MLA-150-Guidelines

This Guideline is divided into Four sections: First layer Standard Exposure, Top Surface Alignment, Back surface Alignment and Series Exposure

Things to consider before training:

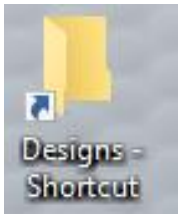
1. User **must have samples coated with photoresist** for second session. No assistance will be provided for designing the patterns. User is advised to design file prepared for second session.
2. Save your design file as YYYYMMDD_designfilename.gds or .dxf (e.g. 20240216_design.gds). Design files will be deleted after 6 months. Do not create your own folder in the convert design. Do not create subfolder within these directories. Make sure the file extension is all lower case (e.g. .gds not .GDS).
3. Stay away from the window panel when opening and closing the door to avoid pinching hazard.
4. Sample requirements: Wafer: 2–6-inch. Substrate (flat and uniform): minimum:5× 5mm, recommended: 10×10 mm
5. **Backside of the sample must be clean and free from any photoresist residue. Apply clean room wipe with acetone.**
6. Remove edge bead on the substrate and do not focus the sample on the rough area of sample.

A. Standard Exposure without alignment

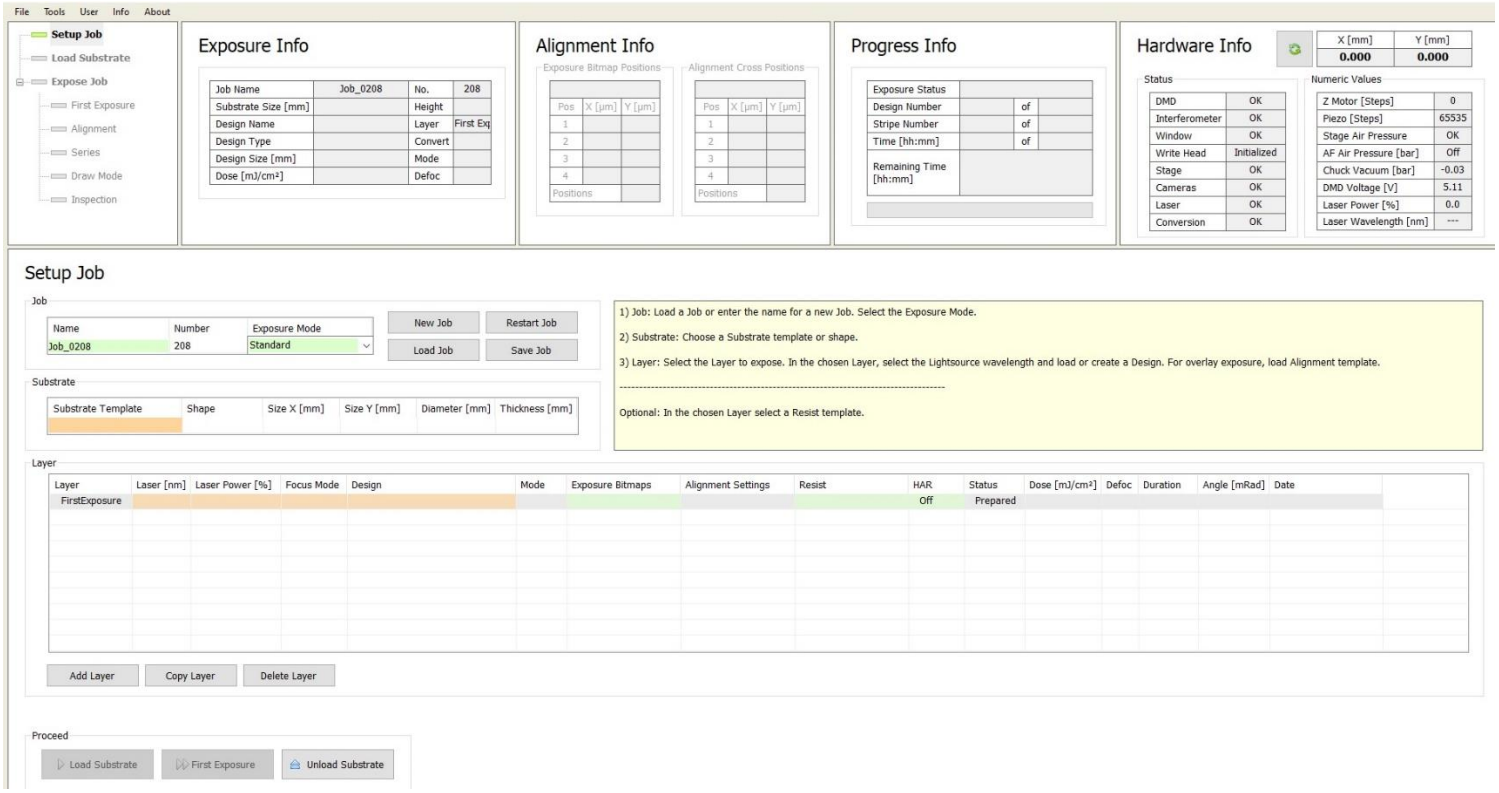
1.Login to the computer:
Username: MLA
Password: mla

2. Click MLAMenu icon if necessary.
3. Preview of MLA 150 software as shown below in Page 2.

4. Copy your design files into **Designs-shortcut** inside the appropriate design format. Recommended file formats are. gdsii and .dxf



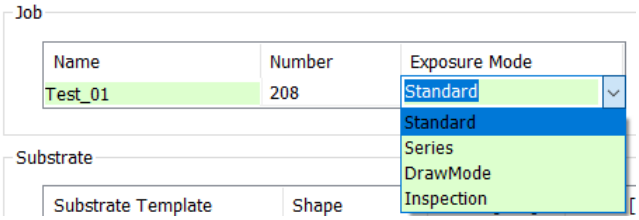
5. **Setup Job:** Choose **New job** to start a new exposure; To repeat older job, choose **Load Job**; To remove previous job, choose **Restart Job**



6. Select **Exposure mode**:

Standard: Single or overlay exposure

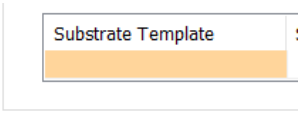
Series: for the dosage and defocus testing

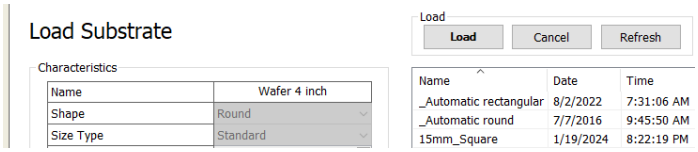


7. Select **substrate template**. Double click on substrate template. In a new window, choose a correct template.

_Automatic rectangular for rectangular, square, or uneven sample.

_Automatic round for wafer; Small is for sample below 12mm×12mm; choose Wafer for the wafers. Click **Load** icon to go back.





8. Under **Layer Menu**:

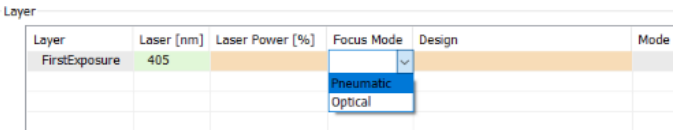
Select first row for **First Exposure**

Click Add layer if desired.

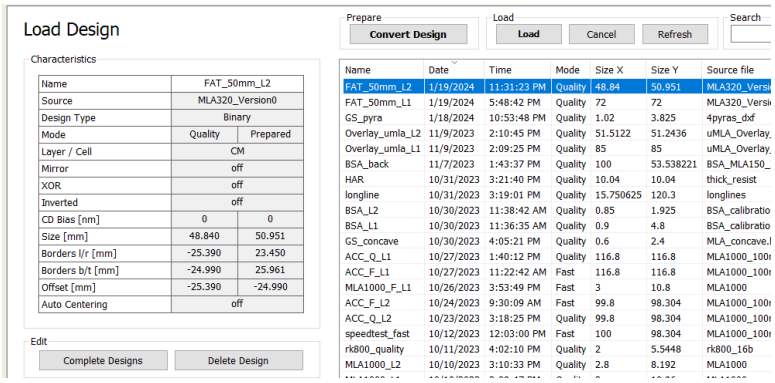
9. Select Laser: click under Laser menu and choose **405 nm** or **375 nm**.

9.1. Laser Power: Choose **100%** for normal exposure and Filter (13%): grayscale

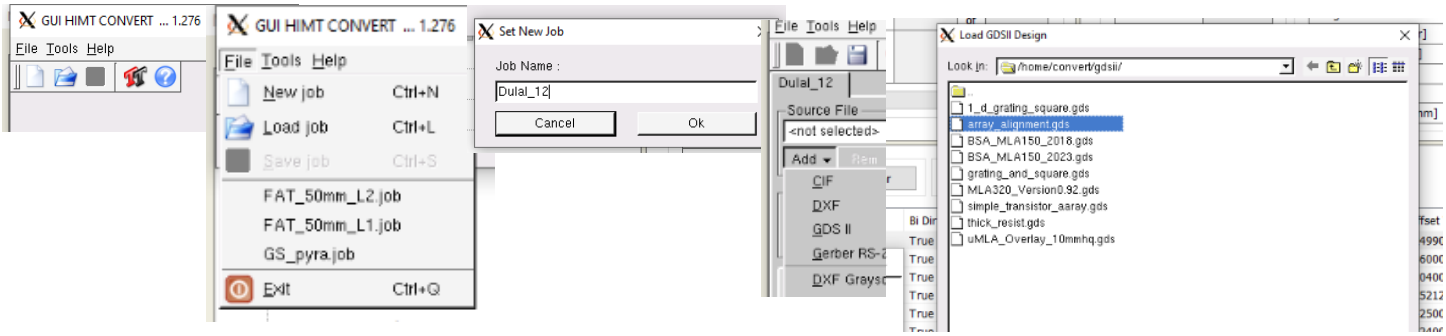
10. Select **Focus Mode**:
Pneumatic: For larger sample greater than 20 mm×20mm; **Optical**: For higher resolution and sample of size less than 20 mm.



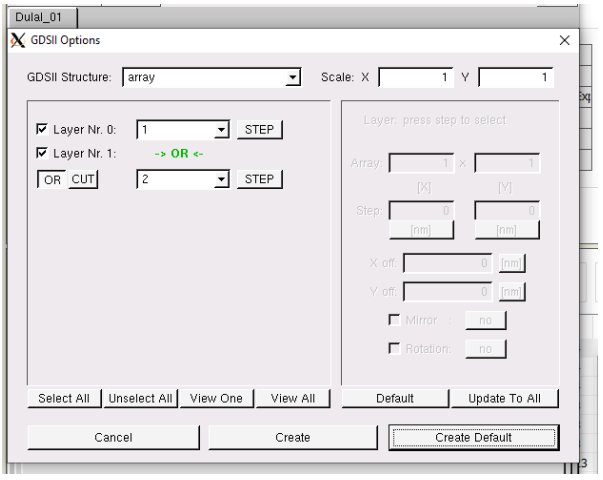
11**. Design and conversion**: Double click on **Design**. In a new window select a file and click **Load** to upload existing design: To add a new design file: Click **Convert design** and a new GUI converter window will open.

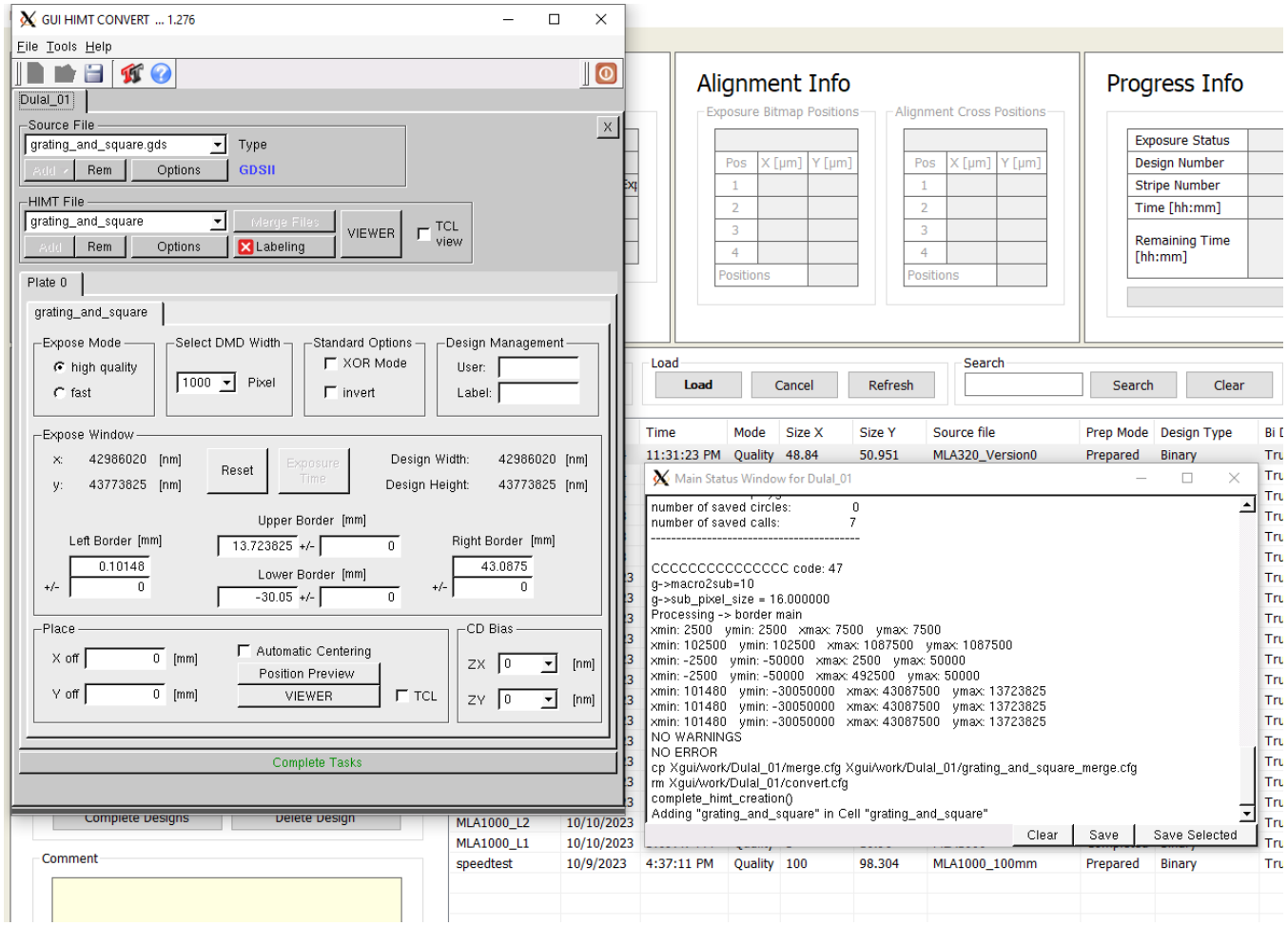


11.1 Steps to covert design filles:



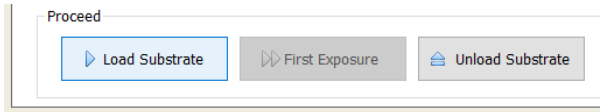
I. Click **File** and New job. Give job name and click ok.
II. Click **Add** and under drop down arrow and select .GDSII or .DXF file format.
III. Select a file to be converted and click open. Scroll down to the bottom if it is a new file with the name convention (e.g. 20240216_design.gds).
IV. choose layers to be exposed and choose **Create default**.
V. In a GUI HIMT Convert window, verify and adjust the parameters, if necessary (**warning, scaling and automatic centering will affect your design coordinates including alignment marks and (0,0), origin**), and hit **Viewer** to see the designs.





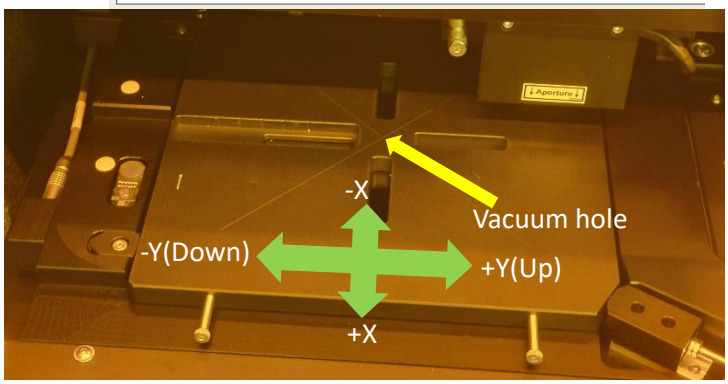
VI. Click **Complete Tasks** and then **Finish** to complete the conversion.
VII. New converted file will appear in the load design window.
VIII. Select the converted design and click **Load** to load your layout.

12. Loading Substrate: Click **Load Substrate**.

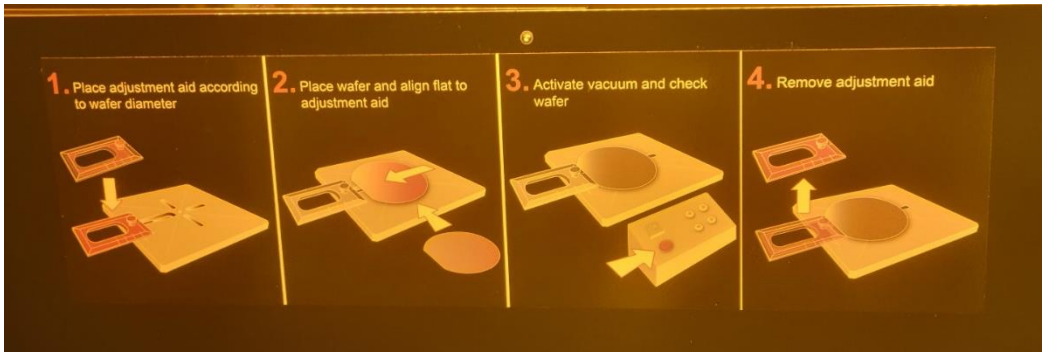


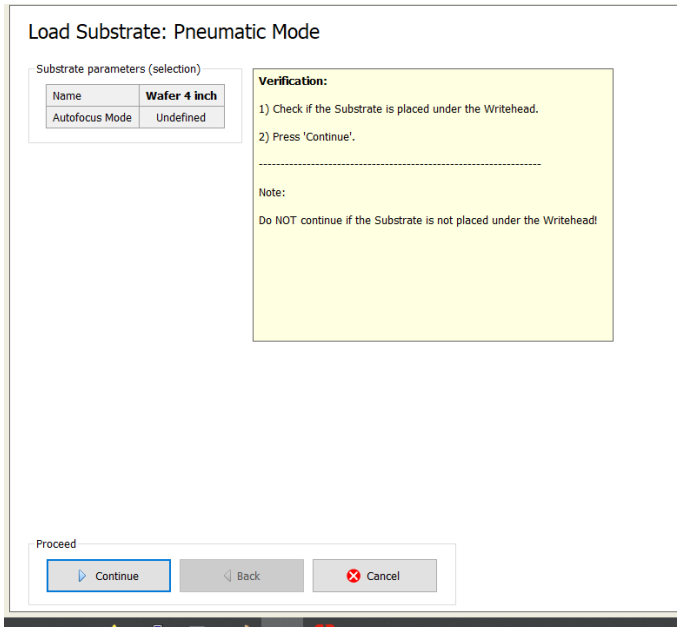
The coordinate system of the stage is rotated 90 clockwise so that left of the chuck is down (-Y) and Right is up (+Y). Make sure a flat/straight edge is on the left(-Y) to detect the substrate rotation.

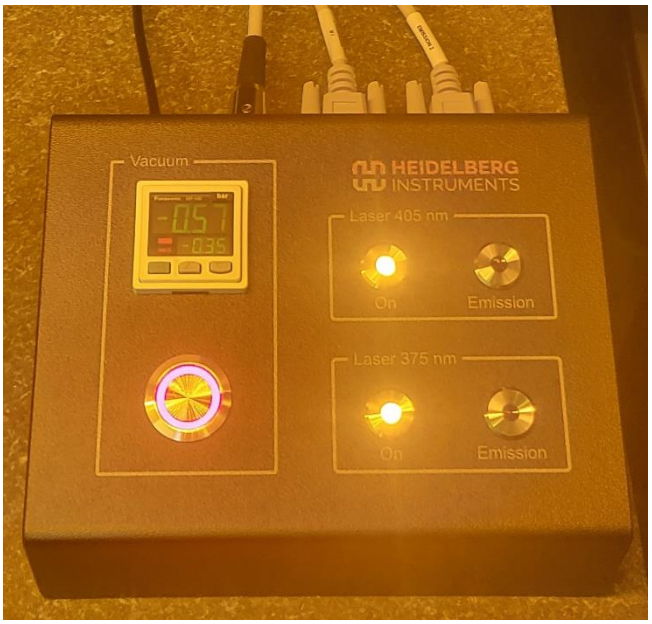
I. Push window up/down arrow and turn on light if necessary.



II. Follow the directions printed above the stage. For small sample (under 20 mm), use the small sample aligner instead. Place small sample







on the vacuum hole and align the substrate straight with flat edge on the left (-Y).

III. Push vacuum button, make sure the vacuum is below -0.5 bar (e.g. -0.52). If not, release vacuum, adjust the wafer position or clean the backside. After vacuum pass the -0.5 bar threshold, remove the adjustment aid.

IV. Close the window, turn off the light, and click **Continue** only **once**. Before proceed, **make sure that substrate is placed under the write head** and then click **Continue**. After the write head moves to the focus plane, Automatic Centering will move sample into the center and will detect the edges of the sample. In case of small samples, system asks the user to center the substrate manually or to confirm the current position. See section 12.1 for manually setting the substrate center.

12.1 For smaller substrate:

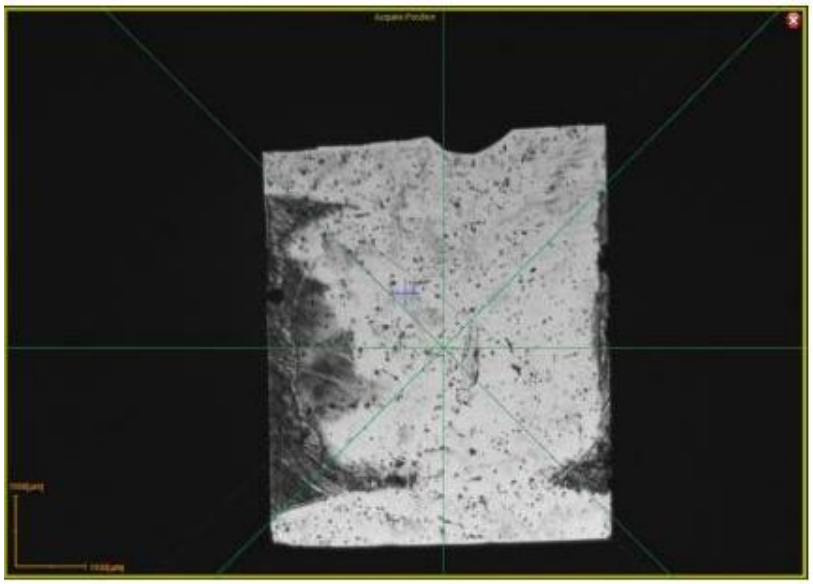
Manually setting the center of the substrate is needed if the system cannot detect the center of the substrate or if the system does not detect the center of the substrate correctly during the find center procedure. Especially when loading small substrates with a size of less than 12 mm, the automatic detection of the substrate center is not successful because of technical restrictions.

Perform the following steps to manually set the center of the substrate:

I. If a dialog box opens, which shows that the automatic centering was not successful, click **OK** to confirm. **The dialog box closes.**

II. In the camera live view, move the + icon to the position of the substrate center.

III. You see + the icon at the correct position of the substrate center in the camera live view



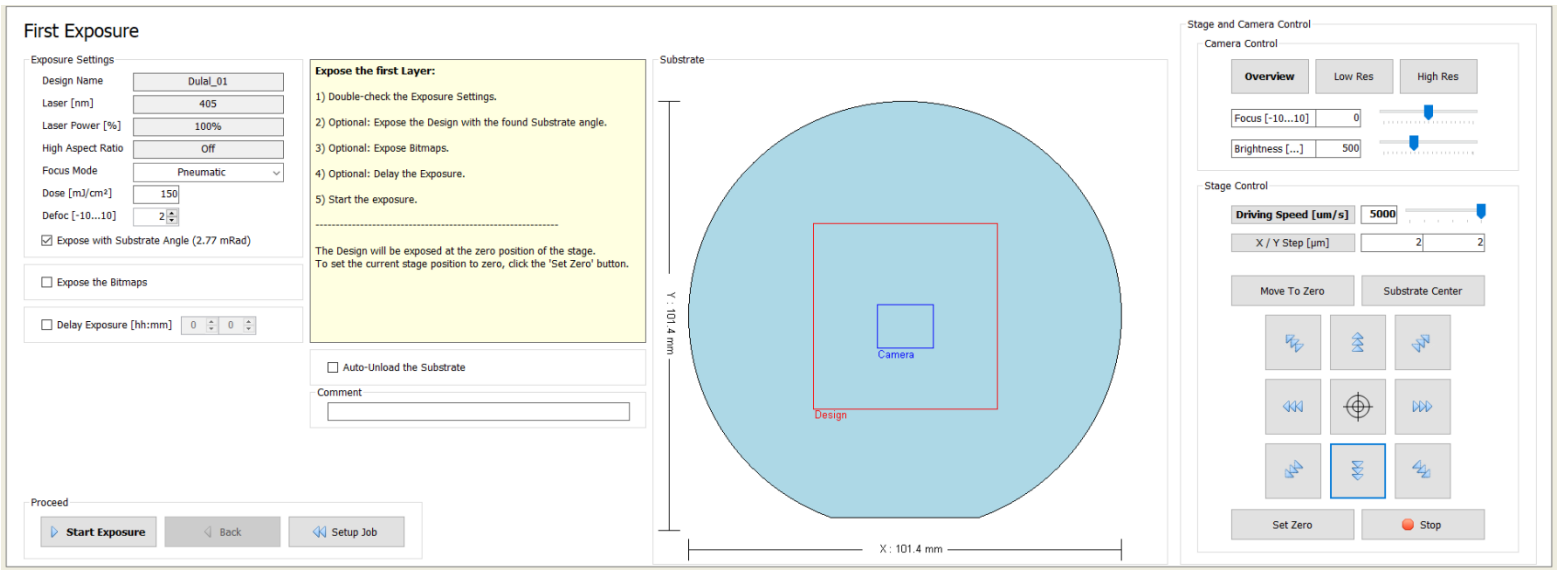
IV. If the icon is not at the correct position, click Set position in the Proceed frame of the Load Substrate frame. Then, you can move the icon again.

V. Click Continue in the Proceed frame of the Load Substrate frame to confirm.

VI. The system starts the centering procedure based on the position of the substrate center that you set. When the procedure is successfully completed, the next frame opens.

13. Resist and defocus fields are optional in the layer frame.

14. Exposure



I. Verify laser wavelength and laser power. Use overview camera to observe the wafer or substrate which has large field of view. Stage control frame on the right side of the panel has driving speed and X/Y Step for the stage movement. Move to zero will move the stage into the previously defined zero position and substrate center icon will move stage into the substrate center. Cross hair can be used the camera live view to specify the position to which you want to move the stage.

II. Insert the desired values of **dose**.

II. **Focus** the sample and adjust the brightness. **Defocus** adjusts the focus position which can range from -10 to +10.

IV. **Substrate Angle** shows the rotation of the substrate on the chuck, check is optional. (warning, if subsequent alignment is required, **uncheck Expose with Substrate Angle** and **within ± 10 mRad** is desired). Check mark on **auto unload the substrate**.

V. Click **Start Exposure** and Check the **progress info** panel in MainMenu.

VI. Unload the substrate if auto unload was not checked, Open the door, turn-off vacuum button.

VII. Remove the sample from the stage and close the door and sign out.

B. Exposure with Top Surface Alignment

Make sure to have a minimum of 2 and maximum of eight alignment marks before proceeding with this step. Steps 1 to 12 are similar to the procedures as described in the previous standard exposure section.

1.Sign on to the computer.

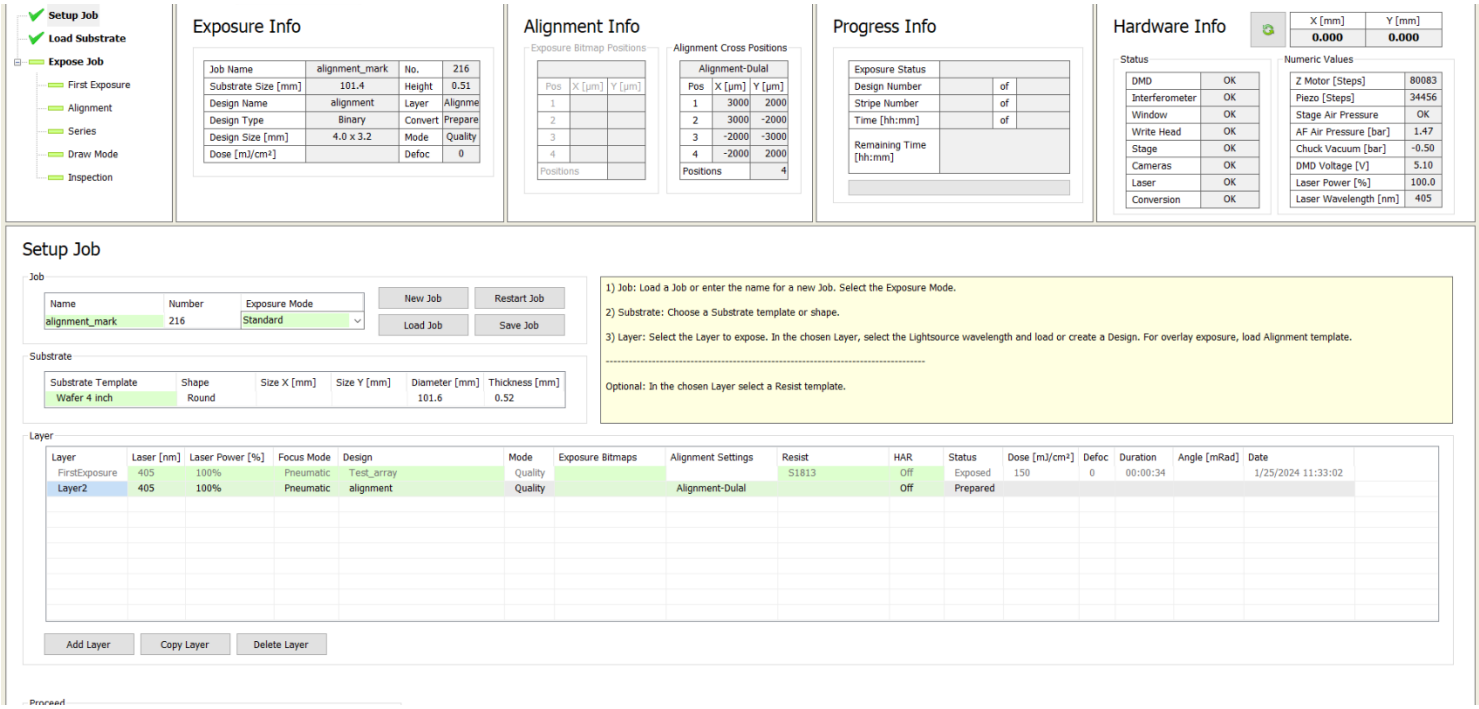
2. Copy your design file into the Design shortcut folder.

3. Set up Job.

4. Select **Standard Exposure** mode.

5. Double click on the **substrate template** and choose appropriate template.

6. Under layer Panel, do not use the first row. Use second and subsequent rows



for overlay exposure and alignment.

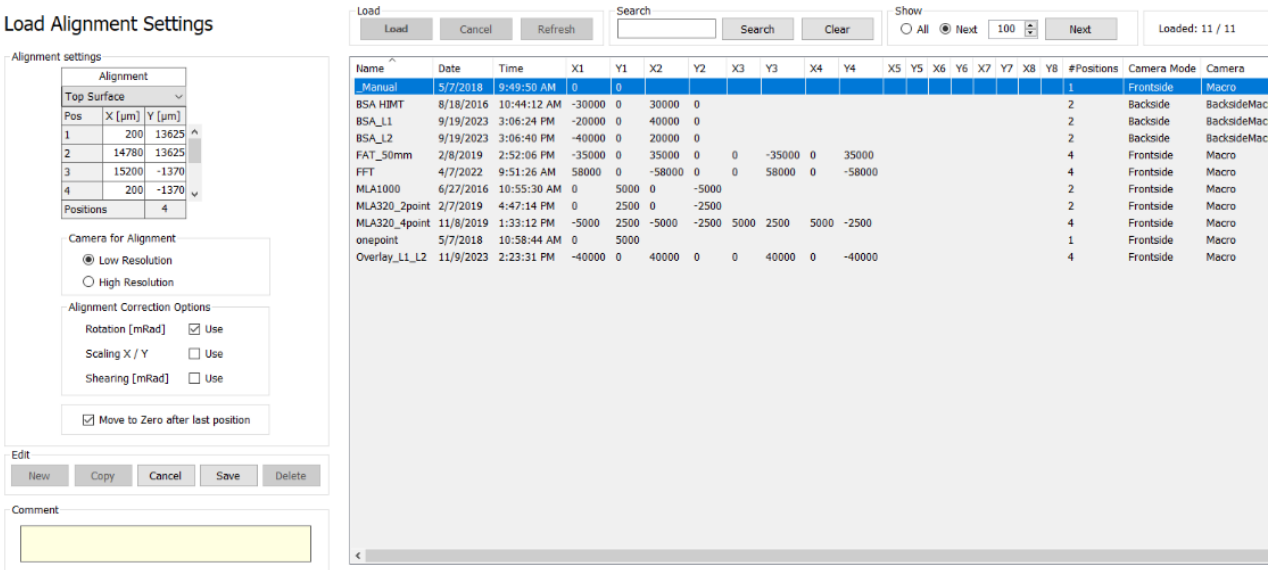
7.Select **375 nm or 405** nm laser wavelength and **100%** laser power.

8. Choose **Pneumatic or Optical** focus mode.

9. Double click on **Designs** and click convert design to convert the files (See **Section A11.1 for the conversion**). Click load after finishing conversion.

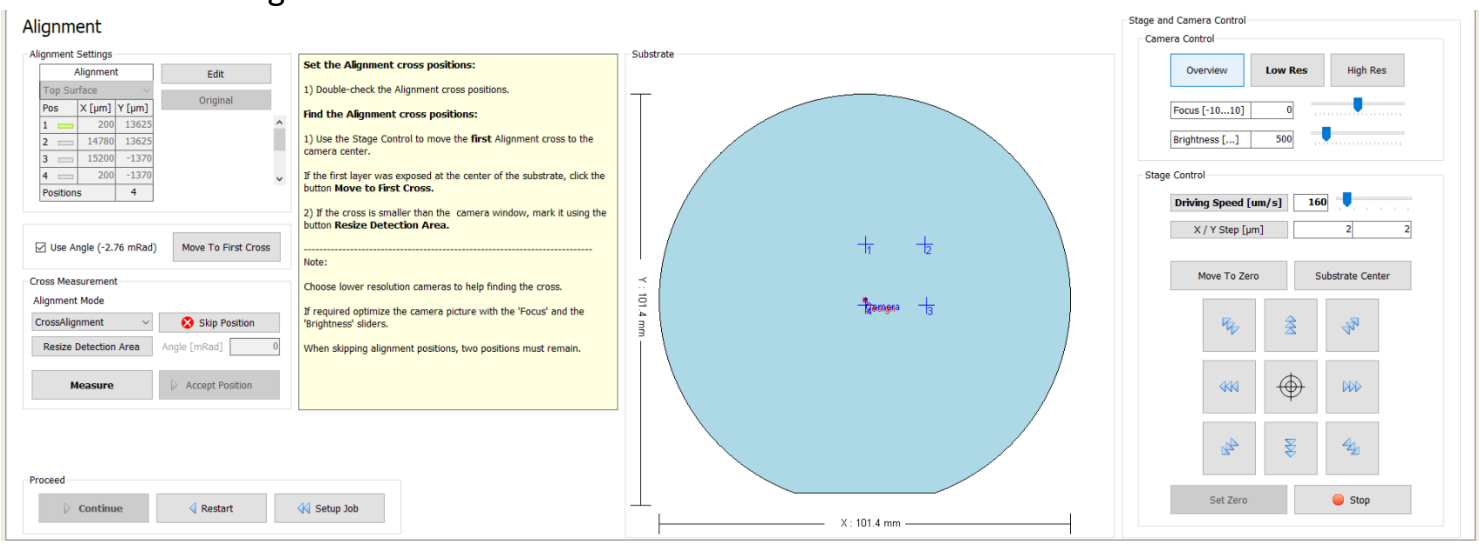
10. **Assigning the Alignment marker co-ordinates**: Double click on alignment **setting**. The Load Alignment setting window will display. To create a new alignment template, go to **Edit** and **New**. Assign file name, choose **Top Surface**

mode and insert the center coordinates of alignment marks. Make sure to check on **Rotation (mRad)**. The system measures the substrate angle and design rotates accordingly. Scaling and Shearing are optional. Save the setting. Check Low resolution camera for the Alignment and click **Load.**



11. **Load the substrate** (Please follow the instructions described in section A.12 for loading the substrate)

12. **Centering the Alignment Markers**: After successful loading of the substrate or wafer, **an Alignment** panel will appear. Alignment markers will be centered on the camera image.



I. Select one of the alignment modes from the Alignment mode drop down list in the **Cross Measurement Frame**: (**a) Cross Alignment:** System will automatically search for cross shaped alignment mark at the given positions**, (b) Rectangle:** system will find the rectangular structure **and (c) Manual**. Click **resize detection area** for smaller marker. If the system fails to locate markers automatically, select manual Alignment where the user will find the center of the marks (section 12.1).
II. Select the **Camera Mode**: Start with Overview camera to navigate and find the alignment marks. Alignment marks must be visible in the field of view of camera. click move to **first cross**. The first mark will be automatically visible. If not, use the visualization of the substrate in the *Substrate* frame of the Alignment frame to move the camera to the first alignment mark using overview camera. Double click the desired position in the substrate frame and the camera moves to the desired position. Move the stage to bring the marks into the camera field of view if required. Center the + icon of the camera live view over the alignment marks. Go to **Low Res and High-Res** micro camera to correctly observe the center of cross. Make sure that alignment cross fill the entire camera window for position detection.
III. Adjust focus and brightness.
V. Click **Measure** in the cross-measurement frame and **Accept Position. Re-measure** if required.
VI. If the alignment mark is not completely visible or does not completely fill the field view of the camera, click **ResizeDetectionArea** and resize the detection area in the camera live view. To reset the size of detection area, click **MaximizeDetectionArea**.
VII. Stage will automatically move to second cross and repeat centering for all the marks.

12.1. If the manual alignment mode is selected:

The stage should be moved manually to the position of the first alignment mark to see the alignment mark in the camera live view. Use arrow buttons in the stage control frame to move the stage to the position of first alignment mark.
In the camera list view, Click **Measure**. In the camera window, **a cross hair appears**. Move the cross hair to the center of the alignment mark. Click the left mouse to fix the position. Click **center cross** to center the location of alignment

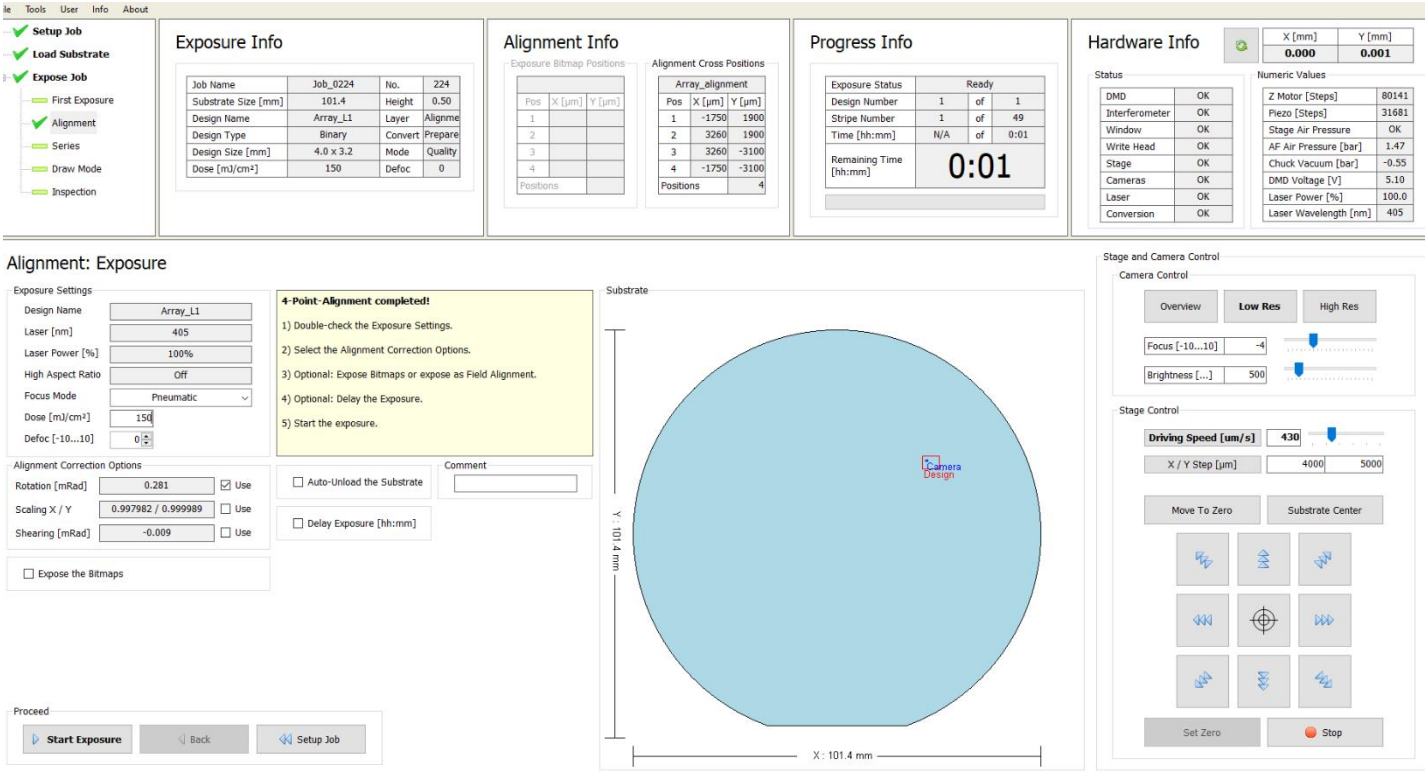
mark inside the camera window and **accept position**. Repeat the operation for all alignment marks.

13. Click **continue** and **Alignment: Exposure** frame will appear**.**

Verify laser and laser power. Insert the amount of dose, make sure to check auto-unload substrate box. Make sure that rotation (best if within ± 10 mRad) is checked under the Alignment correction options. Scaling and Shearing are optional correction options.

14. Click **start Exposure**.

15. Once the process is finished, open the door, turn off the vacuum, remove the sample and log-out from the computer.



C. Overlay Exposure with Back Surface Alignment

Make sure to have a minimum of 2 and maximum of eight alignment marks before proceeding with this step.

1.Sign on to the computer.

2. Copy your design file into the Design shortcut folder.

3. Set up Job.

4. Select **Standard Exposure** mode.

5. Double click on the **substrate template** and choose appropriate template.

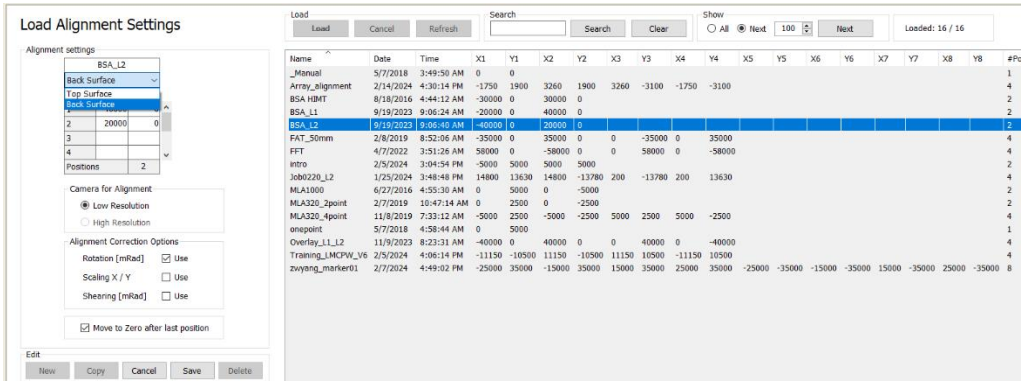
6. Under layer Panel, do not use the first row. Use second and subsequent rows for overlay exposure and alignment.

7. Select **375 nm or 405** nm laser wavelength and **100%** laser power.

8. Choose **Pneumatic or Optical** focus mode.

9. Double click on **Designs** and click convert design to convert the files (**Section A11.1 for the conversion**). Click load after finishing conversion.

10.**Assigning the Alignment marker co-ordinates**: Double click on alignment **setting**. The **Load Alignment setting** window will display. To create a new alignment template, go to **Edit** and **New**. Assign file name, choose **Back Surface** and insert the center coordinates of alignment marks. Make sure to check on **Rotation (mRad)**. The system measures the substrate angle and design rotates accordingly. Scaling and Shearing are optional. Save the setting. Check Low resolution camera and click **Load.**



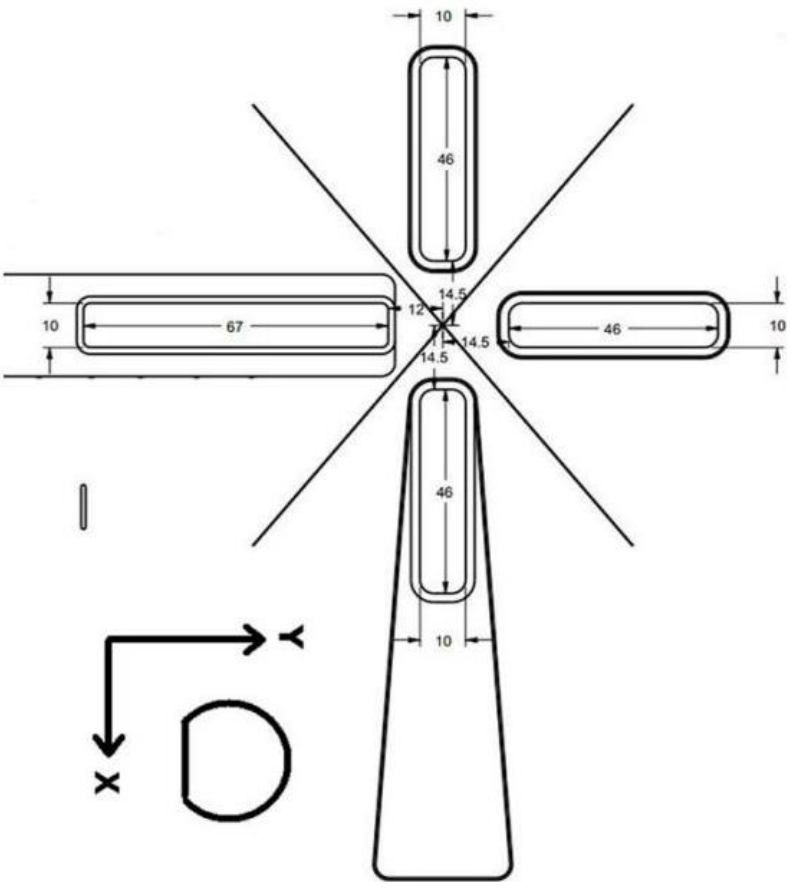
11. **Load the substrate** (Please follow the instructions described in **section A.12 for loading the substrate**)

12. **Centering the Alignment Markers**: After successful loading of the substrate or wafer, **an Alignment** panel appears. Alignment markers will be centered on the

camera image. See section B11 for details about the cross-measurement frame and alignment mode.

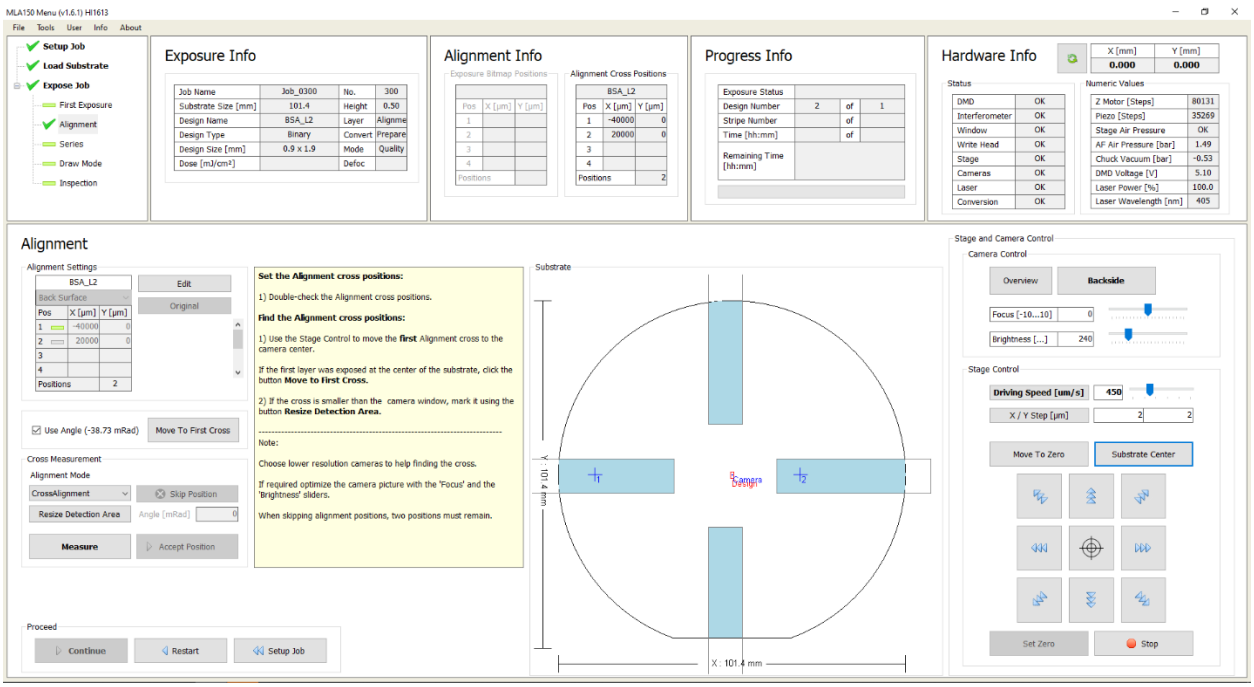
Note: The backside alignment system consists of a micro camera underneath the stage, an overview camera underneath the stage, and a specially designed chuck. The viewing area of the backside alignment cameras cover the lower surface of the substrate. Each opening is 10 mm wide and 46 or 76mm long.

On the first layer, you expose only the alignment marks. For the exposure of all further layers, you turn the substrate so that the exposed alignment marks are at the lower surface. When you perform a backside alignment, note that coordinates always refer to the substrate side that is currently the upper surface. So, an alignment mark that is exposed on the right side will be on the left side when you turn around the substrate. This means, if an alignment mark is exposed at position [X: +20 mm], the alignment mark will be at position [X: -20 mm] for the backside alignment.



Wafer size	Mark 1	Mark 2	Mark 3	Mark 4
2 inch	X: +20 mm Y: 0	X: -20 mm Y: 0	X: 0 Y: +20 mm	X: 0 Y: -20 mm
3 inch	X: +28 mm Y: 0	X: -28 mm Y: 0	X: 0 Y: +28 mm	X: 0 Y: -28 mm
4 inch	X: +40 mm Y: 0	X: -40 mm Y: 0	X: 0 Y: +40 mm	X: 0 Y: -40 mm
5 inch	X: +44 mm Y: 0	X: -44 mm Y: 0	X: 0 Y: +44 mm	X: 0 Y: -44 mm

The alignment marks can be positioned anywhere within the backside alignment zones (Page13). Heidelberg recommends that alignment marks with a cross size of 300 µm × 300 µm and a line width of 20 µm may give good results. Above table (Page 13) can be taken as a consideration for the position of alignment marker



during design.

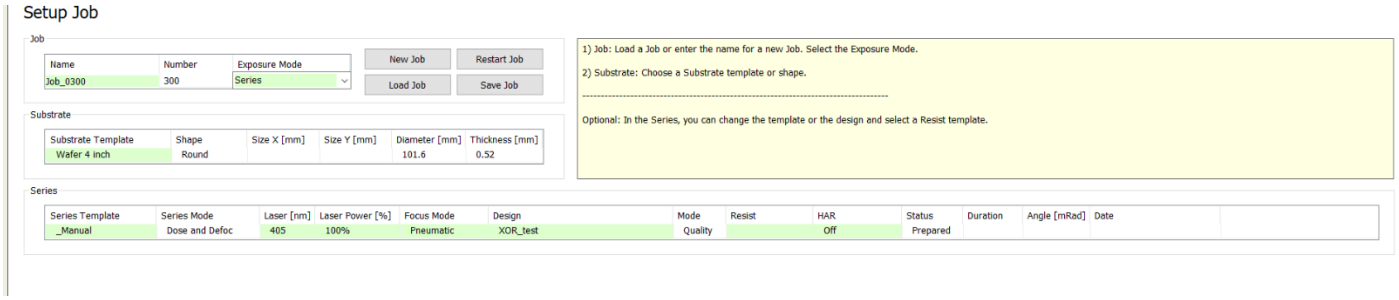
13. Select one of the alignment modes from the Alignment mode drop down list in the **Cross Measurement Frame.** click **move to first cross.** Click **Measure.** The system measures the position of the cross and moves it to the center of the camera window. Examine the positions and click **Accept Position** to confirm it. The procedure moves on to the next alignment cross.

14. Click **continue** and **Alignment: Exposure** frame will appear**.**
Verify laser and laser power. Insert the amount of dose, make sure to check auto-unload substrate box. Make sure that rotation (best if within ± 10 mRad) is checked under the Alignment correction options. Scaling and Shearing are optional correction options.
15. Click **start Exposure**.
16. Once the process is finished, open the door, turn off vacuum, remove the sample and log-out from the computer.

D. Series Exposure Mode

This mode is particularly useful for the testing of devices. Three options are available: **Dose** (varying energy levels), **Defocus** (varying focus) and Dose/Defoc. Sign on to the computer.

1.Sign into the computer.



2. Copy your design file into the Design shortcut folder.
3. Set up Job.
4. Select **Series Exposure** mode.
5. Double click on the **substrate template** and choose appropriate template.
6. Under Series menu: Select **375 nm or 405** nm laser wavelength and **100%** laser power.
7. Choose **Pneumatic or Optical** focus mode.
8. Double click on **Designs** and click convert design to convert the files (**Section A11.1 for the conversion**). Click load after finishing conversion.
9. **Load the substrate** (Please follow the instructions described in section A.12 for loading the substrate)
10. After successfully loading the substrate, Series Frame will appear.
11. In the Series Frame, verify laser and focus mode.
12. In the Series Mode, Select Dose or Defocus or Dose/defocus.
13. In the Dose or Defocus Panel

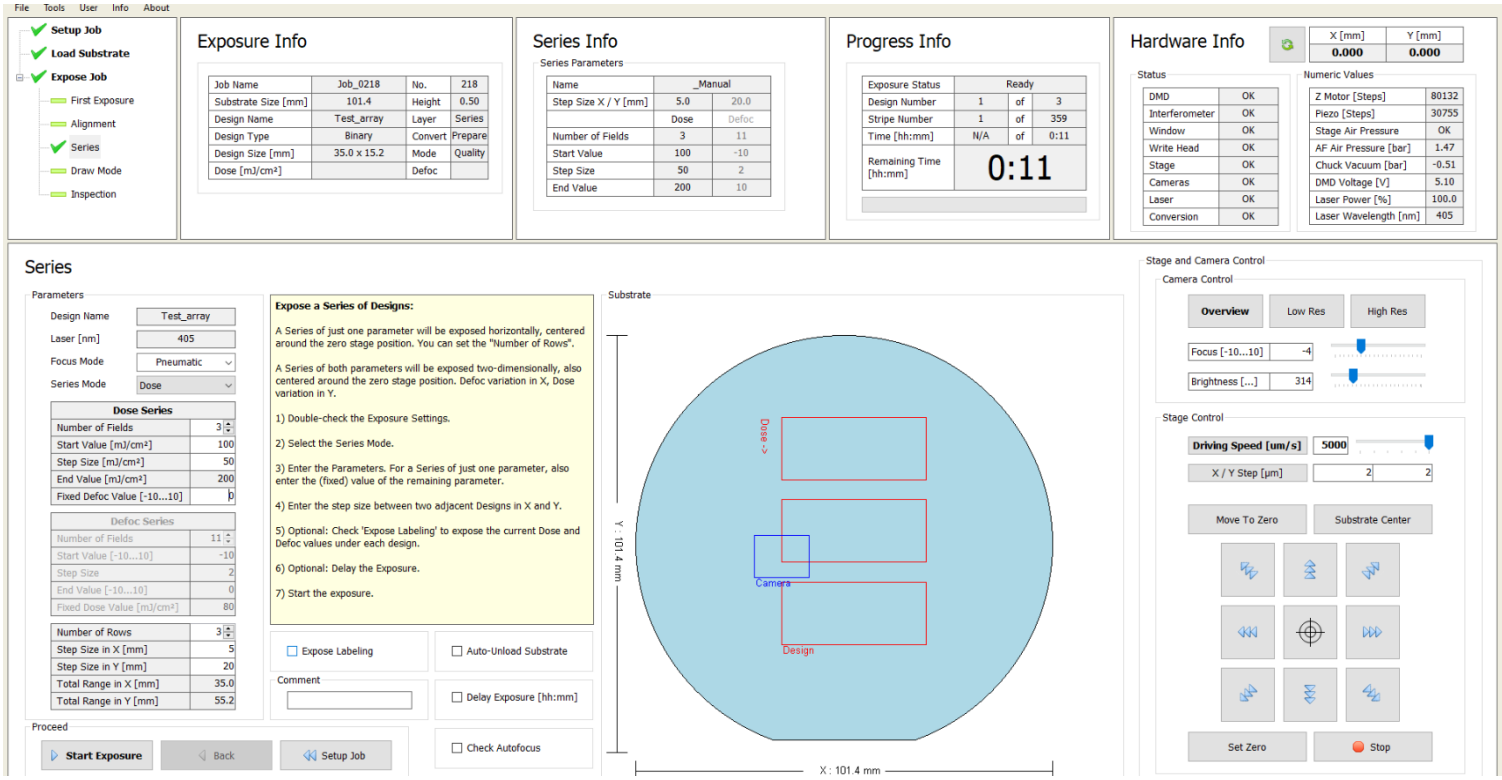
I. Insert the number of fields that how many designs are to be exposed in the exposure series and insert starting value of light intensity or focus offset. Select the correct Step Size which is increment per die that is to be exposed in the exposure Series.

II. Insert End Value of dose or defocus, number of rows to be partitioned, Step Size in X[mm], Step size in Y[mm] which displays the distance between the designs that are to be exposed in the exposure series. Total Range in X and Y change based on the step sizes of X and Y.

III. Activate Exposure labelling to write about the parameters.

V. Verify laser and focus mode. Check auto-unload substrate and hit Start Exposure

VI. After finishing: Turn-off vacuum, unload the sample, close the door and sing-



off computer.

Please report to the lab managers (rdulal@bu.edu or pmak@bu.edu) for any errors with the details.

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Revised by: Zhancheng "Ryan" Yao, Bishop Laboratory