

Overview

This SOP gives instructions on how to set up and execute an exposure job with the MLA150. Follow the instructions carefully. If you require more detailed information, refer to the related document User Guide.

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Restrictions & Precautions

- Max Substrate Thickness: 9 mm
- Max. Substrate Size: 9 x 9 inches
- Minimum Substrate Size: 5 x 5 mm - **Running samples with dimensions < 5 mm requires additional training.**
- **Do not run samples with dimensions <12 mm using pneumatic focus as system damage will occur!**
- **Do not run samples with features >40 µm in height as system damage will occur!**
- **Do not run samples with edge-bead thicker than 120 µm as system damage will occur!** If your sample has a thick edge-bead, use a razor blade or solvent to remove it. For reference these would be PR's that generate bubbles during dispense (PMGI, SU8, BCB) or PR's >5µm thick. These should be checked carefully and can be checked using the following method:
https://wiki.nanotech.ucsb.edu/wiki/UCSB_NanoFab_Microscope_Training#Depth_Measurements_using_focus

Operation

The user and password for the Windows PC is written at the tool. If you ever have to restart the computer, make sure to wait at least 1min after login before launching MLA150Menu.exe, as it loads background drivers.

CAD file Design Info

- GDS / GDSii is the preferred file format (fewest errors). DXF, CIF, BMP and Gerber are also available.
- Note the Cell that you want to print. Only one Cell may be printed, so use Cell Instancing to create combinations of Cells.
- Note the Layer(s) to print. The system can select either a single Layer or can combine multiple layers via Boolean OR.
- The Origin (0,0) in your file is the reference for all coordinates during exposure, including alignment mark exposure/measurement.
- The CAD file's origin should be in a uniform area of the PR, not at the edge bead or non-uniform corners of the sample, or there is risk of Optical Auto Focus failure.
- Your file name cannot contain any spaces or special characters except for underscores.
- Make sure the file extension is all lower case (e.g. .gds not .GDS) as some design programs (e.g. Klayout) will create a file with an upper-case file extension.

Transfer your design file(s) to the tool via Nanofiles FTP

- You must have a folder named according to your group/company on the machine for ~24hrs in order for the MLA150 folder to appear on the Nanofiles SFTP.

On your own computer:

1. Log into the Nanofiles SFTP folder with an FTP client.
See the [Wiki FAQ for steps to get a Nanofiles FTP login](#).
2. Upload your design files into the "**MLA150_Heidelberg**" folder.
You can read/write and create subfolders in this directory.

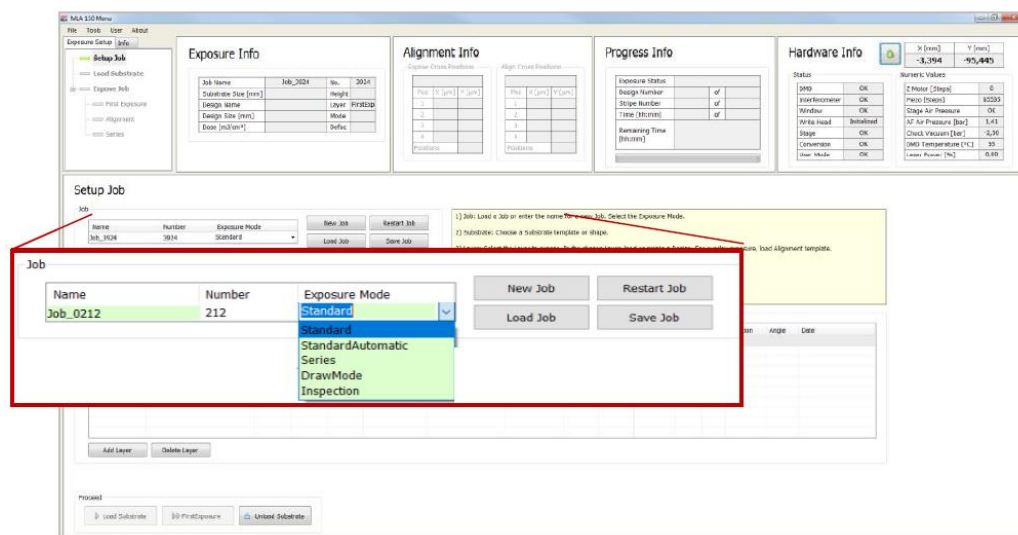
On the MLA computer:

3. Run the "**Sync to Nanofiles**" script on the Desktop, Start Menu or Task Bar.
 - a. Make sure there aren't any errors in the log window, then press any key to complete.
4. Open the "**Users_Nanofiles**" folder (Desktop, Start Menu or File Explorer).
5. Copy or Cut the new design files.
6. Open the "**Designs**" folder and navigate into the correct subfolder for your file type.
7. Paste the CAD file into the correct sub folder.
 - a. Do NOT make subfolders within these directories, or alter the folder names, or the *Convert* software will not be able to read your files.

Setting up the exposure job

If the 'MLA 150 Menu' software is not open, click the shortcut icon on the desktop of the User PC, the wizard opens and leads you to the **Setup Job** panel, where a new job has been created automatically. This system will generate a **Name** and a **Number**. Change the name by clicking into the **Name** field.

The naming convention is **LastnameFirstinitial_jobname** or **companyname_jobname** (e.g. **sawyerl_myfirstjob** or **staff_trainingjob_oct10**).



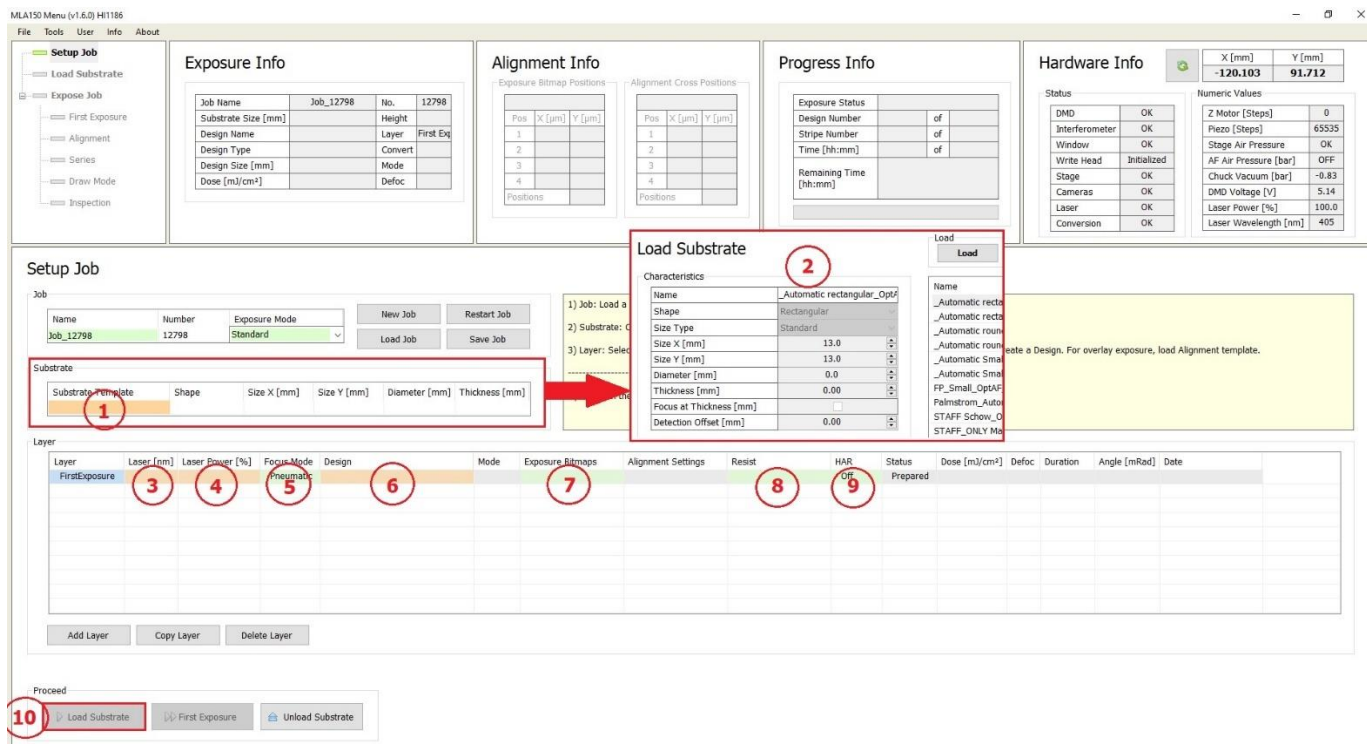
From the drop-down list, select one of the available exposure modes:

- **Standard:** To expose a single design for each layer. This mode is used for overlay exposures as well.
- **Series:** To expose designs (e.g. dose test) several times at different positions with varying parameters (dose or/and defoc). It can also be used for finding the appropriate dose and defoc relation for the exposure.
- **Draw Mode:** To create boxes, circles or ellipses of arbitrary size limited only by the camera field. Used for creating alignment marks/connections on arbitrary structures or for repairing imperfections in structures of an exposed layer. For more information, see pg.60 of the User Manual available at the tool.
- **Inspection:** To inspect and measure the exposed structures.

If you do not intend to use the new job, you can also choose from the following options in the Job frame:

- To continue or repeat a job, click **Load Job**. A list appears from where you select the required job. There is a **Search** option available as well.
- To repeat an exposed layer of that job you need to copy the job with **Restart Job**. The system deletes the process data of the selected job and sets up the job with the same settings but with a new job name/number.
- To start another new job after you have finished an exposure job, click **New Job**. The new job has a new number and a new, but editable, name. Continue with the instructions for a new job.

Standard Exposure (without Overlay)*



*For overlay exposures go to the **Standard Exposure with Overlay** section in this SOP.

In the **Substrate** frame:

1. Double-click **Substrate Template**.
2. The optical autofocus template you select will be based on your substrate's size and shape:
 - For whole wafers > 25 mm diameter select the **_Automatic round_OptAF_Generic** template
 - For pieces <12 mm select the **_Automatic Small_OptAF_Generic** template (**Running samples with dimensions <5 mm requires additional training**)
 - For pieces >12mm select the **_Automatic rectangular_OptAF_Generic** template
3. Once you have identified the correct substrate template, you will need to enter your substrate thickness in the template:
 - b. Verify you have the correct template highlighted and click on the **Edit** button.
 - c. In the **Thickness [mm]** field in the **Characteristics** panel, enter your substrate thickness in millimeters (**!!THIS IS THE ONLY PARAMETER YOU ARE ALLOWED TO CHANGE!!**): **IMPORTANT:** There is some leeway with this value, but not a lot. For example, a substrate thickness entry of 525 μm would work for a range of 500-525 μm . Also, you only must compensate for your resist thickness if it is >15-20 μm .

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Load Substrate

Characteristics	
Name	_Automatic round_OptAF_Ge
Shape	Round
Size Type	Standard
Size X [mm]	0.0
Size Y [mm]	0.0
Diameter [mm]	100.0
Thickness [mm]	0.55
For the thickness [mm] of the substrate	☒
Detection Offset [mm]	0.00

Advanced Parameters	
Autofocus Mode	Optical
Check with Overview Camera	☒
Skip Find Plate Center (FPC)	☐
FPC: Use Piezo Freezing	☒
Focus Offset X / Y [mm]	0.0 0.0
Focus Offset Z [mm]	0.000
Max Velocity [mm/s]	0.0
Stop Autofocus Air	☐
Expose with Camera Focus	☐

Edit

New
Copy
Cancel
Save
Delete

Comment

Samples LARGER than 25mm round ONLY!! OpticalAF

Load
Cancel

Name
Automatic rectangular_C
Automatic rectangular_P
Automatic round_OptAF_
Automatic round_OptAF_
Automatic round_OptAF_
Automatic round_OptAF_
Automatic round_PneuAF_
Automatic Small_OptAF_
Automatic Small_OptAF_
Automatic Small_OptAF_
Automatic Small_OptAF_
Automatic Small_OptAF_
Automatic Small_OptAF_
Automatic Small_OptAF_
Automatic Small_OptAF_
Automatic Small_OptAF_
Automatic Small_OptAF_
Automatic Small_PneuAF_
STAFF_ONLY Manual_Aut
STAFF_ONLY Manual_Def
STAFF_ONLY NoCenter ro
STAFF_ONLY rect_OptAF_
STAFF_PSC_Automatic ro
STAFF_TFST_skinfnc
<

d. Click **Save**.

- Verify you have the correct template highlighted and then click **Load**.

NOTE: If you have experienced out of focus exposures on your substrate, consult with Staff about using a pneumatic focus template instead. **Be aware that PIECES SMALLER THAN 12 MM CANNOT BE RAN WITH PNEUMATIC FOCUS!! SYSTEM DAMAGE WILL OCCUR!!** Refer to the visual aid table at the tool for information on focus templates.

In the **Layer** frame:

- Select a laser from the **Laser [nm]** dropdown list, the choices are **375** or **405 nm**.
 - The laser wavelength corresponds to the photoresist you are exposing.
- Select a power from the **Laser Power [%]** dropdown list, the choices are **100%** and **Filter (14 or 15%)**.
 - You should only consider using the **Filter** option if you are working with very thin resist and need more resolution with the dose setting.
- Select a mode from the **Focus Mode** dropdown list, the choices are **Pneumatic** and **Optical**.
 - This is the focus mode the system will use to write the job. It can be different than the focus mode used for the **Substrate Template**, which is what the system uses to detect the substrate size and position
 - during loading. **You should be using the same focus mode that the substrate template is using unless instructed otherwise by Staff.**

IMPORTANT: The software does not reference the substrate template focus mode and will default to **Pneumatic!!**

- Double-click **Design** and load the design file.

For instructions on how to convert a new design, refer to the **Design Conversion** section at the end of this SOP.

9. To expose alignment marks in addition to your design, you can load or create a template for alignment crosses or shapes which are exposed on the layer. To load a template, double-click into the value field titled **Expose Bitmaps**, select a bitmap template file from the list, and click **Load** (or just double click the file). To create a new file:

Load Exposure Bitmaps

Expose Bitmap positions

Pos	X [μm]	Y [μm]
1	0	0
2		
3		
4		

Positions: 1

Top Surface

Use first bitmap for all

▼

Edit

New

Cancel Edit

Save

Delete

- a. In the **Edit** frame, select **New**. A cursor will appear in the field for the file name. Give the file a name using the standard naming convention, e.g. [sawyerl_alignmentOct10](#).
 - b. **Pos 1** in the table will be populated with 0,0 by default. If you wish to change this, select a cell and enter a coordinate value.
 - Make sure at least one or two of your alignment marks are at coordinates $Y \leq 0$, to allow the Wide-view Overview camera to see them.
 - c. After you have the correct coordinates input for **Pos 1**, use the drop-down menu next to the coordinate entries to select a bitmap design. Standard bitmaps are “Cross” and “cross_inverted”. You can also select **<other>** from the drop-down menu and a pop-up window will appear with previews of the bitmap files.
 - d. Repeat the previous two steps for additional bitmap positions (up to 8).

NOTE: After entering coordinates for **Pos 2**, the **Use first bitmap for all** option will become available. Selecting this will automatically populate the bitmap design used in **Pos 1** for all subsequent positions.
 - e. When you are finished entering bitmap positions, select **Save**. Your new bitmap template file will appear highlighted in the file list.
 - f. Either select **Load** or double click the file to add it to the job.
10. Double-click the value field titled **Resist** to load a resist profile. This will populate the fields for **Dose** and **Defoc** when you get to the **First Exposure** panel and will also set the **Defoc Range** for the job. Select a resist profile from the list and click **Load** (or just double click the file). It is strongly advised to at least select one of the two generic resist profiles; **_Generic_Focus_Std** or **_Generic_Focus_Lrg**. This resist profile will set the **Dose** and **Defoc** to 0 (which you can change on the **First Exposure** panel) and enable the either the **Standard** (-10 to 10) or **Large** (-25 to 25) **Defoc Range**. The standard range can reduce exposure variability across your substrate, whereas the large range gives you greater exposure process flexibility.

NOTE: If you do not select a resist profile, the system will default to the **Standard Defoc Range** of -10 to 10.

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11. Select an option from the **HAR** (High Aspect Ratio) dropdown list, the options are **Off**, **Large** and **X-Large**.
 - a. This is the focus depth the system with use to write the job. Most users will set this to **Off**. Please reference the manual or consult with Staff before using the **Large** and **X-Large** options.
12. Load your Substrate with **[Load Substrate]** → See the “**Substrate Loading**” section of the procedure, on page 16.

In the **First Exposure** panel:

The screenshot shows the 'First Exposure' panel with various settings. Red circles with numbers 11 through 20 and 11.a point to specific elements: 11 points to the Laser [nm] field (375); 12 points to the High Aspect Ratio dropdown (Off); 13 points to the Dose [mJ/cm²] field (130); 14 points to the Defoc [-25..25] field (-5); 15 points to the 'Expose with Substrate Angle' checkbox (checked); 16 points to the 'Expose the Bitmaps' checkbox (unchecked); 17 points to the 'Delay Exposure' checkbox (unchecked); 18 points to the 'Auto-Unload the Substrate' checkbox (checked); 19 points to the 'Comment' text field; 20 points to the 'Start Exposure' button; and 11.a points to the 'Setup Job' button.

First Exposure

Exposure Settings

Design Name: Staff_BO_Cal_L1_042722

Laser [nm]: 375

Laser Power [%]: 100%

High Aspect Ratio: Off

Focus Mode: Optical

Dose [mJ/cm²]: 130

Defoc [-25..25]: -5

☒ Expose with Substrate Angle (-2.77 mRad)

☐ Expose the Bitmaps

☐ Delay Exposure [hh:mm]: 0 0 0

☒ Auto-Unload the Substrate

Comment:

Proceed

Start Exposure **Back** **Setup Job**

Expose the first Layer:

- 1) Double-check the Exposure Settings.
- 2) Optional: Expose the Design with the found Substrate angle.
- 3) Optional: Expose Bitmaps.
- 4) Optional: Delay the Exposure.
- 5) Start the exposure.

The Design will be exposed at the zero position of the stage.
To set the current stage position to zero, click the 'Set Zero' button.

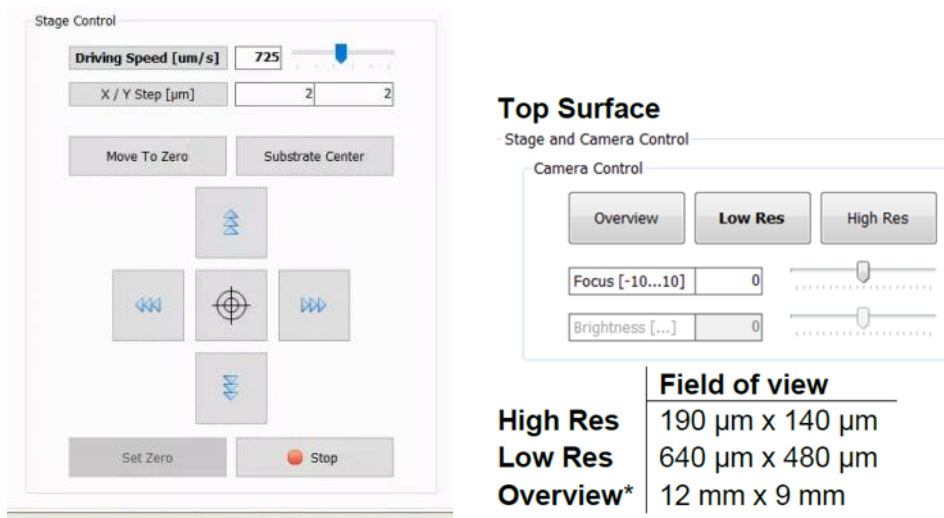
13. Double-check the **Design Name**, **Laser [nm]**, **Laser Power [10%]**, and **High Aspect Ratio** settings.
 - a. If you need to make changes to any of these, click **Setup Job** at the bottom of the screen to return to the **Setup Job** panel.
14. Double-check or edit the **Focus Mode** setting by using the drop-down menu. **You should be using the same focus mode that the substrate template is using unless instructed otherwise by Staff.**
15. Double-check or edit **Dose** value by entering the value into the text field.
16. Double-check or edit **Defoc** value by entering the value into the text field or with the spin buttons (range is -25 to 25).
17. Activate the **Expose with Global Angle** checkbox if it is not already selected.

IMPORTANT: If you are going to expose additional layers on your substrate or if flat/edge alignment is critical, the angle reading in parentheses needs to be at least <10 mRad (0.6°). If measured substrate angle is >10 mRad:

 - a. Click **Setup Job** at the bottom of the screen to return to the **Setup Job** panel.
 - b. Click **Unload Substrate**, a pop-up window will appear confirming you want to unload, click **OK**.

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- c. Wait for the unload sequence to be completed. A pop-up window will appear indicating the substrate has been unloaded, click **OK**.
 - d. Open the sash, release the chuck vacuum, and reposition your substrate using the corresponding alignment fixture.
 - e. Engage the chuck vacuum, remove the alignment fixture, and close the sash.
 - f. Return to Step 10.
18. If you loaded an **Expose Bitmaps** file in the **Setup Job** panel, verify **Expose the Bitmaps** checkbox is selected and that the settings are correct. You can also view the graphic in the **Substrate** frame which shows the approximate location of the bitmaps as numbered crosshairs.
- IMPORTANT:** Although it gives you the option to *create* a bitmap template file on this screen, **DO NOT** do this as it will cause an error.
19. Do not use the **Delay Exposure** option.
20. If desired, activate **Auto-Unload the Substrate**. The system executes the unloading procedure automatically.
21. By default, the system will expose the design with the CAD file's (0,0) origin at the substrate center. To move the exposure location, use the controls in the **Stage Control** frame to drive the stage. You can also select the **Overview***, **Low Res**, or **High Res** camera from the **Camera Control** frame.



*Overview cannot access the entire surface of the substrate due to mechanical limits.

- You can switch between **Driving Speed** (continuous movement) and **X/Y Step** (stepwise movement). In **Driving Speed** mode, change the driving speed [$\mu\text{m}/\text{s}$] either by using the slider or by clicking into the field and entering the speed manually. Alternatively, you can click into the slider field to use the arrow keys on the keyboard for setting the speed. In **X/Y Step** mode enter the step size [μm] for the X and Y direction into the corresponding fields.
- The **Arrow** buttons are used to drive the stage.
- Alternatively, the **Target** button in the center of the **Arrow** buttons can be used to drive the stage to a specific location by clicking on the camera screen. When you click this button it is good for one movement, you will need to click it again for subsequent movements. When activated, use the mouse to move the cursor that has appeared on the camera display to the position you want to move to and then left click on the mouse

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to execute.

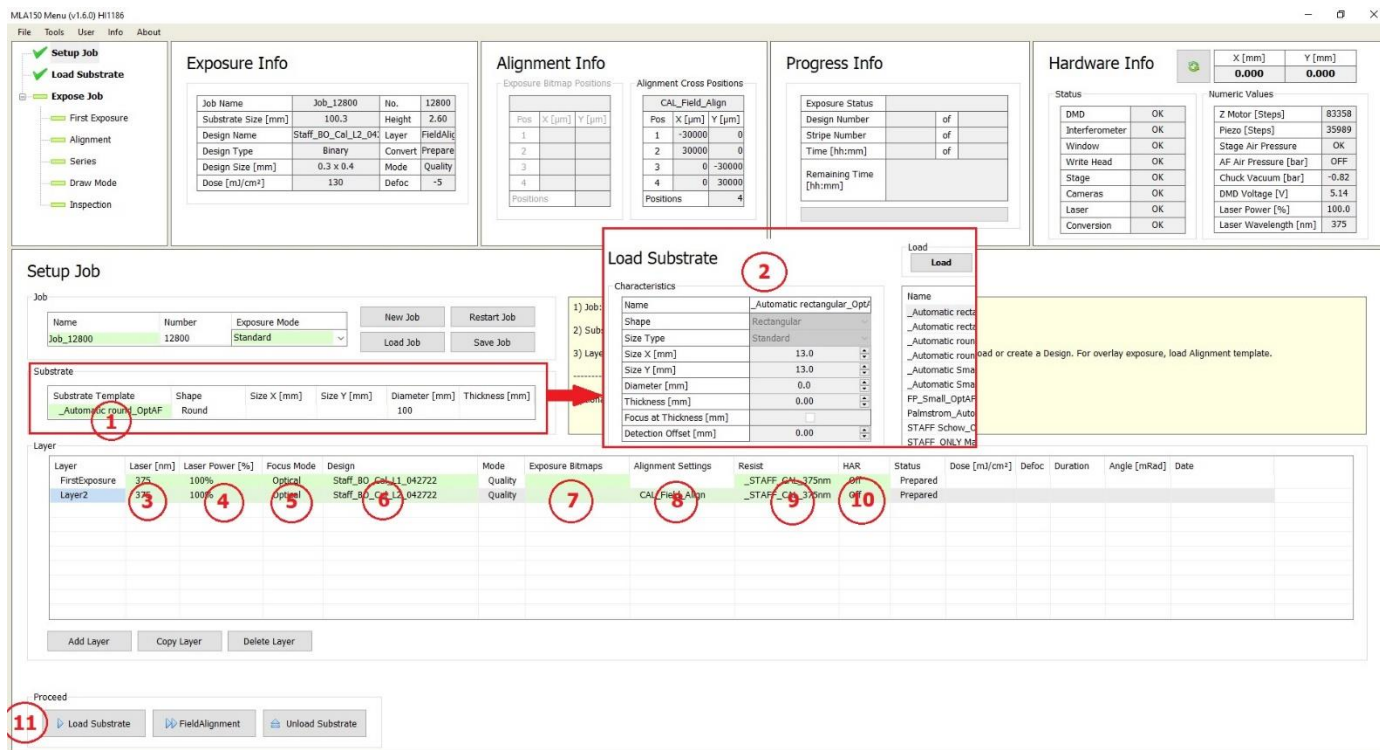
Use the **S** and **C** keyboard keys to toggle the display of a square/circle on the crosshair, and the **Mouse-Wheel** to increase/decrease the size of the guides.

- Additionally, there are **Focus** and **Brightness** controls in the **Camera Control** frame, you can manipulate these the same ways as with **Driving Speed**.
- **Substrate Center** moves to the detected substrate center
- **Set Zero** will set the currently centered location to coordinate (0,0), such that the CAD file's origin (0,0) will be exposed at this location
- **Move To Zero** moves back to the (0,0) coordinates, which defaults to the detected substrate center.
- **Stop** immediately halts a stage movement.

22. Click **Start Exposure**.

IMPORTANT: You must always start your exposure with the **High** or **Low Res** camera selected. Starting an exposure with the **Overview** camera selected can result in an out of focus exposure!

Standard Exposure with Overlay



In the **Substrate** frame:

1. Load a Substrate Template per Steps 1 – 4 of the **Standard Exposure (without Overlay)*** section of this document.

In the **Layer** frame:

For alignment, at minimum, the second layer must be chosen. The first row in the list is always reserved for the first expose without overlay. To leave out the first exposure row, leave it blank and click **Add Layer**.

For alignment, make sure the correct layer # is selected/highlighted. The **FirstExposure** layer can be blank.

2. Select a laser from the **Laser [nm]** dropdown list, the choices are **375** or **405 nm**.
 - The laser wavelength corresponds to the photoresist you are exposing.
3. Select a power from the **Laser Power [%]** dropdown list, the choices are **100%** and **Filter (14 or 15%)**.
 - You should only consider using the **Filter** option if you are working with very thin resist and need more resolution with the dosage setting.
4. Select a mode from the **Focus Mode** dropdown list, the choices are **Pneumatic** and **Optical**.
 - This is the focus mode the system will use to write the job. It can be different than the focus mode used for the **Substrate Template**, which is what the system uses to detect the substrate size during loading. **You should be using the same focus mode that the substrate template is using unless instructed otherwise by Staff.**

IMPORTANT: The software does not reference the substrate template focus mode and will default to **Pneumatic!!**

5. Double-click **Design** and load the design file.
For instructions on how to convert a new design, refer to the **Design Conversion** section at the end of this SOP.
6. You can load or create a template for alignment crosses or shapes which are exposed on the layer. See Step 7 (page 5) of the **Standard Exposure (without Overlay)** section of this SOP for detailed instructions.
7. Double-click the value field titled **Alignment Settings**. From there select an alignment settings template file from the list, choose the “_Manual” setting and click **Load** (or just double click the file). Optionally choose a previous template, or to create a new one:

Load Alignment Settings

Alignment settings

Pos	X [μ m]	Y [μ m]
1	0	0
2		
3		
4		

Positions: 1

Camera for Alignment

☒ Low Resolution
☐ High Resolution

Alignment Correction Options

Rotation [mRad] ☒ Use
Scaling X / Y ☐ Use
Shearing [mRad] ☐ Use

Field Alignment

☐ Use Field Alignment

Load

Edit

New Cancel Edit Save Delete

- a. In the **Edit** frame, select **New**. A cursor will appear in the field for the file name. **Give the file a name using the standard naming convention.**
- b. **Pos 1** in the table will be populated with 0,0 by default. If you wish to change this, select a cell and enter a coordinate value.
NOTE: Whenever possible, your First alignment position should always be on the bottom half (-Y) of the substrate or at 0,0. This will allow the **Overview** camera to be used if needed.
- c. Repeat the previous two steps for additional alignment positions (up to 8).
- d. In the **Camera for Alignment** frame, select either **Low Resolution** or **High Resolution**.

	Field of view
High Res	190 μ m x 140 μ m
Low Res	640 μ m x 480 μ m

NOTE: This will be the initial camera used when you begin your alignment, you will be able to select the other cameras during the alignment process. For more accurate alignment, it is recommended to use the High Res camera.

- e. In the Alignment Correction Options frame make sure the **Rotation** option is selected. **Scaling X/Y** and **Shearing** are also available options.
 - a. These will adjust your CAD file to accommodate measured Rotation, Scaling and Non-Orthogonality measured in the alignment mark positions.

NOTE: When you get to the **Alignment: Exposure** panel, you will have the ability to select/deselect these options as well.

- f. The **Field Alignment** feature is not covered by this SOP.
- g. When you are finished, select **Save**. Your new alignment positions template file will appear highlighted in the file list.
- h. Either select **Load** or double click the file to add it to the job.

Recommendation: To set the alignment marks manually, select the template **_Manual** for manual setup. When using this template file, you will enter the alignment positions after wafer loading sequence.

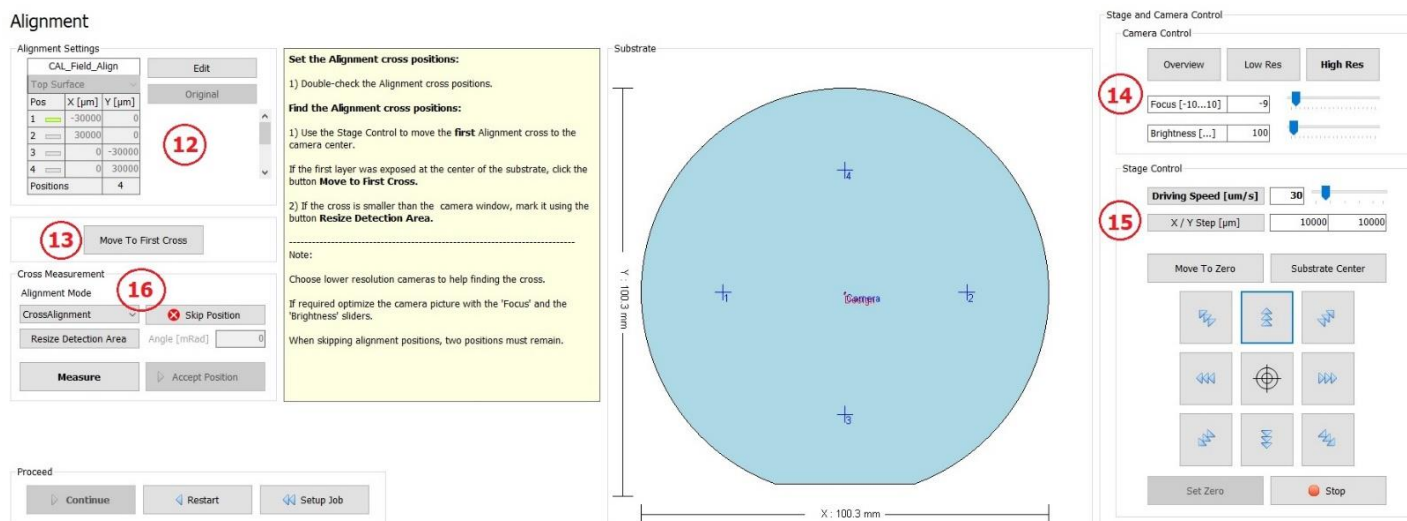
- 8. Double-click the value field titled **Resist** to load a resist profile. This will populate the fields for **Dose** and **Defoc** when you get to the **Alignment: Exposure** panel and will also set the **Defoc Range** for the job. Select a resist profile from the list and click **Load** (or just double click the file). It is strongly advised to at least select the generic resist profile, **_Generic_Focus**. This resist profile will set the **Dose** and **Defoc** to 0 (which you can change on the **Alignment: Exposure** panel) and enable the **Large Defoc Range** (-25 to 25, which gives you greater exposure process flexibility).

NOTE: If you do not select a resist profile, the system will default to the **Standard Defoc Range** of -10 to 10.

- 9. Select an option from the **HAR** dropdown list, the options are **Off**, **Large** and **X-Large**.
 - a. This is the focus depth the system will use to write the job. Most users will set this to **Off**. Please reference the manual or consult with Staff before using the **Large** and **X-Large** options.
- 10. Load your Substrate with **[Load Substrate]** → See the **"Substrate Loading"** section of the procedure, on page 16.

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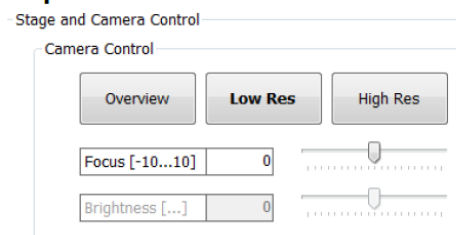
The **Alignment** panel:



In the **Alignment Settings** frame:

- Type in or double-check the positions of the alignment marks taken from the template file. You can also view the graphic in the **Substrate** frame which shows the approximate location of the alignment locations as numbered crosshairs.
 - To change the cross positions, click **Edit**. Now the table entries can be edited and the button caption changes to **Apply**. Enter new values and click **Apply** to leave the editing mode. The positions are stored in a temporary file and turned into a permanent template after the exposure starts.
 - To restore the original positions from the file, click **Original**.
 - If the template **_Manual** was selected, set the alignment marks manually by using the **Edit** function. For every alignment cross enter the coordinates and when finished click **Apply**.
NOTE: Whenever possible, your first alignment position should always be on the bottom half (-Y) of the substrate or at 0,0. This will allow the **Overview** camera to be used if needed.
- The stage location will initially be at 0,0 (detected substrate center) regardless of the location of your first alignment mark. Click **Move To First Cross** to move to **Pos 1** (Position 1) and begin the alignment process.
NOTE: The current location of the stage is displayed in the **Hardware Info** panel in the upper right corner of the screen.
- The default camera will be what you selected when you created the **Alignment Settings** template file (either High or Low Res). You should see your first alignment mark in the camera window on the other screen; it may or may not be centered in the display. If you do not see it, you can select a different camera (**Overview** in this case) from the **Camera Control** frame:

Top Surface

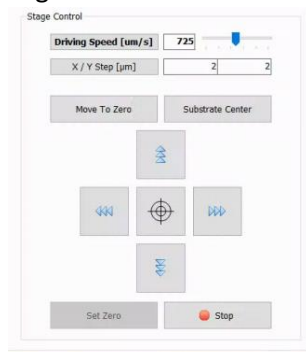


	Field of view
High Res	190 μm x 140 μm
Low Res	640 μm x 480 μm
Overview*	12 mm x 9 mm

*Overview cannot access the entire surface of the substrate due to mechanical limits.

NOTE: Use the **High Res** or **Low Res** camera for alignment. The **Overview** camera is useful for the initial location of alignment marks or alignment procedures with coarse structures.

- Now use the controls in the **Stage Control** frame to drive the stage, roughly placing the center of your alignment mark on the crosshair in the middle of the camera window. You want to work your way up to the **High Res** camera as this will provide the most accurate alignment (given your alignment marks are not too big).



- Refer to the stage movement description in the previous section for detailed instructions.
- In the Cross Measurement frame, use the **Alignment Mode** dropdown list to choose between **CrossAlignment**, **RectangleAlignment**, and **ManualAlignment**. This selection can be made for every single position.
 - Choose **CrossAlignment** or **RectangleAlignment** mode for automatic alignment using digital image recognition based on the shape of your alignment mark.
 - Click **Measure**. The system measures the position of the cross and moves it to the center of the camera window. Optionally Click **Re-Measure** to realign, possibly improving alignment accuracy.
 - Examine the position and click **Accept Position** to confirm it. The procedure moves on to the next alignment cross. In the **Pos** field, the rectangle turns into a green check.
- NOTE:** Unsatisfying measurements can be repeated by clicking **Re-Measure**. For the finding cross function to work properly it is important that the alignment cross fills the entire camera window. If this is not the case, click **ResizeDetectionArea**. Inside the camera window, a rectangle appears showing the new detection area. To enlarge the detection

area, click the right bottom corner of the rectangle without releasing it and drag it to the desired size while holding down the mouse button. To enlarge the detection area again, click **MaximizeDetectionArea** in the panel.

ManualAlignment Mode:

- In this mode, the user locates the alignment mark center by moving the stage.
- Click **Measure**. In the camera window, a crosshair appears. Move the crosshair to the center of your alignment mark*. Once you are satisfied with the placement of the crosshair, click the left mouse button to fix the position. To center the position of the alignment mark inside the camera window, click **Center Cross**. Examine the position and click **Accept Position** to confirm or **Re-Measure** to adjust the position. Once you **Accept Position**, the procedure moves on to the next alignment cross. In the **Pos** field, the rectangle turns into a green check.

***NOTE:** Press S (square) and/or C (circle) on the keyboard and a rectangular and/or a circular frame will appear to support positioning into the center of the mark (both can be on at the same time). The frame can be enlarged or reduced by using the mouse wheel. Pressing C or S again makes the rectangle/circle disappear. To speed up the resizing of the frame, use Ctrl+ mouse wheel.

You can skip bad alignment positions by clicking **Skip Position**. Alignment only works if more than two points are available otherwise the button is disabled. In the **Pos** field the rectangle turns red indicating that this coordinate pair was ignored.

16. Repeat the Steps 12 – 14 for all alignment positions.

NOTE: Restarting the alignment procedure is possible by clicking **Restart**. Alternatively, you can click **Setup Job**; the alignment procedure gets cancelled and the Exposure Wizard moves back to the **Setup Job** panel.

17. Once you accept or skip the last alignment position, the **Alignment: Exposure** panel will appear.

In the **Alignment: Exposure** panel:

Alignment: Exposure

Exposure Settings

Design Name: Staff_BO_Cal_L2_042722

Laser [nm]: 375 (19)

Laser Power [%]: 100%

High Aspect Ratio: Off

Focus Mode (20): Optical

Dose [mJ/cm²]: 130 (21)

Defoc [-25...25] (22): -5

Alignment Correction Options

Rotation [mRad]: 1.757 (23) ☒ Use (25)

Scaling X / Y (23): 0.999999 / 0.999999 ☐ Use (26)

Shearing [mRad]: 0.000 ☐ Use

☐ Auto-Unload the Substrate

☐ Delay Exposure [hh:mm]

☐ Expose the Bitmaps (24)

Field Alignment

☐ Expose the Design several times in a Map using Field Alignment

Comment

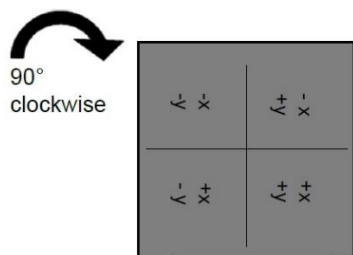
Proceed (27)

Start Exposure (19.a) **Back** **Setup Job**

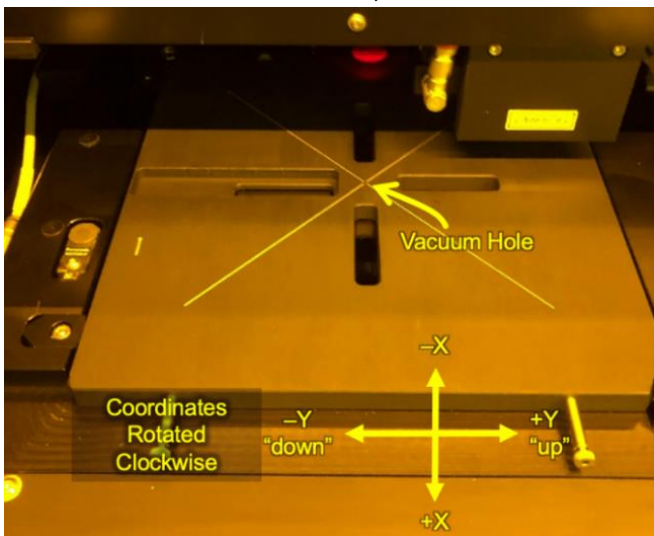
18. Double-check the **Design Name**, **Laser [nm]**, **Laser Power [10%]**, and **High Aspect Ratio** settings.
 - a. If you need to make changes to any of these, click **Setup Job** at the bottom of the screen to return to the **Setup Job** panel.
19. Double-check or edit the **Focus Mode** setting by using the drop-down menu. **You should be using the same focus mode that the substrate template is using unless instructed otherwise by Staff.**
20. Double-check or edit **Dose** value by entering the value into the text field.
21. Double-check or edit **Defoc** value by entering the value into the text field or with the spin buttons (range is -25 to 25).
22. Verify or select the **Alignment Options** (these may have been set at Step 8.e.):
 - **Rotation [mRad]**: This checkbox should be activated. The system corrects for the rotation of the substrate by adjusting the CAD file (only if the design has not been converted yet).
IMPORTANT: For the best results, the angle reading in parentheses needs to be at least <10 mRad (0.6°). If measured substrate angle is >10 mRad:
 - a. Click **Setup Job** at the bottom of the screen to return to the **Setup Job** panel.
 - b. Click **Unload Substrate**, a pop-up window will appear confirming you want to unload, click **OK**.
 - c. Wait for the unload sequence to be completed. A pop-up window will appear indicating the substrate has been unloaded, click **OK**.
 - d. Open the sash, release the chuck vacuum, and reposition your substrate using the corresponding alignment fixture.
 - e. Engage the chuck vacuum, remove the alignment fixture, and close the sash.
 - f. Return to Step 11.
 - **Scaling X/Y**: The system compares the distance measured during alignment with the distance given by the alignment positions. From the deviation, a scaling factor results. On this basis, the alignment design is shrunk or stretched in order to match the previous layer.
 - **Shearing [mRad]**: The system compensates small distortions such as a rectangle that appears more like a parallelogram.
23. If you loaded an **Expose Bitmaps** file in the **Setup Job** panel, verify **Expose the Bitmaps** checkbox is selected and that the settings are correct. You can also view the graphic in the **Substrate** frame which shows the approximate location of the bitmaps as numbered crosshairs.
IMPORTANT: Although it gives you the option to *create* a bitmap template file on this screen, **DO NOT** do this as it will cause an error.
24. If desired, activate **Auto-Unload the Substrate**. The system executes the unloading procedure automatically.
25. Do not use the **Delay Exposure** option.
26. Click **Start Exposure**.
IMPORTANT: You must always start your exposure with the **High** or **Low Res** camera selected. Starting an exposure with the **Overview** camera selected can result in an out of focus exposure!

Substrate Loading

- The coordinate system is rotated 90° Clockwise, so the Left of the chuck is “down” (–Y), and Right is “up” (+Y).



- Make sure a flat / straight edge is on the *LEFT* (–Y), for the system to detect substrate rotation.
 - Do not open the Chamber Window during loading/unloading – system will abort stage movements.
- If not already done, load a Substrate Template per Steps 1 – 4 of the **Standard Exposure (without Overlay)*** section of this document.
NOTE: If you have experienced out of focus exposures on your substrate, consult with Staff about using a pneumatic focus template instead. **Be aware that PIECES SMALLER THAN 12 MM CANNOT BE RAN WITH PNEUMATIC FOCUS!! SYSTEM DAMAGE WILL OCCUR!!** Refer to the visual aid table at the tool for information on focus templates.
 - Fill in the Job Name, Exposure Mode, Laser and Design as detailed above.
 - Verify the stage is in the load/unload position (see photo below).
If stage is not in load/unload position, then:
 - Close the Chamber Window and click on **Unload Substrate** in the **Setup Job** panel.
A pop-up will appear confirming you want to unload, click **OK**.
Once the unload process is complete another window will pop-up stating the substrate has been unloaded, click **OK**.



**Stage in
Load/Unload
Position**

- Click the **[Substrate Load]** Button and follow the instructions.
- If needed, turn on the flow/environmental box light by pressing the orange button on the front of the system.

MLA150 Operation

6. Press the lower red button ($\uparrow\downarrow$) to open the sash of the flow box.

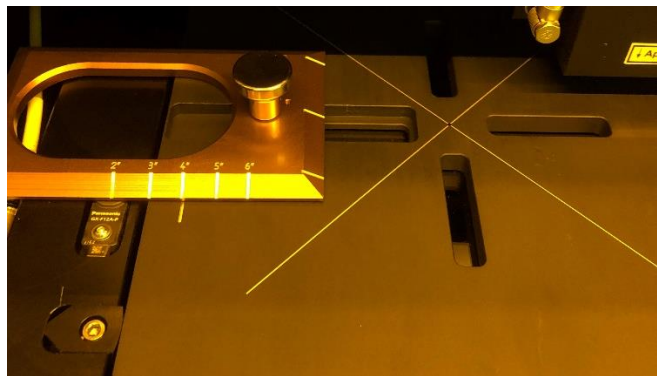
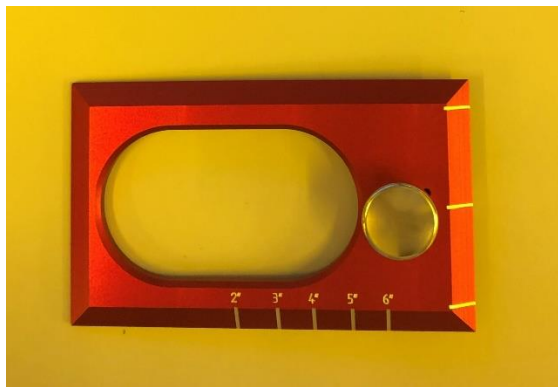


← Lighting

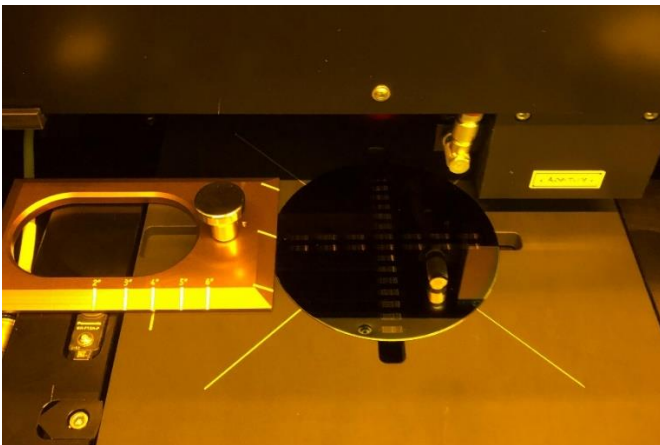
← Open/Close Window

If Loading a Full Wafer (round)

7. Find the wafer flat alignment fixture from inside the flow box and place it on the chuck as shown. There are labeled increments on the fixture for 2 – 6" wafers. Line up the increment corresponding to your wafer size with the white hash mark on the stage, you will feel an indent for each increment.



8. Place your wafer on the chuck and press the Wafer Flat to the Left, against the alignment fixture as shown.

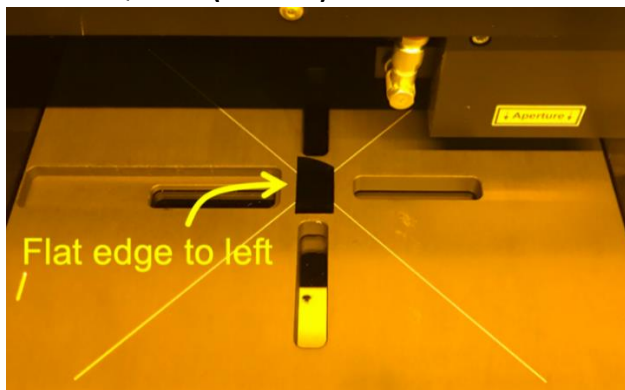


MLA150 Operation

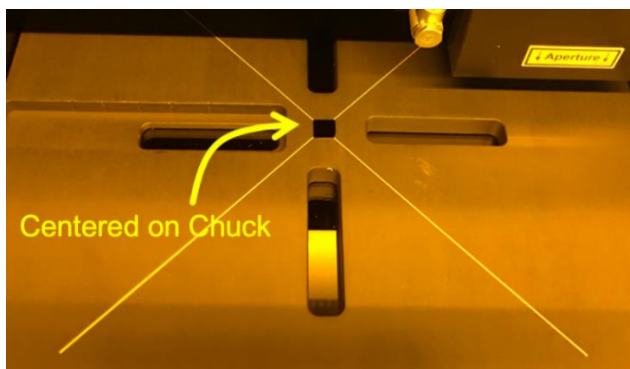
If Loading a Piece (irregular or rectangular)

9. Make sure to place the piece centered on the chuck. Important to prevent crashing and for good vacuum.
 - a. Try to position the piece as straight as possible, with a flat edge to the left for automatic substrate rotation measurement.

Cleaved Quarter (> 12mm):



≤ 12mm Piece:



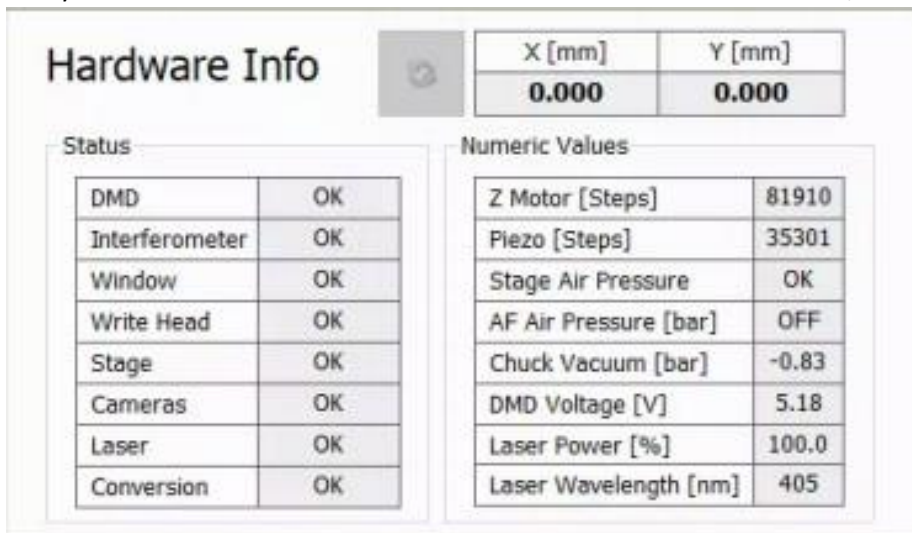
10. Turn On Vacuum: To your right, inside the flow box, is the chuck vacuum control. Press the button below the display to turn on the vacuum. The upper reading on the Vacuum display should be better than -0.50 bar. If it is not, turn off the vacuum and inspect the back of your substrate for cleanliness.



11. Push the sample from the side to ensure sample is held well by vacuum.
12. **IMPORTANT:** Remove the alignment fixture from the chuck and close the sash.
 - a. **Make sure nothing on the stage is taller than the sample, and sample is centered, to prevent crashing the exposure optics!**

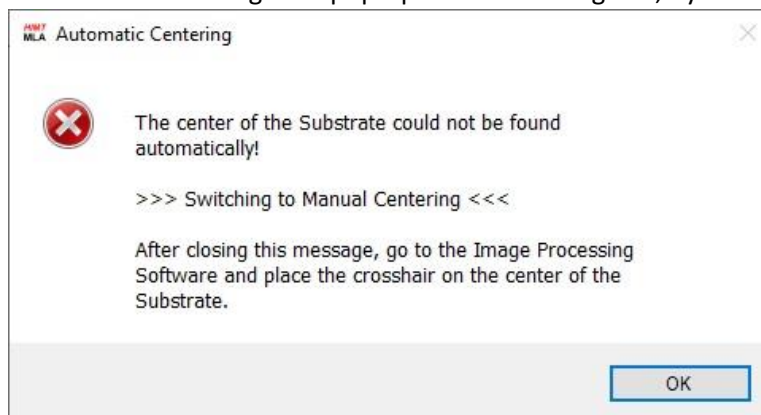
MLA150 Operation

13. Press **[Continue]**, the system will drive the wafer stage under the exposure lens.
14. The system will pause again, while you visually verify the sample is under the lens. You should also verify that the X and Y values in the **Hardware Info** Panel are close to 0,0.



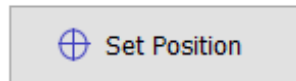
The amount of tolerance for these values will depend on your sample size. For example, if your sample is 10 x 10 mm, then a value of >4 mm (for X or Y) could potentially create a situation where the head could crash. To rectify this, you will need to initialize the stage as follows:

- a. Select **[Cancel]**. A pop-up window will appear asking if you want to cancel loading, select **Yes**.
 - b. Once the stage has moved to the unload position, select **Tools → Initialize Stage** from the menu at the top. A pop-up window will appear stating the Stage is already initialized. Initialize anyway? Select **OK**.
NOTE: You can run the stage initialization with your substrate on the stage.
 - c. Wait for the system to complete the stage initialization process (~2 min), when it is finished select **OK** to close the pop-up window.
 - d. The stage will be left in the loaded position; you will need to select **[Unload Substrate]** to proceed. Select **OK** for both of the pop-up windows.
 - e. Now select **[Load Substrate]** to proceed.
15. If you chose any **OptAF** or the **_Automatic small_PneuAF** substrate template:
- a. The system should ask you to locate the substrate center manually, using the Overview camera. Acknowledge the pop-up window stating this, by clicking **OK**.



MLA150 Operation

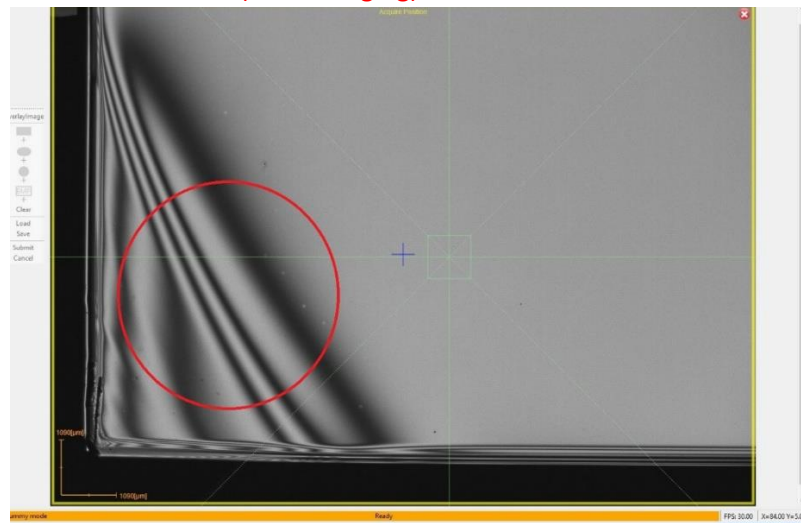
NOTE: There can be instances when this pop-up window does not appear. You will still need to perform manual centering though. To do this, select **Set Position** (bottom of the screen) and proceed to the next step.



- b. Now position the crosshair in the center of your substrate and left click to continue. You can use the C/S keyboard keys and Mouse-Wheel up/down to aid in aligning the substrate.

IMPORTANT: When doing this for a **_OptAF** template, make sure that the optical autofocus laser spot is not landing on:

- A dark line (resist fringing)

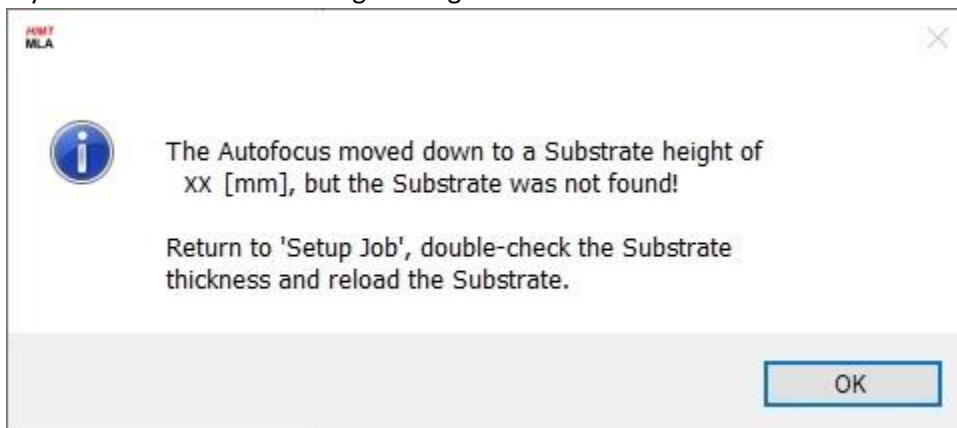


- A highly reflective feature
- A feature edge
- Ideally it should be placed in an area like this if possible:



MLA150 Operation

16. Select **[Accept]** if you are sure the sample is under the lens and it is in an acceptable area. If unsure, select **[Cancel]** and make the necessary adjustments.
 - a. The system will bring the exposure lens down on the sample and measure the sample edges using either optical or pneumatic focus detection.
17. If you encounter the following message:



This means that the substrate thickness you entered was possibly not correct. Refer to the **MLA150 STC Rack Reset** document at the tool to troubleshoot/resolve this issue.

18. You may encounter a **Find Plate Center** pop-up window indicating that the measured size of the substrate differs from the programmed size.
 - a. Verify the measured size & shape is correct for your sample and select **Yes**.
 - b. If the wrong substrate template was chosen (e.g. round instead of rectangular) click **No** and go back to **[Setup]** to make the correction.

Important: If the exposure lens engages off the edge of the sample, or sample is too small, the exposure lens will crash sideways into the sample and/or photoresist on the next step. Contaminating the exposure lens' pneumatic autofocus may affect lithography defocus on all user's exposures.

Substrate Unload

To unload the substrate:

1. go back to the Setup screen by clicking [**<< Setup**], and
2. choose [**Unload Substrate**]
3. Turn off the Vacuum and remove your sample.

Re-align the Substrate Rotation

If flat/edge alignment is critical, or when exposing a layer with Alignment, it is recommended that the measured substrate angle reading “**Global Angle**” be < 10 mRad (< 0.6°). This measurement is found on the **First Exposure** and **Alignment** screens.

If the measured substrate angle is >10 mRad and you want to realign rotation manually:

27. Click [**<< Setup Job**] at the bottom of the screen to return to the **Setup Job** panel.
28. Click **Unload Substrate**, a pop-up window will appear confirming you want to unload, click **OK**.
29. Wait for the unload sequence to be completed. A pop-up window will appear indicating the substrate has been unloaded, click **OK**.
30. Open the sash,
31. release the chuck vacuum, and
32. reposition your substrate using the corresponding alignment fixture.
33. Engage the chuck vacuum,
34. remove the alignment fixture, and
35. close the sash.
36. Return to **Substrate Loading**.

Design Conversion

The XWindows Conversion software is case-sensitive, and files must be placed in the exact directory expected for the software to function properly.

Your design files must be located in the appropriate file-type folder, one of:

- C:\HIMT\Designs\gdsii
- C:\HIMT\Designs\bmp
- C:\HIMT\Designs\dxg
- C:\HIMT\Designs\cif
- C:\HIMT\Designs\gerber

Subfolders within these are *not* supported.

Filenames must not have any spaces, but underscores `_` are allowed.

File extensions (.gds, .cif) must be lowercase or XWindows will not show them in the file browser. (KLayout.app saves as capital “.GDS” by default.)

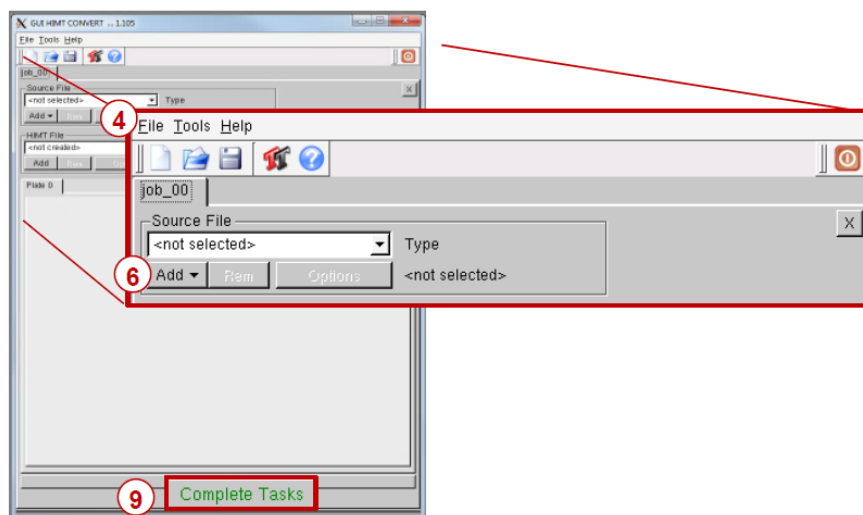
In the **Layer** frame:

1. Double-click into the value field titled **Design**. The **Load Design** panel containing a list of designs opens, where you normally select one of them for your exposure.
2. To create a new design, click **Convert Design**.



3. The conversion software opens.

In the **Conversion** window:

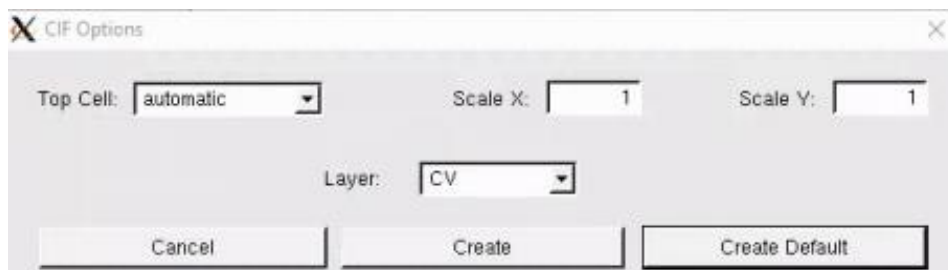


4. From the menu bar, select **File→New Job**.
5. Enter a name for the job using the naming convention and click **Ok**.

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- The naming convention is *LastnameFirstinitial_jobname* or *companyname_jobname* (e.g. *sawyerl_myfirstjob* or *staff_trainingjob_oct10*).
6. Click the **Add** drop down menu and select a design format. A pop-up window will appear that shows the directory containing the source files for the selected design format.
 7. From the directory, select the file to be converted.
 8. A pop-up window will appear giving you various options depending on the file format:

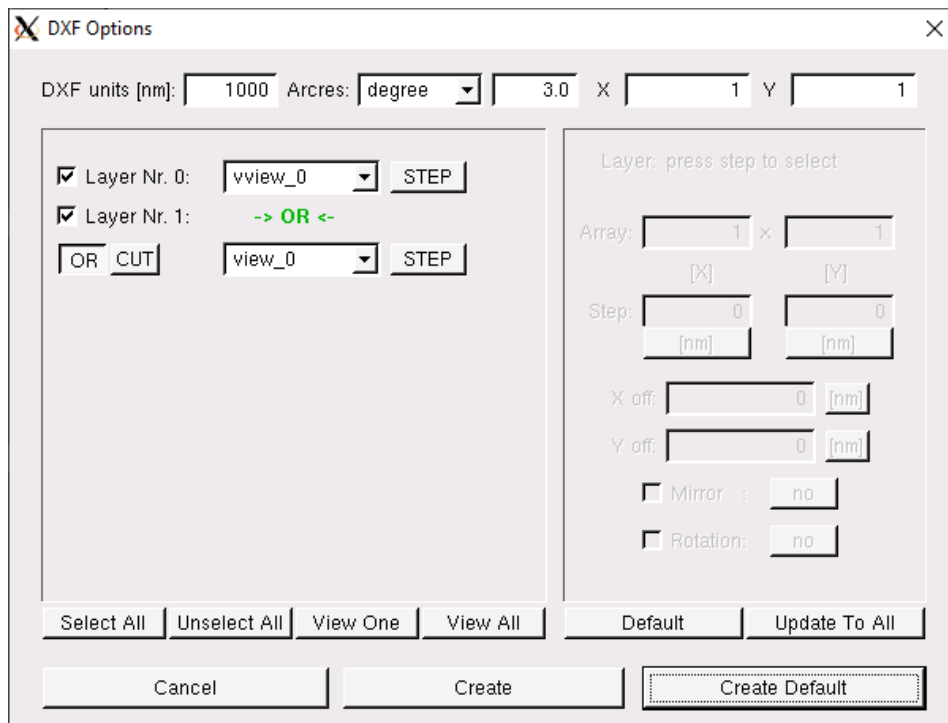
CIF



The CIF Options dialog box contains the following controls:

- Top Cell: dropdown menu set to "automatic"
- Scale X: text input field set to "1"
- Scale Y: text input field set to "1"
- Layer: dropdown menu set to "CV"
- Buttons: "Cancel", "Create", and "Create Default"

DXF

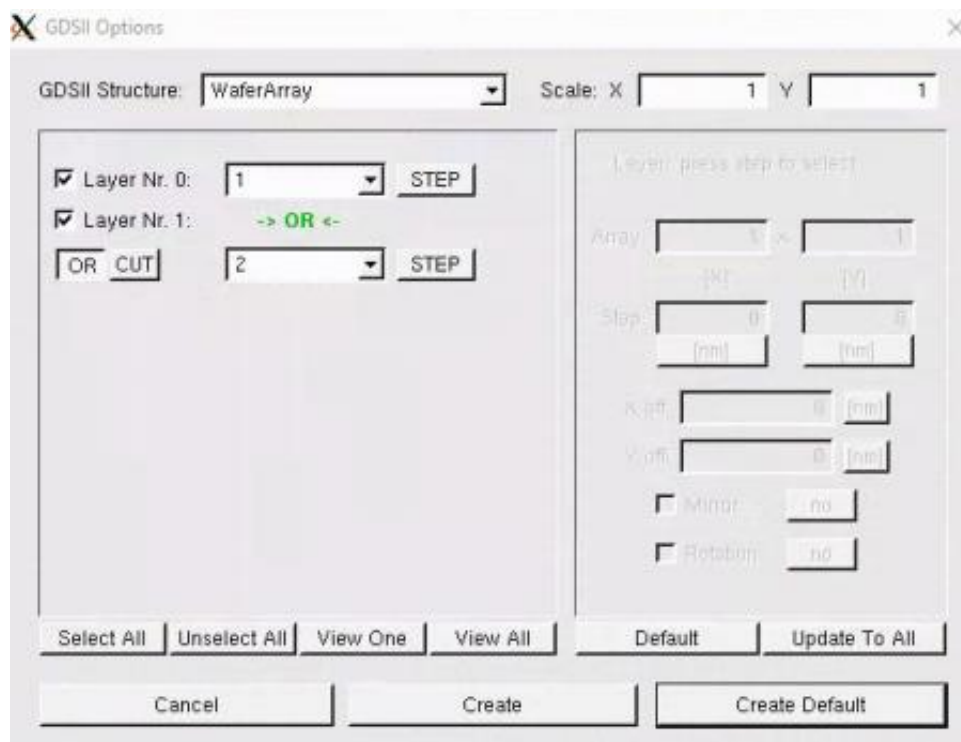


The DXF Options dialog box contains the following controls:

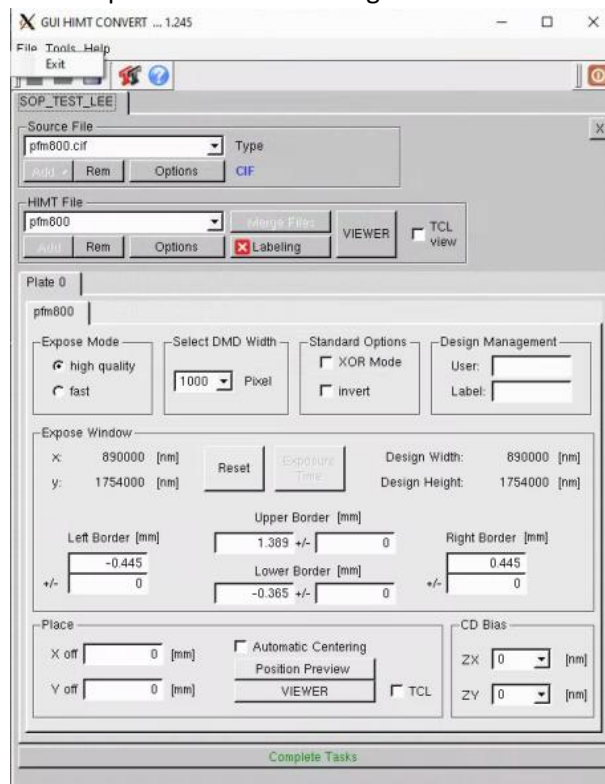
- DXF units [nm]: text input field set to "1000"
- Arcres: dropdown menu set to "degree"
- 3.0: text input field
- X: text input field set to "1"
- Y: text input field set to "1"
- Layer settings:
 - Layer Nr. 0: dropdown menu set to "vview_0" with a "STEP" button
 - Layer Nr. 1: dropdown menu set to "view_0" with a "STEP" button
 - Between Layer Nr. 0 and 1: "-> OR <-"
 - Buttons: "OR", "CUT"
- Array: text input field set to "1" with a "x" symbol and another text input field set to "1"
- Step: two text input fields set to "0" with "[nm]" labels
- X off: text input field set to "0" with "[nm]" label
- Y off: text input field set to "0" with "[nm]" label
- Mirror: checkbox (unchecked) with "no" text
- Rotation: checkbox (unchecked) with "no" text
- Buttons: "Select All", "Unselect All", "View One", "View All", "Default", "Update To All", "Cancel", "Create", and "Create Default"

MLA150 Operation

GDSII



- Note that the “> OR <” option will combine/ Boolean Union the selected layers.
9. Once you have all of your settings correct, click **Create Default**.
 10. The **Conversion** window will populate with more settings that pertain to the quality of the write and the placement of the design.



11. Before making any changes, you should verify that your settings are correct from the file option window:
 - Check your **Design Width & Height** in the **Expose Window** frame, you can change the unit of measure by clicking on it.
 - You can view a preview of your design by clicking on the **VIEWER** button in the **HIMT File** frame. The viewer will also allow you to measure feature sizes.
 - Check the placement of your design using the **Border** data provided in the **Expose Window** frame.
 - Increasing the border values will prevent stitching together of inverted exposes that don't have the correct data extent markers.
12. The standard write quality settings are automatically populated, **high quality & 1000 Pixel DMD width**, and are recommended as a starting point for new users. Other commonly used settings/options:
 - **XOR Mode** – overlapping objects will subtract each other.
 - **invert** – changes the polarity of your design (dark field design would write as clear field). The data extents are important for this option.
 - **Automatic Centering** – Centers your design – warning, this will adjust your design's (0,0) origin.
13. Click **Complete Tasks**, a save file pop-up window will appear with the file name you designated in Step 5, there is no need to change the name so just click **Save**.
14. A file conversion window will appear, once the **Status** reads **Done!** And the status bar is at 100%, click **Finish**.
15. Your new design file will appear highlighted in the MLAMenu file list. Either select **Load** or double click the file to add it to the job.