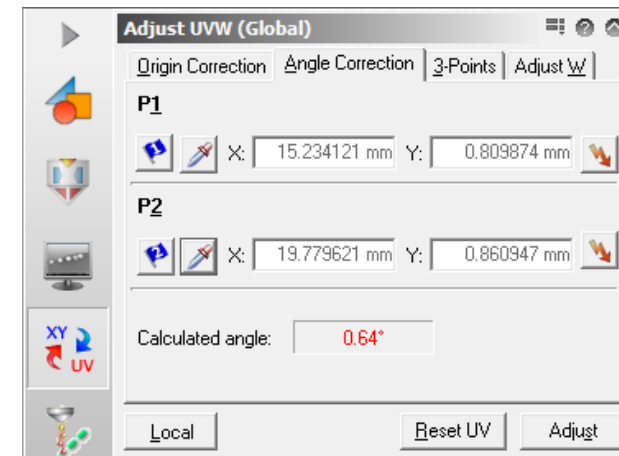


Adjust axes

- Adjust the origin correction by
It is recommended to set the
down left corner of the sample
to U:0,V:0.



- If necessary, Adjust the angle
correction by using two points on
the x axis of the sample/wafer,
read there XY positions (P1, P2)
and click "Adjust". The calculated
angle will appear

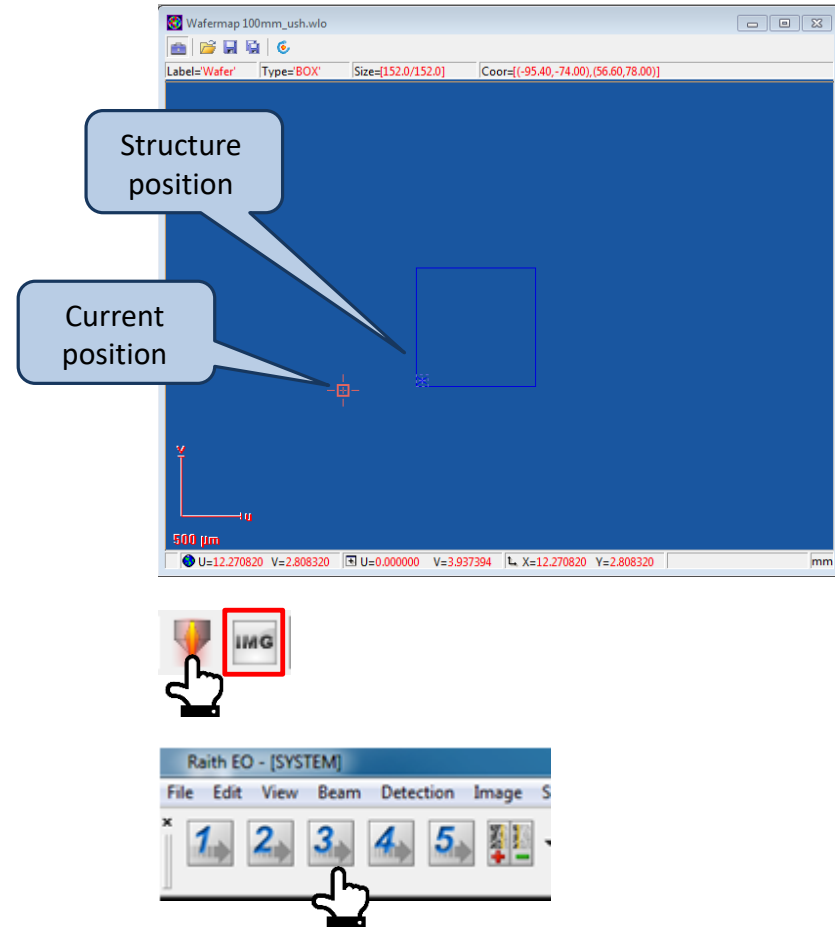


- If necessary, also perform the 3-
point alignment procedure



Focus

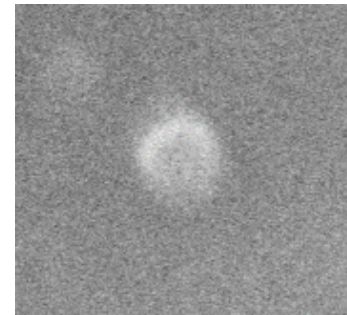
- Move close to the exposure coordinates of the structure placed on the wafer-map
- Turn the beam on and ensure that the system is in imaging mode
- Reduce the scanning window, increase the magnification and decrease the scan speed
- Focus on the sample surface for optimum image





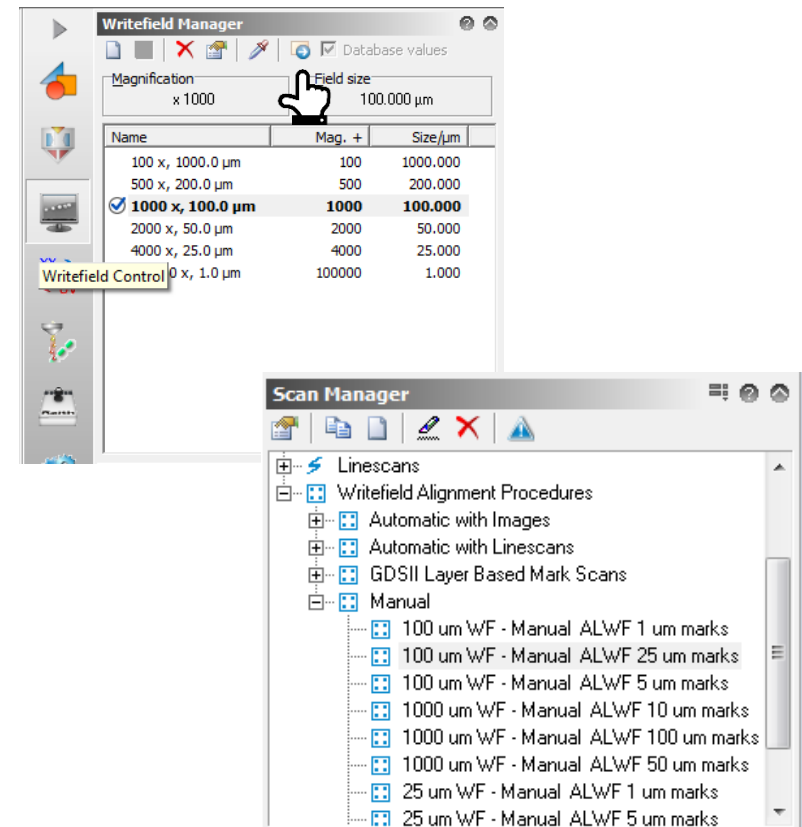
Focus

- While the beam turned on, left click on “**Burn a spot**” icon. Fine tune the focusing until getting a clear and small point (~20nm diameter)
- Adjust the stigmator’s XY nodes until the circle is ideal
- Adjust brightness and contrast as needed
- Repeat the spot burning to ensure the focus is ideal
- Ensure that the working distance (WD) from the sample is reasonable (9-10mm)
- Ensure that the spot is clearly visible and the crosshairs mark centered to this spot



Write-field alignment

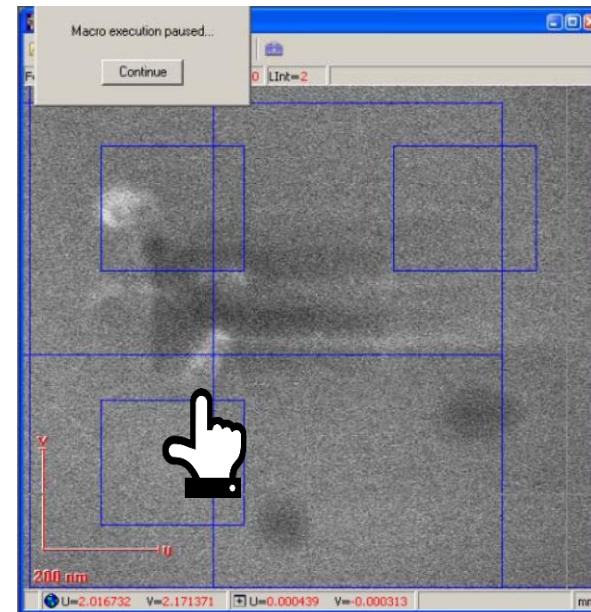
- Click on the “Writefield control” icon
- At the “Writefield manager” tab select the proper writefield and click “F9” or “Set new writefield” icon.
- In the “Scan manager” tab, select the needed alignment procedure, accordingly to the writefield size selected and click “F9” or right click and select “Execute”. For example at the “Manual” sub header select “100um WF – manual 25um marks” and click execute.
- Usually start with the largest scan size to the smallest one.





Write-field alignment

- Executing a WF procedure would start a macro that will scan the field from several marks so it can be fine aligned.
- Use a the centered spot as the center reference point and drag the cursor to this point by (**Ctrl+Left click**) and click “**Continue**”
- After the macro will finish, execute another procedure with smaller scan field size until reaching to the smallest scan size for higher resolution
- The Zoom, Shift and rotation parameters will appear after each iteration. Accept them if they seem reasonable. Check the reasonability of the final values of the parameters at the Writefield alignment tab.
- Run the procedure as needed until the cursor change is negligible



Writefield Alignment			
Zoom	U: 0.92000	1.00000	<input type="button" value="Get marks"/>
<input type="text" value="beam"/>	V: 0.92000	1.00000	
			Marks: 0
Shift	U: 0.000 μm	0.000 μm	<input type="button" value="Reset"/>
<input type="text" value="beam"/>	V: 0.000 μm	0.000 μm	
Rotation	U: 0.000 deg	0.000 deg	<input type="button" value="Send"/>
<input type="text" value="beam"/>	V: 0.000 deg	0.000 deg	

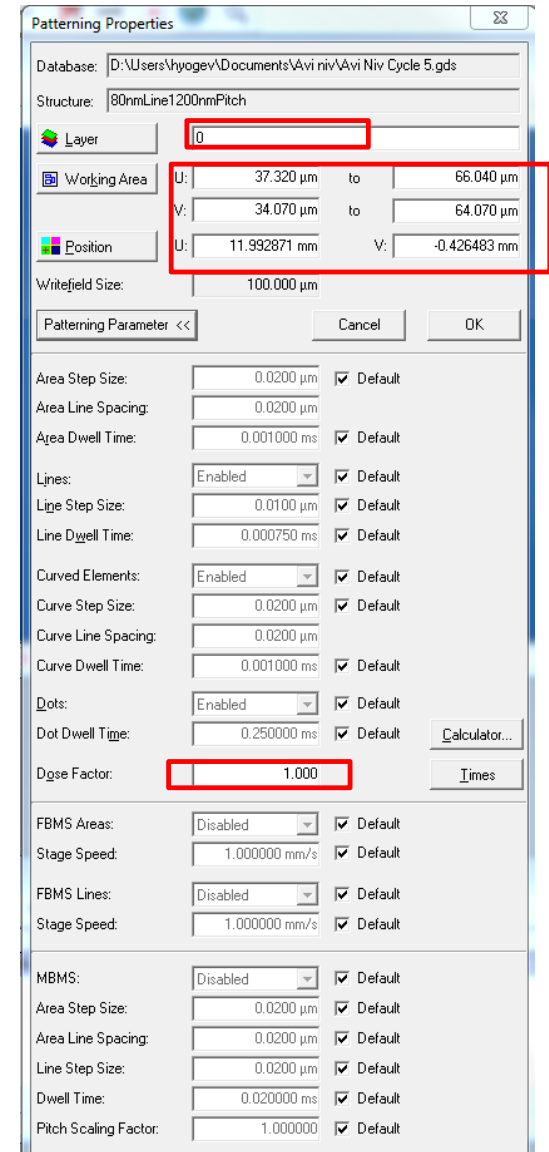
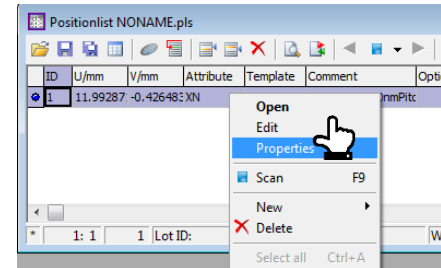
Exposure

- Verify that the final exposing parameters are correct:

1. Exposing parameters are set correctly

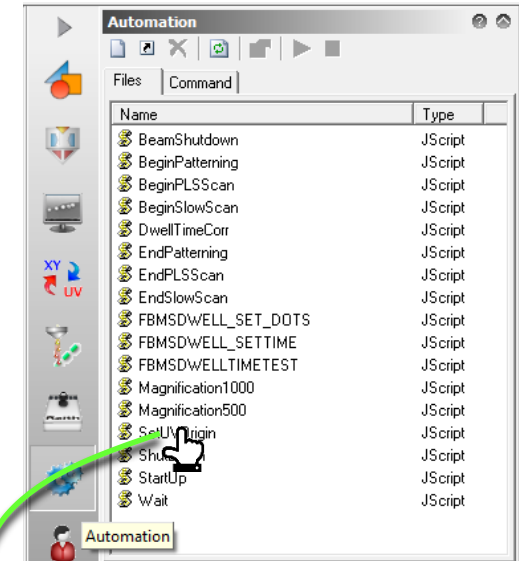
In the patterning properties pop-up window (**right click** on the structure line and click **“Properties”**):

1. Structure position is correct
2. Selected layers are correct
3. Working area is correct
4. Dose factor is as needed



Exposure

- In the “Automation” tab, drag the needed macro to the position list to run it during or after the scan exposure process.
- For shutting down the beam (close EHT) after scan exposure is finished , drag the BeamShutDown macro to the end of the position list.



Positionlist NONAME.pls

Include: all Exclude: none

ID	U/mm	V/mm	Attribute	Template	Comment	Options	Type	Pos1/um	Pos2/um	Pos3/um
1	11.99287	-0.426483	XN	UV	80nmLine1200nmPitc		EXPOSURE	50.000	50.000	
2	0.000000	0.000000	MN	dUV		STAY	MACRO			

* 1: 1 1 Lot ID: WaferID: Slot:

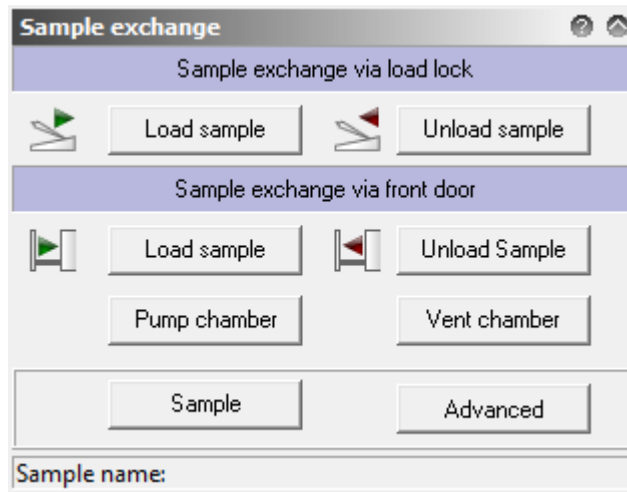
Unloading sample

Raith eLINE software:

- Click on **Load-lock** sample exchange menu icon



- Click on **Unload sample** on “Sample exchange via load lock” bar

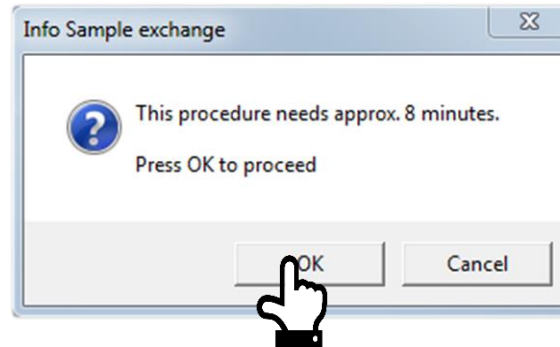


Notice!
Using the “Sample exchange
Via front door” menu will open
The main chamber and lose the
system vacuum!



Unloading sample

- Click OK to proceed



- Close and fasten the load lock door



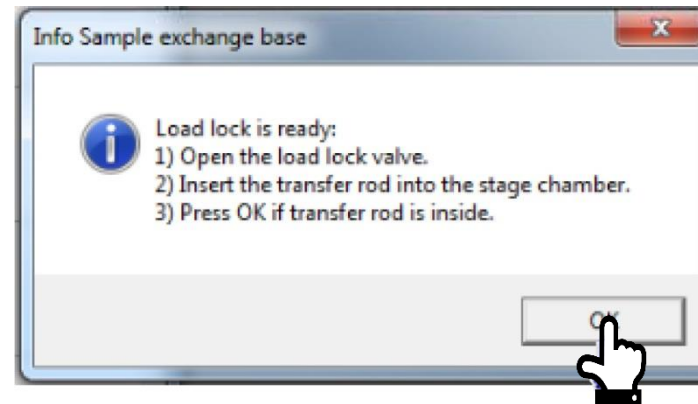
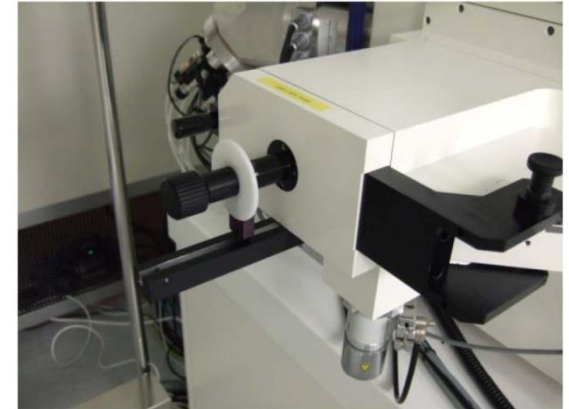
- Click OK to proceed





Unloading sample

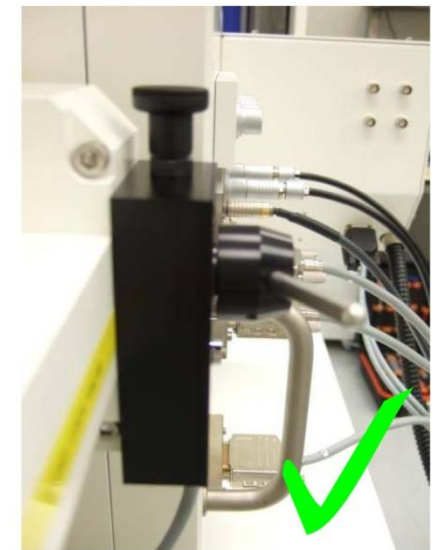
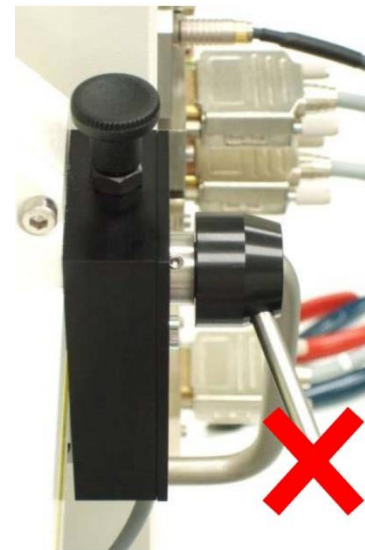
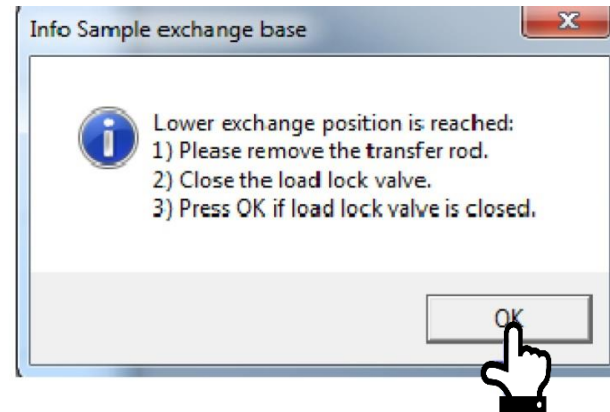
- When the load lock vacuum is ready, open the load lock valve, insert the rod and click **OK**





Unloading sample

- After the holder is placed in the exchange place the “Info sample exchange base” pop-up window will appear
- Remove the transfer rod, close the load lock valve and click **OK**



Unloading sample

- Click **OK** when the unload procedure finished completely. Wait for 1-2 minutes until the load lock chamber is vented, and the venting has stopped.
- Unload the holder and remove the sample.
- Close the load lock door and fasten it gently.
- Place the holder in its dedicated box in the eLINE room bookcase drawer.

