ZEISS SUPRA 40VP NPGS SOP

Zeiss Supra 40VP is for performing electron beam lithography using NPGS. Users are required to demonstrate the imaging skills in Supra 55 VP to begin electron beam lithography (EBL). Users are responsible to generate their own design files

Follow the Supra 55VP SOP for imaging the gold standard. Best focusing of Au standard and sample corner or scratch must require for EBL.

Pre-requirements: Users must spin coat e-beam resist and bake. Samples must be dry and conducting.

Sample preparation

1. Prepare your sample, the Faraday cup to measure the current and the gold standard for focusing on the **carousel** (**Figure 1**).

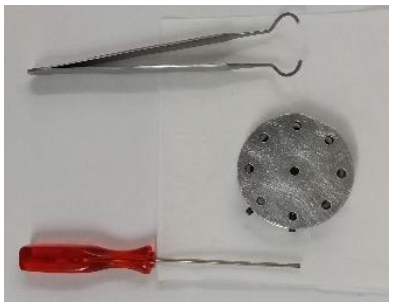


Figure 1

2. Spray your sample with Nitrogen gun prior to loading the sample in the chamber to clean the debris in the sample.
3. Sign into the computer using local account
   Username: SEM2-user
   Password: Supra40VPFESEM!
4. **Sign into** EM server
   Username: SEMuser2
   Password: SEMuser02
5. Keep record of gun vacuum and chamber vacuum **(Figure 2)**
6. Sign into NPGS computer using local account
   Username: NPGS-local
   Password: Supra40VPgreatmachine!!!
7. Once you start it, NPGS will make two automatic calibration (**Figure 3**). The first one occurs at the moment you start it and second

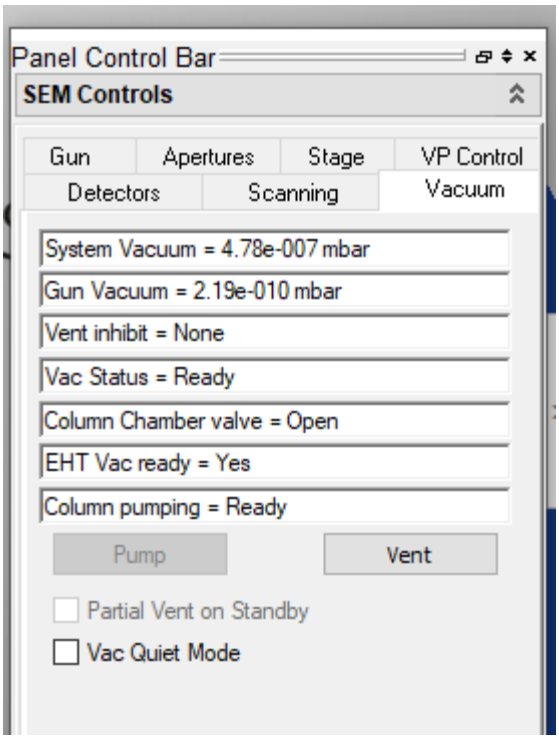


Figure 2

one starts 20 minutes later. Do not escape the calibration. Preview of NPGS window is shown in **Figure 3**.

Loading sample in the chamber

1. Press **vent** in **SEM controls** (**Figure 2**) and wait until the door can be opened.
2. Slide the chamber door and insert the sample carousel into SEM chamber stage holder using both hands.
3. Close door carefully
4. Press **pump** button in SEM control panel and **wait**

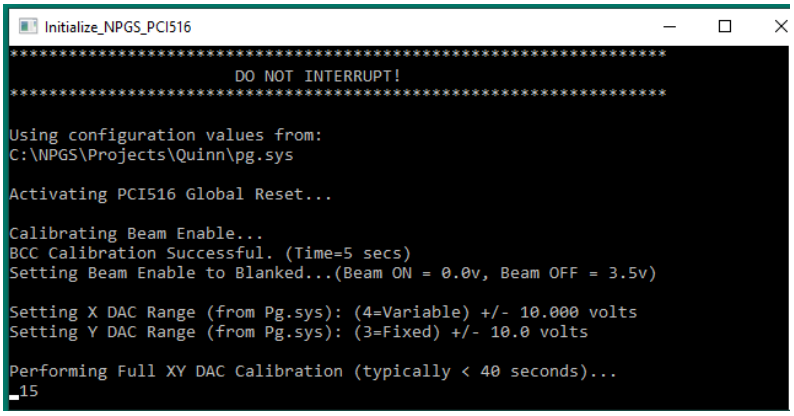


Figure 3

Follow Supra 55VP imaging technique for selecting aperture, alignment, and focus the gold standard and your sample.

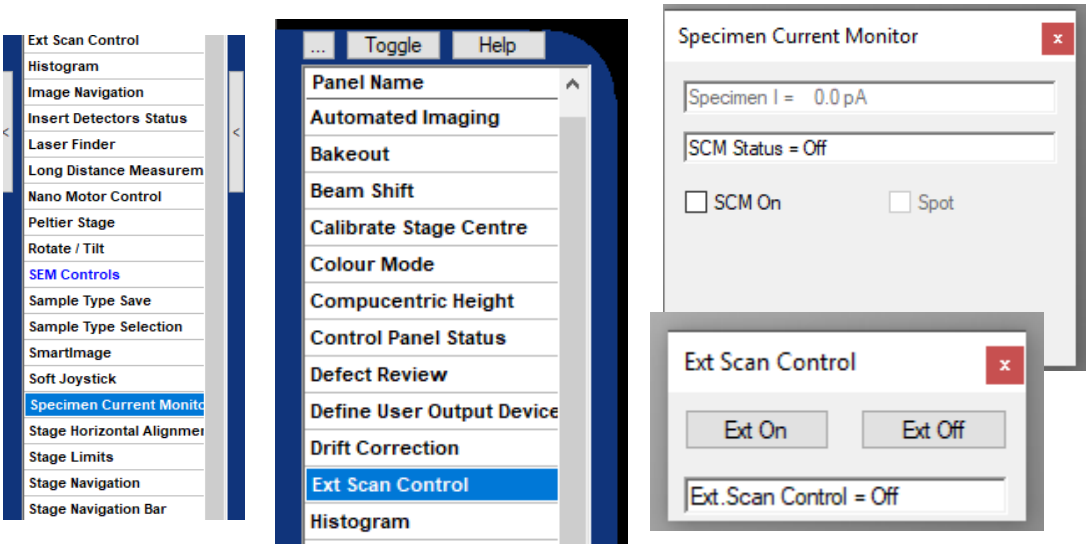


Figure 4

Measuring current on Faraday Cup

1. From the Zeiss display side bar, select **specimen current monitor (Figure 4)**
2. Locate **Faraday cup** and focus on it.
3. Select **Ext. Scan control** (**Figure 4**)

4. Click **SCM On** (**Figure 9**) button in the **Specimen current monitor** to activate current monitor. Record current and ramp up the voltage to **20 KV** at **5 KV** increments. Ramp up **1 KV** at a time between **20- 30 KV** and observe gun vacuum being stable (should be around 10^{-10} mbar range). If it goes above 10^{-10} mbar, wait until the vacuum reaches 10^{-10} mbar level.
5. Keep record of system and gun vacuum and measured beam current at 30 kV. Then click **SCM OFF**

NPGS Connection

1. Start **REMCON 32** by clicking Remconn32 shortcut on the desktop of the Zeiss microscope (**Figure 5**). Make sure that Remconn is open at **port 2**.
2. Start **NPGS** software (**Figure 6**).

Figure 5

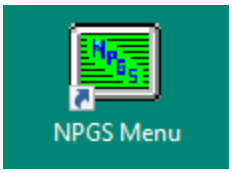


Figure 6

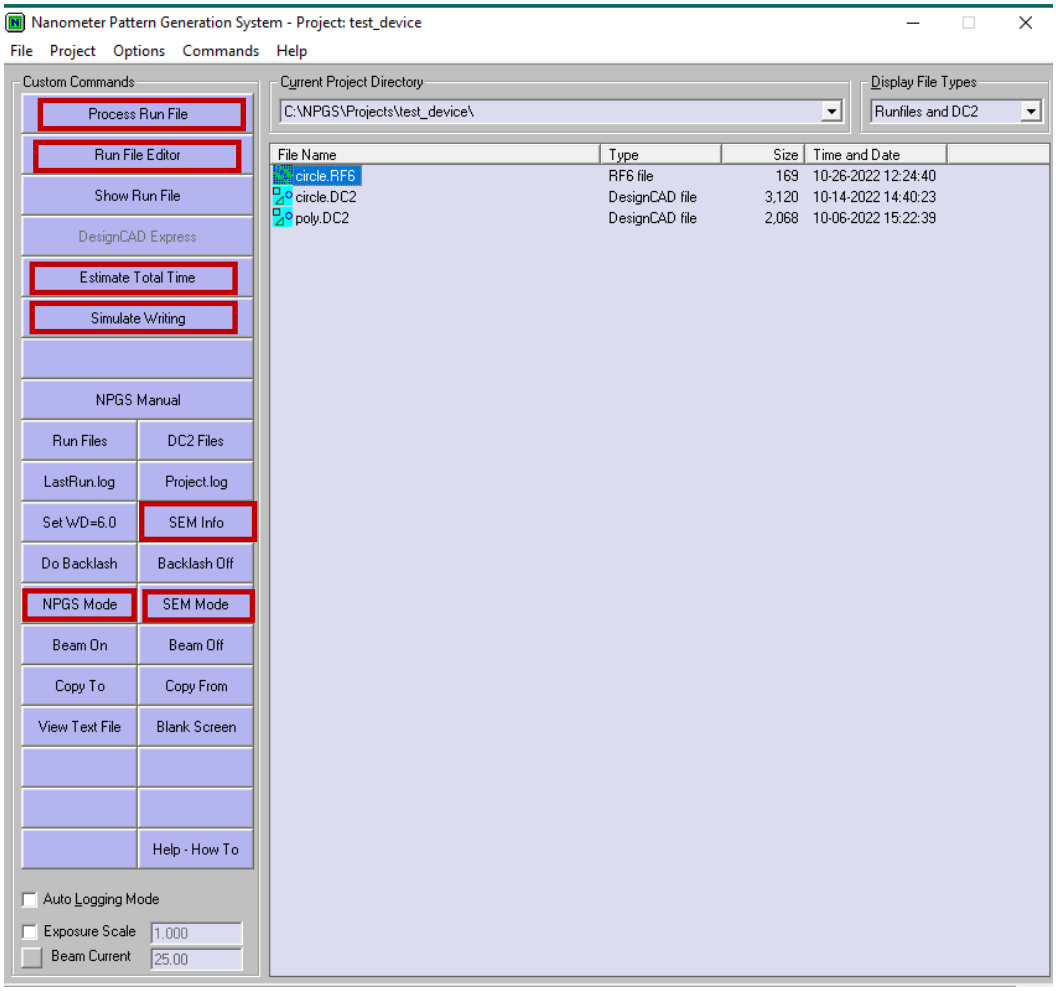


Figure 7

3. Click **SEM info** button in NPGS window (**Figure 7)** to verify that SEM and NPGS are communicating. All the important options in NPGs interface are highlighted by red box in the left side of Figure **7.**

Create New Project

In NPGs window, select **Project** and then **Create New Project** option. A new window pops up and insert New Project Name. Click **Create** (**Figure 8).**

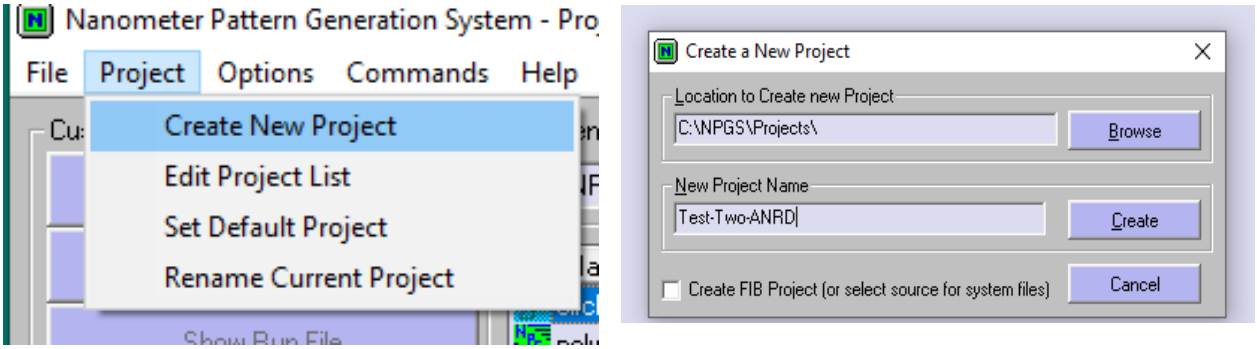


Figure 8

File Design and Conversion

NPGS only accept DC2 file. For conversion NPGS prefers GDS or CIF file.

Skip below steps if DC2 file already existed.

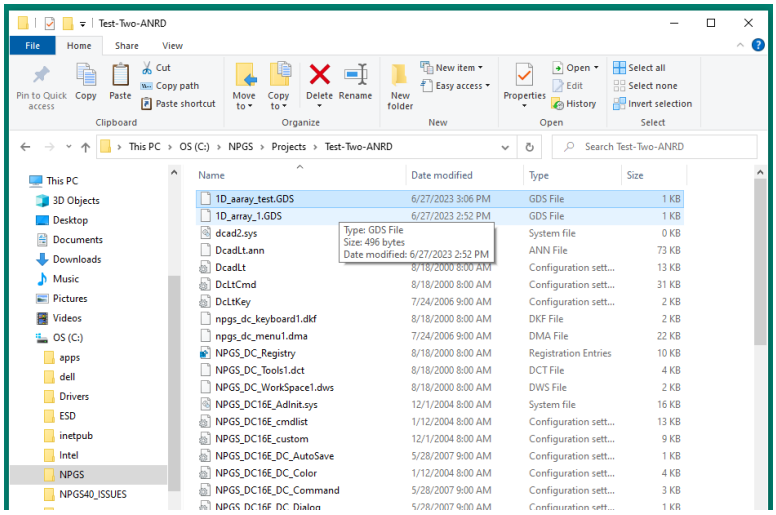


Figure 9

1. Copy your design file into NPGS project directory. **Select C, NPGS, Projects and your folder (Figure 9**).
2. Once the right files are in the directory, go to **NPGS** menu and make sure to choose proper **Current Project Directory.** In display file type, select **All Pattern Files**. Highlight the design file you want to convert (**Figure 10**).
3. Select **File> Pattern Import. Choose right format and then Convert (Figure 10**)
4. Check that DC2 file is in the directory after conversion

5. Next step is to check using NPGS default design CAD so that NPGS can write the patterns properly.
6. Right click on .DC2 file (**Figure 11**) and open by **Design CAD LT2000**. Design CAD window will open.

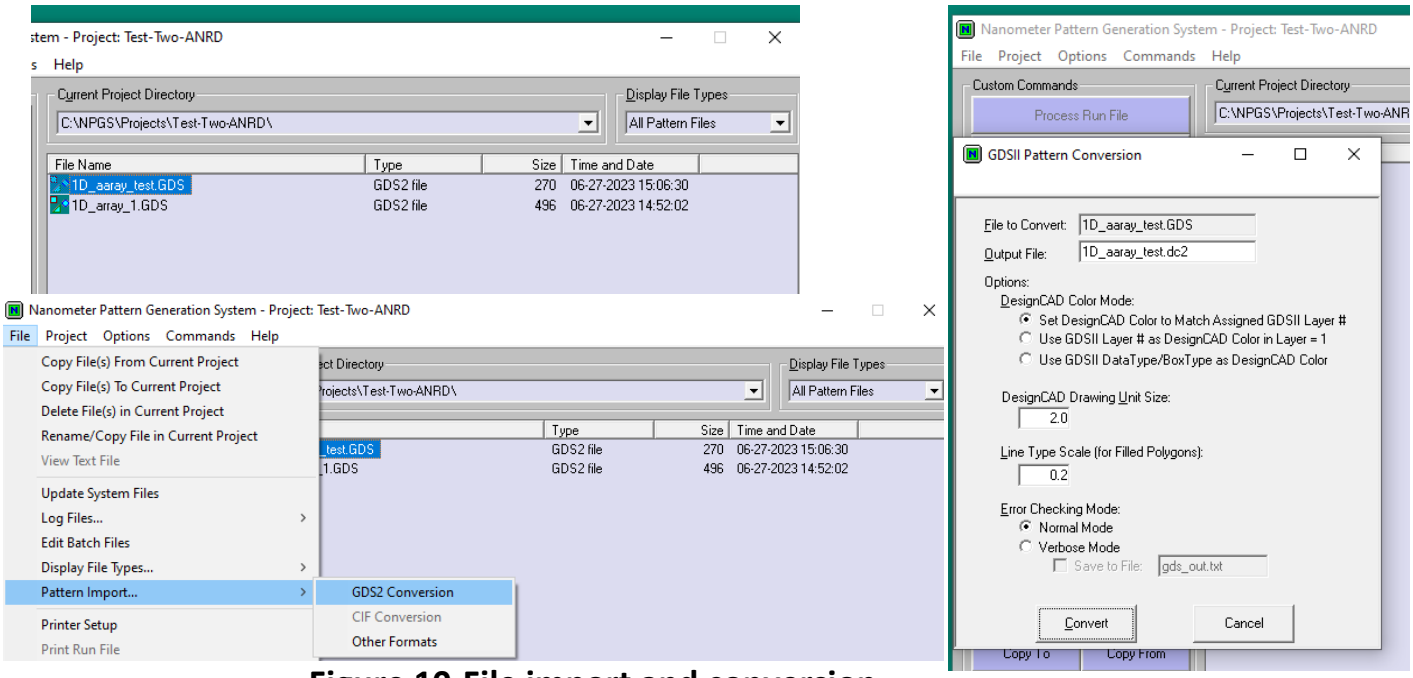


Figure 10-File import and conversion

7. In CAD window, select **NPGS menu > MaxMag> hit "O"** to properly adjust the magnification with SEM column (**Figure 12**). Save only using NPGS menu.

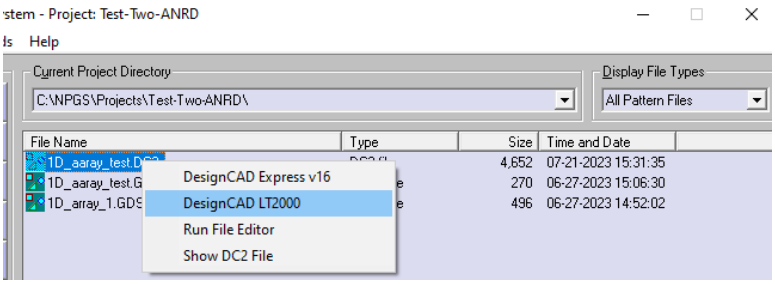


Figure 11- CAD LT2000

Constructing A New Run file

1. Right click on the DC2 file (**Figure 13**) or from commands menu, select **Run File Editor**, run file window appears (**Figure 14**) and users are required to edit patterns in NPGS interface. All the highlighted options are shown by coloring.
2. In the run file window, number of entities could be 1 to 16. Add entities by the arrow. Allow **advanced mode- always yes** (**Figure 14**).

3. Entities type can be “Alignment”, “Pattern’, “Array”, “Fracture”, “MoveOnly”, “command or comment”, “runfile”. The Default is Pattern.
4. Click on the allow advanced mode and make sure non-stop writing mode is yes, **Disable Automated Stage Control and Disable Digital SEM Control> NO, Enable Global Rotation Correction: Yes (Figure 14)**

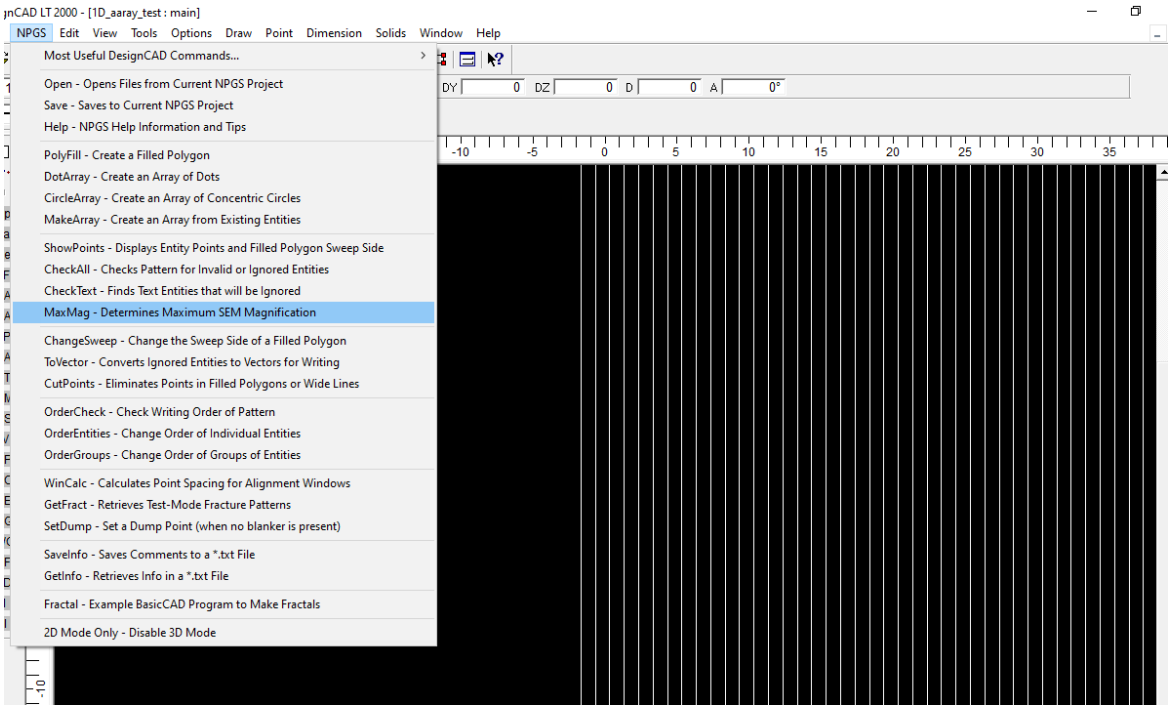


Figure 12- CAD LT2000 window with NPGS menu

5. In moveOnly, XY Move to writing Field center does not mean to move to the center. It is just stage move. In order to protect sample, Move only is very useful.
6. Click on the **PatName,** you will be asked to select the design cad file. For each pattern entities, you can select separate cad file **(Figure 14)**. Check on the highlighted entity data. Insert the right number of aperture from SEM control window. Insert the correct value of **Measured beam current** from Faraday Cup at 30 KV EHT **(Figure 14)**. Select “Line dose”, “Area dose” or “point dose” depending upon your application.

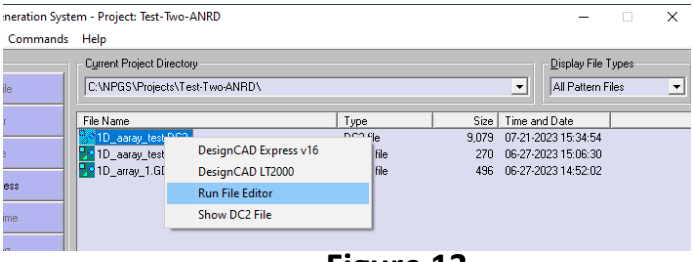


Figure 13

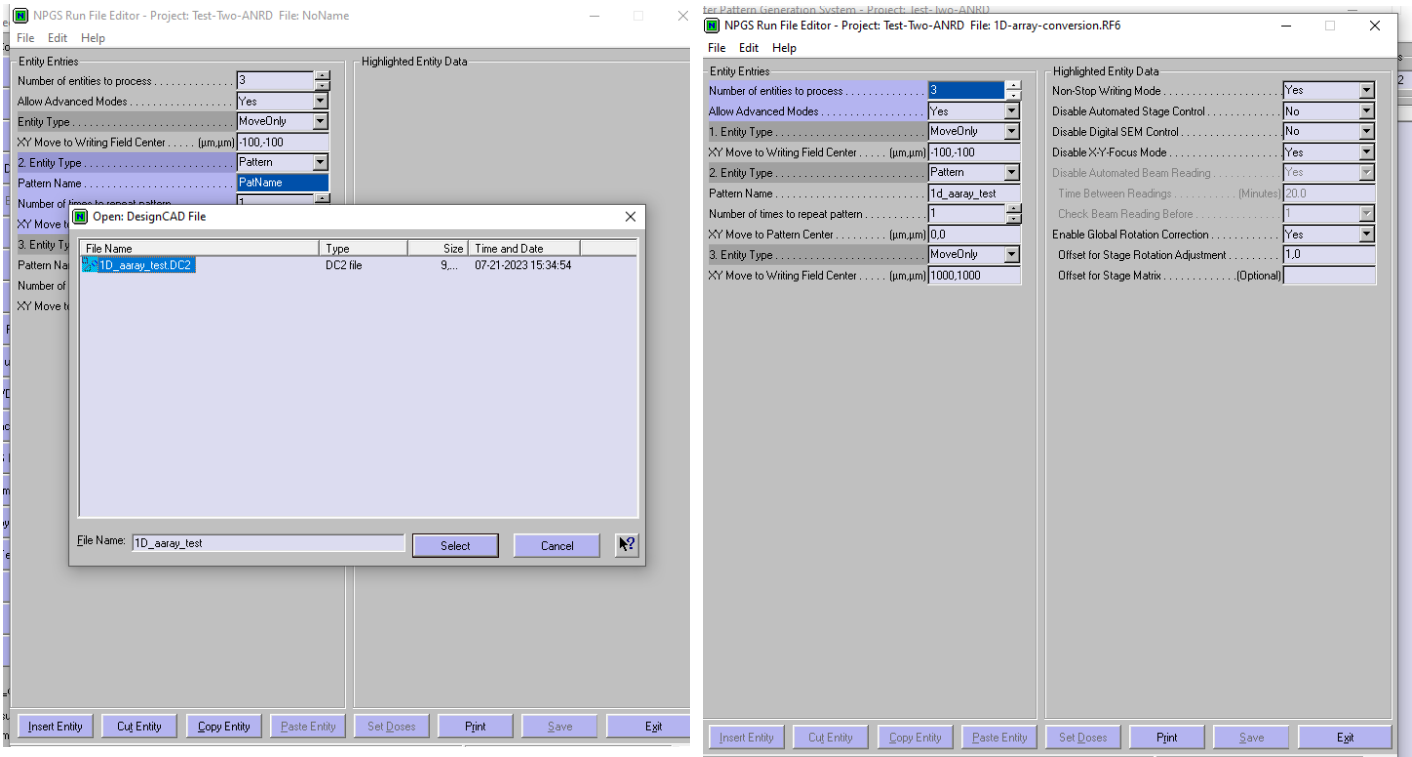
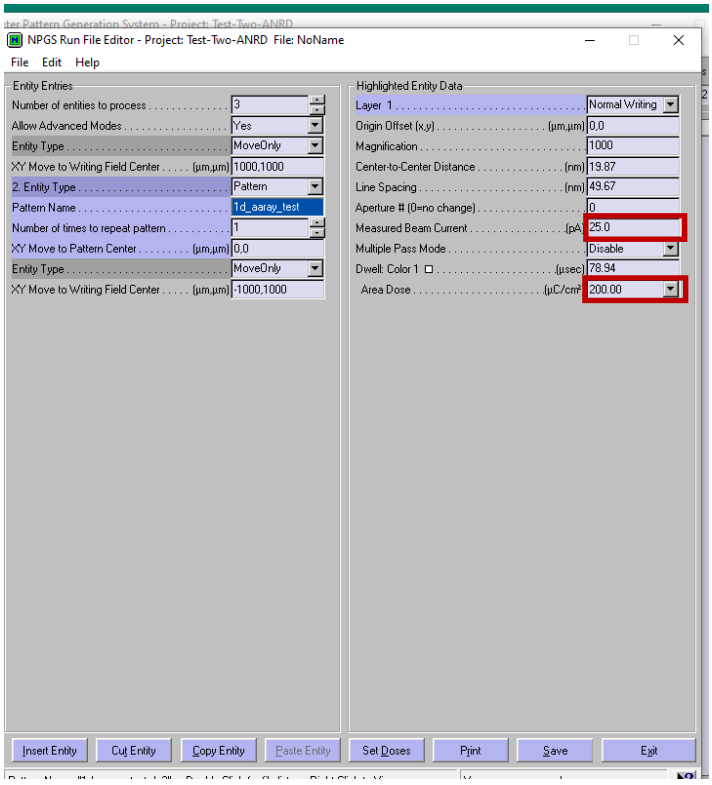


Figure 14: Run file editor window



7. Save and enter the name of run file and hit Exit.
8. Run file will be saved into current directory as .rf6 file.

Preparation and Exposure

1. Check time of writing by **Estimate Total Time (Figure 7)** and check the estimate timing (**Figure 15**)
2. **Check the correctness of** patterns by **Simulate Writing option** in NPGS menu **(Figure 7)** and **(Figure 15 right panel).** Hit space to see the patterns. If the window struck, restart the computer.
3. Do not proceed to write unless NPGS interface shows total writing time and simulated patterns. Align your sample horizontally with the SEM stage.

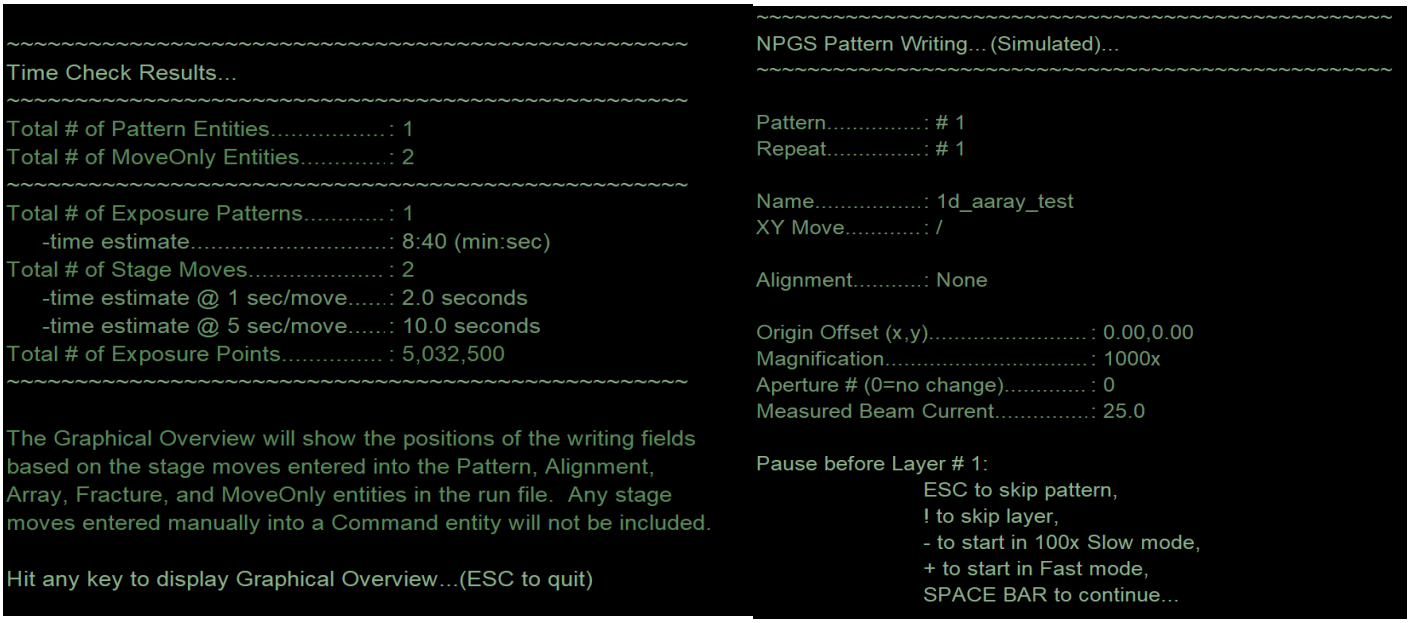
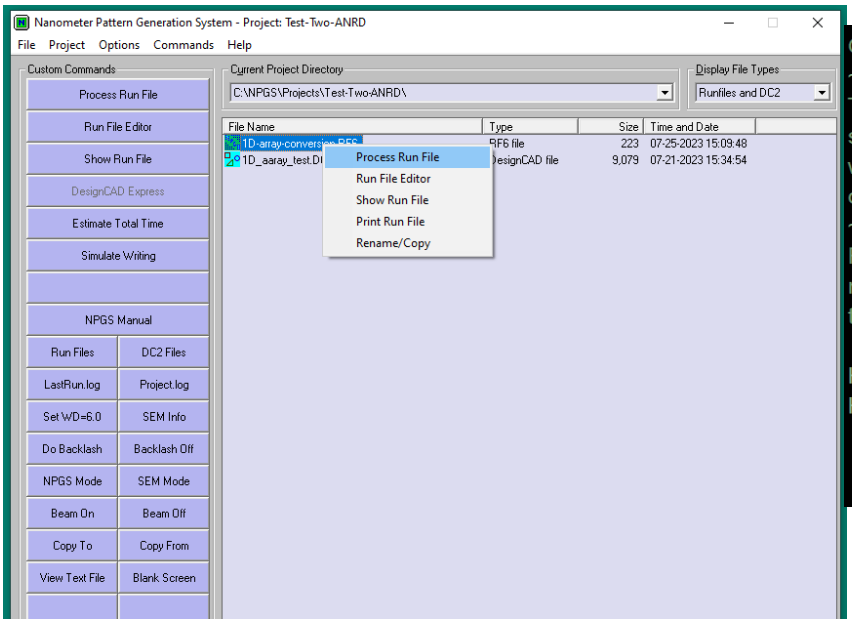


Figure 15: Time estimation and simulate writing window

Make sure that corners or scratches are focused beyond 20 K magnification to ensure the fine writing. Use cross hair from SEM edit option in software. Align your sample horizontally to the cross-hair. User can choose the corners of substrate or alignment marks.

4. Turn on the **Raith Beam Blanker**. The Blanker should be either on Beam on (electrons are hitting on the sample) or Beam Off (beam is blanked) position
5. Turn off the Smart SEM chamber Scope camera before writing.
6. Switch to **NPGS mode** to control SEM by NPGS (**Figure 7**). The **EXT. Scan control** window will show on. Toggle between NPGs and SEM mode if stage requires to move.

7. Click **process run file (Figure 16)** and follow the prompt (**Figure 16**) to correct the global rotation.



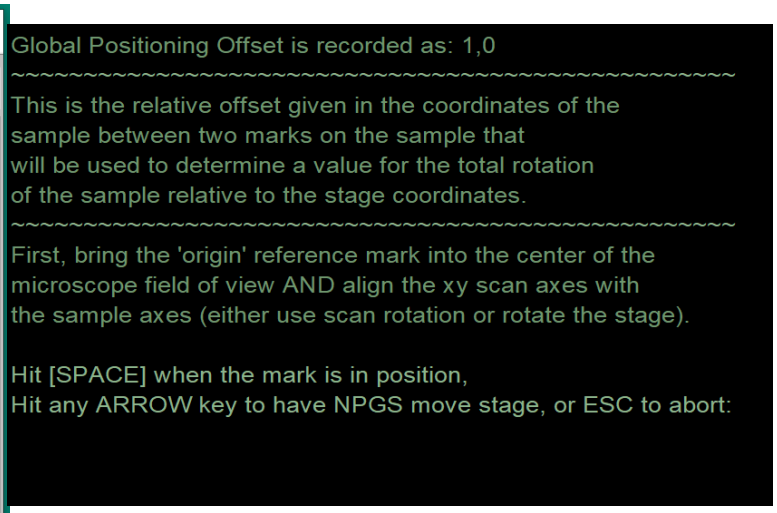


Figure 16: Process run file and prompt window

Taking out sample

1. Switch to **SEM mode** from NPGS window
2. Switch off Beam Blanker
3. Move stage to Faraday Cup and click **SCM ON** to activate **specimen current monitor** window. Keep record of current after writing pattern at **30 KV**. Reduce voltage from 30-20 KV with an interval of 1KV. and from 20 to 5 KV by 5KV, record current and vacuum at 5 kV
4. Turn off specimen current monitor
5. Lower down the stage manually
6. Turn off EHT
7. Close **NPGS** widow and restart NPGS computer and turn off monitor power
8. Initialize stage before unloading the sample
9. Click **vent** and wait
10. Gently take out the sample
11. **Pump** the chamber
12. Log off smart SEM and Log off Windows

13. Remove sample and store sample in storage box and clean the preparation area
14. Make sure you have entered your sample information and any error message you encountered in the log-book.

In case you encounter any error, report error using the following procedure

- Take **screen shot of the error message**
- Save the screen shot into **Supra 40VP_Issues** folder in **Data (D:)** drive (**Figure 17**)
- Enter the details of the error in log-book

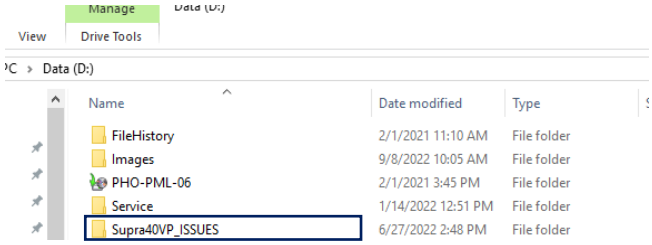


Figure 17