Standard Operating Procedure (SOP)

IntlVac Nanoquest 1 IBE

(DE-01)

*In case of fire or injury please call 911 (511 from campus phones)*

If there is an error on the system/tool please report it in NEMO, the staff will take care of it

Please *DO NOT* run diagnosis without a staff member's approval

General safety tips and common mistakes

1) If the system is not running, make sure you are logged into the tool on NEMO.
2) Every time you engage or disengage the holder and the clamp, confirm the procedure is complete through the viewport
3) Make sure the drichuck is sitting under the sample without creases or air bubbles.
4) For small samples, use the small sample holder.
5) If using the small sample holder, make sure all the screws are tight before loading
6) Ensure the holder is placed properly on the fork pin.
7) When loading, check the gap between the stopper and the slider on the arm and make sure it is ~ 1mm.
8) Make sure you check proper clamping through the viewport
9) Always follow the instructions on the screen during loading and unloading process
10) Use gentle force and a low angle when removing your sample from drichuck with metal tweezers
11) Make sure you turn the Nitrogen source off after removing your sample

IntlVac Nanoquest 1 IBE
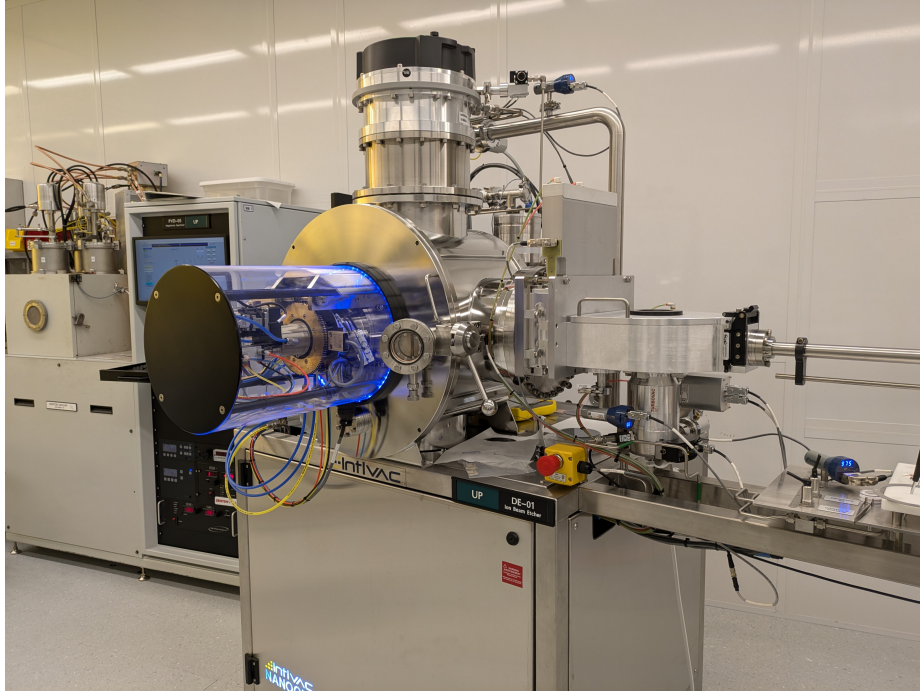
- Primary tool owner: Sam Azadi.
  For questions regarding process development and characterization of etch rates contact Sam Azadi at: azadi@seas.upenn.edu
  Problems with the tool **MUST** be reported on NEMO. Do not contact primary tool owner with tool issues directly.

Tool Policy:

- Not reporting an issue with the loading mechanism is considered tool misuse.

Tool Overview:

NanoQuest 1 is an ion miller connected to Ar gas and capable of etching small mm-scale samples up to full 4" wafers. The tool is equipped with a secondary ion mass spectroscopy (SIMS) unit and is capable of etching with manual endpoint detection. The stage has a tilt motor that allows for etch angles between 0 (directly facing the beam) and 90 degrees (parallel to the beam).

The tool in QNF is connected to Ar gas and can etch samples up to 4" wafers. Available beam voltages are: 300 V, 400 V, 450 V, and 500 V

Singh Center's Wiki page for the tool can be found *here*

Tool operation video can be found *here*

Full procedure:

| Log into the tool via NEMO	
1. Vent the loadlock and load your sample: 1.1. From the top "Load-lock" section on right side of the screen press and hold "**LL Vent**" until the vent starts. 1.2. While loadlock is venting, mount your sample on the holder. *For 4" wafers and small samples taped onto 4" wafers, use the 4" carrier and the cooling pad.* 1.2.1. Place the cooling pad on the sample carrier and place your wafer on top 1.2.2. Connect the plastic tube to the carrier and open the "drichuck vacuum" switch 1.2.3. Monitor the pressure and confirm it drops below 100 Torr Allow the pressure to stabilize for 5 minutes	
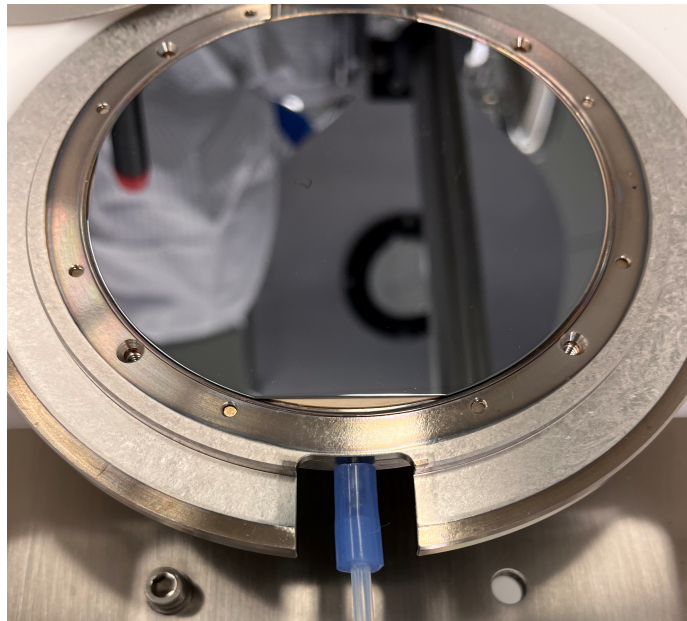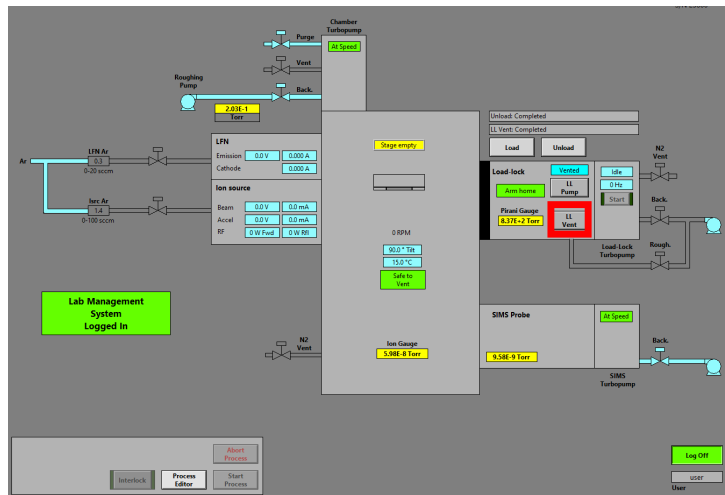
1.2.4. Mount the ring on the wafer and finger-tight the screws in a star pattern using the screwdriver
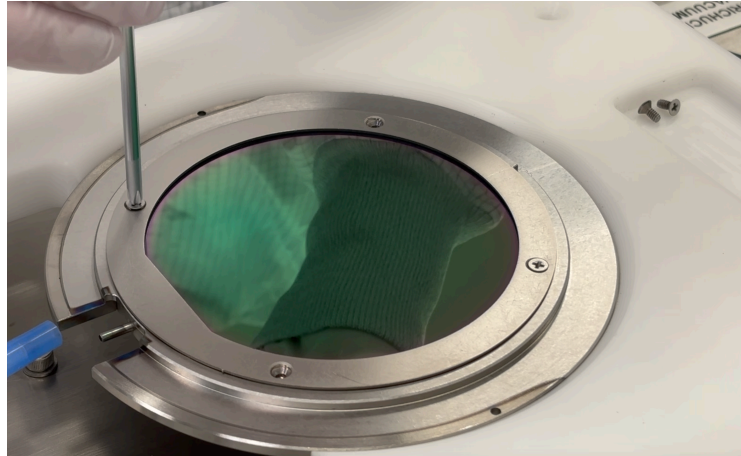
1.3. If you are using the small sample holder, use a single piece of cooling pad and make sure the pad is not exposed to the plasma.

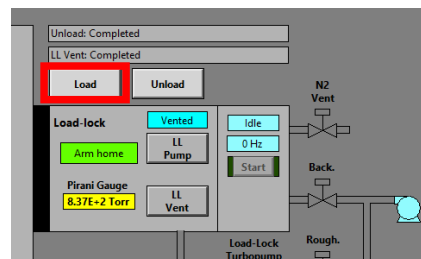1.3.1. Once sample is mounted, make sure all the pins are tight
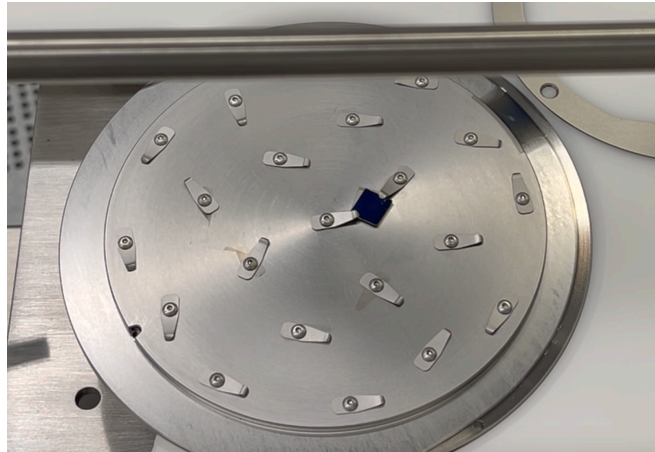
1.4. In the software confirm the chamber status reads "**Venting finished**"

1.5. Open the loadlock lid and place the sample holder on the fork, make sure the holder sits flush on the fork
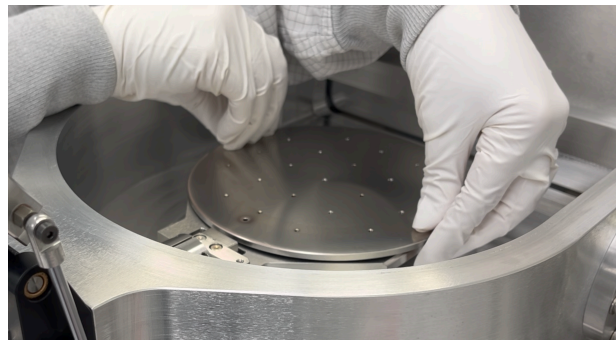
1.6. In the software press and hold the "**Load**" button

2. Extend the arm and clamp the sample holder:

Please read and follow these steps carefully as the manual loading procedure is prone to errors, issues, and inconsistencies that could cause major problems for the tool.

Once the tool is ready for loading, the gate valve automatically opens, and you'll see the following text:

Load: Extend arm and press Proc Adv to close clamp

2.1. Slowly extend the arm and allow the arm to push against the stopper. Release the holder.
At this point the slider bounces back by about a millimeter.

Attention! You MUST confirm the sample is under the cold head by looking through the viewport using a flashlight.

2.2. Once proper placement is confirmed, In the software press the flashing "Process Advance" button.

2.3. Confirm proper clamping through the viewport.

Attention! You MUST confirm the sample is under the cold head by looking through the viewport using a flashlight.
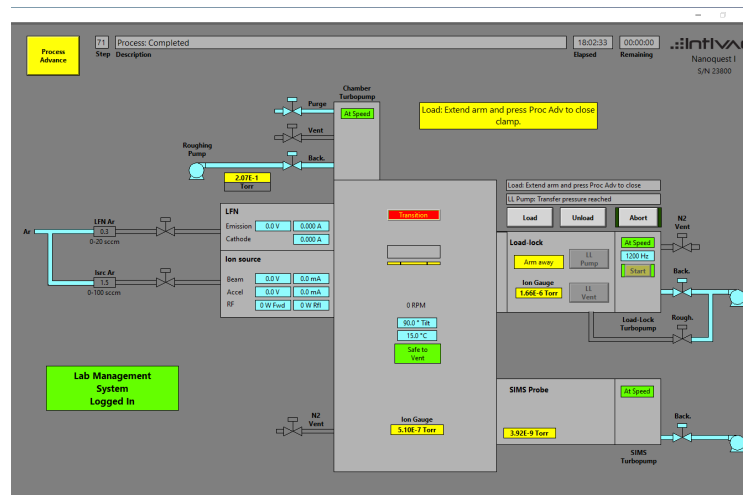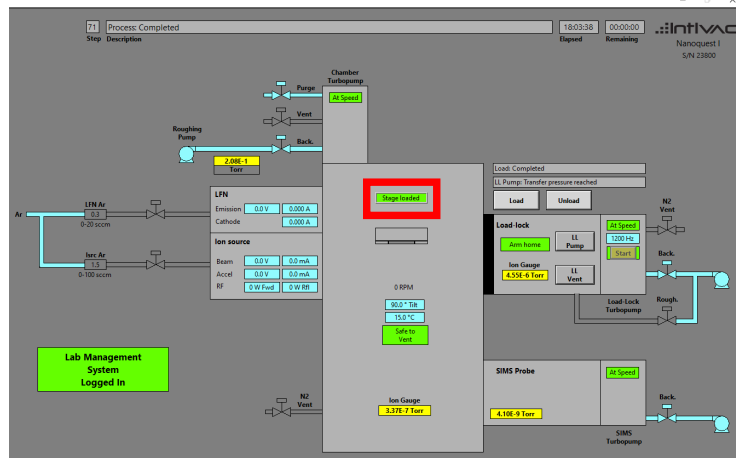
2.4. Once the text reads:

<mark>Retract arm and press Proc Adv to close gate vale</mark>

gently retract the arm and confirm the arm is coming out by looking through the loadlock viewport.

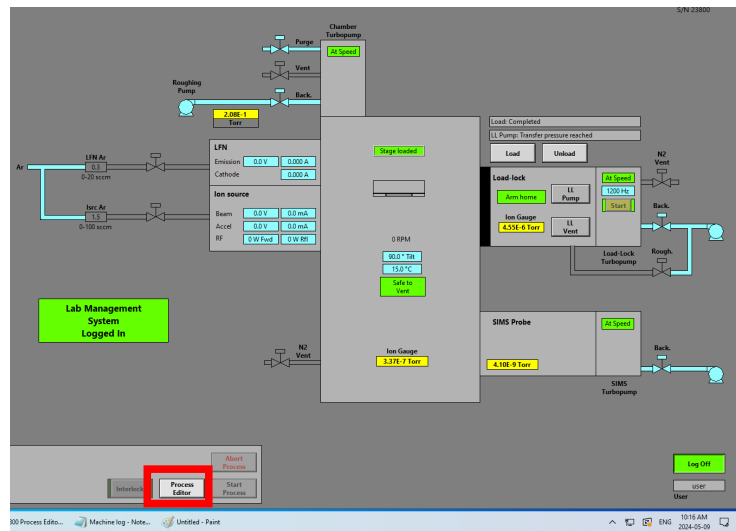*Confirm the fork is out and in the loadlock by looking through the loadlock viewport.*

2.5. Press "**Process Advance**" to close the gate valve
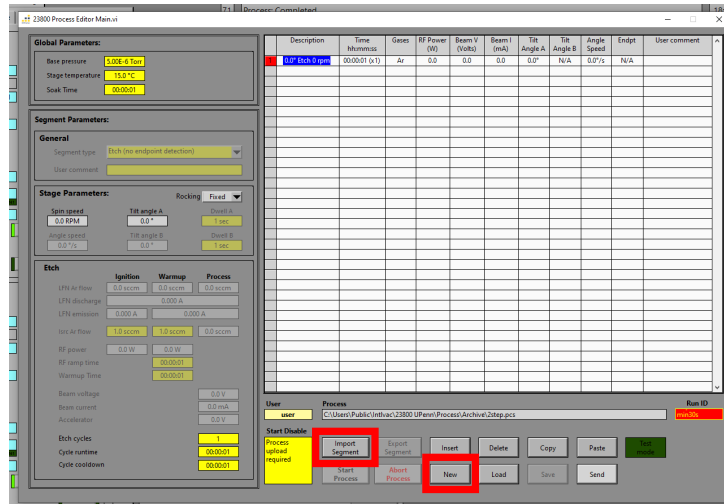
Confirm the stage status reads "*Stage Loaded*"

3. **Choose/Modify recipe and run etch:**

3.1. Press "**Process Editor**" at the bottom of the screen

3.2. Press "**New**" and then click on "**Import Segment**".

There are two categories of recipes:
   a. Timed etch segments
    b. SIMS Manual endpoint segments

Attention! If you are running SIMS manual endpoint etch processes, please follow Appendix 1 for SIMS setup. Before moving to the next step

3.3. Import your desired segment

3.4. Adjust the values of tilt and rotation.

If you are introducing rotation, it should be around 10-15 RPM.

3.5. Adjust the number of cycles, cycle etch time, and cycle cooldown time
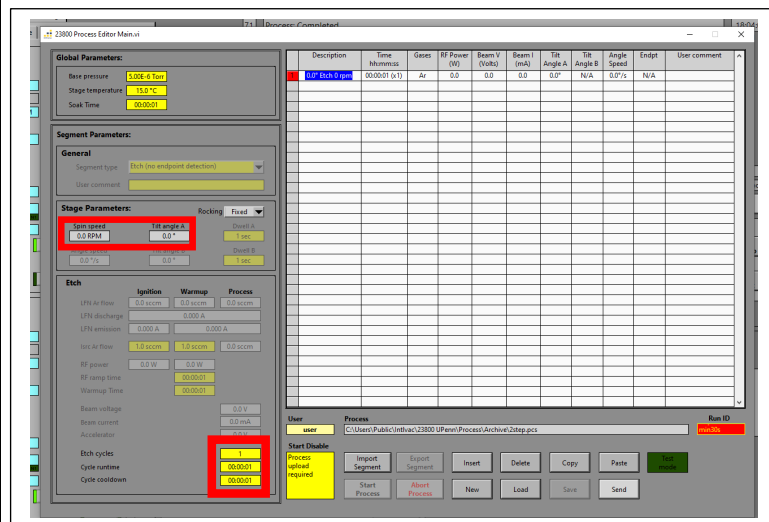
3.6. Give the recipe an ID.

The ID convention is:
*Voltage-total etch time-
PennKey*

3.7. Click "**Send**" and click on the main page of the software.

3.8. Click "**Start Process**"

Attention! If your etch is long, and you need to step away, make sure the etch starts. Once you confirm the etch starts you may leave the tool

SIMS end point detection requires a separate training. Please do not run the unit without being trained by the staff

Once trained, for proper SIMS set up instructions please review Appendix 1.
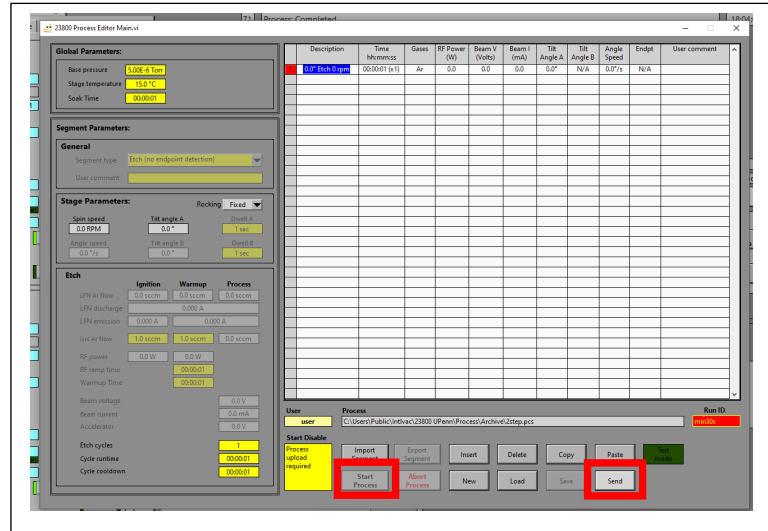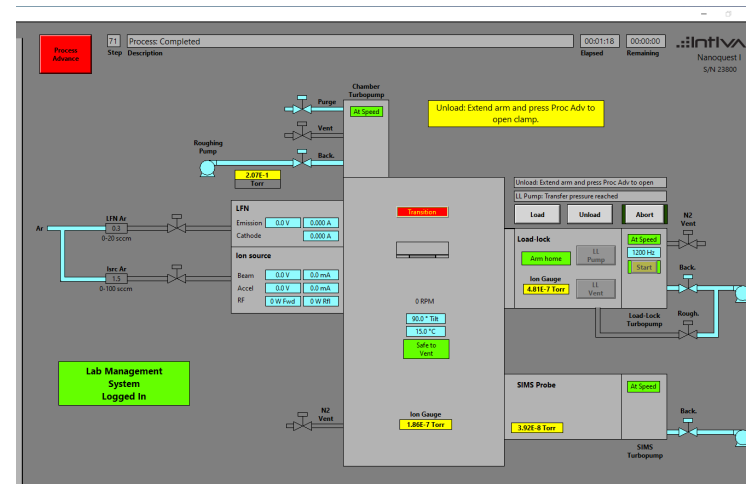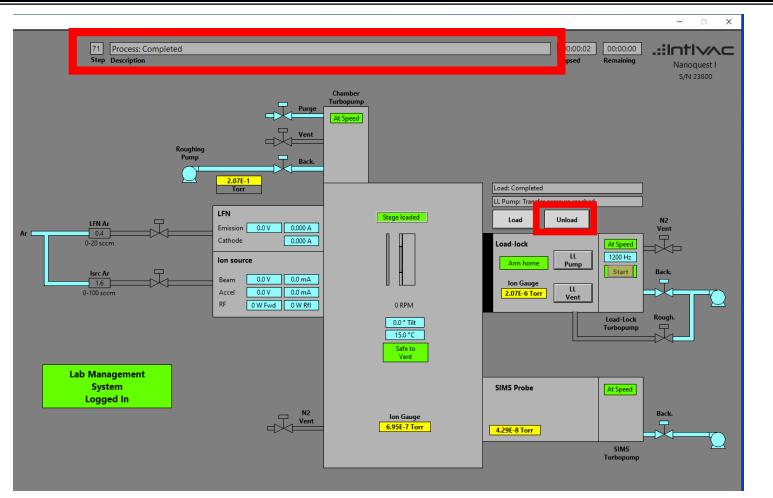
4. Unload sample

4.1. Confirm completion of the process from the textbox at the top of the screen

4.2. Press and hold "**Unload**" and wait until the software asks you to extend the arm

4.3. Once the tool is ready, the software will display

Unload: extend arm and press Proc Adv to open clamp

4.4. Extend the arm and make sure the arm is inserted all the way into the chamber.

4.5. Look through the viewport and confirm the fork is directly under the holder

4.6. Go to the software and press "**Process advance**"

4.7. Go back to the viewport and confirm the holder is released and is on the fork.

Note: It is OK if the holder is not completely flat on the fork, as long as it is released.

4.8. Once the text on the screen reads ==Unload: retract the arm and press Process Advance== retract the arm slowly and completely.

By looking through the loadlock window confirm the sample holder is out. Once this is confirmed you may proceed to the next step.

4.9. Go to the software and press "**Process Advance**" to close the clamp and the gate valve.

4.10. Press and hold "**LL Vent**" to vent the loadlock. Once this is done you can open the loadlock lid and remove the holder.

4.11. Close the loadlock lid, go to the software and press and hold "**LL pump**"
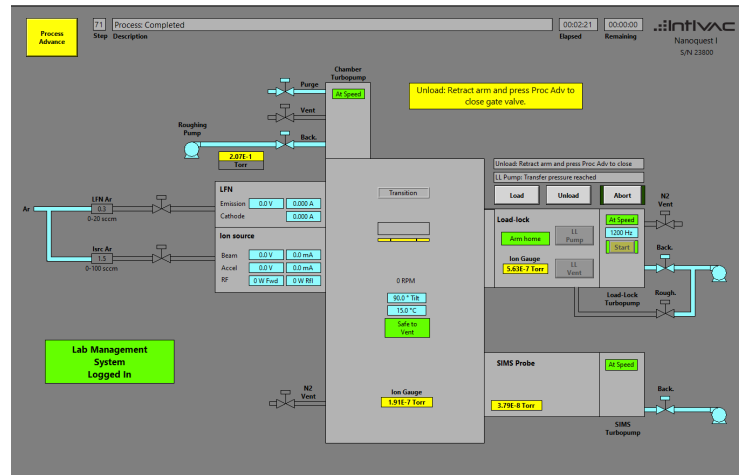
5. Remove you sample from the holder. - If you are using the small sample holder, loosen the screws and remove your sample. Make sure you tighten the screws once you're done. - If you are using the 4" holder follow these steps: 5.1. Connect the holder to the drichuck N_2 line and turn the N_2 on. Remove the 4 screws and the ring 5.2. Allow the sample to sit for 5 minutes 5.3. Using 4" tweezers and at a very small angle (very close to horizontal) lift the wafer from the major flat and move the tweezers under the edge of the wafer all around. 5.4. Repeat step 5.3. until the wafer is released. 5.5. If the drichuck is stuck to the back of the wafer, slowly and gently peel it off and place it back on the metal holder. **Make sure you report any abnormalities and issues you face during your process**	
Log out of the tool via NEMO once the pumping is done	

Feel free to contact the staff members with any questions about your process and the tool.

Appendix 1. SIMS set up and operation	
If you are running the SIMS once the tool is ready, it asks you to confirm the SIMS is set up properly. Follow the steps in the correct order: 1. On the left screen, load the SIMS experiment 2. On the right screen, start the etch process Once the message appears make sure you have the SIMs set up correctly and press "**Process Advance**" Attention! When the process starts, make sure the right screen is active by clicking anywhere on the right screen that is NOT a button – best is to click on the dark gray area without any text or button 3. Monitor the etch and press "**End process**" under the SIMS chamber icon on the screen based on the SIMS plots.	