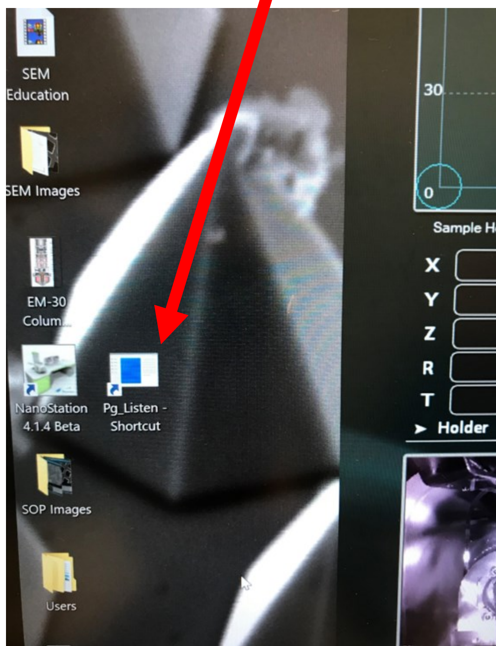
UNT
COLLEGE OF SCIENCE
DEPARTMENT OF PHYSICS

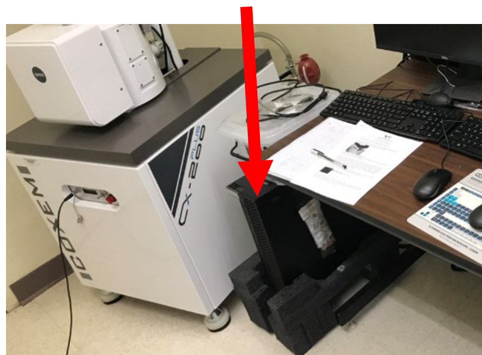
Operation manual for

E-beam Lithography (EBL) – Exposure Section

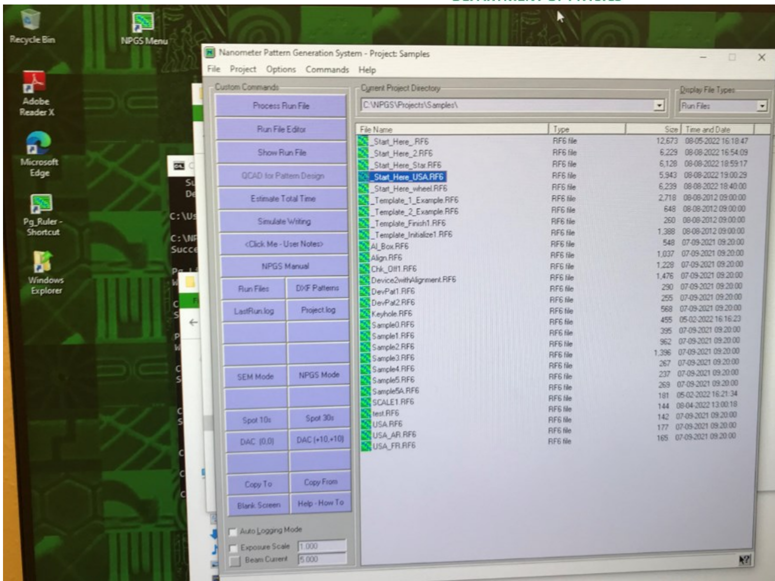
1. Turn on the SEM computer, follow the operation manual of COXEM CX-200Plus and find the area of interest on NanoStation software.
2. Run software **Pg_Listen** on the desktop. A confirmation window will pop up, click yes to confirm.



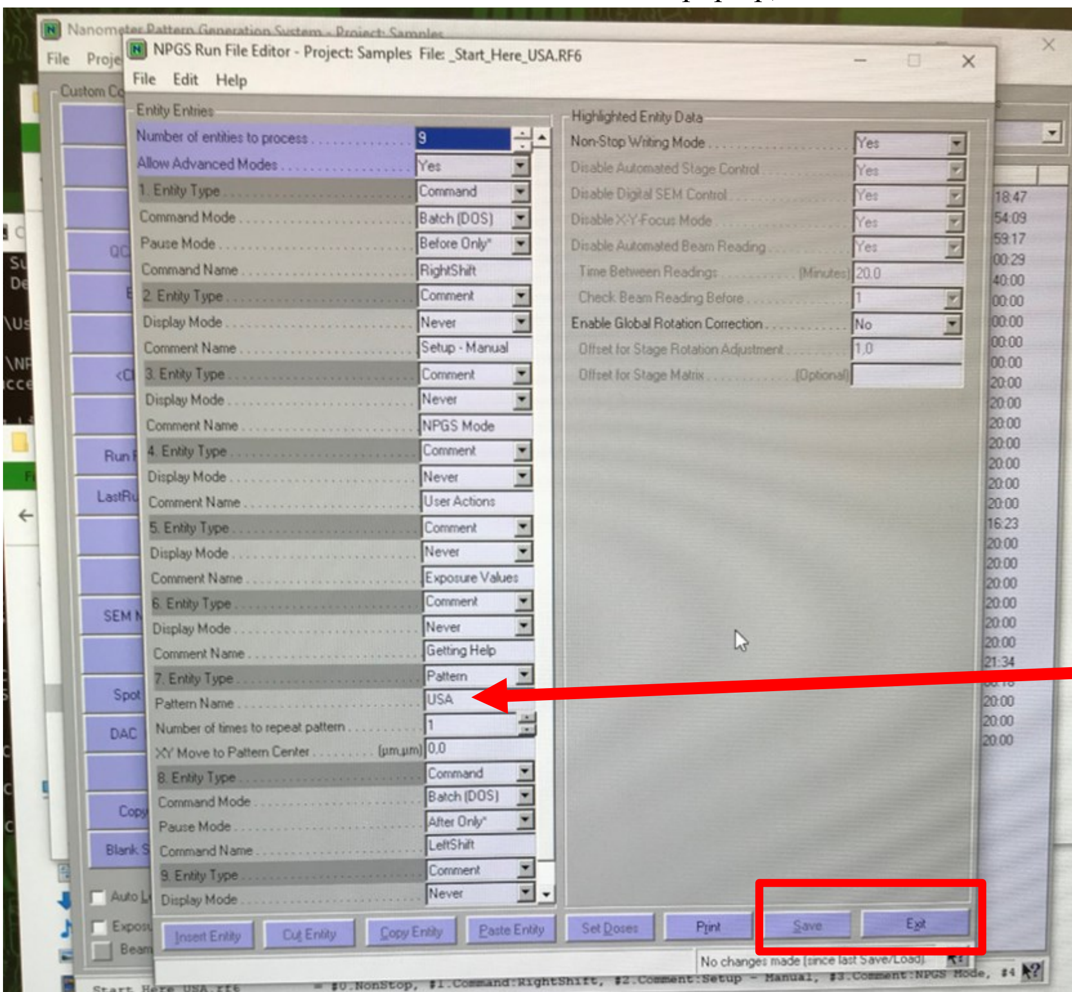
3. Turn on the EBL computer. At this moment, the SEM and SEM computer are both on.



4. Wait for the completion of the automatic DACs calibration shown on the command prompt. Two calibrations will be performed, roughly 3 s + 40 s. If any errors show, please stop using it and consult with the Lab Supervisor.
5. After calibration is done, open the **NPGS Menu**. A tutorial window will pop up, close it and continue, as shown below.



6. Select **_Start_Here_USA.RF6** by left-click once, click on **Run File Editor**, located on the second line from the left column. A window will pop up, shown below.



7. Change the name of the pattern file from “USA” to your file name. Make sure the location is at C:\NPGS\Projects\Samples\.
8. Save and Exit from the bottom panel.
9. Set the Magnification of SEM the same as that in your pattern file (eg. X1000 for 200 µm field size of your pattern).
10. Click on **NPGS Mode** on the left panel of NPGS software.
11. Click on **Process Run File** on the top of the left panel of NPGS software. Confirm on the pop-up window.
12. Wait for the completion of the full-screen mode. The EBL process will be done once exit the full-screen.
13. Click on **SEM Mode** on the left panel of NPGS software. Now the E-beam exposure is done.
14. Follow the procedure of the SEM operation manual. Turn off the E-beam, wait for 5 minutes then vent the chamber, take out your samples, pump down the chamber, and turn off the SEM.
15. Turn off the EBL computer. Fill in your name, date, time in, and time out on the EBL logbook. Refer to the Development Section or 117 Lab from the Physics Department website for further development and optical microscope check.

E-beam Lithography (EBL) – Development Section

HARP PMMA Resists are developed with a Water/IPA Developer using immersion, puddle, and spray techniques. HARP PMMA Developer: Water/IPA 1:10 fast develop in 30 seconds.

Learning materials:

[1] SEM learning file.

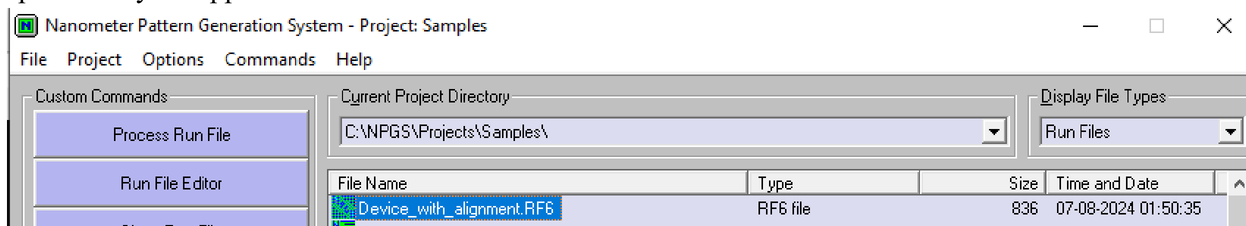
[2] EBL patterns support lines of the arbitrary slope, circles, circular arcs, and arbitrary filled polygons. Text, spline curves, and elliptical arcs can also be easily generated and written as a series of short lines with an almost unlimited number of exposure conditions. QCAD natively supports DXF and DWG formats. Here download the QCAD software.

[3] 1000 HARP PMMA eb 0.1 is supplied as e-beam resist. Spin coat at 1500 rpm for 1 minute results in PMMA film with 100 nm thickness. Followed by soft bake on the hot plate at 180°C for 2 min.

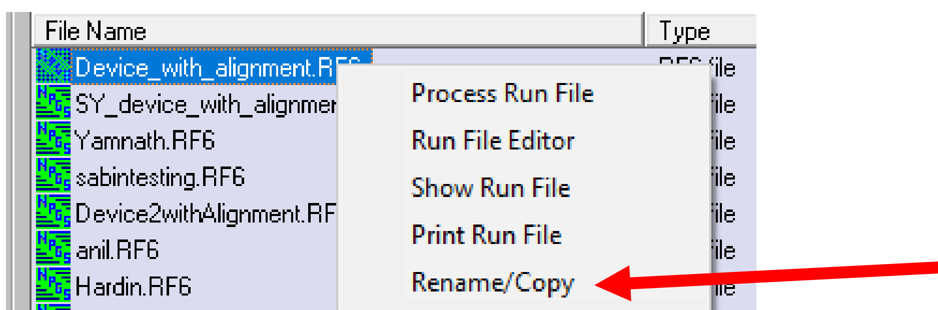
E-beam Lithography (EBL) – Exposure with Alignment Section

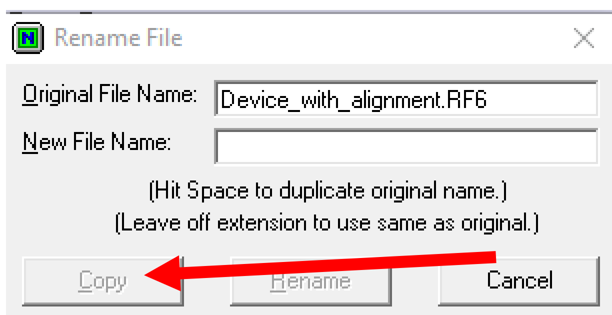
To write a pattern on a pre-defined position on the substrate, a position alignment is needed for the software to locate the sample position and run exposure. Here are the steps for running exposure with alignment. Follow the steps and the pattern should be generated in the desired position considering both the location shift and rotation correction from the sample due to processing and transferring.

1. Start with steps 1-5 in the Exposure Section (without alignment). Then the Run file to follow is called **Device_with_alignment.RF6**. Right-click the file and make a copy with a different name specific to your application.

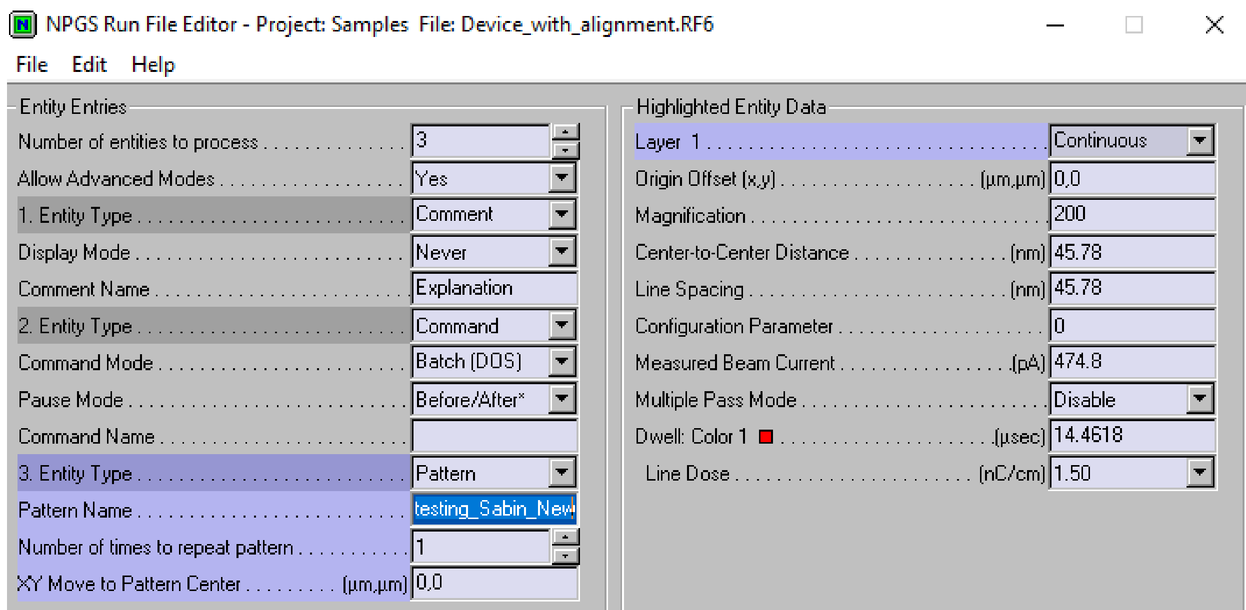


2. Click on Rename/Copy and then enter the new file name in the blank and click on Copy. The following procedures apply to the new file created specifically. **Device_with_alignment.RF6** should remain unchanged.

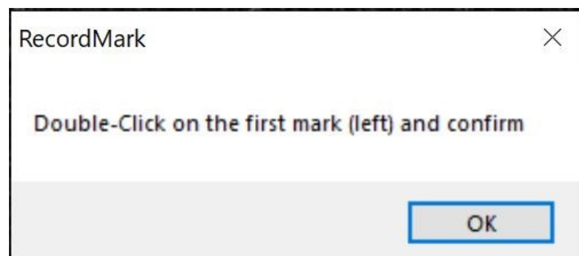


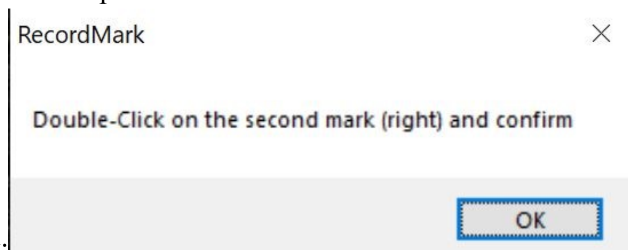


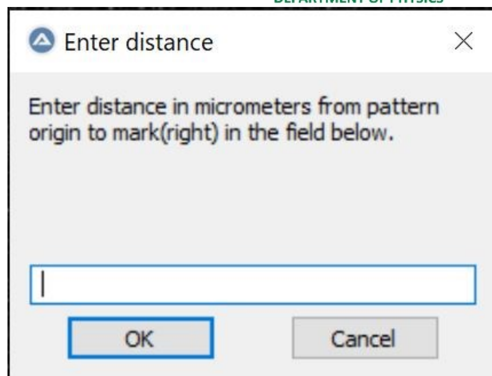
3. Open the new file and go to the pattern section. All other sections will remain unchanged.



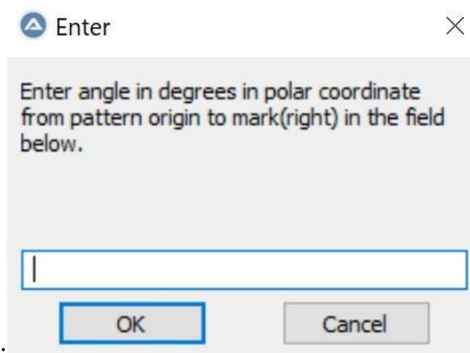
From the pattern section, change the **Pattern Name** by typing in the pattern file name in DC2 format or double-click on the **Pattern Name** area and select from the list. The magnification value on the right side is going to be set in SEM later to keep it consistent.

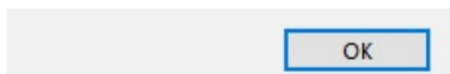
4. With SEM running and the electron beam turned on, the marks of the sample should be located in the SEM image area. There should be two marks on the substrate, either by previous exposure at random locations but close to samples, or by mechanical scratch. The marks are going to be used as calibration for position and rotation. A relative distance and angle between the mark and the sample should be evaluated using optical microscopy and measurement tool, prior to the exposure section. Record the **relative distance (µm)** and **angle (degrees)** using polar coordinates and align the pattern with the horizontal base by two marks.
5. Process the run file. A sequence of messages will pop out to complete the alignment and exposure.
6. First window: 

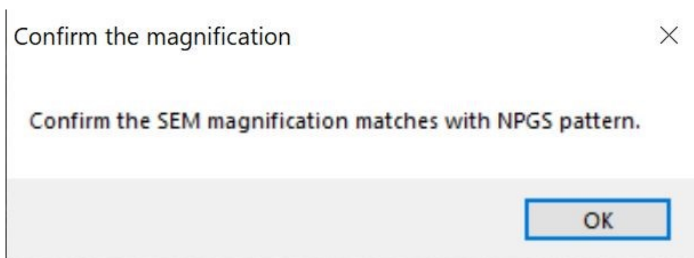
Double-click on the position of the first mark where the polar coordinate base is used. Same to the second mark.
7. Second window: 

8. Third window: 

Enter the **relative distance (µm)** in the box. Confirm the value.

9. Fourth window: 

Enter the **angle (degrees)** in the box. Confirm the value. 

10. Last window: 

Confirm the magnification of the SEM matches with the value in the pattern file, mentioned in step 3. Once it's confirmed, the stage will automatically move to the sample position after position shift and rotation correction. Then the NPGS will immediately run the exposure. An exposure window will display.

11. Follow the procedure of the SEM operation manual. Turn off the E-beam, wait for 5 minutes then vent the chamber, take out your samples, pump down the chamber, and turn off the SEM.
12. Turn off the EBL computer. Fill in your name, date, time in, and time out on the EBL logbook. Refer to the Development Section or 117 Lab from the Physics Department website for further development and optical microscope check.