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**Oxford Cobra Metal Trench Etcher**

**Operation Procedure**

**1.0 SCOPE**

This document establishes the procedures for operating the Oxford Metal Trench Etching system inside the MSE cleanroom. There is no additional charge to use this tool, standard cleanroom fees apply the entire time that the tool is occupied. Online reservations are mandatory.

**2.0 APPLICABLE DOCUMENTS**

This Manual

**3.0 MATERIALS AND EQUIPMENT**

Face Mask

Tweezers

6” silicon support wafer (see important notes)

Nitrile Gloves

Wafer attachment material (see important notes)

**4.0 GENERAL**

**Tool Overview**

The Oxford Cobra Metal Trench Etcher is a chlorine-based Inductively Coupled Plasma (ICP) etch tool that provides capability for highly anisotropic dry etching of Ti with high mask selectivity. The standard baseline etch process for this tool include:

* **Ti Etch:** Low temperature (10°C) Cl2-based process for anisotropic etching of Ti with ~3.5 um/min etch rate, ~27:1 Ti:SiO2 selectivity, and >85° sidewall profile.\*

*\*These etch performance parameters are only meant to serve as a general guide. Actual performance will depend heavily on pattern geometry, exposed area, substrate size, etc.*

**Tool: Metal Trench Etcher**

**4.1**

**IMPORTANT NOTES:**

* Users must complete tool training with the Cleanroom personnel AND undergo two supervised sessions with designated tool Superusers before they are granted access to the tool. A list of current Superusers is posted on the tool.
* Users are only permitted to run the standard baseline etch processes for this tool (i.e. Ti Etch). Users interested in running other processes must first seek approval from Prof. Masaru Rao ([mprao@engr.ucr.edu](mailto:mprao@engr.ucr.edu)).
* Users must run appropriate chamber clean & conditioning processes before their etch, as well as an appropriate chamber clean process after their etch. These processes are to be run using 150mm Si Clean/Condition Wafers provided by the cleanroom. Do not use your Device Wafers for these processes.
* Recipes #1-3 are the standard baseline processes for this tool (see Appendices for process conditions for all Baseline processes). Users may only modify the run times in these recipes; no other process conditions may be altered without permission.

* The tool is configured with a mechanical clamp for use with 150mm Si wafers. Users working with chip-scale substrates must affix their substrates to a 150mm Si Carrier Wafer using one of the following methods: 1) Santovac oil; 2) Fomblin oil; 3) 3M Thermally Conductive double-sided adhesive tape; or 4) Photoresist. NO OTHER FIXATION METHODS ARE ALLOWED. For all approved fixation methods (except PR), users must ensure that the fixative agent is not directly exposed to the plasma.
* Users performing wafer-scale etches with thick PR masks (thickness > 3 µm) must perform edge-bead removal to minimize potential for clamp contamination and wafer breakage.
* Users performing long and/or through-wafer etches must use Si Carrier Wafers with sufficient thickness and/or masking to ensure that the carrier maintains sufficient integrity for the duration of the etch.
* Users must log their etches in the log book, and clearly document any issues, if they occur (e.g., wafer drop or breakage, robot arm stuck, plasma failure, etc.). Users should also immediately report any issues to the cleanroom personnel.

* **Failure to comply with any of the aforementioned requirements will result in immediate suspension of tool access.**

**5.0**

**Tool Operation Overview**

Users must run appropriate chamber clean & conditioning processes before their etch, as well as an appropriate chamber clean process after their etch. This is required to minimize chamber contamination, and thus, ensure greater etch reproducibility, as well as increased time between mechanical chamber cleans. The specific sequence of processes is as follows:

1. **Pre-etch Chamber Clean:** Short duration recipes that remove residual contamination from chamber walls (process is run using a Si Clean/Condition Wafer).
2. **Pre-etch Chamber Condition:** Short duration recipes that coat chamber walls with species specific to your etch to ensure greater reproducibility (process is run using a Si Clean/Condition Wafer).
3. **Wafer Load:** Procedure to open the load lock to remove the Si Clean/Condition Wafer and load your Device Wafer for etching.
4. **User Etch:** Your specific etch process.
5. **Wafer Unload:** Procedure to remove your Device Wafer from the load lock after etching and insert a Si Clean/Condition Wafer for the Post-etch Chamber Clean.
6. **Post-etch Chamber Clean:** Recipes that remove contamination from chamber walls. The duration of the recipe should be the same as that of the User Etch, with a 5 minute minimum (process is run using a Si Clean/Condition Wafer).

***Failure to comply with pre- and post-etch condition/clean procedures will result in immediate suspension of tool access.***

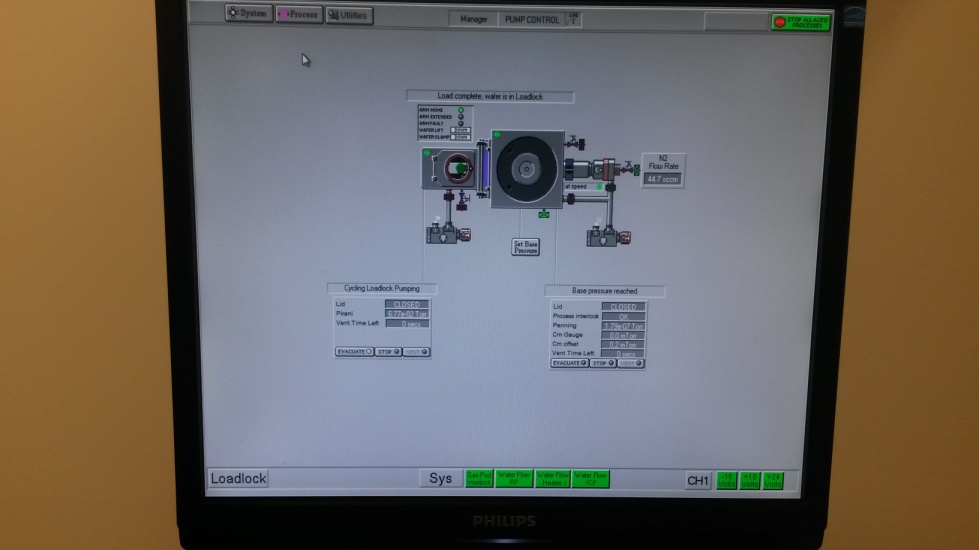
**6.0**

**Detailed Tool Operation Instructions**

* 1. **Pre-etch Chamber Clean**

*REMINDER****:*** *This process is run using a Si Clean/Condition Wafer, not your Device Wafer.*

* 1. The system should be in the “System Pumping Screen.”

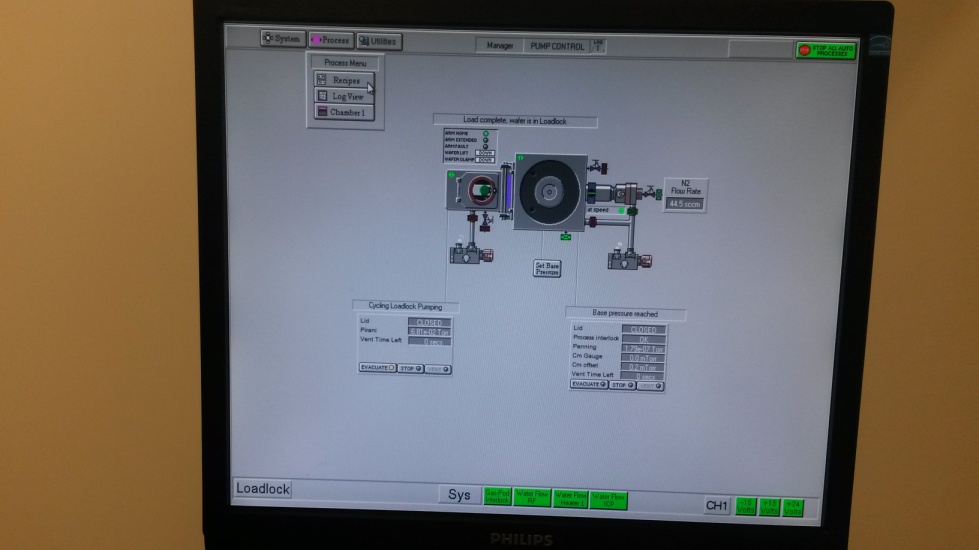


6.1 Look through the load lock window to confirm the presence of a clean and correctly positioned Si

Clean/Condition Wafer on the robotic arm. Also confirm that the load lock is under vacuum.

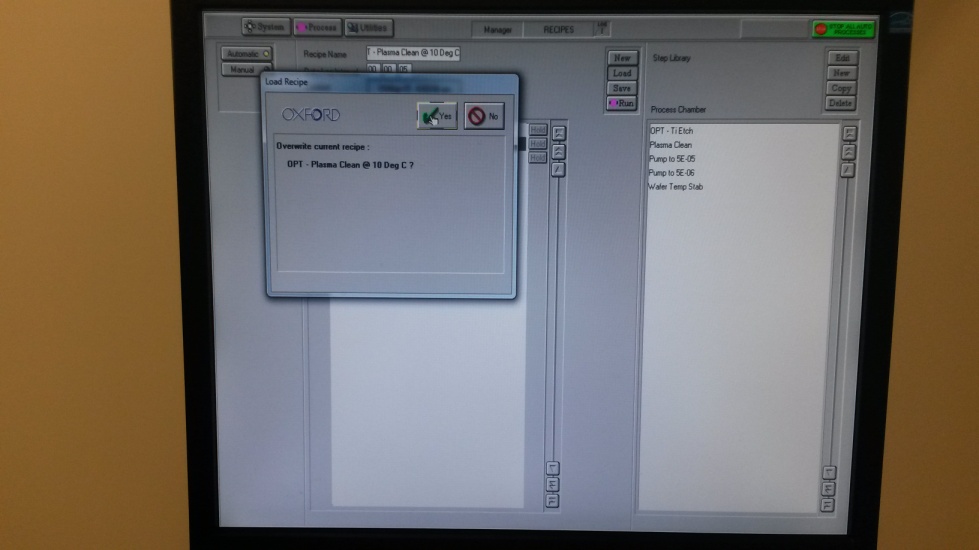


* 1. Press **Process** in the top left to drop down the “Process Menu” and then click on **Recipes**.



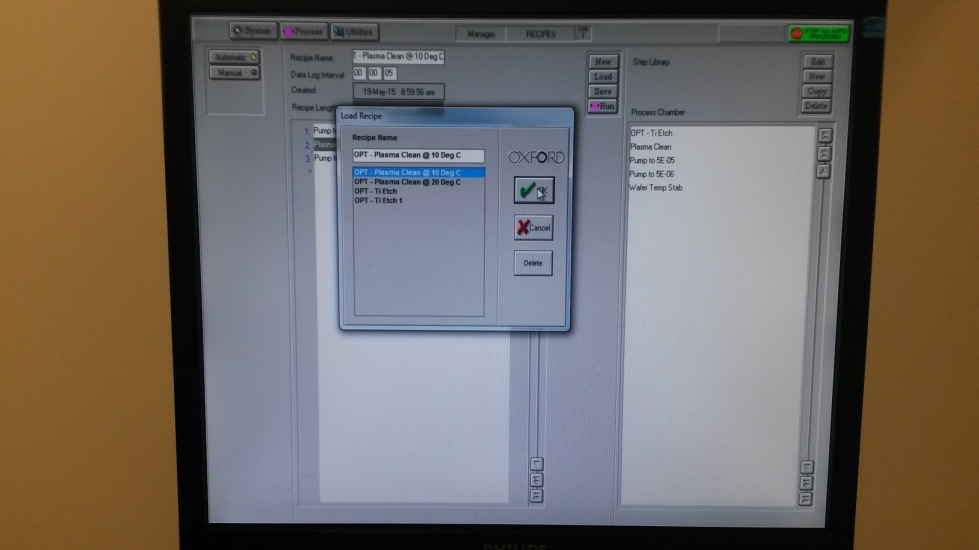
* 1. On the “Recipes” page, press **Load** and it will prompt you about overwriting the current Recipe.

Press **Yes**.

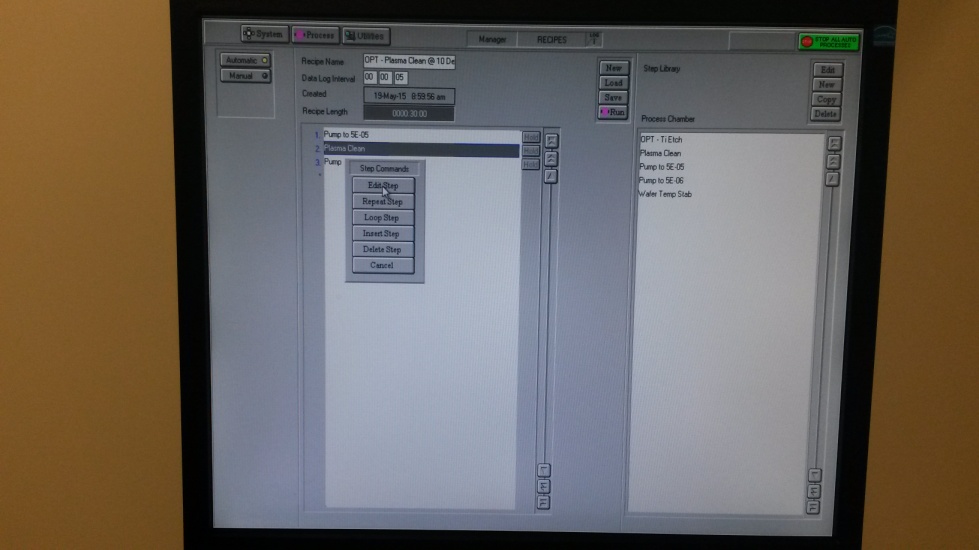


* 1. Select the appropriate chamber cleaning recipe for your intended etch process, and then press

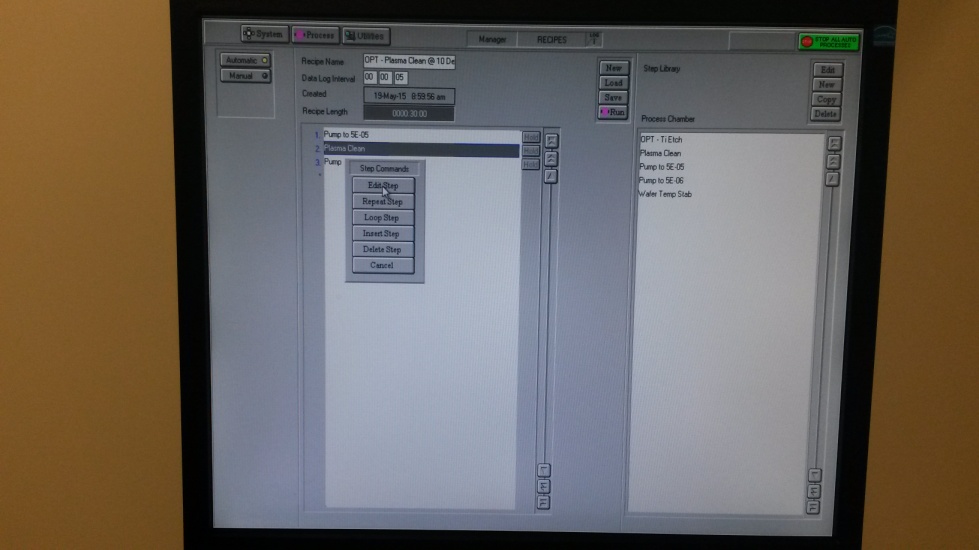
**OK**.



* 1. Left click on **Plasma Clean** to bring up a drop down menu.

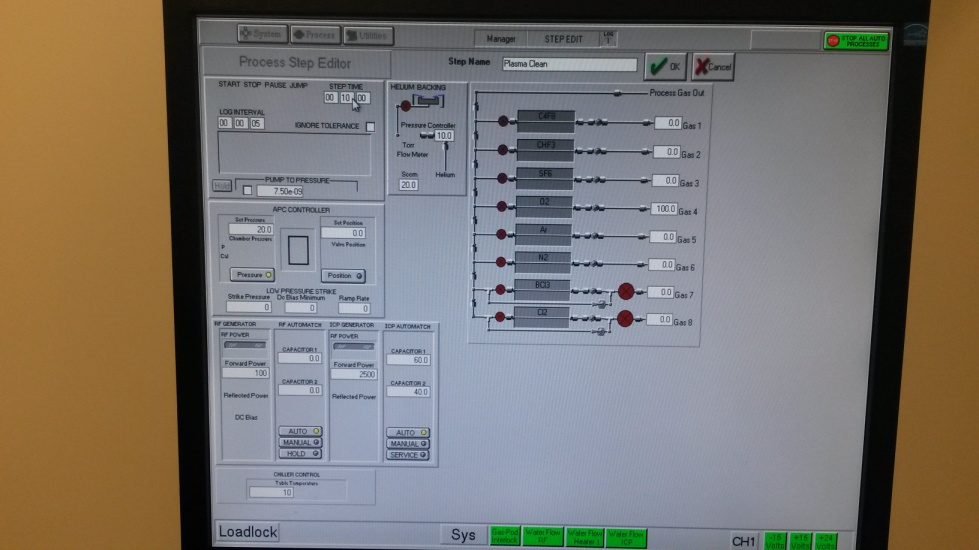


* 1. Press **Edit Step** to bring up the parameter screen.

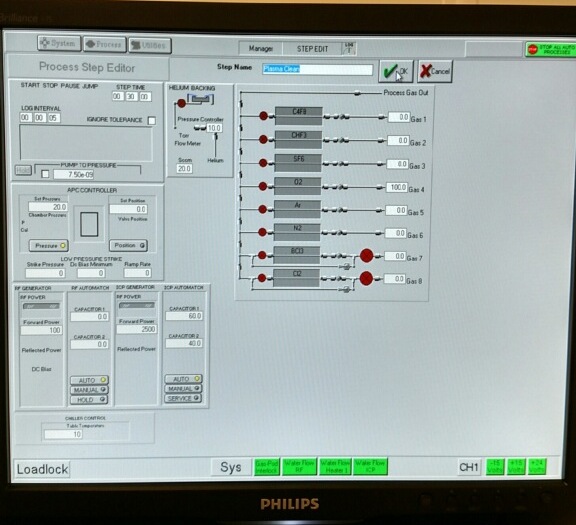


* 1. Set the “Step Time” (if necessary) to 10 minutes. DO NOT CHANGE THE OTHER

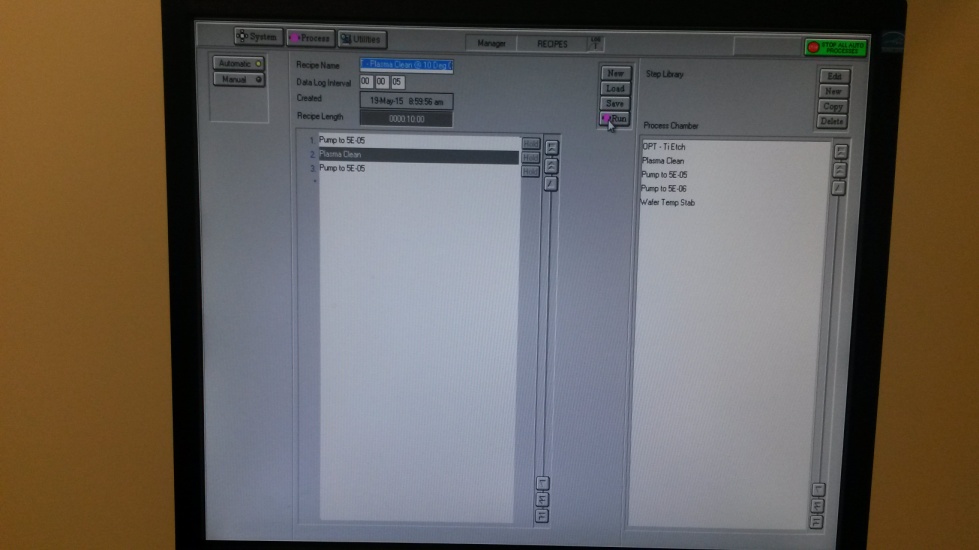
PARAMETERS!



* 1. Press **OK** to return to the previous screen.

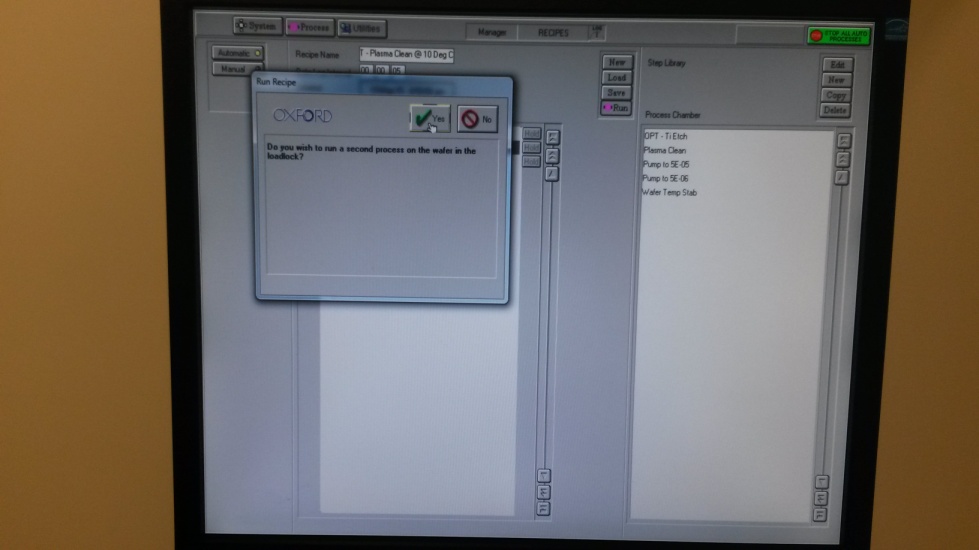


* 1. Press **Run** to run the Pre-etch Chamber Clean.



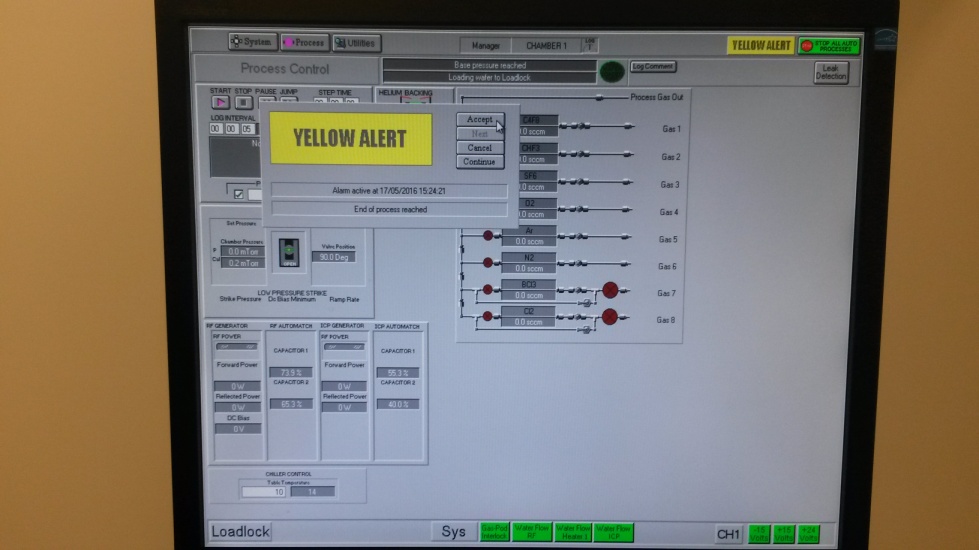
* 1. If it prompts you about running another process on the wafer in the Loadlock, press **Yes**.

The wafer should transfer into the chamber and the plasma should initiate.



* 1. When this process is complete, the wafer should transfer back into the load lock and a yellow

Alert will pop up. Click **Accept**.



* 1. After a while, the screen should return to the “System Pumping Screen” and prompt you that the

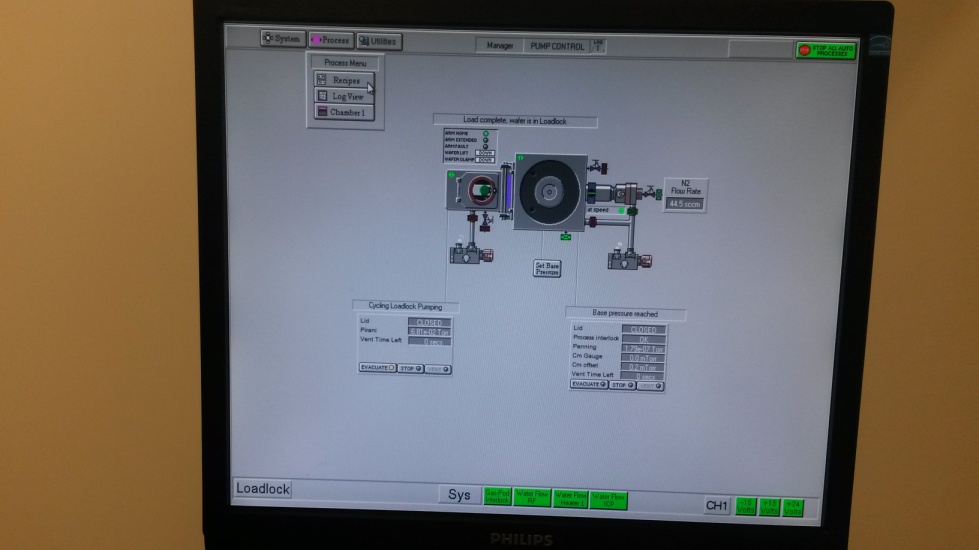
Process Completed OK. Press **OK**. You may now move on to the Chamber Conditioning step.

1. **Pre-etch Chamber Condition**

*REMINDER****:*** *This process is run using a Si Clean/Condition Wafer, not your Device Wafer.*

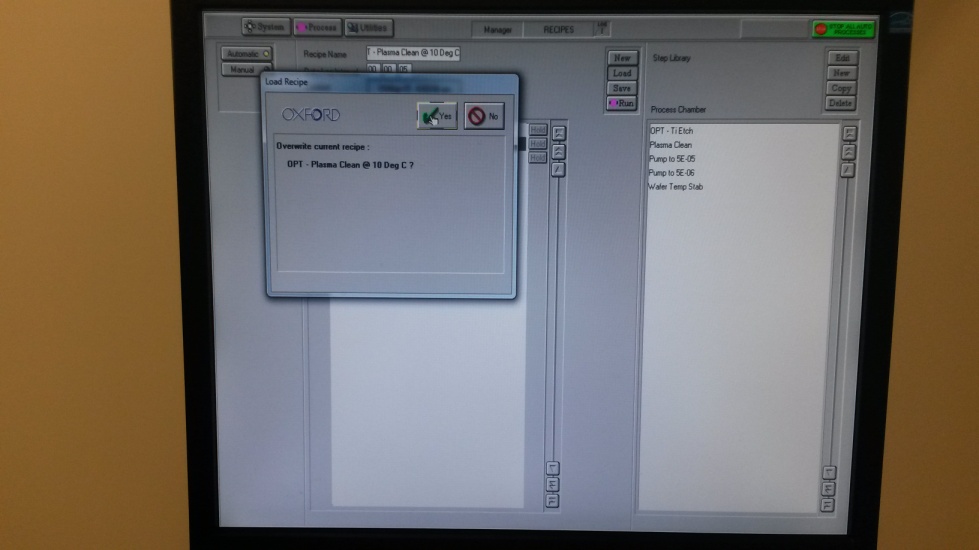
* 1. The system should be in the “System Pumping Screen.” Press **Process** in the top left to drop

down the “Process Menu” and then click on **Recipes**.



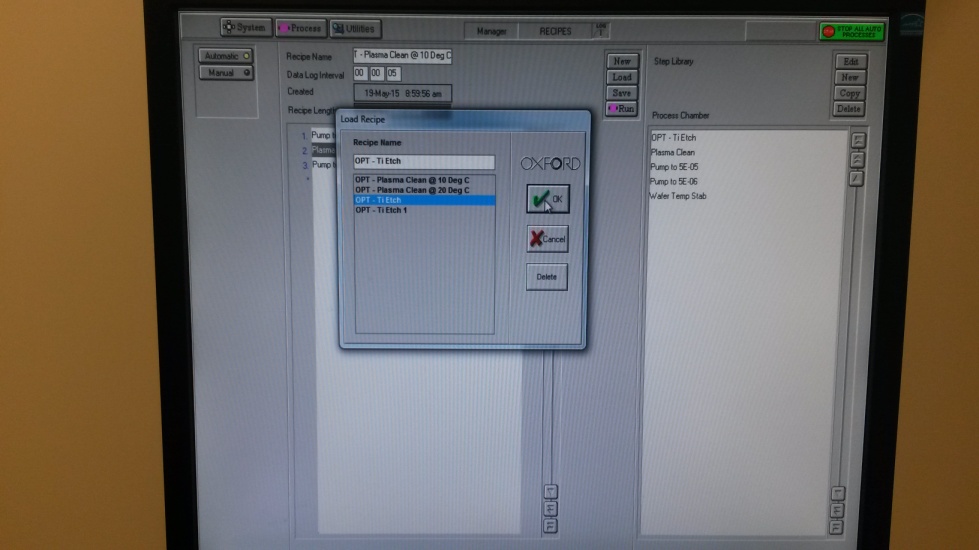
* 1. On the “Recipes” page, press **Load** and it will prompt you about overwriting the current Recipe.

Press **Yes**.



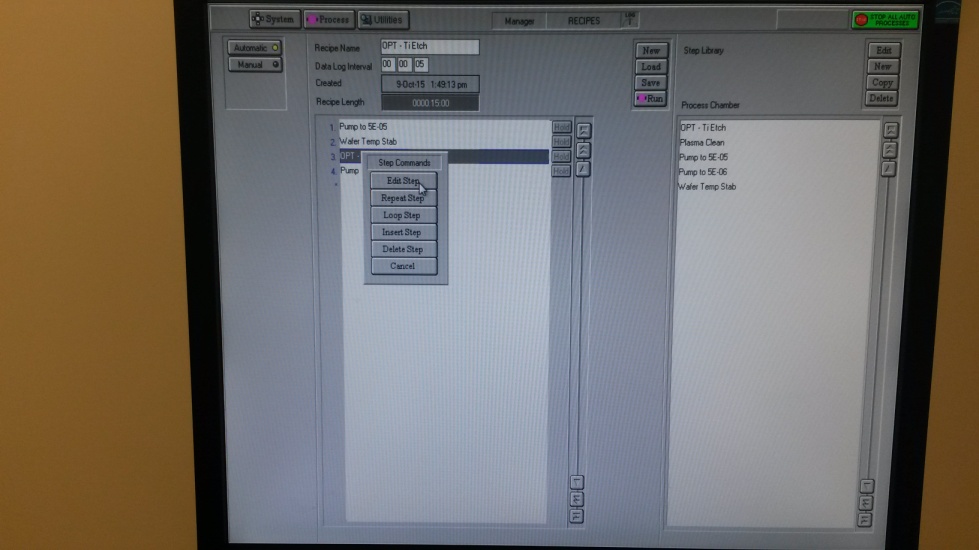
* 1. Select the appropriate chamber conditioning recipe for your intended etch process, and

then press **OK**.



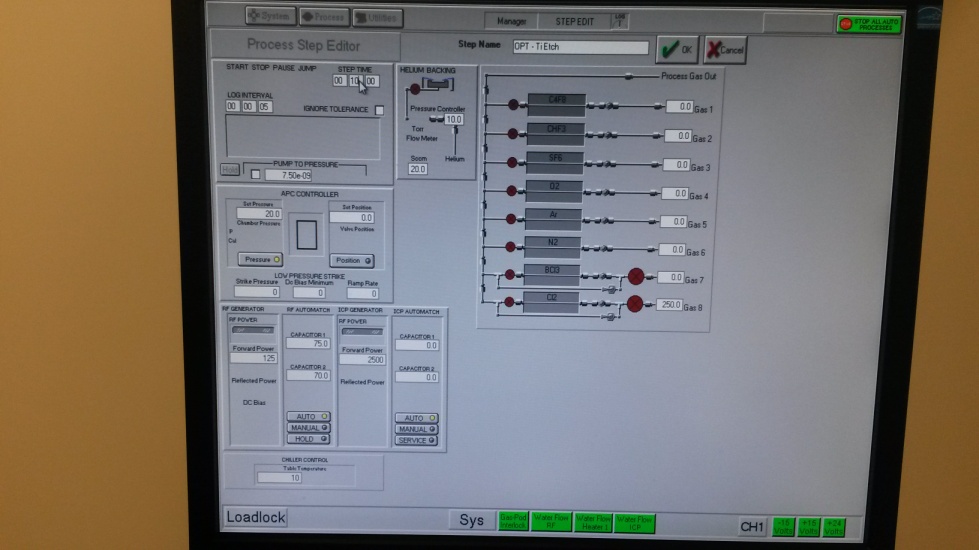
* 1. Left click on the Etch Step to bring up a drop down menu. Press **Edit Step** to bring up the

parameter screen

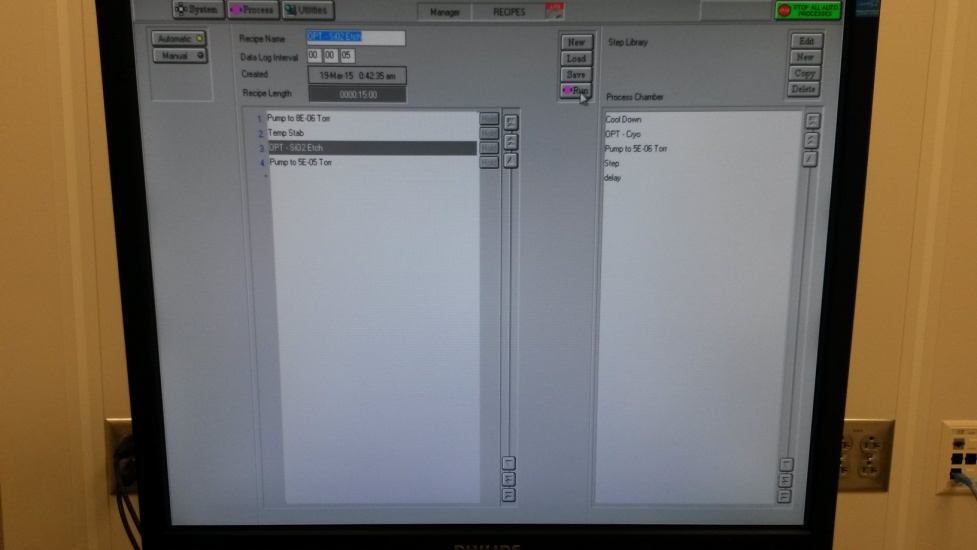


* 1. Set the “Step Time” (if necessary) to 10 minutes. DO NOT CHANGE THE OTHER

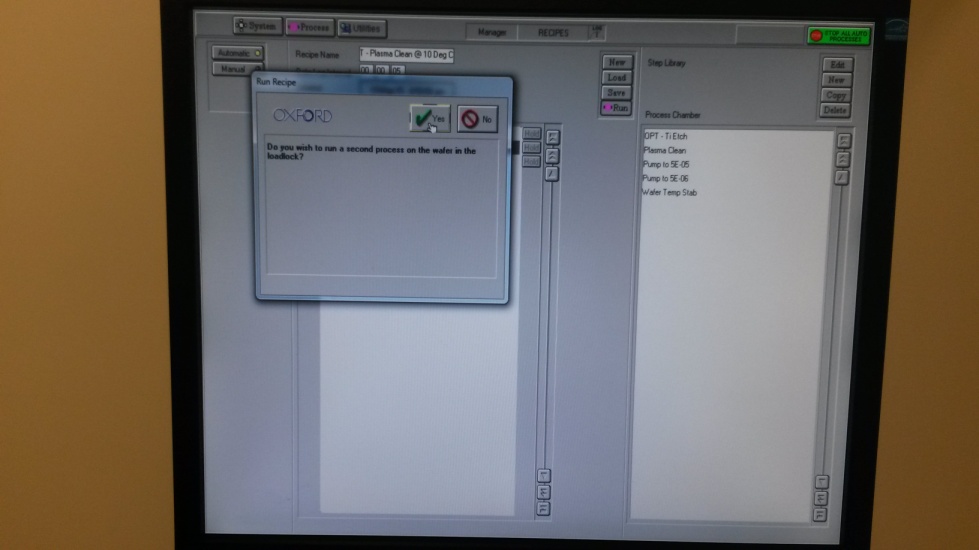
PARAMETERS! Then press **OK** to return to the previous screen.



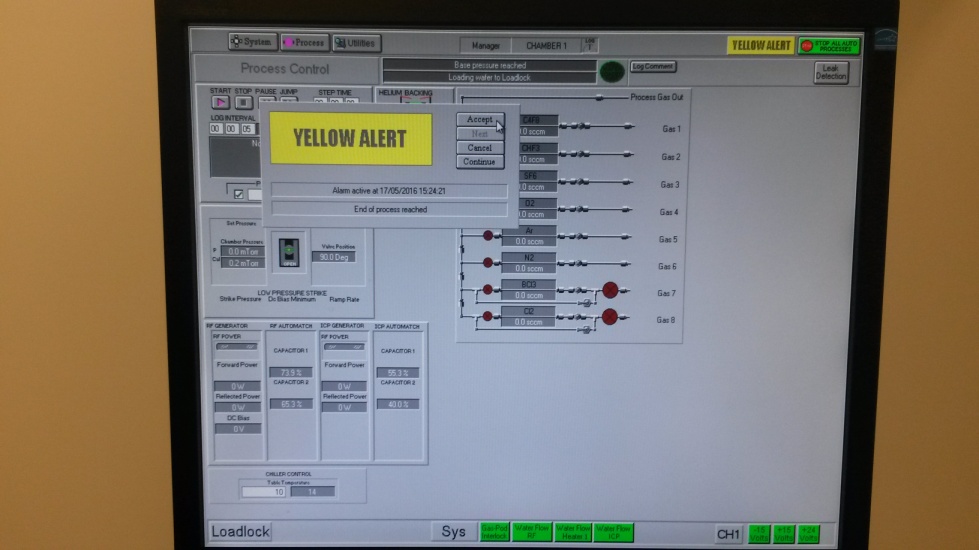
* 1. Press **Run** to run the Chamber Condition.



* 1. If it prompts you about running another process on the wafer in the load lock, press **Yes**. The wafer should transfer into the chamber and the plasma should initiate.



* 1. When this process is complete, the wafer should transfer back into the load lock and a yellow alert will pop up. Click **Accept.**



* 1. After a short while, it should return the screen to the “System Pumping Screen” and prompt you that the Process Completed OK. Press **OK**. You may now move on to the Wafer Load step.

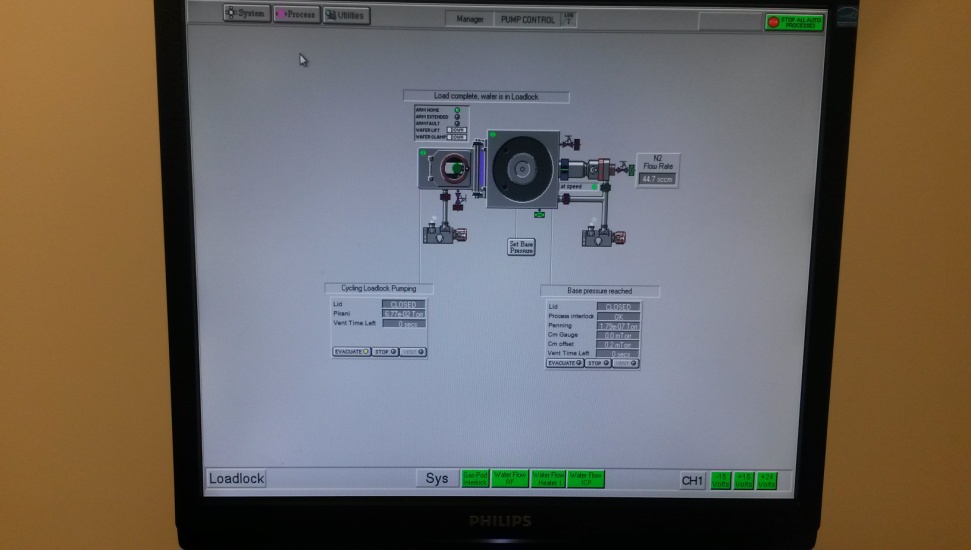
**8.0 Wafer Load**

*REMINDER****:*** *This process is used for unloading the Si Clean/Condition Wafer, and then loading your Device Wafer.*

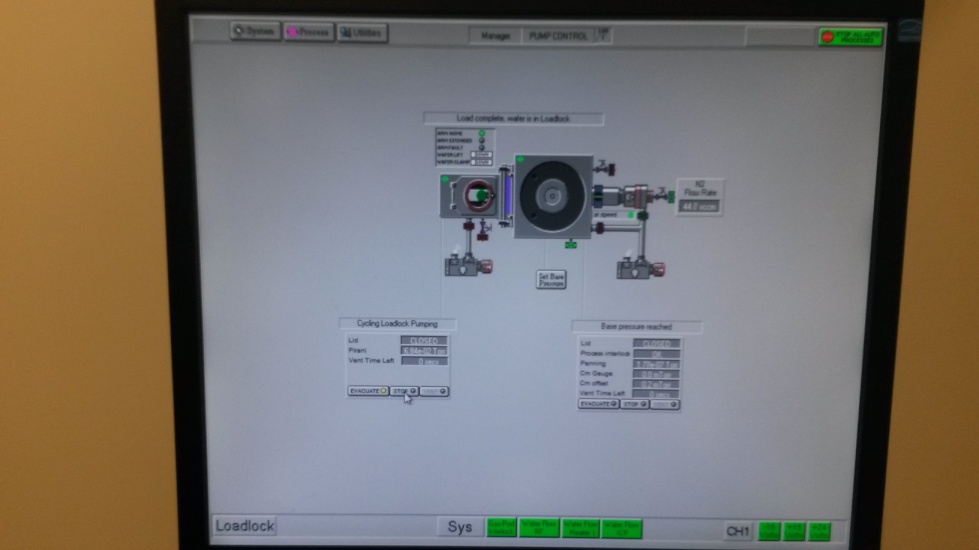
8.1 The load lock must be vented before opening.

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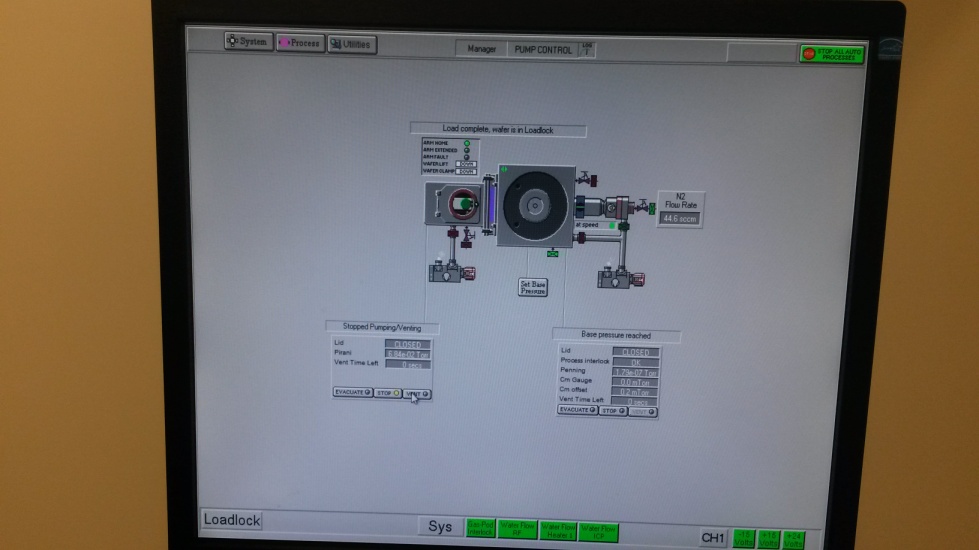
8.2 The system should be in the “System Pumping Screen.”

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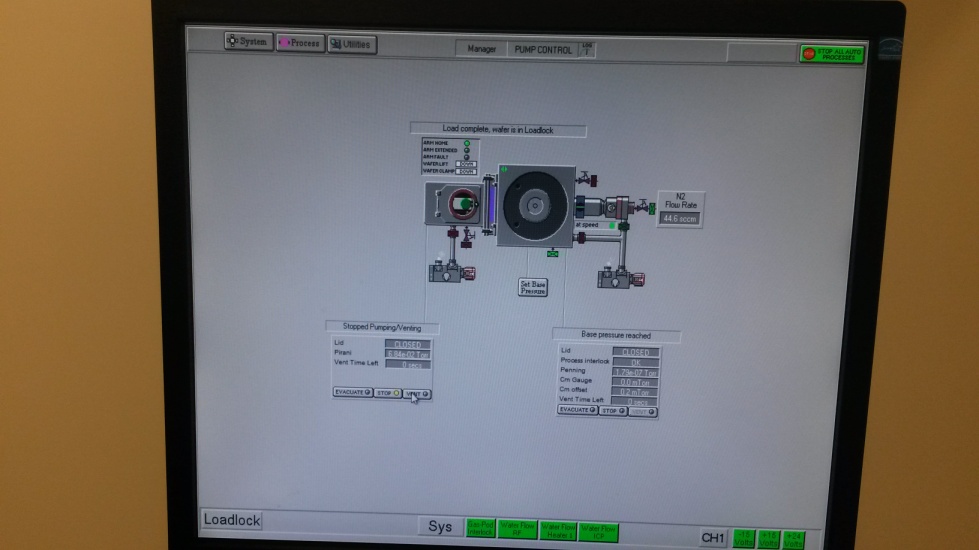
8.3 Press the button that says **STOP** under “Cycling Loadlock Pumping.”



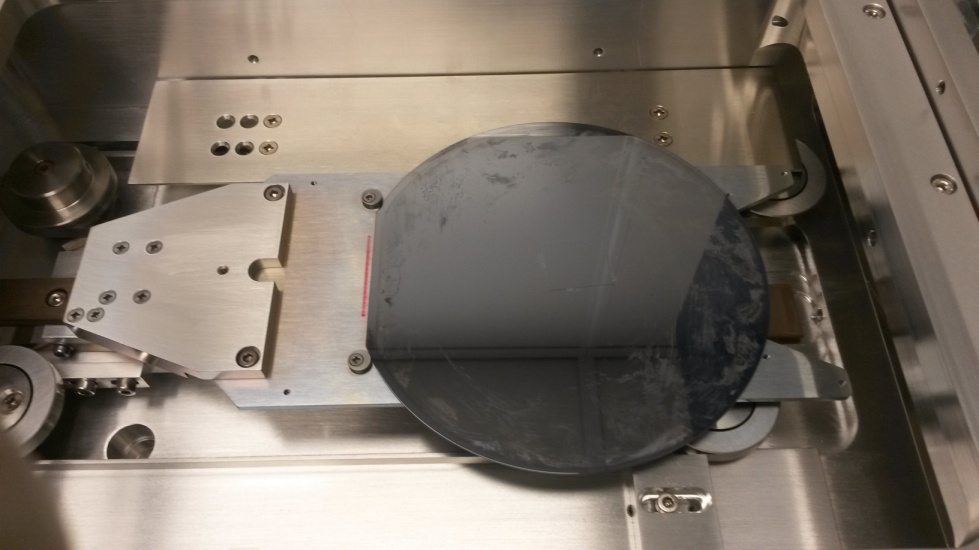
* 1. Wait a few seconds, and then press the button that says **VENT** under “Cycling Loadlock Pumping”.



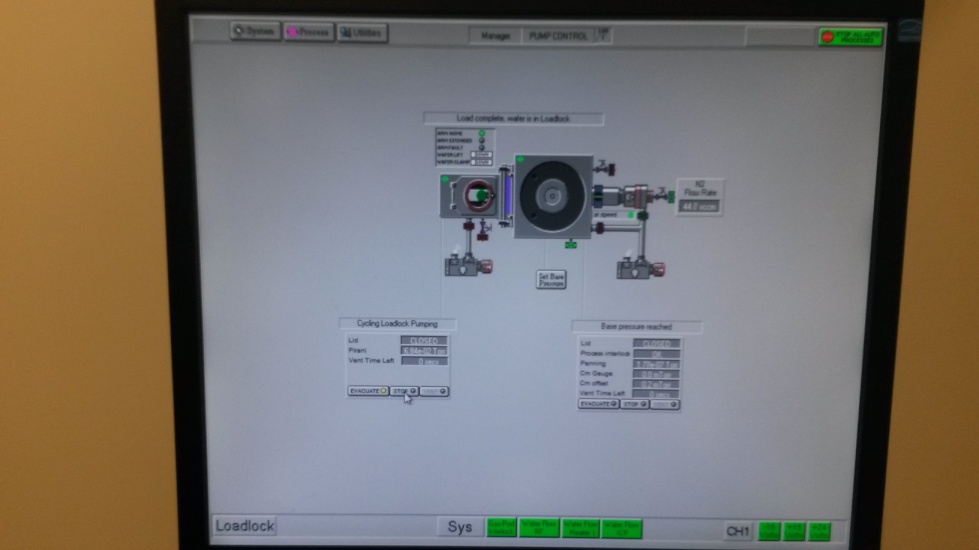
* 1. Wait until the “Vent Time Left” is under 90 seconds. You may then open the load lock by pulling up on the knob. Do not open before this time, or you may damage the tool!



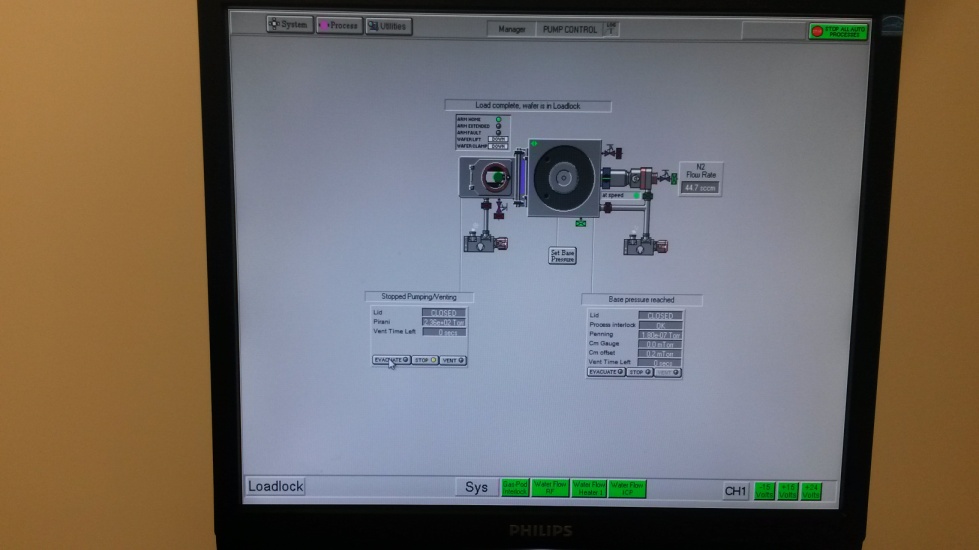
* 1. Remove the Si Clean/Condition Wafer from the load lock, and then place your Device Wafer. Make sure to align it so that the flat is positioned in the middle between the two pins!



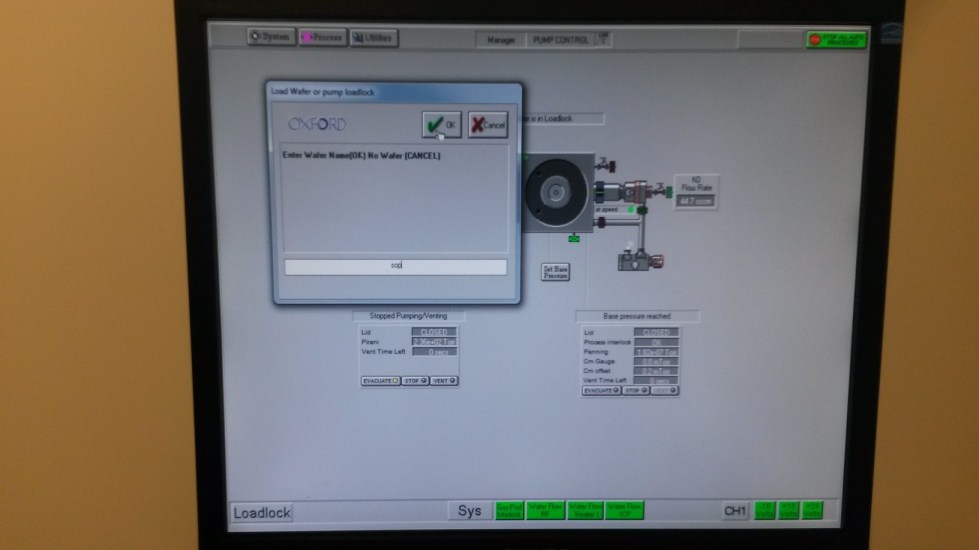
* 1. Lower the load lock door and make sure it is fully closed. Then press the **STOP** button under “Cycling Loadlock Pumping.”



* 1. Wait a few seconds and then press the **EVACUATE** button under “Cycling Loadlock Pumping.”



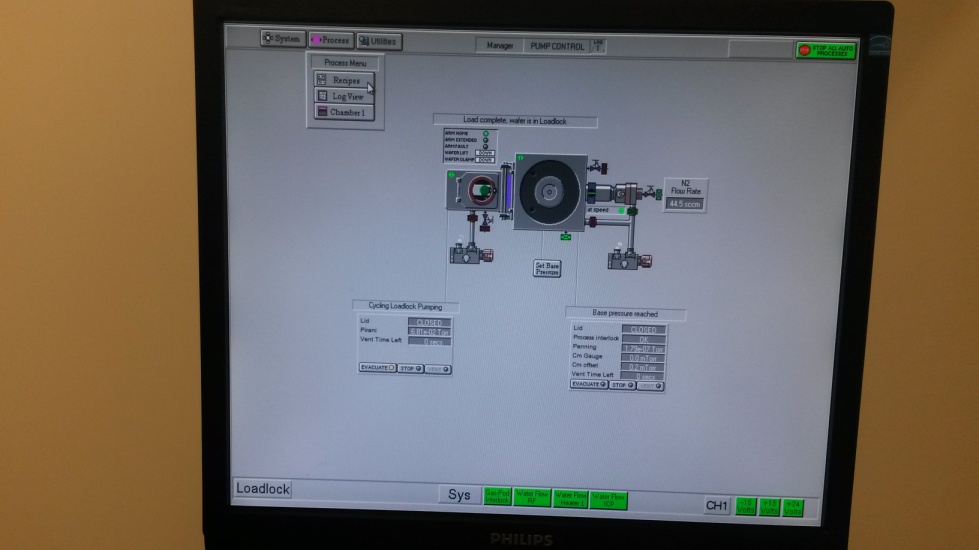
* 1. The tool will prompt you to enter a name for the wafer. Type a name for the wafer process and press **OK**.



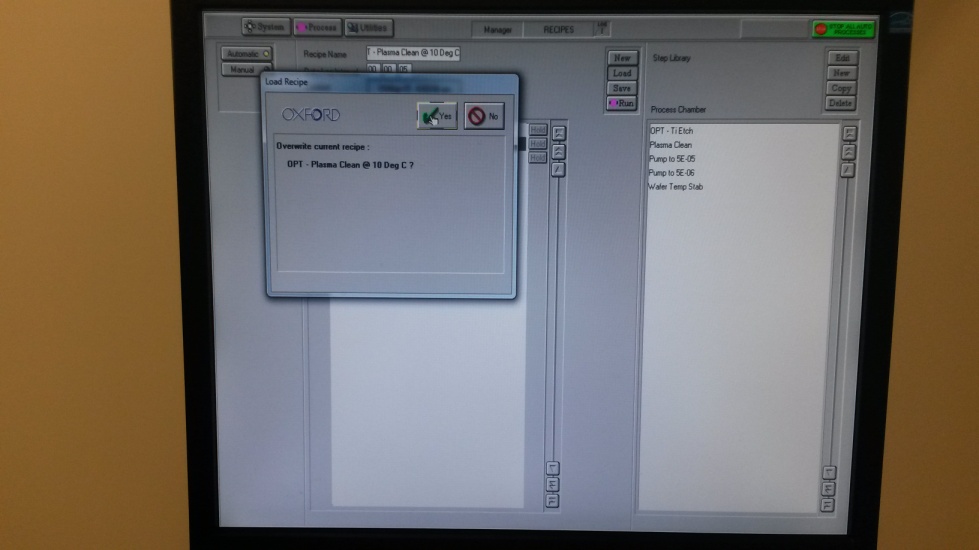
* 1. Once the load lock is pumped, you may move onto the User Etch step.

**9.0 User Etch**

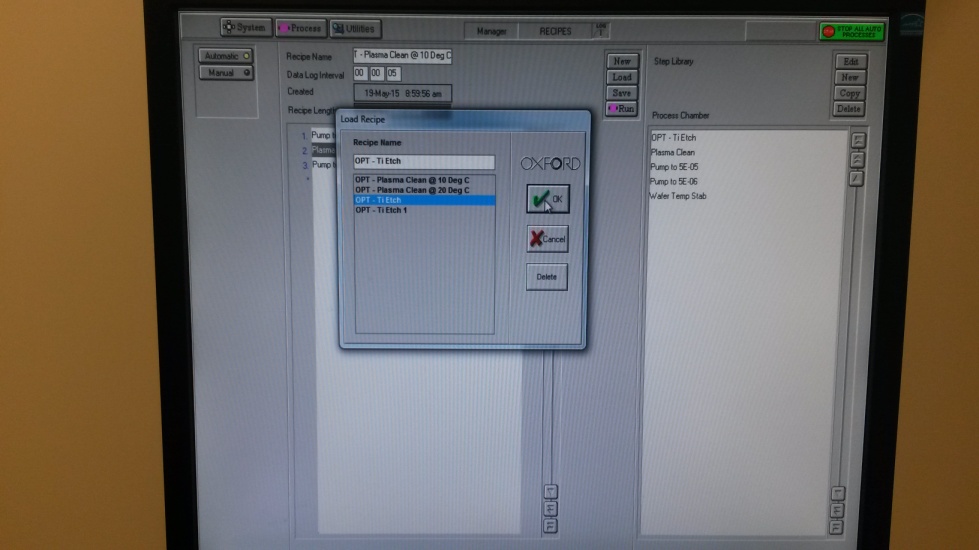
9.1 The system should be in the “System Pumping Screen.” Press **Process** in the top left to drop down the “Process Menu” and then click on **Recipes**.



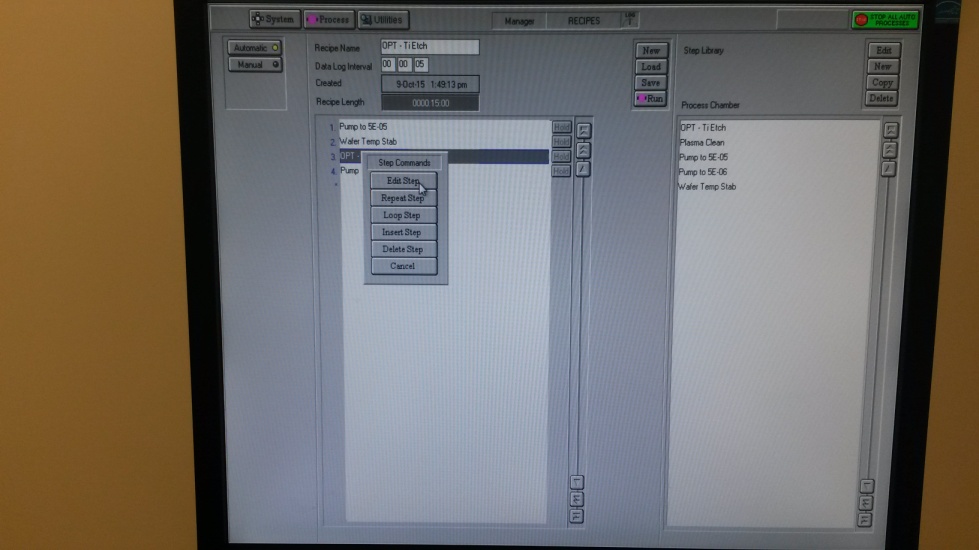
* 1. On the “Recipes” page, press **Load** and it should prompt you about overwriting the current Recipe. Press **Yes**.



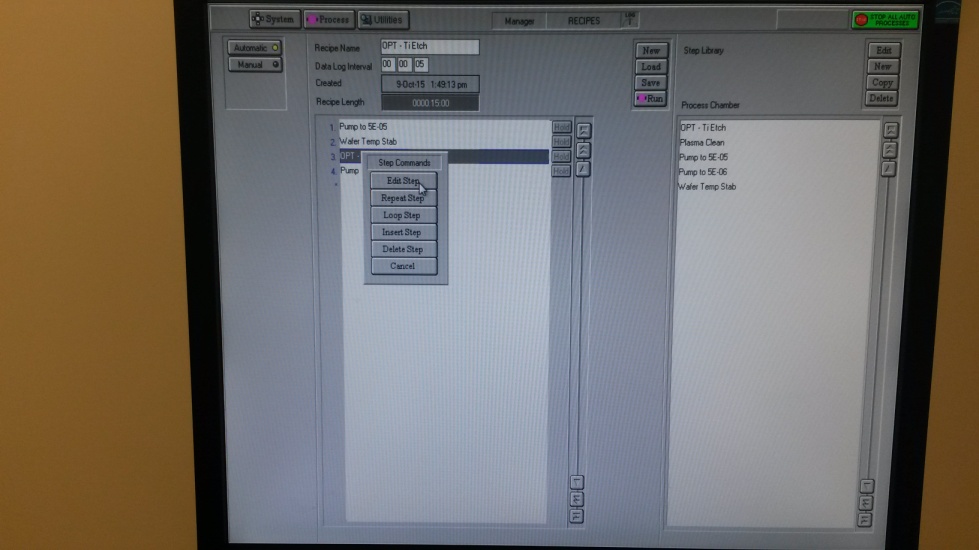
* 1. Select the etch that you want to run and then press **OK**.



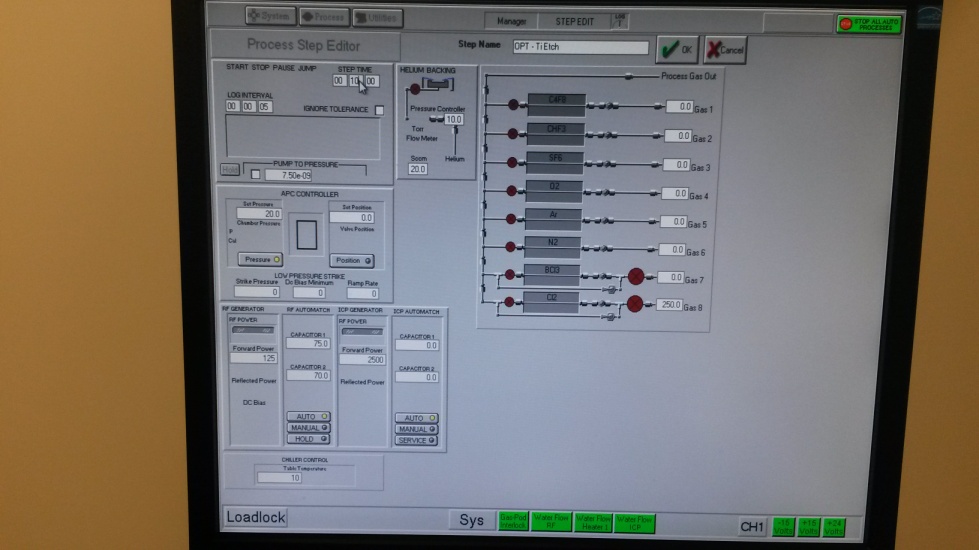
9.4 Left click on the etch step to bring up a drop down menu.



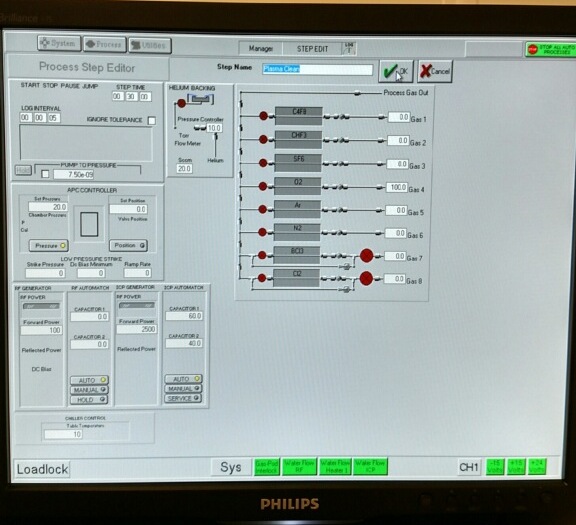
* 1. Press **Edit Step** to bring up the parameter screen.



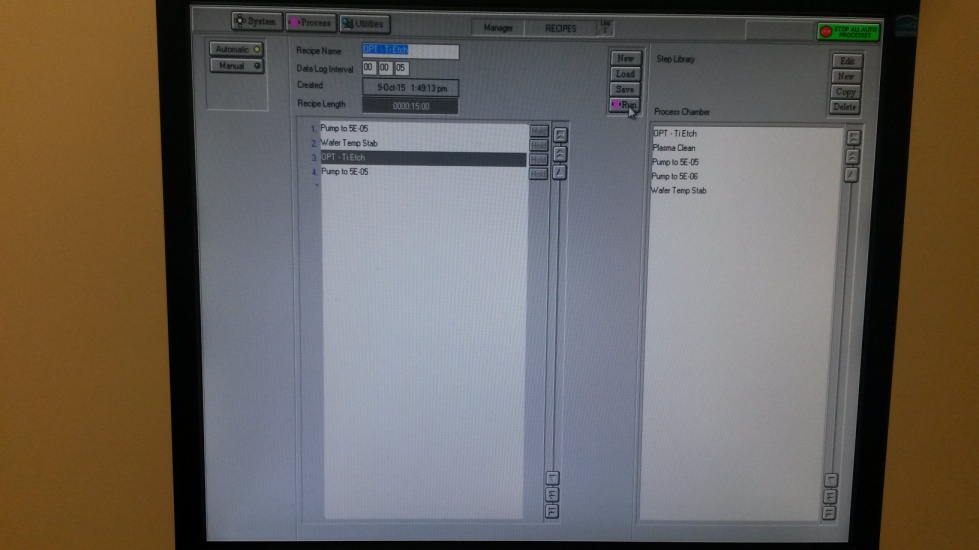
* 1. Set the “Step Time” to your desired etch time. DO NOT CHANGE THE OTHER PARAMETERS!



* 1. Press **OK** to return to the previous screen.

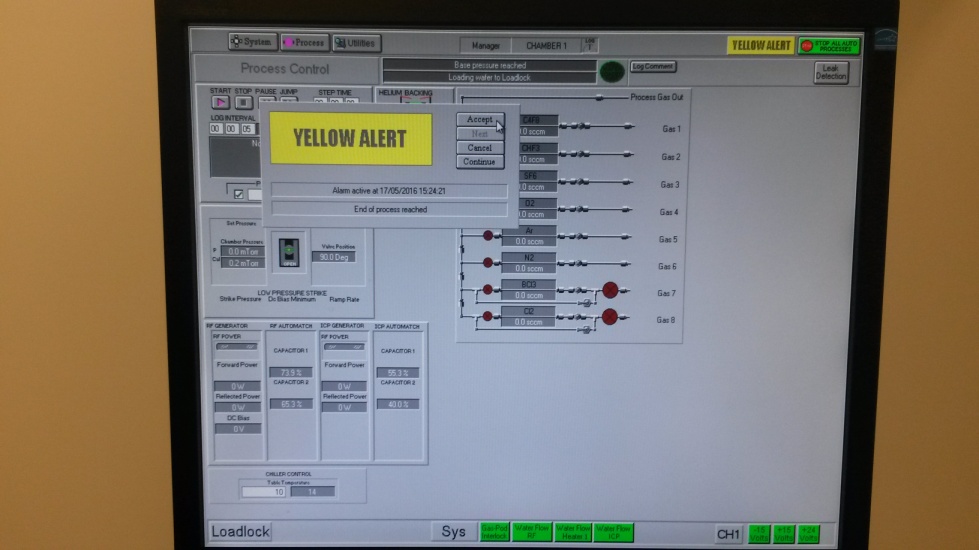


* 1. Press **Run** to begin the etch on your sample. The wafer should transfer into the chamber and the plasma should initiate.



* 1. When this process is complete, the wafer should transfer back into the load lock and a yellow

alert will pop up. Click **Accept**.

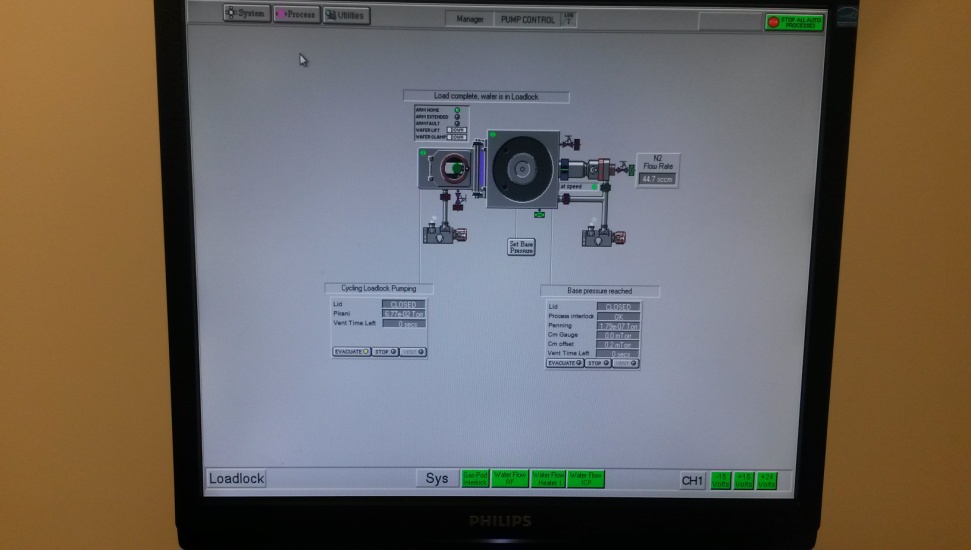


* 1. This should return the screen to the “System Pumping Screen,” where you will be prompted with Process Completed OK. Press **OK**. You may now move on to the Wafer Unload step.

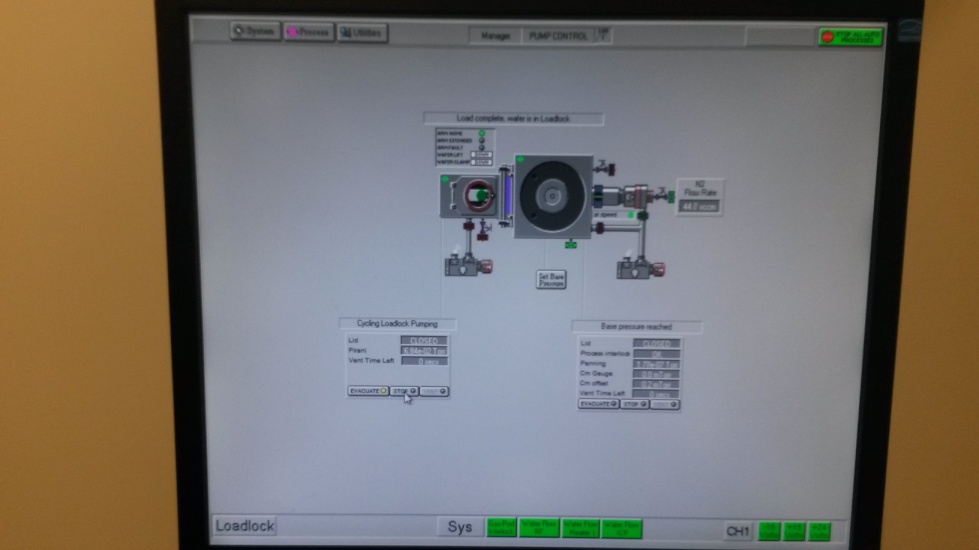
**10.0 Wafer Unload**

*REMINDER****:*** *This process is used for unloading your Device Wafer, and then loading the Si Clean/Condition Wafer.*

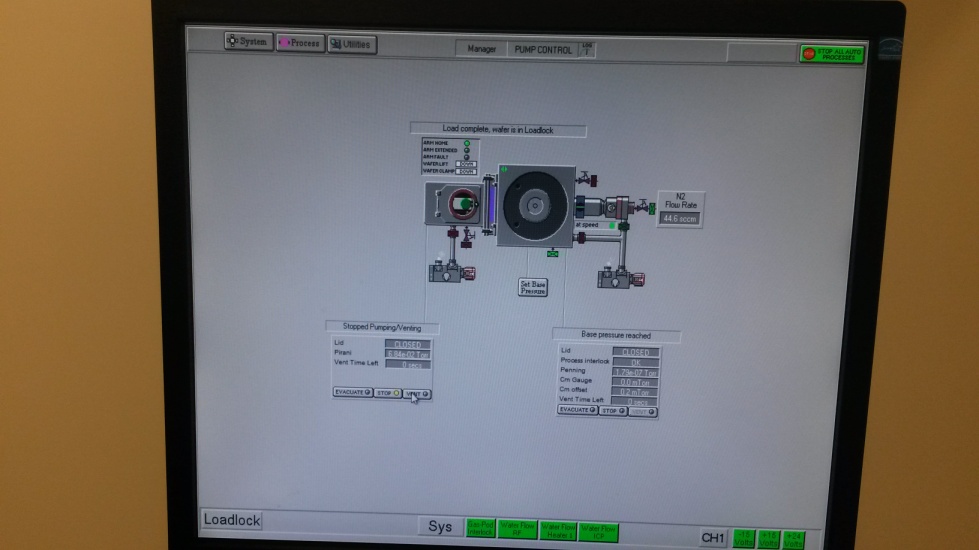
* 1. The system should be in the “System Pumping Screen.”

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10.2 Press the button that says **STOP** under “Cycling Loadlock Pumping.”

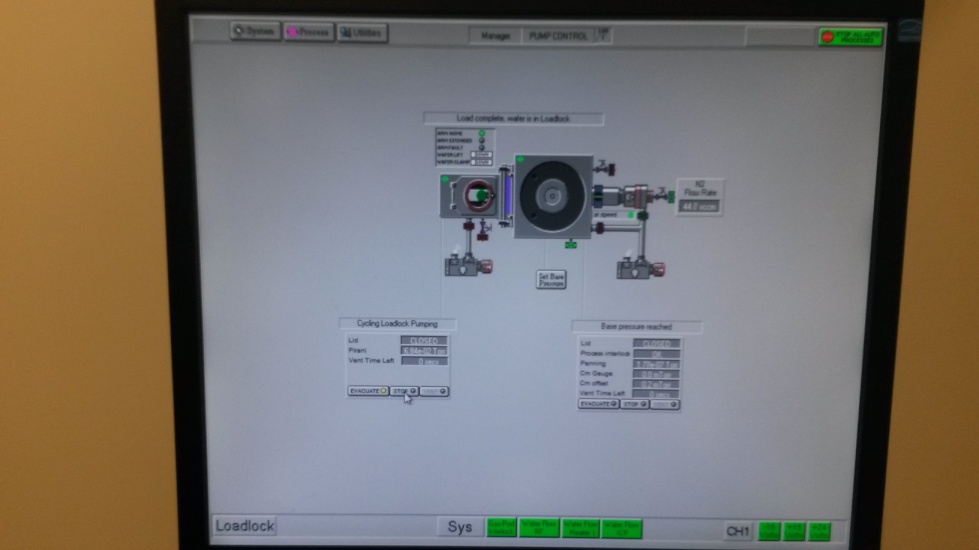


* 1. Wait a few seconds, and then press the button that says **VENT** under “Cycling Loadlock Pumping.”

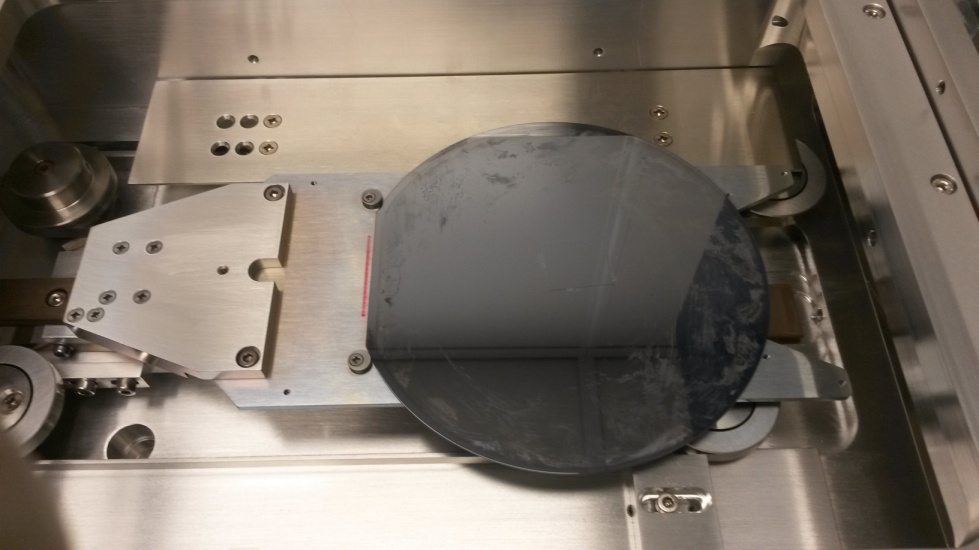


* 1. Wait until the “Vent Time Left” is under 90 seconds, you may then open the load lock by pulling

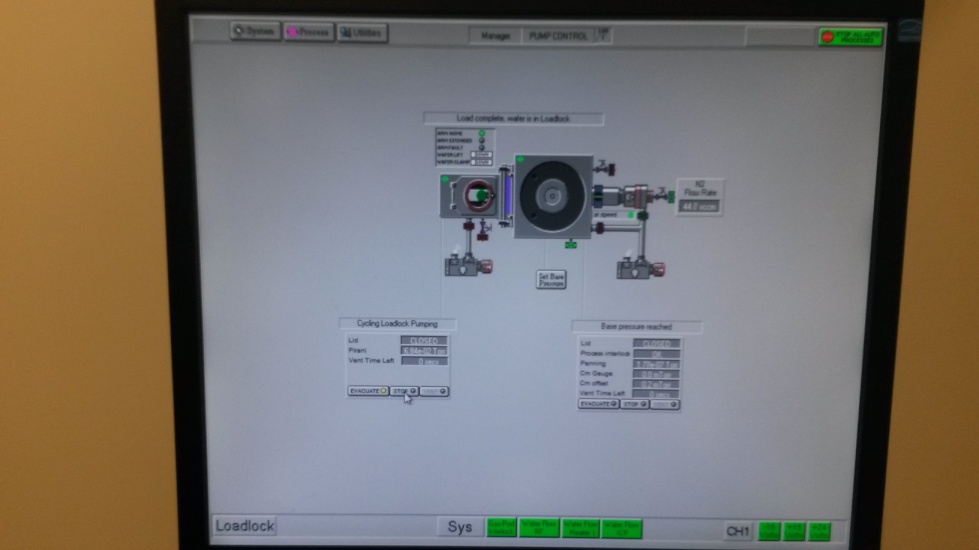
up on the knob. Do not open before this time, or you may damage the tool!



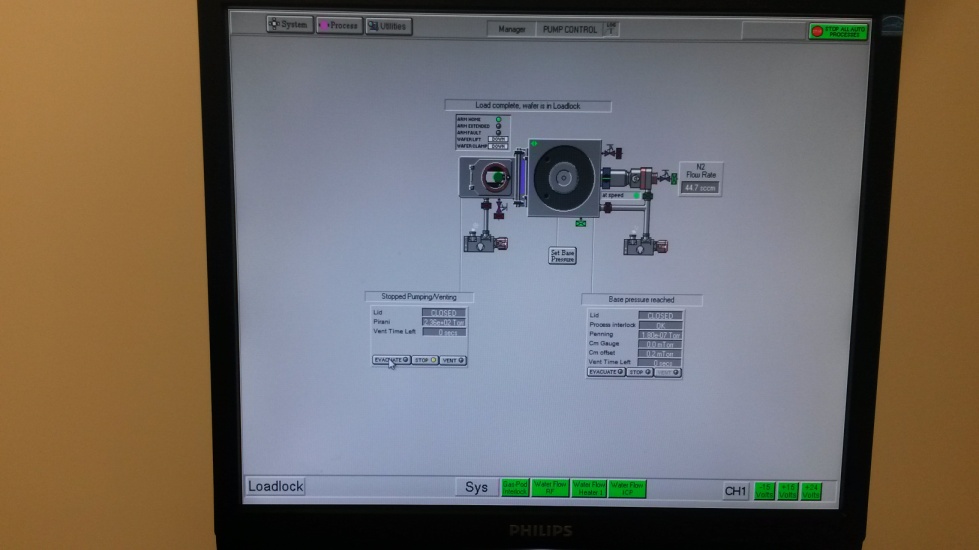
* 1. Remove your Device Wafer from the load lock, and then place a Si Clean/Condition Wafer. Make sure to align it so that the flat is positioned in the middle between the two pins!



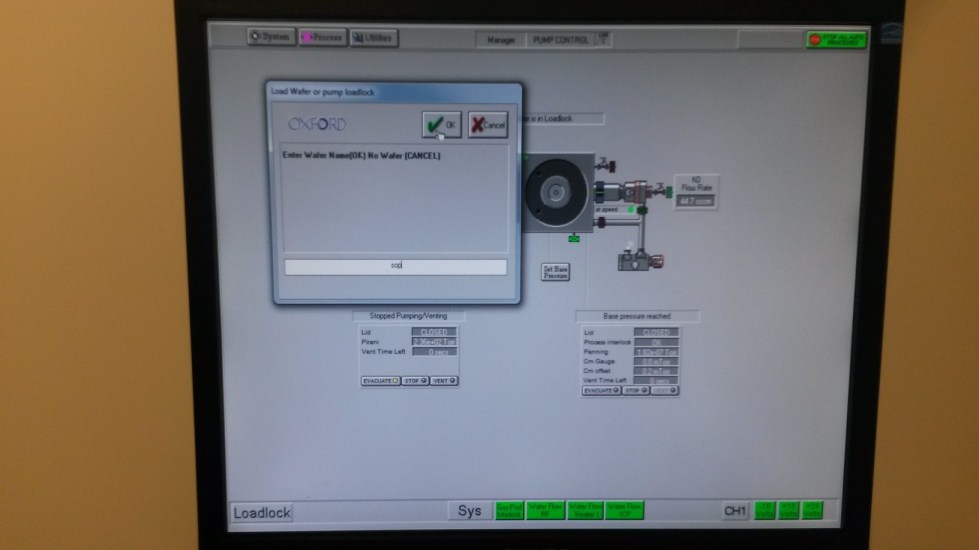
* 1. Close the load lock door and make sure it is fully closed. Then press the **STOP** button under “Cycling Loadlock Pumping.”



* 1. Wait a few seconds and then press the **EVACUATE** button under “Cycling Loadlock Pumping.”



* 1. The tool will then prompt you to enter a name for the wafer. Type a name and press **OK**.

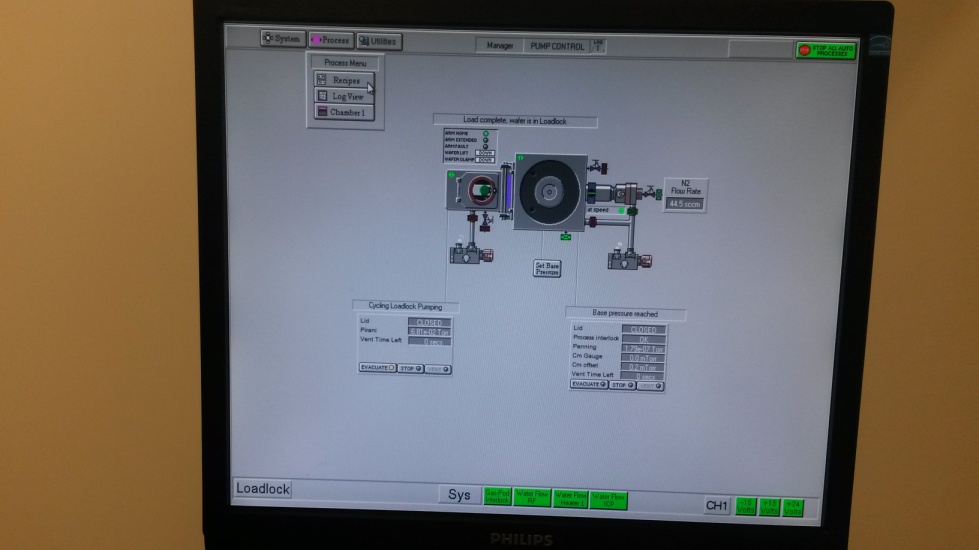


* 1. Once the load lock is pumped, you may move onto the Post-Etch Chamber Clean step.

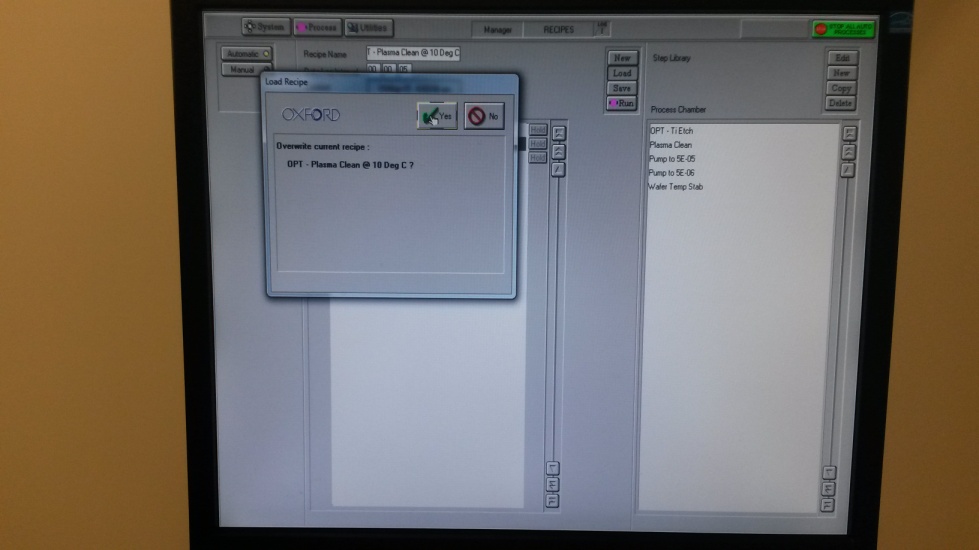
1. **Post-etch Chamber Clean**

*REMINDER****:*** *This process is run using a Si Clean/Condition Wafer, not your Device Wafer.*

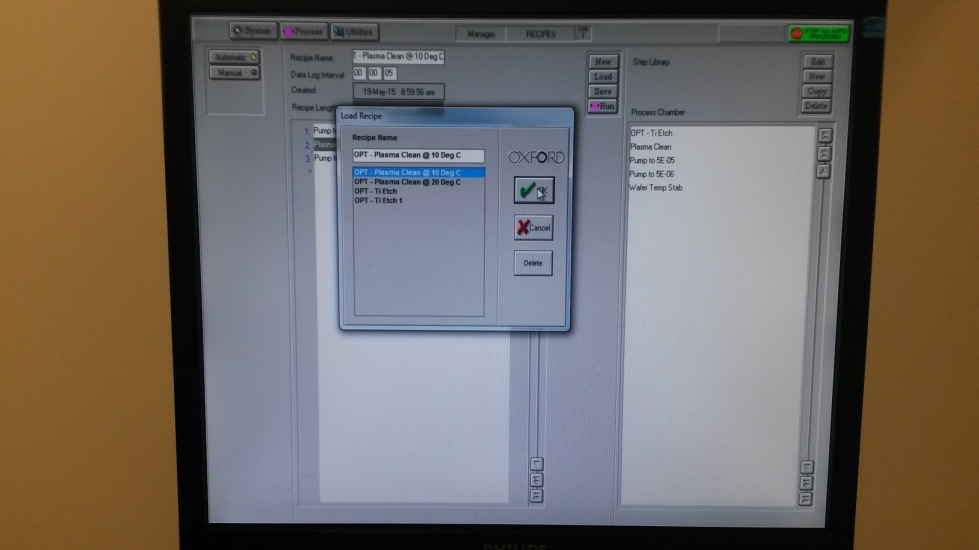
* 1. The system should be in the “System Pumping Screen.” Press **Process** in the top left to drop down the “Process Menu” and then click on **Recipes**.



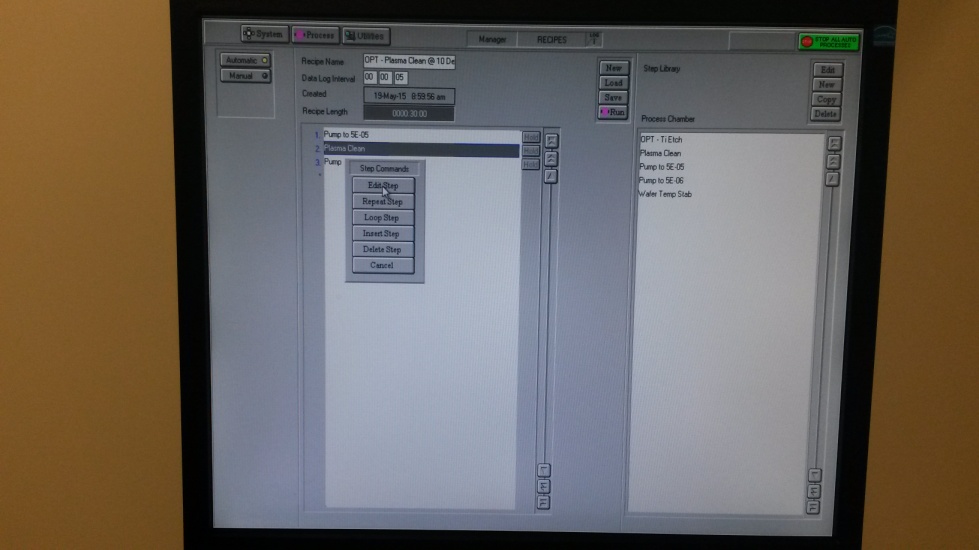
* 1. On the “Recipes” page, press **Load** and it should prompt you about overwriting the current Recipe. Press **Yes**.



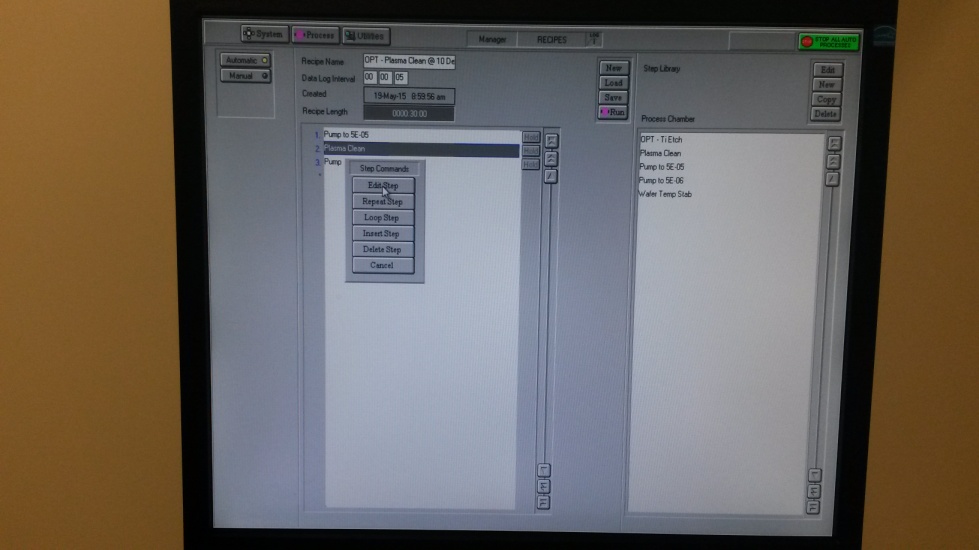
* 1. Select the appropriate chamber clean and then press **OK**.



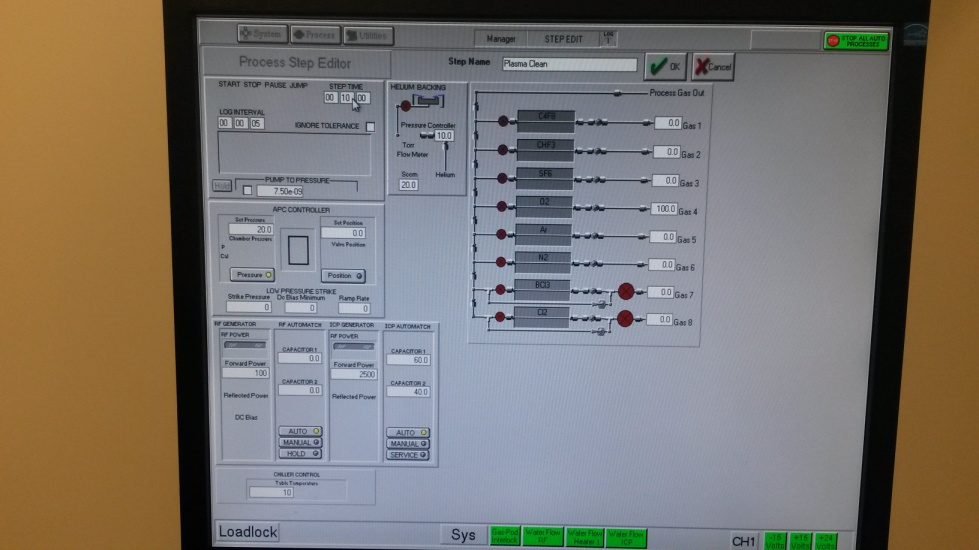
* 1. Left click on **Plasma Clean** to bring up a drop down menu.



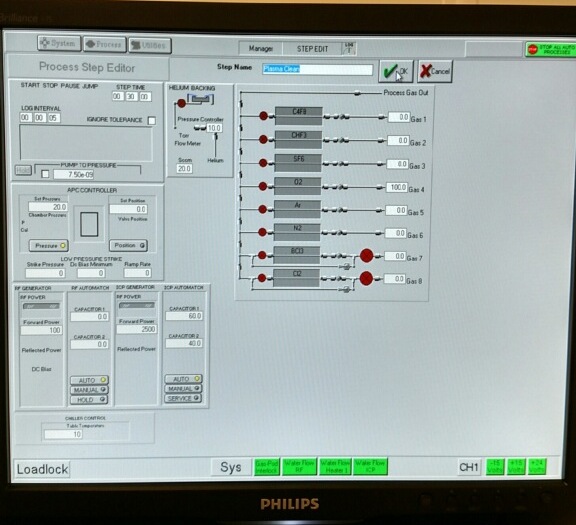
* 1. Press **Edit Step** to bring up the parameter screen.



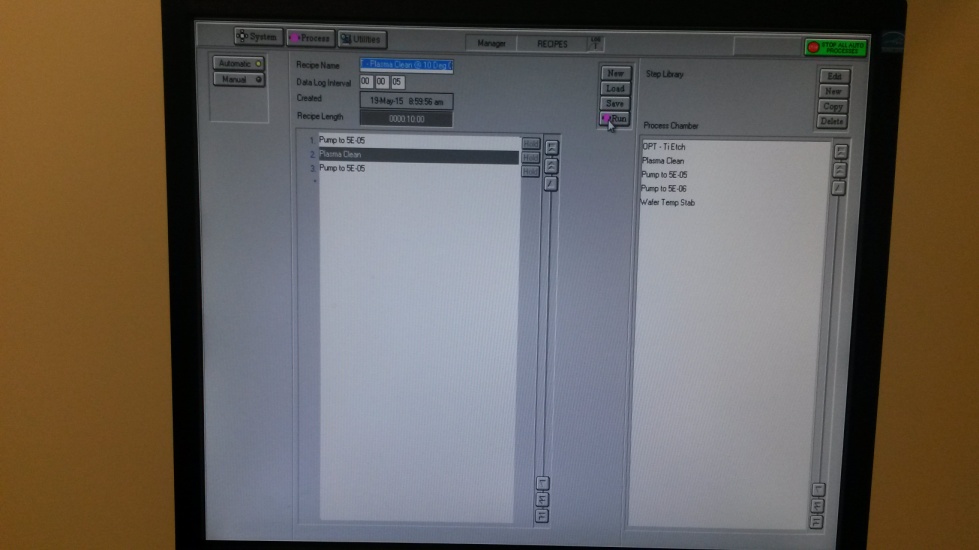
* 1. Set the “Step Time” to the same time you used for the User Etch, or to 5 minutes if the User Etch was less than that. DO NOT CHANGE THE OTHER PARAMETERS!



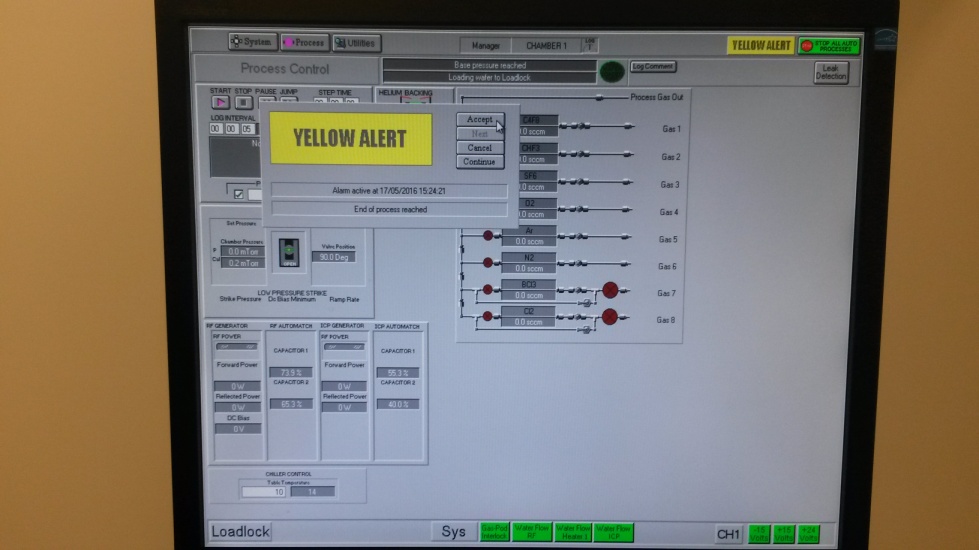
* 1. Press **OK** to return to the previous screen.



* 1. Press **Run** to run the Post-Etch Chamber Clean. The wafer should transfer into the chamber and the plasma should initiate.



* 1. When this process is complete, the wafer should transfer back into the load lock and a yellow alert will pop up. Click **Accept.**



* 1. This should return the screen to the “System Pumping Screen,” where you will be prompted with Process Completed OK. Press **OK**.
  2. Fill out the log book
  3. Clean up after yourself and make sure everything is put back where it belongs before you leave