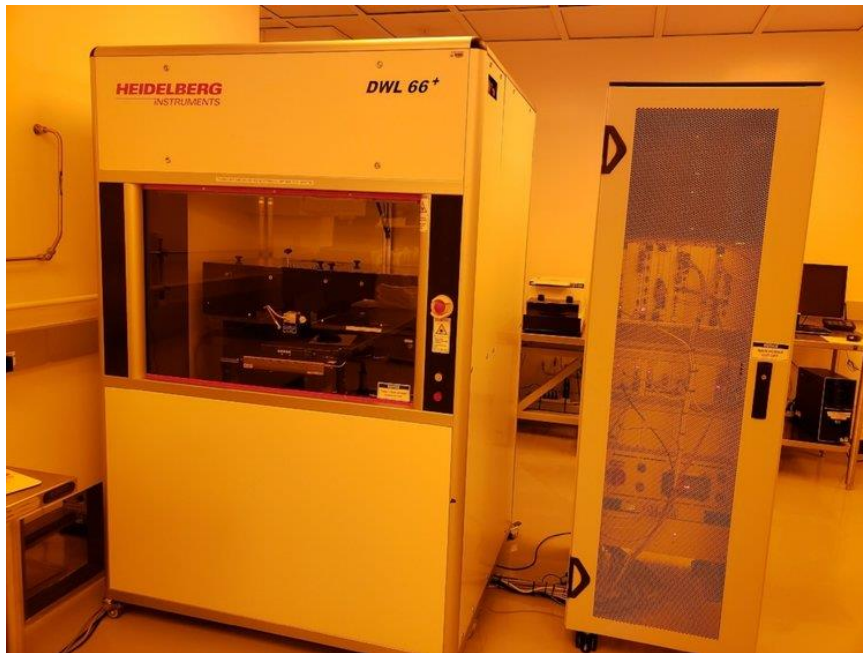


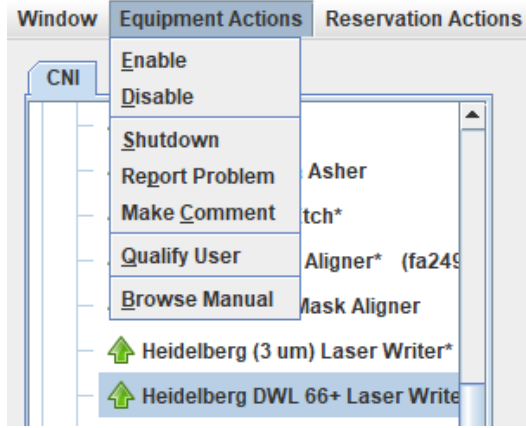


# HEIDELBERG DWL 66<sup>+</sup> LASER WRITER Standard Operating Procedure



These instructions are intended for reference only, and will *not* replace the thorough training required for proper system operation. Contact a clean room staff member with questions or to report a system problem.

Written by Gaurang Bhatt. Edited by Dr. Jaeun Yu, and Dr. Nava Ariel-Sternberg

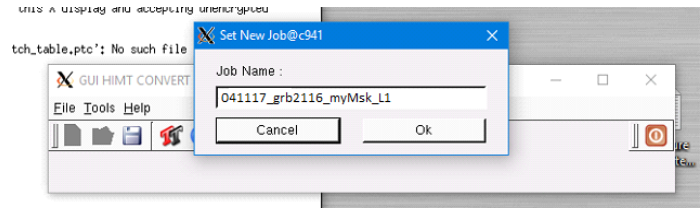
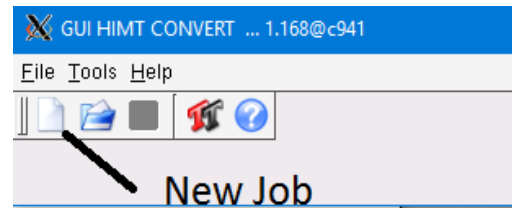


<p><b>1. BADGER:</b> Enable the tool in badger.</p>	
<p><b>2. FILE TRANSFER:</b> The system accepts the following file types for your mask design: DXF, CIF, GDSII, and Gerber files.</p> <p>You need to copy your files to the computer of the system. Use the USB port on the left monitor to connect a USB drive (Or use the USB port of the lower PC).</p> <p>Copy your files to: /home/convert/File type. (e.g.: /home/convert/CIF).</p> <p>To access the folder, double click on the icon “convert (172.18.41.201)” on the desktop.</p>	
<p><b>3. CONVERSION:</b> Double click on the “APP” icon on the desktop.</p>	



Click on “new job” icon.  
Enter a job name by the convention of the lab:  
MMDDYY\_UNI\_MaskName\_Layer Name.

The file name should be up to 26 characters and should not include whitespace. Other job formats will be deleted. Jobs older than a month will be periodically deleted to free up disk space. Do not save your files anywhere else on the computer.



**Job Name:**  
**MMDDYY\_UNI\_MaskName\_LayerName**

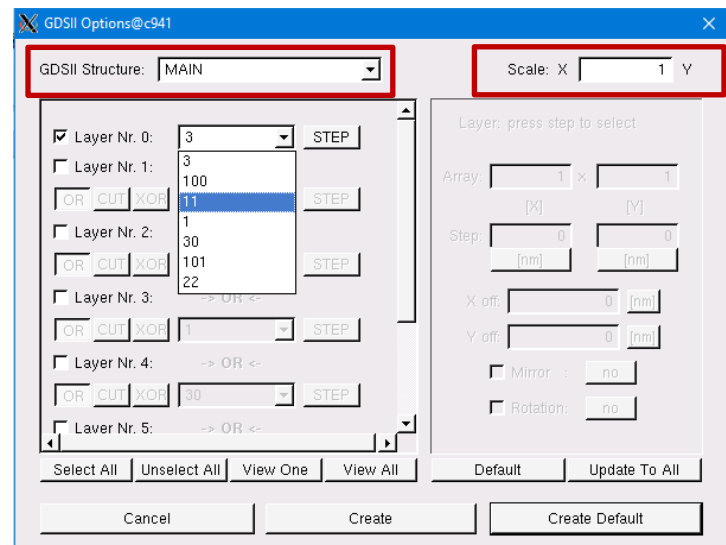
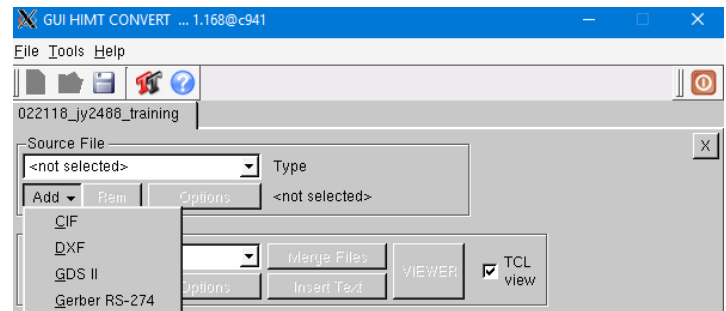
**4. CONVERSION cont.:**

From the “Add” icon drop-down menu choose the format of your file.

A new window will open. Make sure to select the right parameters.

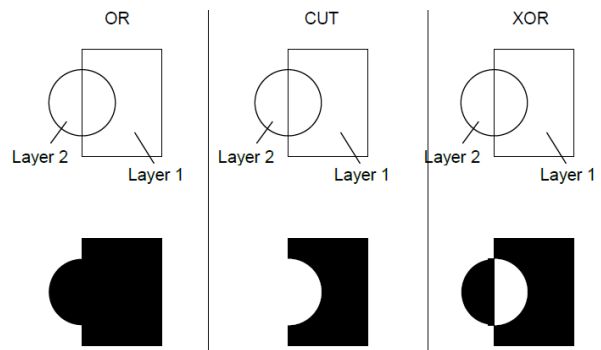
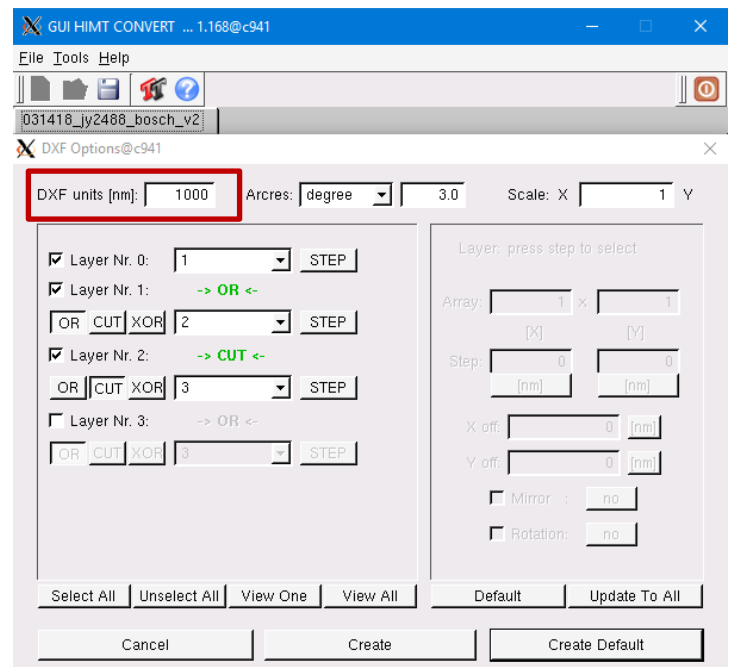
Review the scale on the top right corner of the window to make sure it’s correct for your design (Generally X: 1 Y by default).

For **GDS II**, “GDSII Structure” is the cell you want to write. It’s typically the highest cell in your CAD hierarchy.



For **DXF**, type the DXF units in nm (e.g., enter 1000 if  $\mu\text{m}$  is your unit on the design).

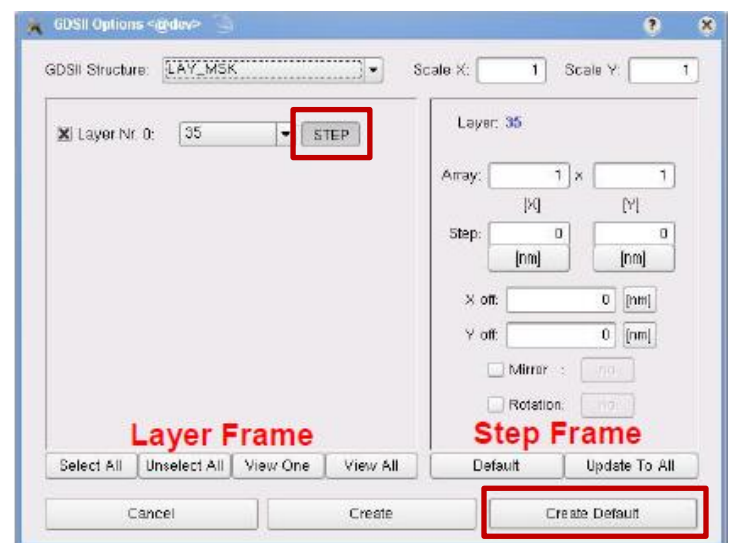
Unclick all the layers, and then choose the layer you wish to write. Alternatively, you can select several layers in parallel and use the functions (OR, CUT, XOR). These functions can allow you to merge layers by using a combined pattern from two layers (OR) or removing the overlapping parts in one or both layers (CUT and XOR).

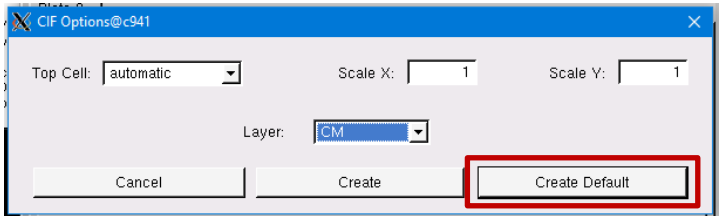


**5. CONVERSION cont.:**

To mirror, rotate, or shift the layer, press on "STEP". The window to the right will become available.

You can set an array by entering the number of columns (X) and rows (Y), and then set the distances in both directions for the step and repeat function.



<p>X off and Y off are shifts of the layer. You can change the units by clicking on them.</p> <p>Mirror can be added by checking it, and then choose the axis (by X or by Y). Rotation can be checked for 90, 180, and 270 degrees clockwise rotation.</p> <p>For <b>CIF</b>, set to “automatic”. The highest number in the list will be used as the top cell. Select the Layer you want to write.</p> <p>When you are done, click on “Create Default” to store the configuration into the configuration file.</p>	
<p><b>6. REVIEW DESIGN:</b></p> <p>Unclick TCL view and click on “VIEWER” to review your design.</p> <p>The Expose Window tab shows the size of the current expose window (can be adjusted). You can type in new numbers or use the +/- to adjust the window size. You can use “Reset” to return to the original values. Units can be changed by clicking on them (mm/nm/μm).</p>	

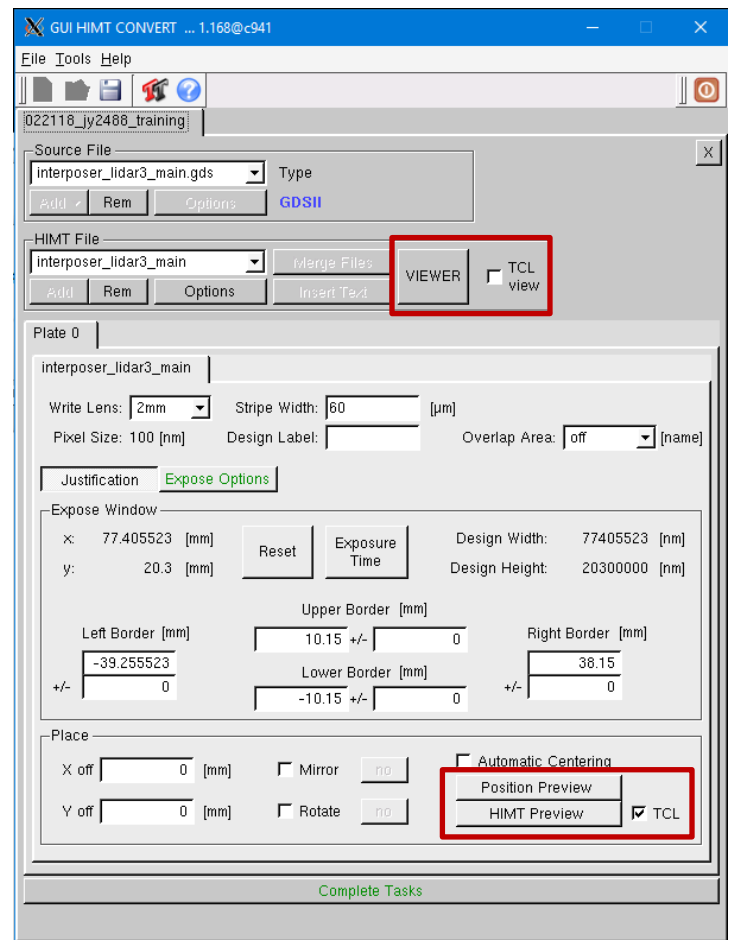


At the Place tab choose the required X and Y offset, rotation angle, and mirroring if you need them for your design adjustment. To switch between mirror at X or Y click on them.

If “Automatic Centering” is checked, the design origin will be the center of the exposed window.

Click on “Position Preview” to view design placement on the plate. If there is an offset, it will appear as a red box.

Do not change any other parameters in Plate 0.

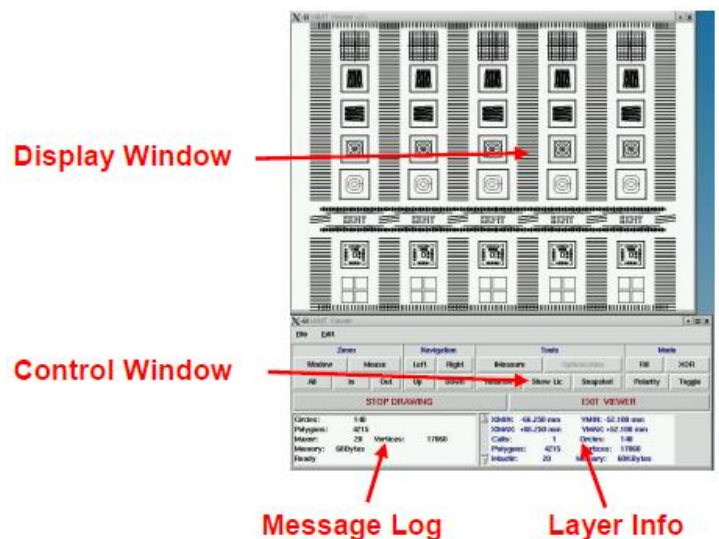


## 7. HIMT VIEWER:

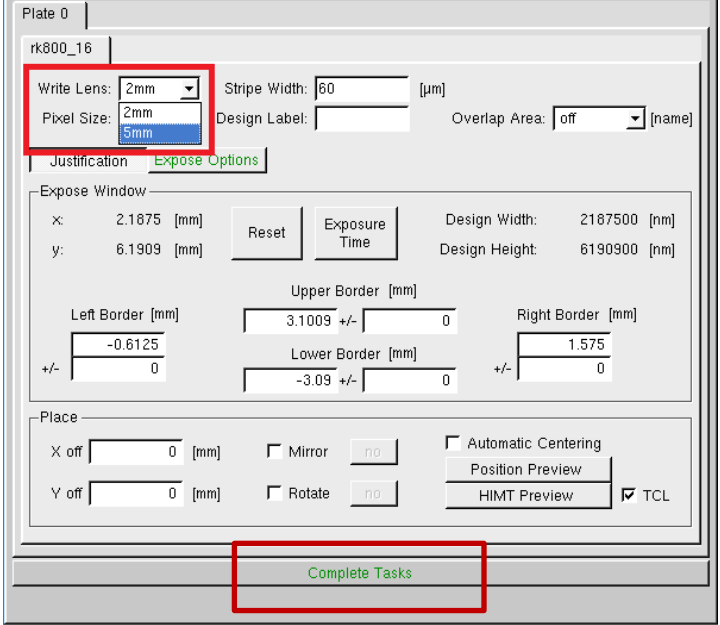
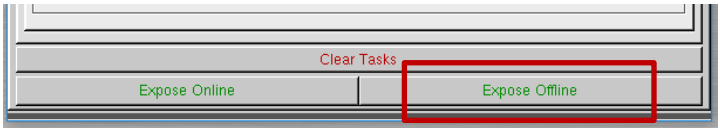
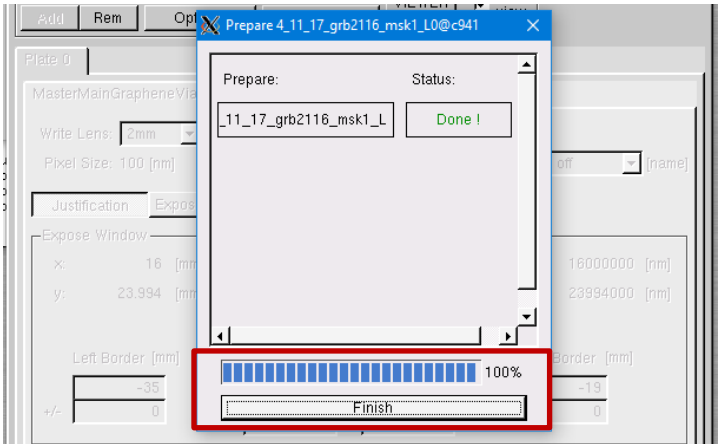

To view your final and modified design unclick TCL in the Place tab and then click on “HIMT preview”.

Once you open your design in HIMT viewer, you will see two windows: Control Window and Display Window.

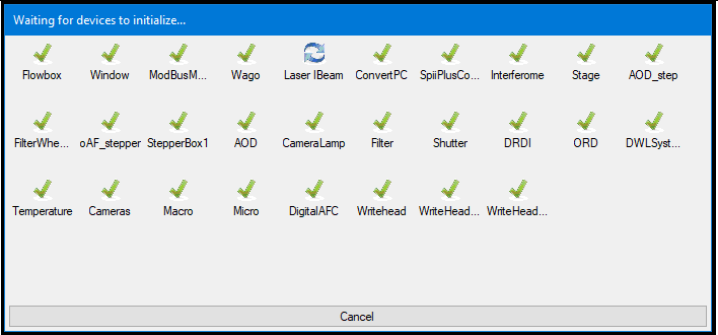
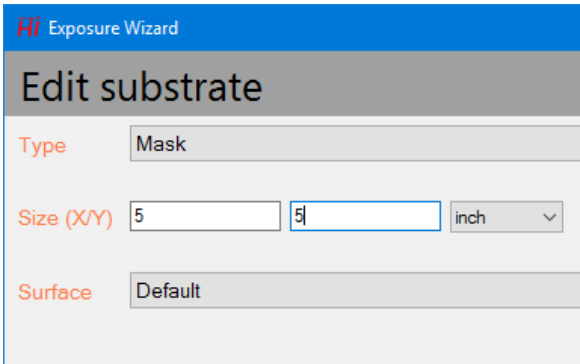
In the Control Window, you can see the messages on the progress of the task and the Layer box provides info on the design layers.





	<p>Click on “Exit Viewer” button to close the HIMT viewer.</p>
<p><b>8. COMPLETE TASK AND SAVE:</b>  <b>Make sure you choose the right write head.</b></p> <p>Then, click on “Complete Tasks” and then save the file with a .job extension. <b>Do not change the file name.</b> The write time in the pop-up window is not accurate.</p> <p>Then, click “Expose Offline” to transfer the file to Laser Internal Code =LIC format accepted by the machine. Wait for the transfer to complete, and then, click on “Finish”.</p> <p>Close the conversion window and the APP software.</p>	  
<p><b>9. VERIFY SYSTEM STATUS:</b>          Make sure the window of a flow box is closed. Open the <b>Lithography Menu</b> software.</p>	

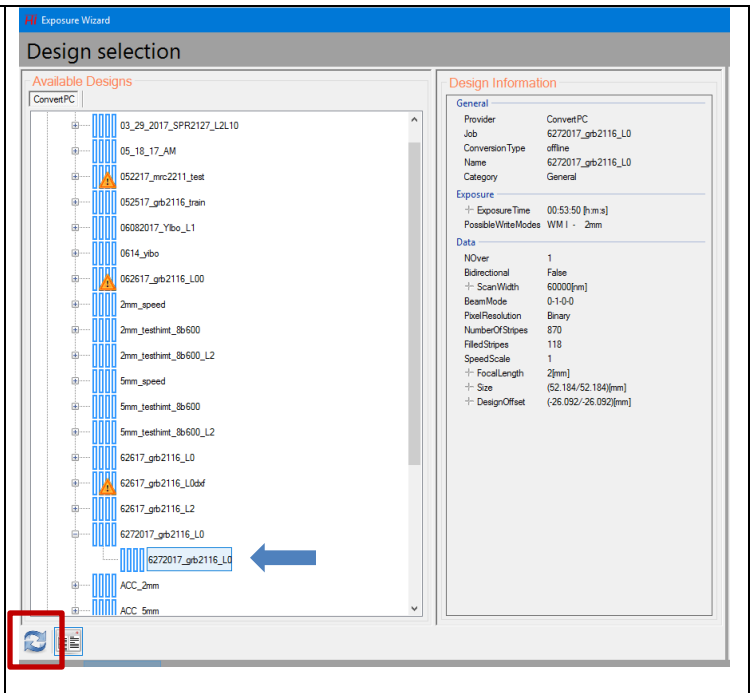



	<p>Log-in as basic or user accounts</p> <p>Monitor for all the indicators in the pop-up window to show green. If there is any issue, please report to the superusers or cleanroom staff.</p>	
<p><b>10. EXPOSURE WIZARD:</b></p>	<p>For a basic mode, the “Exposure Wizard” window will be open. If it doesn’t show automatically, go to <b>Wizardry&gt;Exposure Wizard</b>.</p>	
<p><b>11. EDIT SUBSTRATE:</b></p>	<p>Choose your substrate type from the drop-down menu.</p> <p>If you are doing a direct write on a substrate other than a standard mask plate, choose the type as a mask if the substrate is rectangular.</p> <p>Chose 4” wafer only if you are writing on a full wafer. The tool will automatically align the design (write direction) to the primary flat of the wafer.</p> <p>Click Next step.</p>	
<p><b>12. DESIGN SELECTION:</b></p>	<p>Find your converted design from the list in the left half of the</p>	

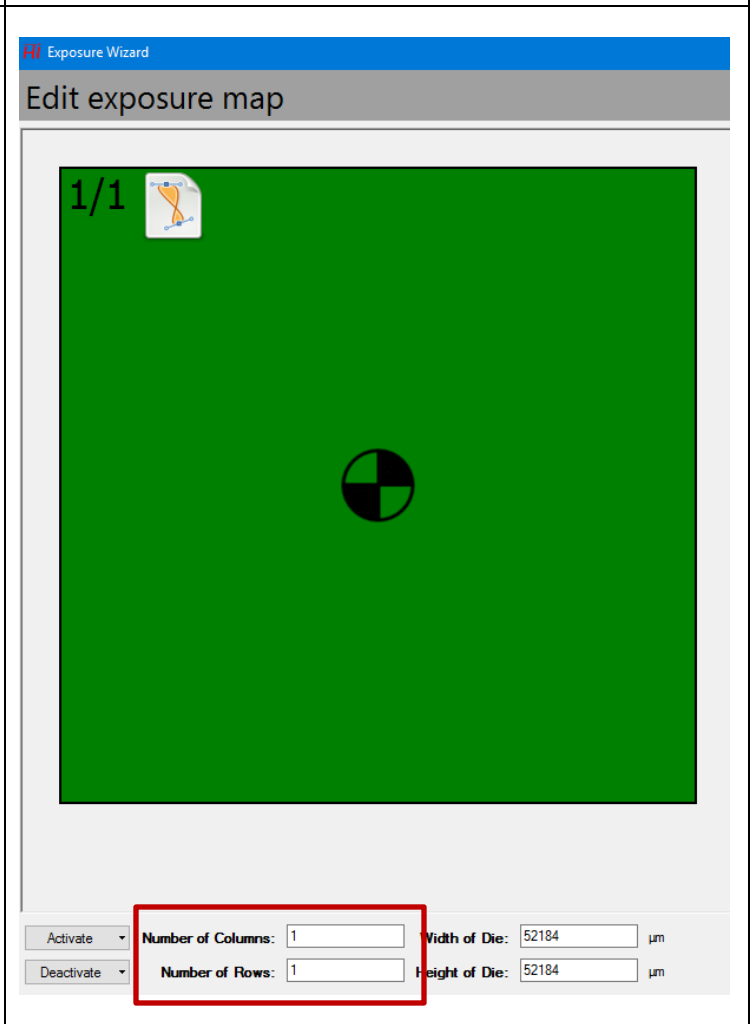




window. Click on the '+' icon next to your design and choose the design file nested under.  
  
 Click refresh icon on the left bottom corner if you can't find your design.  
  
 Once the design is chosen, refer the right side of the window for writing time information.  
  
 Click Next step.



**13. EDIT EXPOSURE MAP:**  
 The width and height of the write area will be automatically populated. The wizard will show the standard one-field map.  
  
 The cross  represents the stage coordinate origin. It can be modified via drag-and-drop into other possible positions.

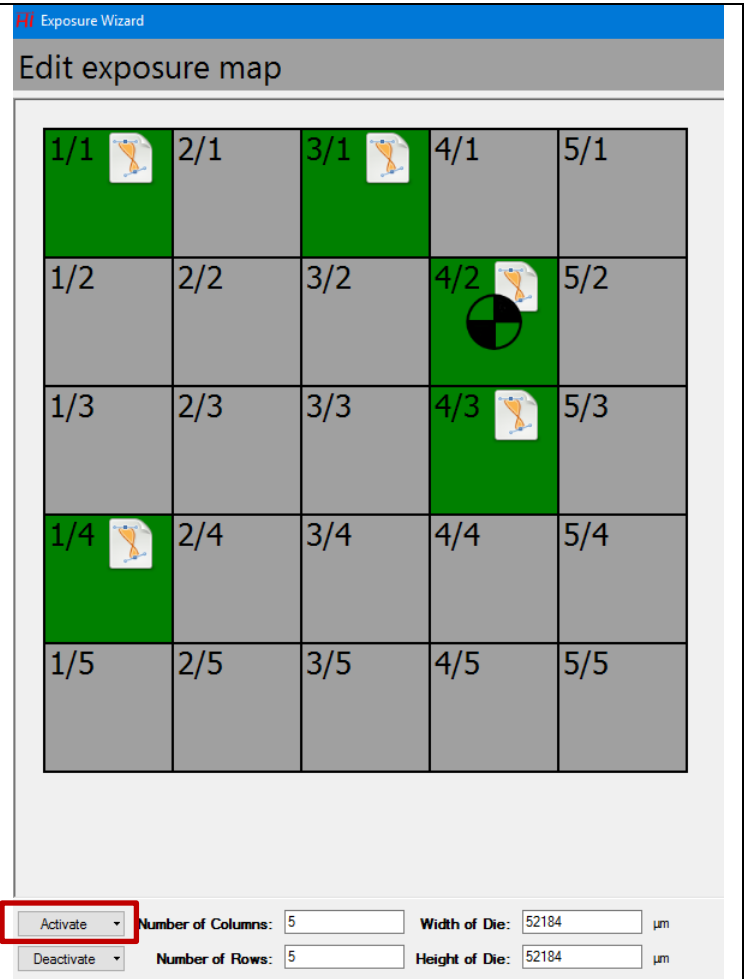


If you want to repeat the design in a grid fashion on the substrate, use the column/row numbers.

Make sure to click “Activate” for each of the grid cells. If the grid cell is Green, it is activated to write. If it is Grey, it is disabled and will not be written.

Move the cross  to the desired position.

Click Next step.



**14. PARAMETER SETUP:**

Enter the Dose parameters. The parameters for the regular mask with S1800 resist are available on the desktop note. Please check the most updated parameters.

Enter Laser Power:

Intensity:

Filter:

Focus: Pneumatic or Optical

Offset (-100..100%):

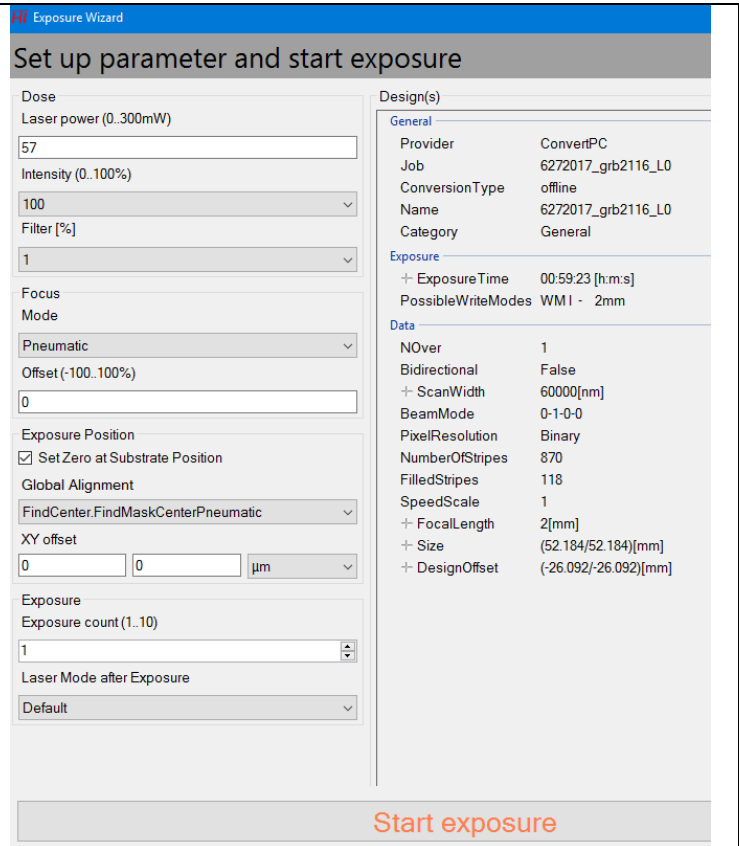


Choose the focus mode as Optical for the finer resolution.

For Global Alignment method, choose one of the following as per your write requirements.

FindCenter.FindMaskCenterPneumatic  
 FindCenter.FindMaskCenterOptical  
 FindCenter.FindWaferCenterPneumatic  
 FindCenter.FindWaferCenterOptical

FindWaferCenterOptical and FindWaferCenterPneumatic are for 4" wafers. If you are using rectangular wafer chips, they are considered as a mask for the alignment algorithm.



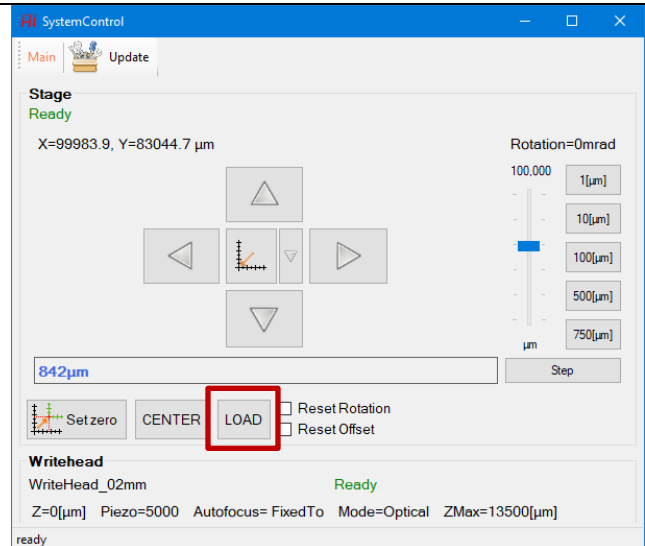
**15. SUBSTRATE LOADING:**

Ensure that the stage is in the load position (see the picture on the next page). The write head will be at the left back corner of the stage.

If the stage is not at the load position, open the stage control window:

**Controls>SystemControl.**  
 Then, Click "LOAD".

Press the red button on the tool side to open the flow box window.

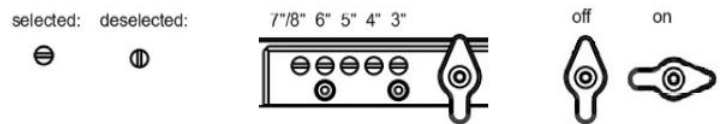
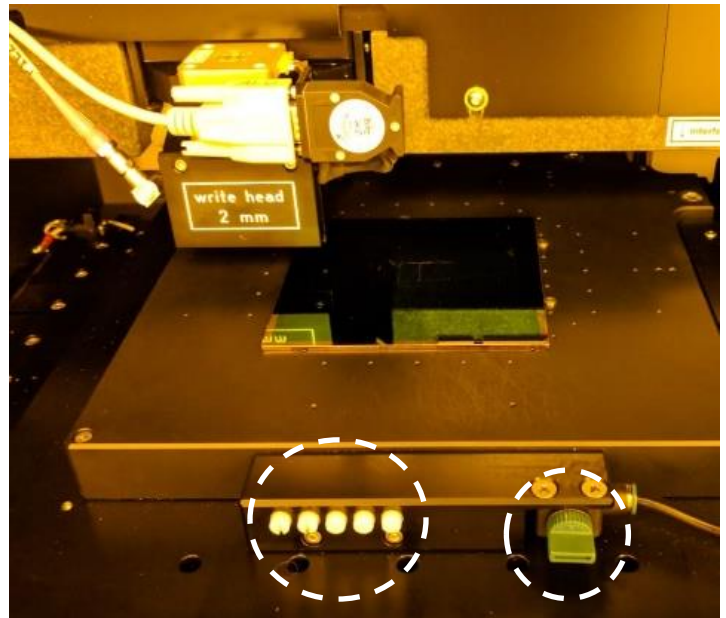


Choose the front five white screws to select the vacuum for the appropriate size of the substrate. From Left-to-Right the screws are for 7", 6", 5", 4" and 3" substrate size.

While placing the substrate, ensure not to hit the write head and the side mirrors on the stage. Avoid putting weight or force on the stage while loading the substrate.

Once the substrate is placed turn the green master vacuum switch on to enable vacuum. Turn horizontal for "on" and vertical for "off".

Close the flow box window.

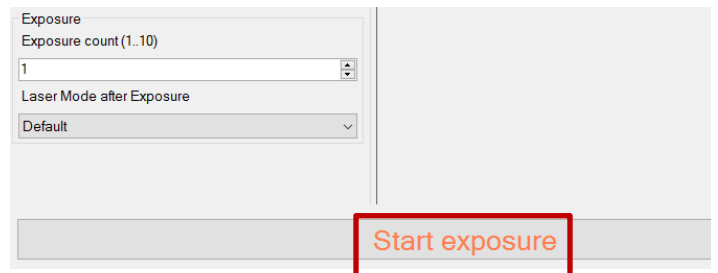


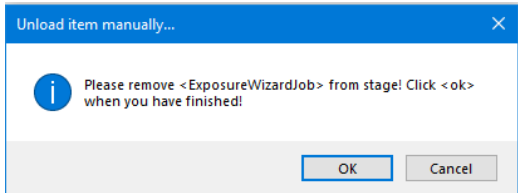
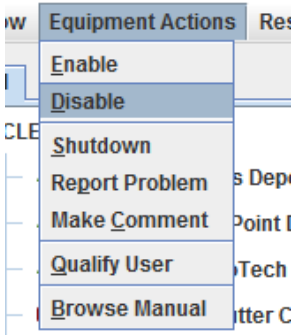
**16. EXPOSURE:**

Click on "Start Exposure" to begin the exposure.

The pop-up message will say "Write Head is NOT focused! Do this right now or cancel processing item?" Click "Yes".

Once the write head is focused on the substrate, FindCenter will be executed.

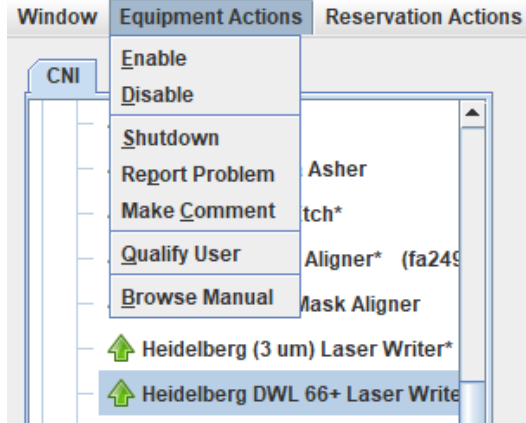

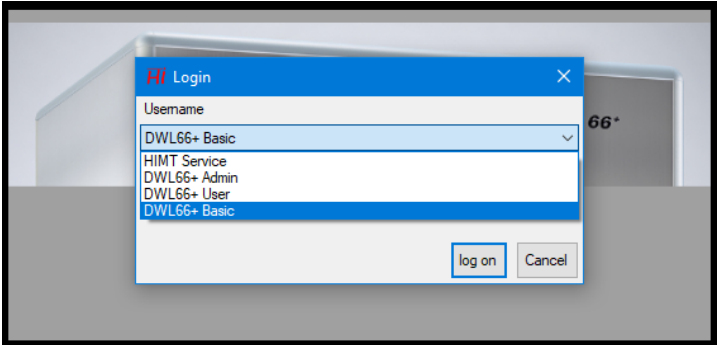
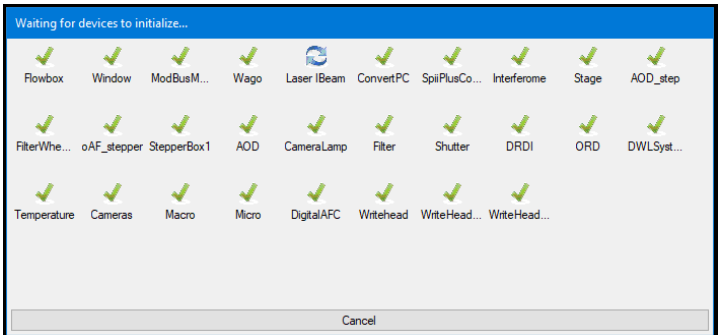


	<p>Wait until another pop-up message asking if you want to start the laser for writing. Click “Yes”.</p> <p>The exposure will start. The progress of the exposure is shown in the wizard.</p> <p>The exposure can be stopped at any time by clicking on “Stop exposure”.</p>	
<p><b>17. UNLOADING:</b></p>	<p>Once the writing is over the stage will automatically move to the load position.</p> <p>Open the flow box window. Turn off the vacuum switch and remove the mask. Close the flow box window.</p> <p>Turn off the software.</p>	
<p><b>18. BADGER LOGOUT:</b></p>	<p>Don’t forget to disable the tool in badger after you’re done.</p>	



**MANUAL MODE:**

You can do exposure in the manual mode when you want to add multiple design patterns into one job file, when you want to do an overlay exposure, or when you want to do a dose test for non-standard resist films other than 530-nm of S1800.

<p><b>19. BADGER:</b> Enable the tool in badger.</p>	
<p><b>20. OPEN SOFTWARE:</b> Follow <b>steps 2-8</b>.</p> <p>Open the <b>Lithography Menu</b> software.</p> <p>Log-in as a <b>User</b> account.</p> <p>Monitor for all the indicators in the pop-up window to show green. If there is any issue, please report to the superusers or cleanroom staff.</p>	  





## 21. SUBSTRATE LOADING:

Ensure that the stage is in the load position. The write head will be at the left back corner of the stage.

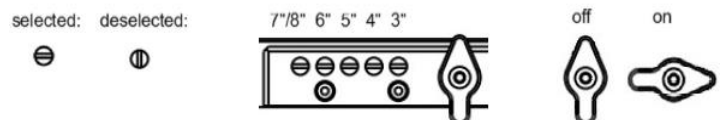
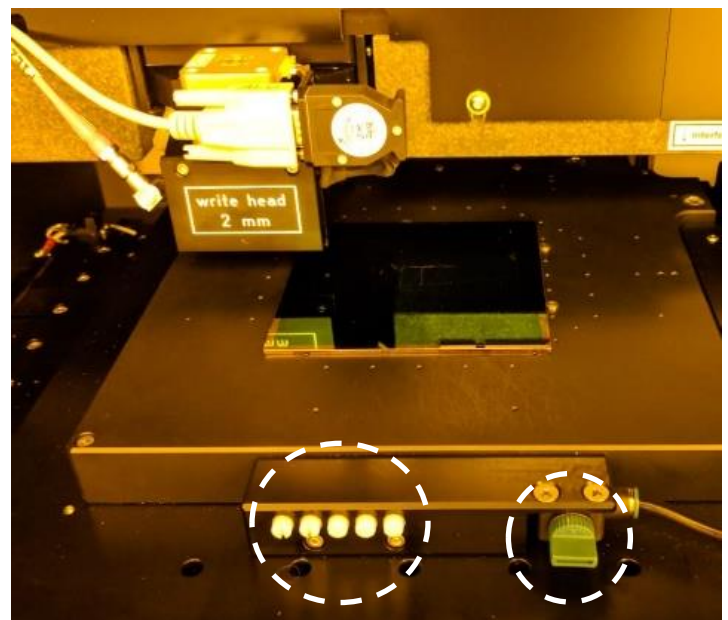
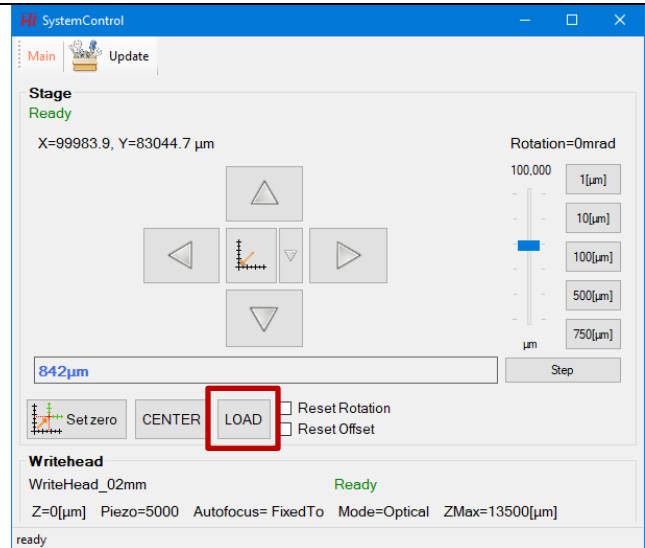
If the stage is not at the load position, click “LOAD”.

Press the red button on the tool side to open the flow box window.

Choose the front five white screws to select the vacuum for the appropriate size of the substrate. From Left-to-Right the screws are for 7”,6”,5”,4” and 3” substrate size.

While placing the substrate, ensure not to hit the write head and the side mirrors on the stage. Avoid putting weight or force on the stage while loading the substrate.

Once the substrate is placed, turn the switch on to enable vacuum. Close the flow box window.





## 22. FOCUS:


Click "CENTER".

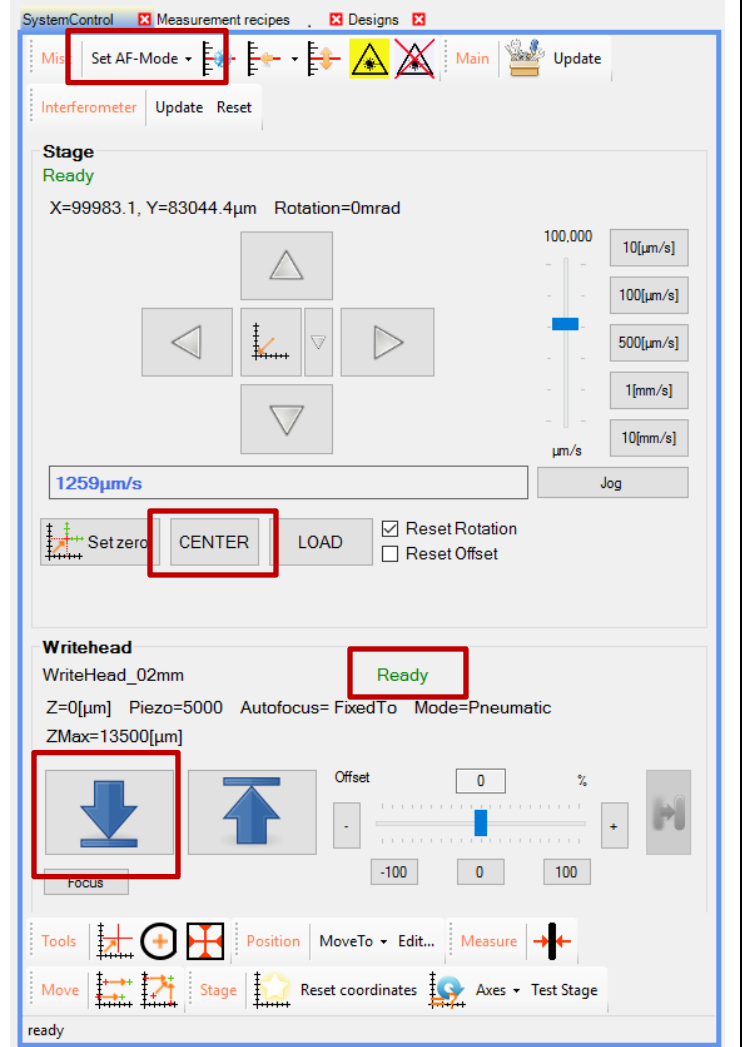
If the camera window doesn't show, go to **Devices>Vision>Cameras**.

Under 'Set AF-Mode', choose the autofocus mode: **Pneumatic or Optical**.

Use the optical autofocus for the finer resolution.

Use the pneumatic autofocus for overlay exposure.

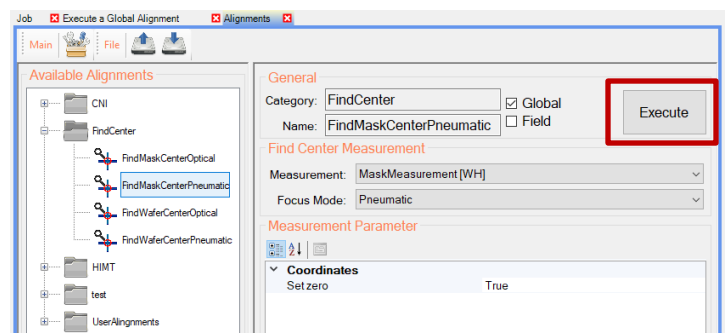
Then, click the focus button . Wait until it shows 'Ready'.



## 23. FIND SUBSTRATE CENTER:

Under the 'Alignments' tab, choose a FindCenter method and click "Execute".

FindWaferCenterOptical and FindWaferCenterPneumatic are for 4" wafers. If you are using rectangular wafer chips, they are considered as a mask for the alignment algorithm.



## 24. CREATE JOB:

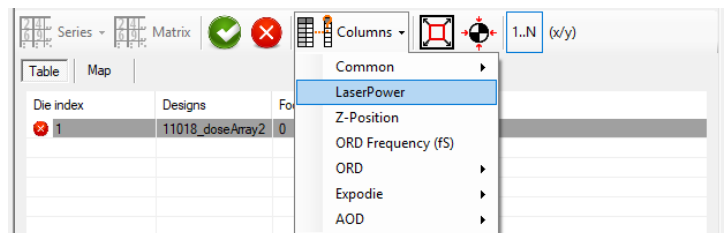
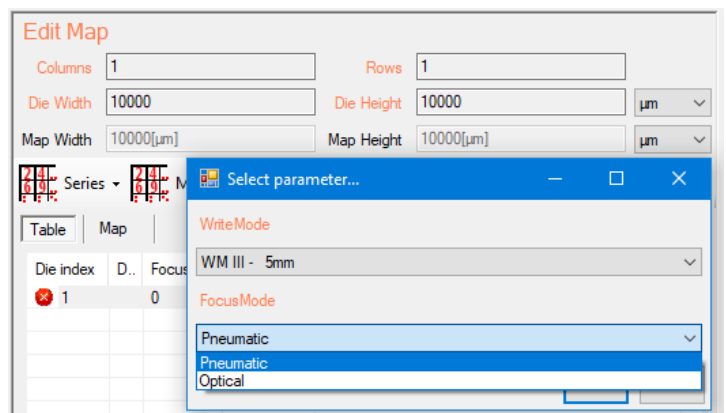
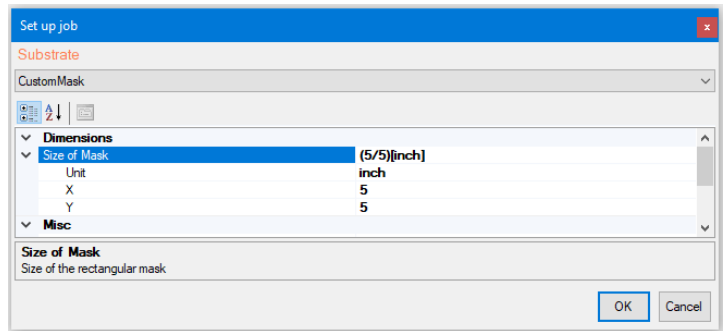
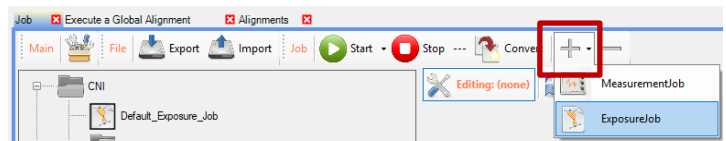
Under the 'Job' tab, choose or create your group directory. Then, create a job by clicking "+" button and selecting "ExposureJob".

Choose your substrate type from the drop-down menu. Update the size of mask according to your sample or mask plate.

Click on a row. Find your converted design under the 'Designs' tab in the right half of the window. Click on the '+' icon next to your design and choose the design file nested under. Drag the design into the die. Make sure the WriteMode is correct. Then, select the FocusMode.

Add a column of 'LaserPower'. Double click on each box and type the dose parameters. The parameters for the regular mask with S1800 resist are available on the desktop note. Please check the most updated parameters.

**\*\*If you want to do an overlay exposure, please see the Global Alignment section (steps 29 - 34).**



## 25. SERIES EXPOSURE:

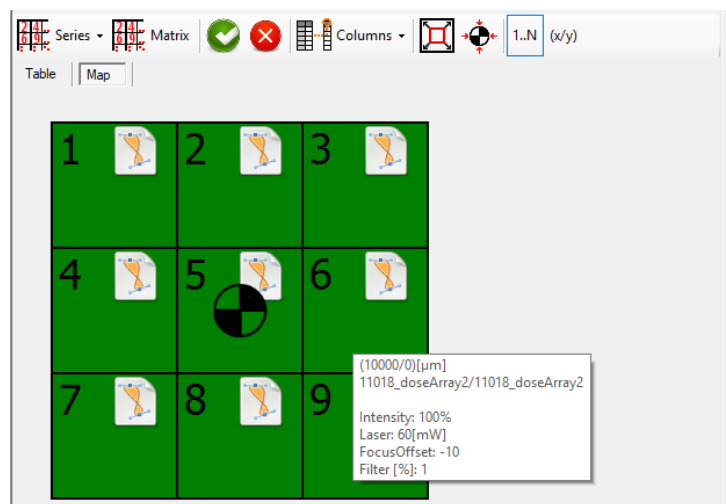
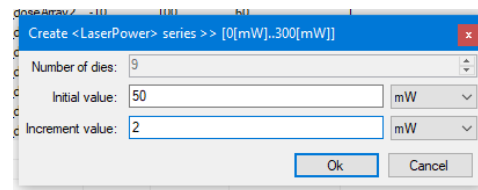
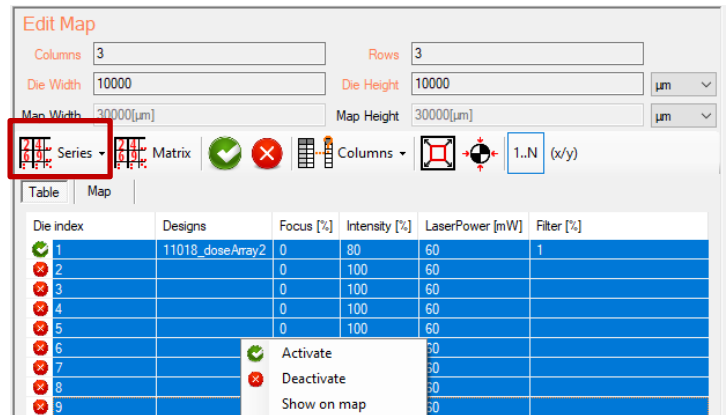
To repeat the design in a grid fashion on the substrate or to do a dose test, use the column/row numbers. Considering the size of your design and the spacing between designs, update 'Die Width' and 'Die Height'. You need to double click on each box and to type and enter to update the values.

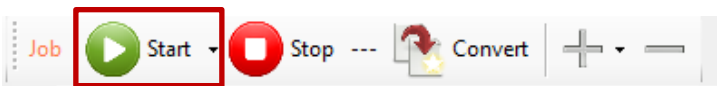
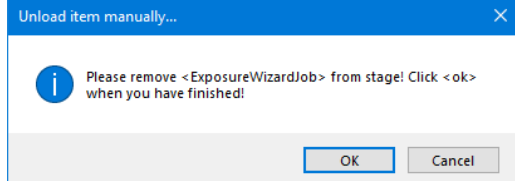

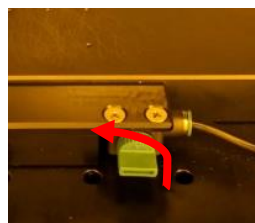
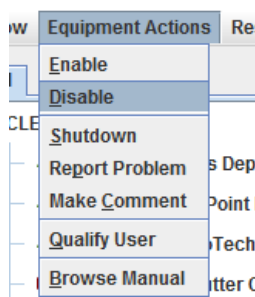
You can also load different designs into one job file.

To do a dose test, use the 'Series' drop-down list. You can do series exposures of Intensity (20 – 90%), Laser Power (up to 270 mW), and Filter (0.1 – 50%).

Make sure to click "Activate" for each of the grid cells. If the grid cell is Green, it is activated to write.

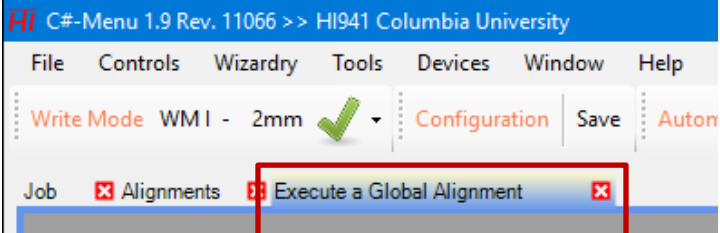

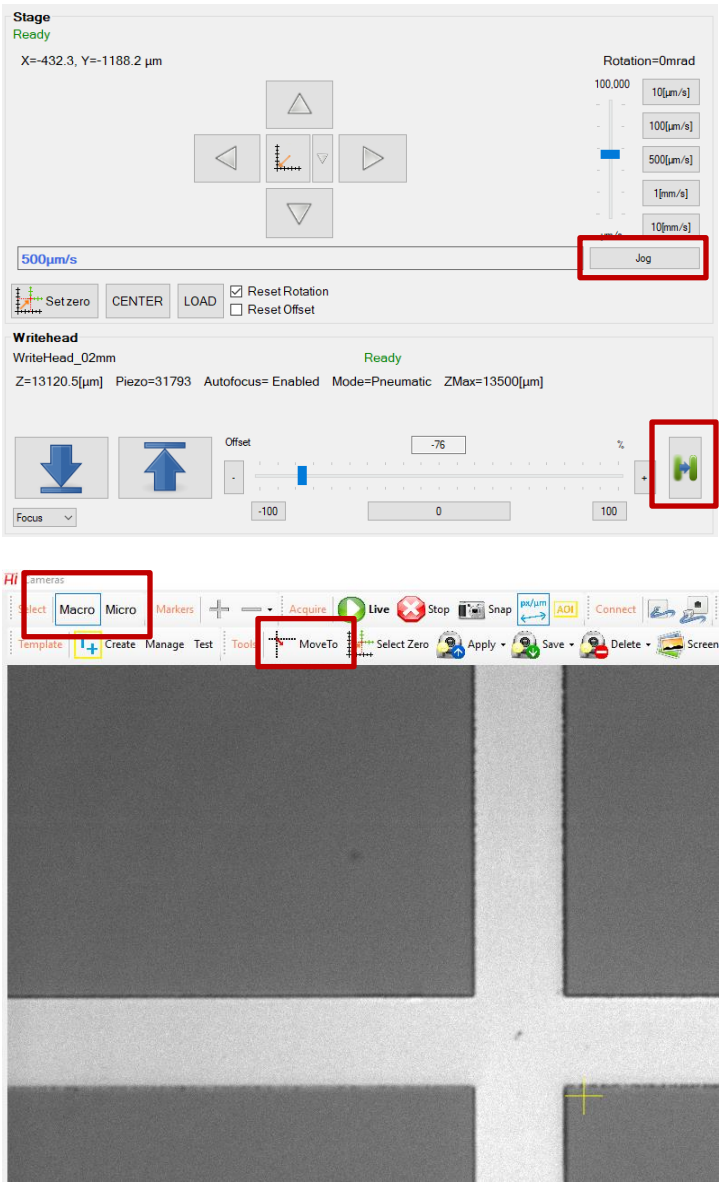
Go to 'Map' view and move the crosshair to the desired position, which represents the center of the substrate.



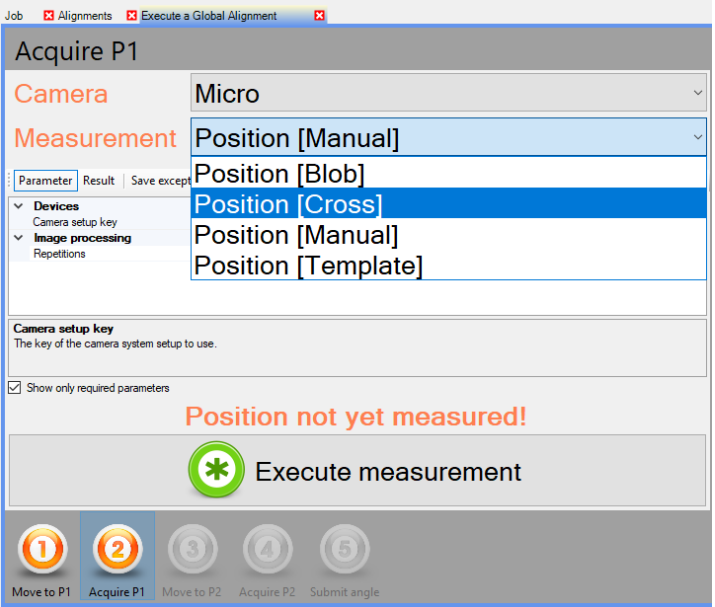
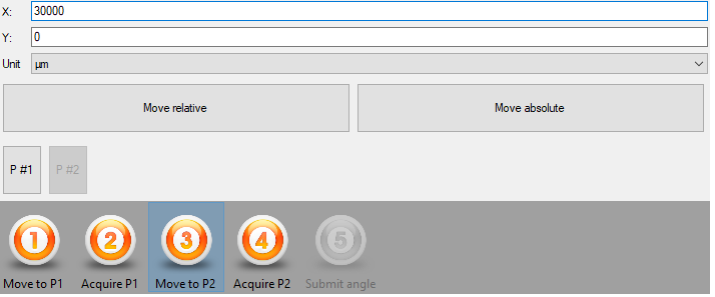

<p><b>26. EXPOSURE:</b></p> <p>Review all parameters carefully and then click “Start”.</p> <p>The pop-up message will ask if you want to start the laser for writing. Click “Yes”.</p> <p>The exposure will start. The progress of the exposure is shown in the wizard. The exposure can be stopped at any time by clicking on “Stop exposure”.</p>	
<p><b>27. UNLOADING:</b></p> <p>Once the writing is over the stage will automatically move to the load position.</p> <p>Open the flow box window (red button). Turn off the vacuum switch and remove the mask. Be careful not to hit the write head. Close the flow box window.</p> <p>Close the software.</p>	  
<p><b>28. BADGER LOGOUT:</b></p> <p>Don't forget to disable the tool in badger after you're done.</p>	



## GLOBAL ALIGNMENT:

<p><b>29. GLOBAL ALIGNMENT:</b>          In the user mode, the “Execute a Global Alignment” window will be available. If it doesn’t show, go to <b>Wizardry&gt;Execute a Global Alignment</b>.</p>	
<p><b>30. MOVE TO P1:</b>          If the camera window doesn’t show, go to <b>Devices&gt;Vision&gt;Cameras</b>.</p> <p>First choose “Macro” camera and find the first alignment mark using ‘Step’ or ‘Jog’. Click on “Move To” icon to bring the center of the mark to the center of the camera window.</p> <p>Click the focus offset button  to get a fine focus of the marks. Then, change it to “Micro” camera and do the fine focus again.</p> <p><b>Note that you must use the “Micro” camera to do a global alignment.</b></p>	



<p><b>31. ACQUIRE P1:</b></p> <p>Choose the type of measurement. For [Blob] and [Cross] measurements, the structure should be small enough to fit in the “Micro” camera view.</p> <ul style="list-style-type: none"> <li>- Position [Blob]: the center of a certain structure</li> <li>- Position [Cross]: the center of a cross structure</li> <li>- Position [Manual]: user manually marks the point of interest in the camera window when prompted.</li> </ul> <p>Click “Execute measurement”.</p>	
<p><b>32. MOVE TO P2:</b></p> <p>Locate the second alignment mark by either using the wizard panel or the SystemControl.</p>	
<p><b>33. ACQUIRE P2:</b></p> <p>Choose the same type of measurement for P1. Click “Execute Measurement”. Then, the final page will show you the corrected angle.</p> <p>You should “Save” to apply the angle.</p>	






### 34. SET ZERO:

Move to the position where you want to set zero. Then, click on “Set zero”.

Note that if you set zero before the global alignment. You should set zero again because (0,0) position will be slightly moved after the rotation applies.

Also, ‘CENTER’ position is the center of the loading stage, not (0,0). To go to (0,0) position, click on the axis icon.

If your alignment mark is a cross structure, you can use the pre-defined detection method to set zero. Click on the cross icon  and define the Area of Interest (AOI). Then, the center of the cross will be detected and set to be a zero position.

