

## 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:

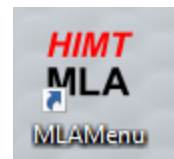
1. User **must have samples coated with photoresist** for second session. No assistance will be provided for designing the patterns. User is advised to design file prepared for second session.
2. Save your design file as YYYYMMDD\_designfilename.gds or .dxf (e.g. 20240216\_design.gds). Design files will 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**

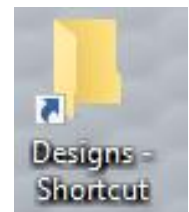
**Password: mla**



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**

**Setup Job**

Job

Name: Job\_0208, Number: 208, Exposure Mode: Standard

Buttons: New Job, Restart Job, Load Job, Save Job

Substrate

Substrate Template, Shape, Size X [mm], Size Y [mm], Diameter [mm], Thickness [mm]

Layer

Layer	Laser [nm]	Laser Power [%]	Focus Mode	Design	Mode	Exposure Bitmaps	Alignment Settings	Resist	HAR	Status	Dose [mJ/cm²]	Defoc	Duration	Angle [mRad]	Date
FirstExposure									Off	Prepared					

Buttons: Add Layer, Copy Layer, Delete Layer

Proceed

Buttons: Load Substrate, First Exposure, Unload Substrate

Instructions:

- 1) Job: Load a Job or enter the name for a new Job. Select the Exposure Mode.
- 2) Substrate: Choose a Substrate template or shape.
- 3) Layer: Select the Layer to expose. In the chosen Layer, select the Lightsources wavelength and load or create a Design. For overlay exposure, load Alignment template.

Optional: In the chosen Layer select a Resist template.

6. Select **Exposure mode:**  
**Standard:** Single or overlay exposure  
**Series:** for the dosage and defocus testing

**Job**

Name: Test\_01, Number: 208, Exposure Mode: Standard

**Substrate**

Substrate Template, Shape

Exposure Mode dropdown: Standard, Series, DrawMode, Inspection

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.

**Load Substrate**

Name	Shape	Size Type
Wafer 4 inch	Round	Standard
_Automatic round		
15mm_Square		

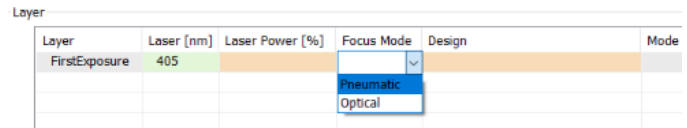
8. Under **Layer Menu:**  
 Select first row for **First Exposure**  
 Click Add layer if desired.

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

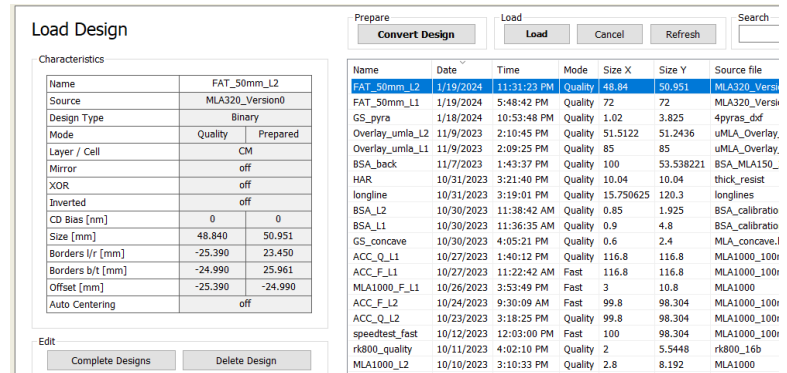
9.1. Laser Power: Choose **100%** for normal exposure and Filter (13%): grayscale

10. Select **Focus Mode**:

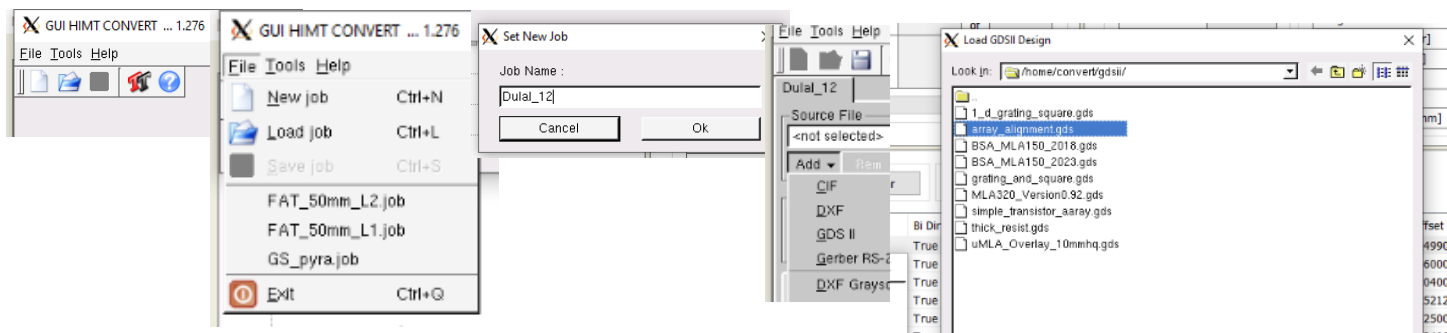
**Pneumatic**: For larger sample greater than 20 mm×20mm; **Optical**: For higher resolution and sample of size less than 20 mm.



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 files:**

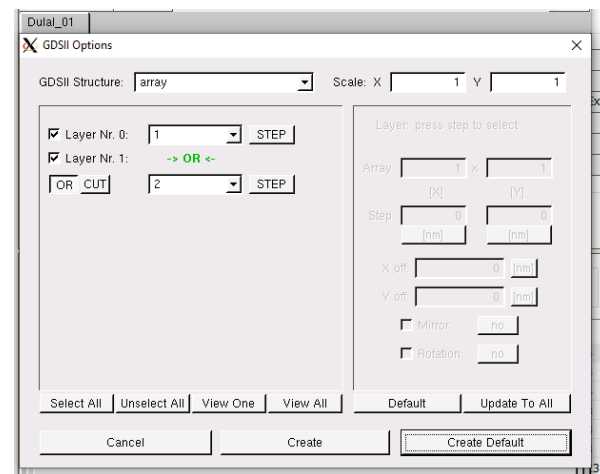


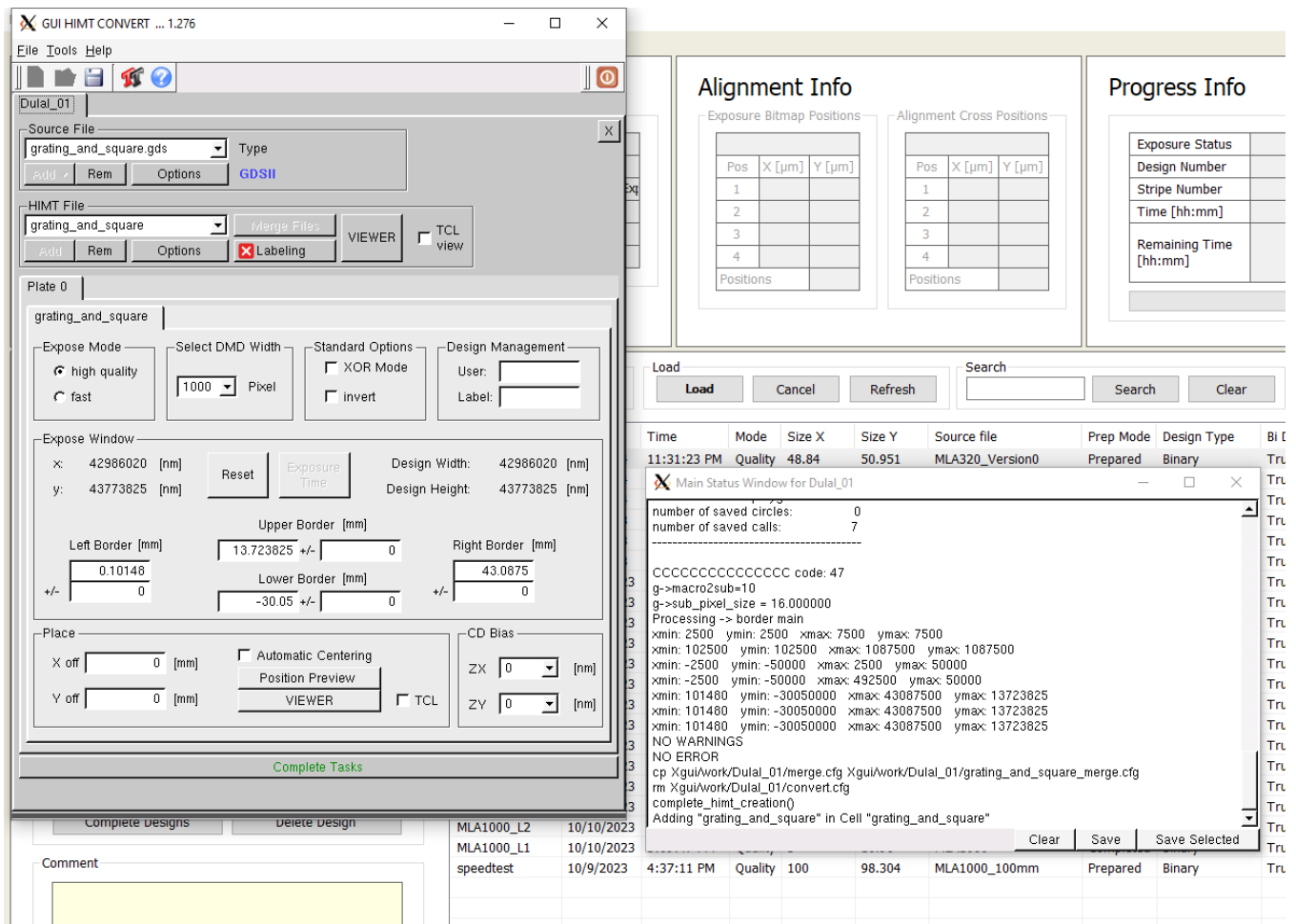
I. Click **File** and **New job**. Give job name and click ok.  
 II. Click **Add** and under drop down arrow and select .GDSII or .DXF file format.

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.

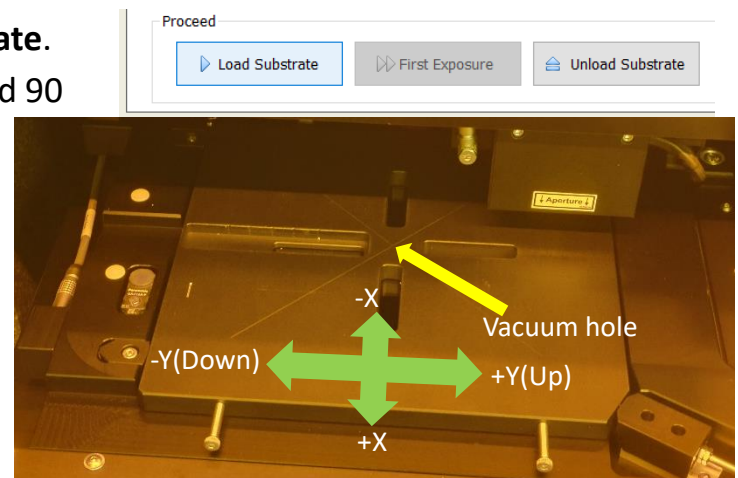
VII. New converted file will appear in the load design window.

VIII. Select the converted design and click **Load** to load your layout.

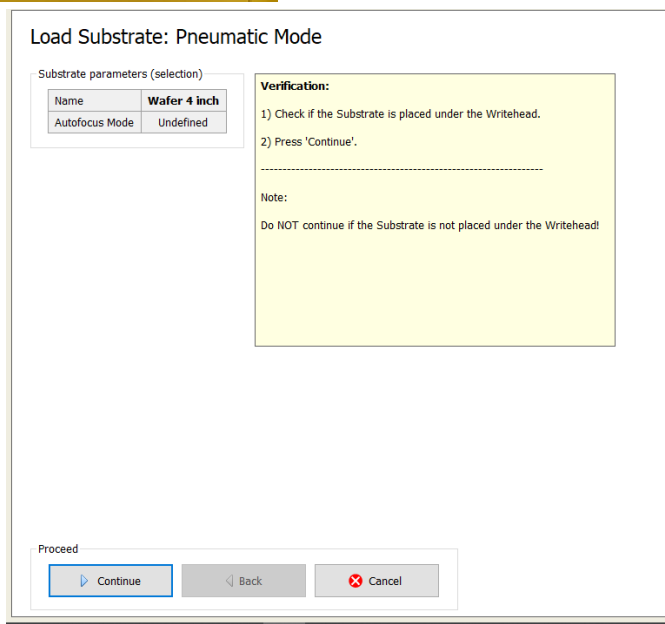
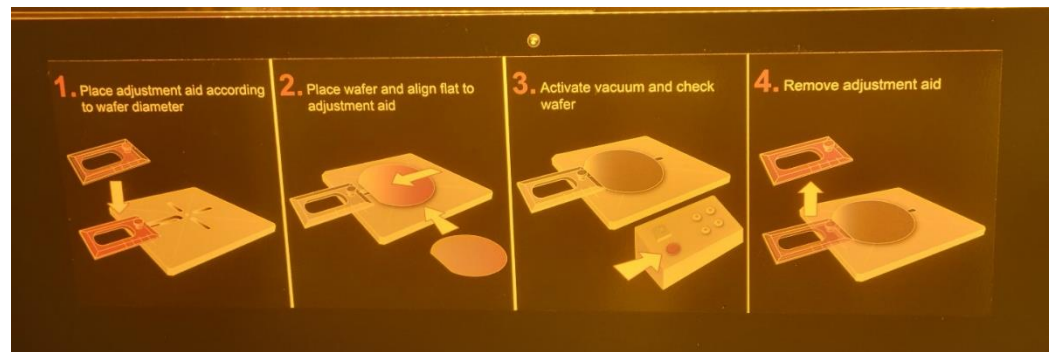
## 12. Loading Substrate: Click **Load Substrate**.

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.

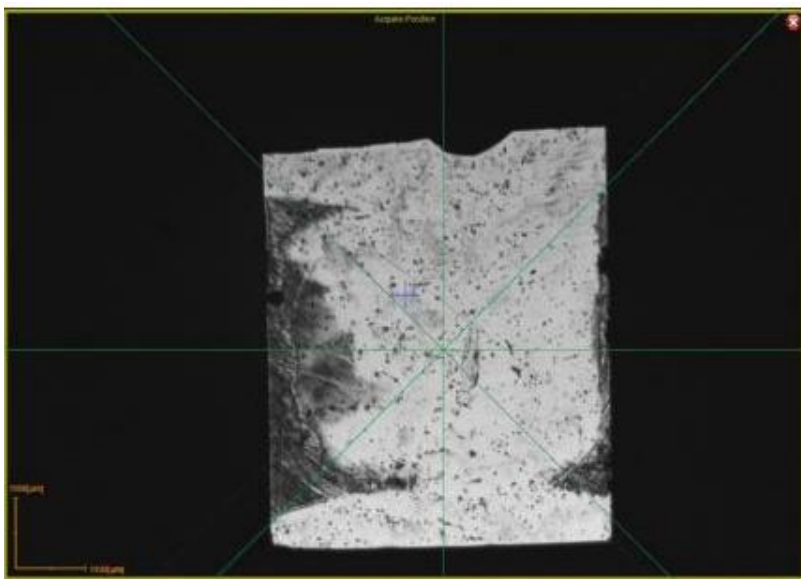
III. You see  the icon at the correct position of the substrate center in the camera live view

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  $\pm 10$  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

Setup Job

Load Substrate

Exposure Job

First Exposure

Alignment

Series

Draw Mode

Inspection

Exposure Info

Job Name	alignment_mark	No.	216
Substrate Size [mm]	101.4	Height	0.51
Design Name	alignment	Layer	Alignme
Design Type	Binary	Convert	Prepare
Design Size [mm]	4.0 x 3.2	Mode	Quality
Dose [mJ/cm <sup>2</sup> ]		Defoc	0

Alignment Info

Exposure Bitmap Positions

Pos	X [μm]	Y [μm]
1		
2		
3		
4		

Alignment Cross Positions

Pos	X [μm]	Y [μm]
1	3000	2000
2	3000	-2000
3	-2000	-3000
4	-2000	2000

Progress Info

Exposure Status	
Design Number	of
Stripe Number	of
Time [h:mm]	of
Remaining Time [h:mm]	

Hardware Info

X [mm]	0.000	Y [mm]	0.000
--------	-------	--------	-------

Status

DMD	OK
Interferometer	OK
Window	OK
Write Head	OK
Stage	OK
Cameras	OK
Laser	OK
Conversion	OK

Numeric Values

Z Motor [Steps]	80083
Piezo [Steps]	34456
Stage Air Pressure	OK
AF Air Pressure [bar]	1.47
Chuck Vacuum [bar]	-0.50
DMD Voltage [V]	5.10
Laser Power [%]	100.0
Laser Wavelength [nm]	405

Setup Job

Job

Name

alignment\_mark

Number

216

Exposure Mode

Standard

New Job

Restart Job

Load Job

Save Job

Substrate

Substrate Template	Shape	Size X [mm]	Size Y [mm]	Diameter [mm]	Thickness [mm]
Wafer 4 inch	Round			101.6	0.52

1) Job: Load a Job or enter the name for a new Job. Select the Exposure Mode.

2) Substrate: Choose a Substrate template or shape.

3) Layer: Select the Layer to expose. In the chosen Layer, select the Lightsource wavelength and load or create a Design. For overlay exposure, load Alignment template.

Optional: In the chosen Layer select a Resist template.

Layer

Layer	Laser [nm]	Laser Power [%]	Focus Mode	Design	Mode	Exposure Bitmaps	Alignment Settings	Resist	HAR	Status	Dose [mJ/cm <sup>2</sup> ]	Defoc	Duration	Angle [mRad]	Date
FirstExposure	405	100%	Pneumatic	Test_array	Quality			S1813	Off	Exposed	150	0	00:00:34		1/25/2024 11:33:02
Layer2	405	100%	Pneumatic	alignment	Quality		Alignment-Dual		Off	Prepared					

Add Layer

Copy Layer

Delete Layer

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**.

### Load Alignment Settings

Alignment

Top Surface

Pos

X [μm]

Y [μm]

Pos	X [μm]	Y [μm]
1	200	13625
2	14780	13625
3	15200	-1370
4	200	-1370

Positions 4

Camera for Alignment

☒ Low Resolution
 ☐ High Resolution

Alignment Correction Options

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

☒ Move to Zero after last position

Edit

New

Copy

Cancel

Save

Delete

Comment

Load

Cancel

Refresh

Search

Search

Clear

Show

☐ All
 ☒ Next

100

Next

Loaded: 11 / 11

Name	Date	Time	X1	Y1	X2	Y2	X3	Y3	X4	Y4	X5	Y5	X6	Y6	X7	Y7	X8	Y8	#Positions	Camera Mode	Camera
Manual	5/7/2018	9:49:59 AM	0	0															1	Frontside	Macro
BSA HIMT	8/18/2016	10:44:12 AM	-30000	0	30000	0													2	Backside	BacksideMac
BSA_L1	9/19/2023	3:06:24 PM	-20000	0	40000	0													2	Backside	BacksideMac
BSA_L2	9/19/2023	3:06:40 PM	-40000	0	20000	0													2	Backside	BacksideMac
FAT_50mm	2/8/2019	2:52:06 PM	-35000	0	35000	0	0	-35000	0	35000									4	Frontside	Macro
FFT	4/7/2022	9:51:26 AM	58000	0	-58000	0	0	58000	0	-58000									4	Frontside	Macro
MLA1000	6/27/2016	10:55:30 AM	0	5000	0	-5000													2	Frontside	Macro
MLA320_2point	2/7/2019	4:47:14 PM	0	2500	0	-2500													2	Frontside	Macro
MLA320_4point	11/8/2019	1:33:12 PM	-5000	2500	-5000	-2500	5000	2500	5000	-2500									4	Frontside	Macro
onepoint	5/7/2018	10:58:44 AM	0	5000															1	Frontside	Macro
Overlay_L1_L2	11/9/2023	2:23:31 PM	-40000	0	40000	0	0	40000	0	-40000									4	Frontside	Macro

**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.

### Alignment

Alignment Settings

Alignment

Top Surface

Pos

X [μm]

Y [μm]

Pos	X [μm]	Y [μm]
1	200	13625
2	14780	13625
3	15200	-1370
4	200	-1370

Positions 4

☒ Use Angle (-2.76 mRad)
 

Move To First Cross

Cross Measurement

Alignment Mode

CrossAlignment

Resize Detection Area

Angle [mRad]

Measure

Accept Position

Proceed

Continue

Restart

Setup Job

Set the Alignment cross positions:

1) Double-check the Alignment cross positions.

Find the Alignment cross positions:

1) Use the Stage Control to move the first Alignment cross to the camera center.

If the first layer was exposed at the center of the substrate, click the button **Move to First Cross**.

2) If the cross is smaller than the camera window, mark it using the button **Resize Detection Area**.

Note:

Choose lower resolution cameras to help finding the cross.

If required optimize the camera picture with the 'Focus' and the 'Brightness' sliders.

When skipping alignment positions, two positions must remain.

Substrate

Stage and Camera Control

Camera Control

Overview

Low Res

High Res

Focus [-10...10]

0

Brightness [...]

500

Stage Control

Driving Speed [μm/s]

160

X / Y Step [μm]

2

2

Move To Zero

Substrate Center


Move

Stop

Set Zero

Stop

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  $\pm 10$  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.

**Exposure Info**

Job Name	Job_0224	No.	224
Substrate Size [mm]	101.4	Height	0.50
Design Name	Array_L1	Layer	Alignme
Design Type	Binary	Convert	Prepare
Design Size [mm]	4.0 x 3.2	Mode	Quality
Dose [mJ/cm <sup>2</sup> ]	150	Defoc	0

**Alignment Info**

Exposure Bitmap Positions

Pos	X [μm]	Y [μm]
1		
2		
3		
4		

Alignment Cross Positions

Pos	X [μm]	Y [μm]
1	-1750	1900
2	3260	1900
3	3260	-3100
4	-1750	-3100

**Progress Info**

Exposure Status	Ready
Design Number	1 of 1
Stripe Number	1 of 49
Time [hh:mm]	N/A of 0:01
Remaining Time [hh:mm]	0:01

**Hardware Info**

Status	OK
DMD	OK
Interferometer	OK
Window	OK
Write Head	OK
Stage	OK
Cameras	OK
Laser	OK
Conversion	OK

**Exposure Settings**

Design Name: Array\_L1

Laser [nm]: 405

Laser Power [%]: 100%

High Aspect Ratio: Off

Focus Mode: Pneumatic

Dose [mJ/cm<sup>2</sup>]: 150

Defoc [-10...10]: 0

**Alignment Correction Options**

Rotation [mRad]: 0.281 ☒ Use

Scaling X / Y: 0.997982 / 0.999989 ☐ Use

Shearing [mRad]: -0.009 ☐ Use

☐ Expose the Bitmaps

**4-Point-Alignment completed!**

- 1) Double-check the Exposure Settings.
- 2) Select the Alignment Correction Options.
- 3) Optional: Expose Bitmaps or expose as Field Alignment.
- 4) Optional: Delay the Exposure.
- 5) Start the exposure.

☐ Auto-Unload the Substrate

☐ Delay Exposure [hh:mm]

**Stage and Camera Control**

Camera Control

Overview Low Res High Res

Focus [-10...10]: -4

Brightness [...]: 500

Stage Control

Driving Speed [μm/s]: 430

X / Y Step [μm]: 4000 5000

Move To Zero Substrate Center

Set Zero Stop

**Substrate**

X: 101.4 mm

Y: 101.4 mm

**Proceed**

Start Exposure Back Setup Job

## 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.

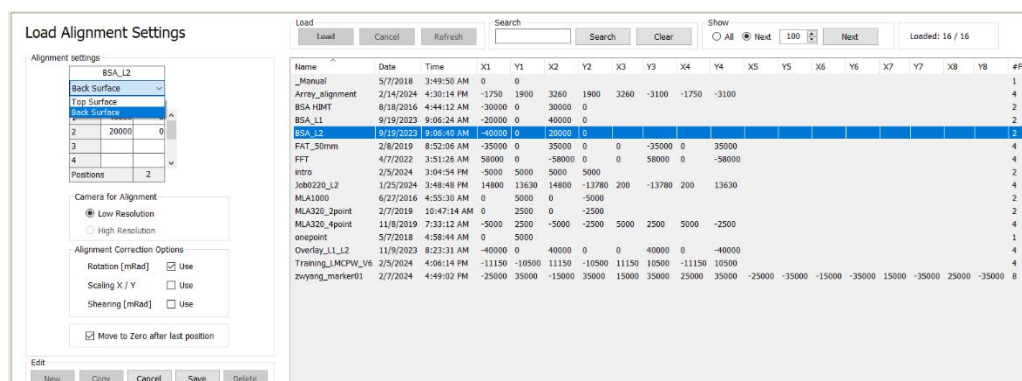
**10. Assigning the Alignment marker co-ordinates:** Double click on alignment setting. The **Load Alignment setting** window will display. To create a new alignment template, go to **Edit and New**. Assign file name, choose **Back Surface** and insert the

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**.



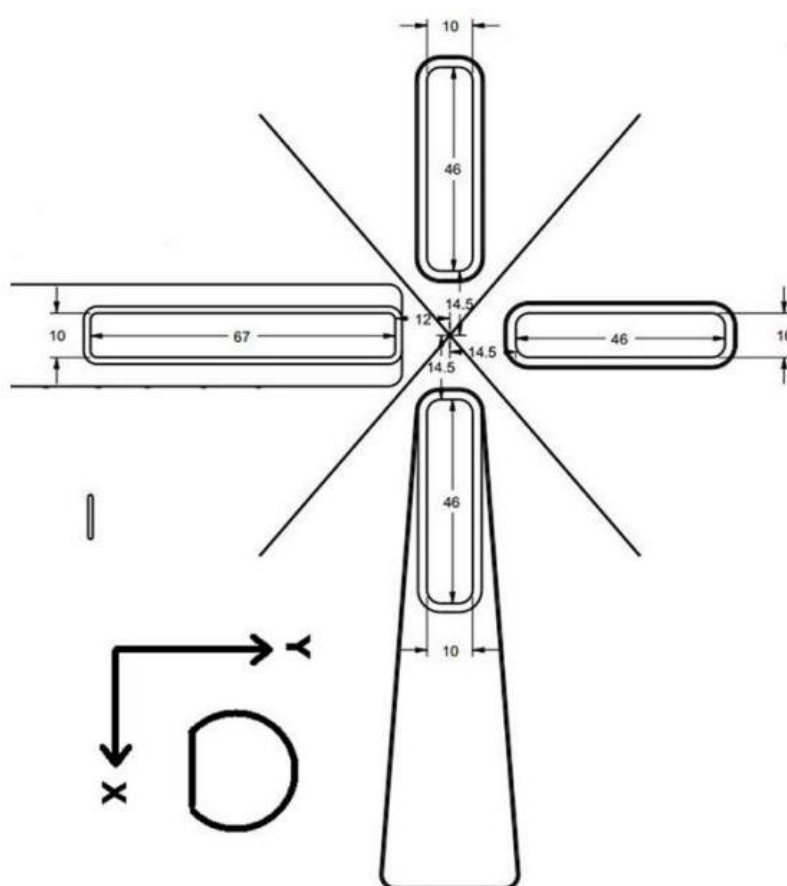
**11. Load the substrate** (Please follow the instructions described in **section A.12** for loading the substrate)

**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.

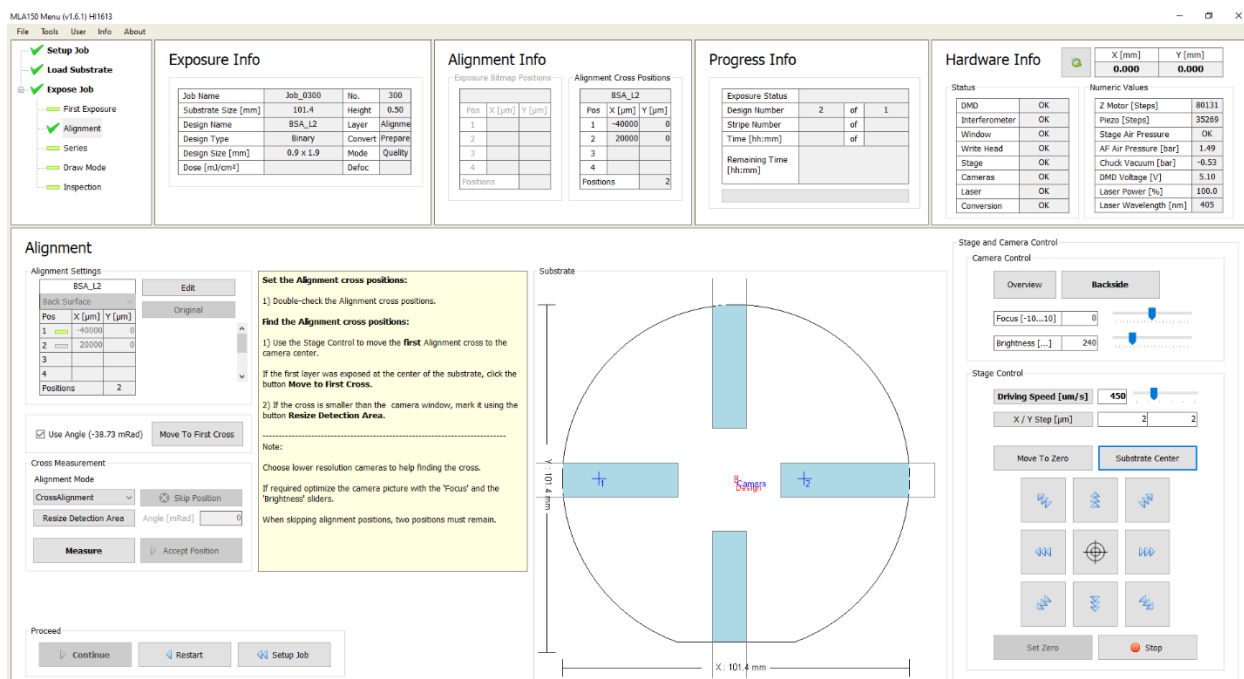
*Note: The backside alignment system consists of a micro camera underneath the stage, an overview camera underneath the stage, and a specially designed chuck. The viewing area of the backside alignment cameras cover the lower surface of the substrate. Each opening is 10 mm wide and 46 or 76mm long.*

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  $300\text{ }\mu\text{m} \times 300\text{ }\mu\text{m}$  and a line width of  $20\text{ }\mu\text{m}$  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  $\pm 10\text{ mRad}$ ) 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.

Setup Job

Job

Name	Number	Exposure Mode	New Job	Restart Job
Job_0300	300	Series	Load Job	Save Job

Substrate

Substrate Template	Shape	Size X [mm]	Size Y [mm]	Diameter [mm]	Thickness [mm]
Wafer 4 inch	Round			101.6	0.52

Series

Series Template	Series Mode	Laser [nm]	Laser Power [%]	Focus Mode	Design	Mode	Resist	HAR	Status	Duration	Angle [mRad]	Date
_Manual	Dose and Defoc	405	100%	Pneumatic	XDR_test	Quality		Off	Prepared			

1) Job: Load a Job or enter the name for a new Job. Select the Exposure Mode.  
2) Substrate: Choose a Substrate template or shape.  
Optional: In the Series, you can change the template or the design and select a Resist template.

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-

The screenshot displays a software interface for a lithography system. The top section contains several informational panels: 'Exposure Info' with job details (Job Name: Job\_0218, Substrate Size: 101.4 mm, Design Name: Test\_array, Design Type: Binary, Design Size: 35.0 x 15.2 mm, Dose: 50 mJ/cm²), 'Series Info' with series parameters (Name: \_Manual, Step Size X/Y: 5.0/20.0 mm, Number of Fields: 3, Start Value: 100, Step Size: 50, End Value: 200), 'Progress Info' showing exposure status (Ready, Design Number: 1 of 3, Stripe Number: 1 of 359, Time: N/A of 0:11, Remaining Time: 0:11), and 'Hardware Info' with status (DMD, Interferometer, Window, Write Head, Stage, Cameras, Laser, Conversion) and numeric values (Z Motor: 89132, Piezo: 30755, Stage Air Pressure: OK, AF Air Pressure: 1.47, Chuck Vacuum: -0.51, DMD Voltage: 5.10, Laser Power: 100.0, Laser Wavelength: 405). The bottom section is divided into 'Series' parameters (Design Name: Test\_array, Laser: 405 nm, Focus Mode: Pneumatic, Series Mode: Dose, Dose Series: Number of Fields: 3, Start Value: 100, Step Size: 50, End Value: 200, Fixed Defoc Value: 0, Defoc Series: Number of Fields: 11, Start Value: -10, Step Size: 2, End Value: 0, Fixed Dose Value: 80, Number of Rows: 3, Step Size in X: 5, Step Size in Y: 20, Total Range in X: 35.0, Total Range in Y: 55.2) and a 'Stage and Camera Control' panel (Overview, Low Res, High Res, Focus: -10...10, Brightness: 314, Driving Speed: 5000 um/s, X/Y Step: 2/2, Move To Zero, Substrate Center, Set Zero, Stop). A central diagram shows a circular substrate with a grid of exposure fields and a camera view.

off computer.

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

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