EPFL

CMi EPFL Center of MicroNanoTechnology

MLA 150

User manual

1. Exposing with MLA 150

A. Start
B. Setup job
C. Expose
D. End

2. Design conversion

3. Troubleshooting main error/issues - to be added

4. Mask Fabrication (Backup VPG 740) - to be added

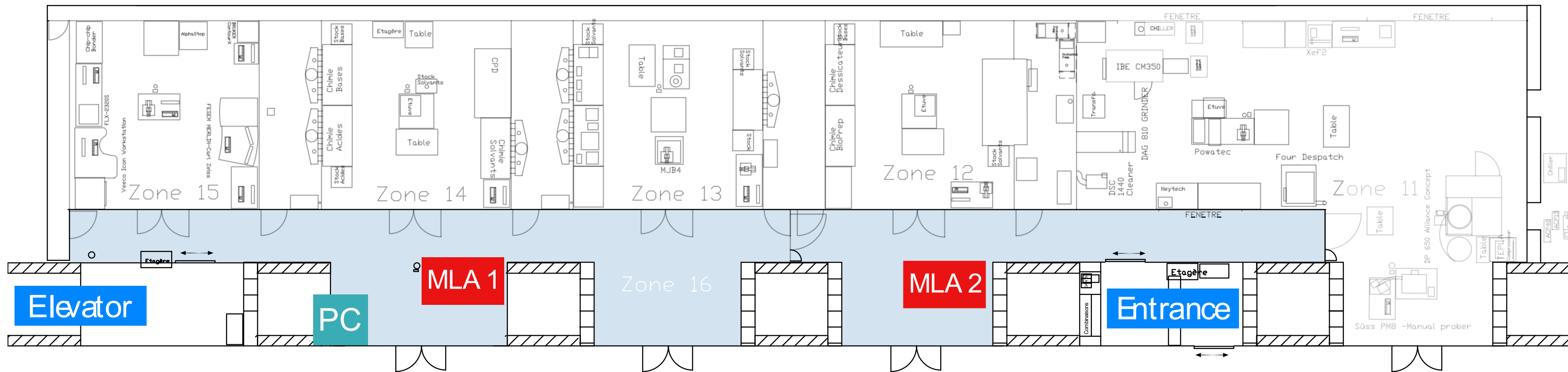
5. MLA 150 - 2 / Greyscale - to be added

6. Theory about the machine - to be added

1.Exposing with MLA 150

1. A – Start

Level +1



1. log in on CAE PC

🛈	Z16 Heidelberg MLA 150 - MaskLessAligner	10.11.2022	08:08:17	00:04:43 $		
🛈	Z16 Heidelberg MLA 150 2 - MaskLessAligner	10.11.2022	08:04:43	00:04:17 $		

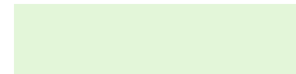
2. Start the menu

→ If not started yet, open the desktop applications (control and camera)

1.B – Setup job

- First be aware of this colour rule regarding boxes

= input required



= input optional

MLA150 Menu (v1.6.0) HI1416-10mm

File Tools User Info About

Setup Job
Load Substrate
Expose Job
First Exposure
Alignment
Series
Draw Mode
Inspection

Exposure Info

Job Name	Job_1502	No.	1502
Substrate Size [mm]		Height	
Design Name		Layer	First Ex
Design Type		Convert	
Design Size [mm]		Mode	
Dose [mJ/cm²]		Defoc	

Alignment Info

Exposure Bitmap Positions

Pos	X [µm]	Y [µm]
1		
2		
3		
4		
Positions		

Alignment Cross Positions

Pos	X [µm]	Y [µm]
1		
2		
3		
4		
Positions		

Progress Info

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

Hardware Info

X [mm]	Y [mm]
-107.363	71.114

Status

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

Numeric Values

Z Motor [Steps]	0
Piezo [Steps]	65535
Stage Air Pressure	OK
AF Air Pressure [bar]	1.60
Chuck Vacuum [bar]	-0.86
DMD Voltage [V]	5.18
Laser Power [%]	100.0
Laser Wavelength [nm]	375

Setup Job

1

Job

Name	Number	Exposure Mode
Job_1502	1502	Standard

New Job | Restart Job | Load Job | Save Job

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.

2

Substrate

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

3

Layer

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

Add Layer | Copy Layer | Delete Layer

Proceed

Load Substrate | First Exposure | Unload Substrate

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1

Job

Name	Number	Exposure Mode
Job_1502	1502	Standard

New Job | Restart Job | Load Job | Save Job

- Create a new job or load one
→ when done setting a job, you can save it (please give it a specific name, jobs without one will be deleted)

- Chose the exposure mode :

1. Standard : Expose the design once
2. Series : Expose the design N times with different parameters for dose and defoc
→ how to determine optimal parameters for your project
3. DrawMode : Use the camera to expose designs (bitmap format) in specific location
4. Inspection : To inspect the loaded substrate with the camera

2

Substrate

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

- Double click on the orange box to chose your substrate :

- *Wafer X inch* or *Mask X inch* (X = diameter [in])
- *Small* : if your sample is smaller than 50x50mm
- *_Automatic X* template : if you are not sure about the dimensions of your substrate

→ <u>Thickness value is not important</u>

3

Job layers

→ Each layer is determined by : design + laser parameters for the exposition (Dose and focus are set later in the process)

→ Each lithography step of your process flow can be represented by a layer (In this case save your job and reload it [see slide 5] when performing further steps)

→ You can add, copy or delete layers

→ It exist 2 types of layer :

- First Exposure = no alignment

- Layer 2, 3,… = with alignment

Job parameters

- Laser : choose between *375nm* and *405nm* according to recommendation

- Laser power : *100%* (filter is used for Greyscale)

- Design : Choose from the list of converted design
  → See Chapter 2 to convert your design

- Exposure bitmaps : to add extra bitmaps image to be exposed in specific positions

- Resist :
  1 - LargeDefoc = to extend focus range from [-10;10] to [-25;25] → used with 20 to 100um thick resist

- HAR (High Aspect Ratio) : increase the depth of focus → require higher dose
  Large → for 100 to 300um thick resist
  X-Large → for >300um thick resist

3 Alignment Settings

→ Can be set only for non-FirstExposure layers

→ Load an alignment setting or create one :

a) Name : to find the settings later in the list

b) Top or Back side alignment (see next slide for more information about backside alignment)

c) Position of the marks : enter the coordinates of your marks

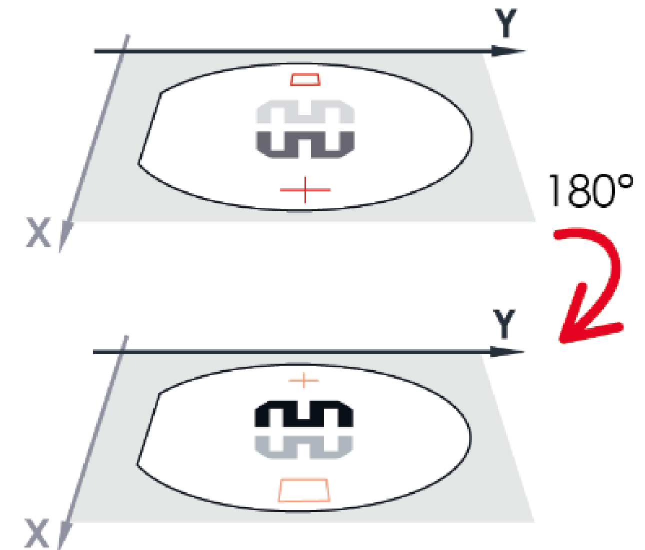
d) Camera for alignment : the one used during the procedure

e) Alignment Correction Options :
- Rotation : minimum **2** marks
- Scaling and Shearing : minimum **3** marks

→ After creating/editing settings, save, and refresh the list if needed

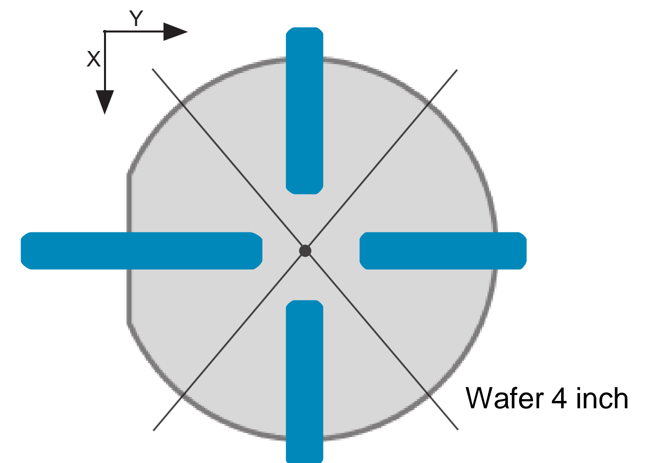
3 Alignment Settings – Information for backside alignment

- The coordinates on the MLA always refer to the substrate side that is currently the upper surface (e.g. if an alignment mark is exposed at the position [X: +20 mm], the alignment mark will be at position [X: -20 mm] for the backside alignment.

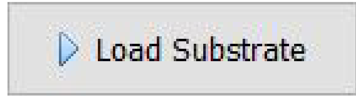


- The alignment marks need to be in a specific area. See blue zone on the image or **layer 65** in the *CMi layout template* for exact positions. Example of correct positions :

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



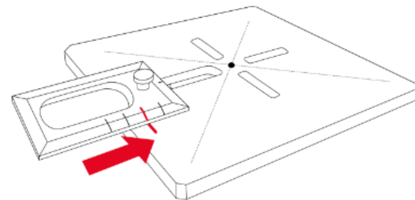
1.C Expose

→ When your job is ready, select the layer to be exposed and click on 

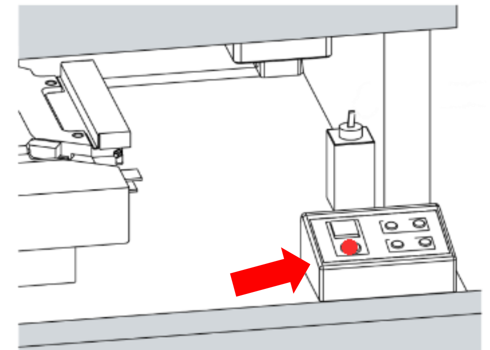
→ **For wafer** :

1. open the window

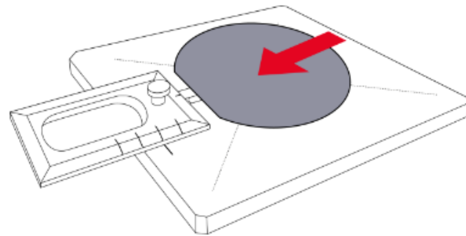
2. Place the guide according to your wafer size



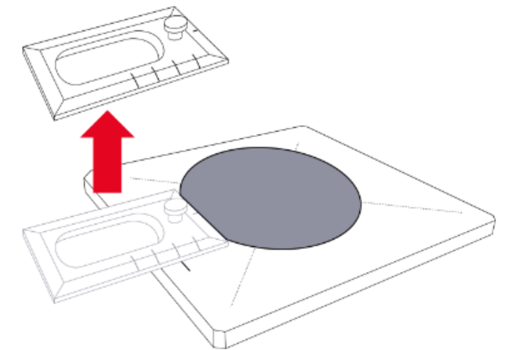
4. Activate the Vacuum



3. Place and centre the wafer against the guide



5. Remove the guide, close the door and follow screen instructions

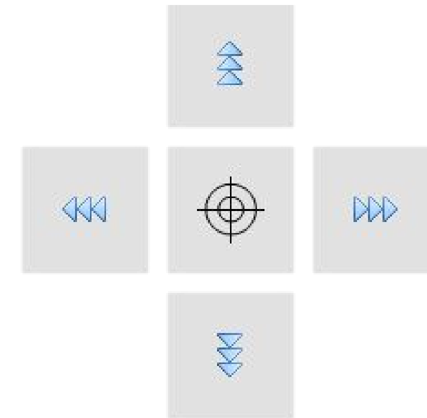


1.C Expose

→ **For small samples** :

- 1. Open the window 2. Place your sample in the **centre** of the chuck (best to align it in X and Y directions) 3. activate the vacuum 4. close the door → Follow screen instructions

- You will need to determine the centre of your sample. Move with the arrows or the target tool to go manually to the centre of your sample (Target tool is always enable at beginning, simply click on the substrate where you think is the middle, you will be able to fine tune the position later)



- Validate the position only when you are at the centre of the substrate !

→ **Next steps depend on your job :**

1) Standard [s.12] **2) Standard with alignment** [s.13] **3) Series** [s.15]

1) Standard

Be aware that MLA-1 and MLA-2 have different Resist Tables

a) Set a dose and focus according to the Resist Table (Desktop) or from your own experience

b) The design can be tilted based on the rotation of your substrate measured by the machine

c) Enable the exposition of bitmaps you set previously

d) Delay the exposure [hour:minutes]

e) Auto-unload the substrate if you want to expose only one layer

First Exposure

Exposure Settings

Design Name	job_001
Laser [nm]	375
Laser Power [%]	100%
High Aspect Ratio	Off
Dose [mJ/cm²]	500 (a)
Defoc [-10...10]	10

☐ Expose with Substrate Angle (8.51 mRad) (b)

☐ Expose the Bitmaps (c)

☐ Delay Exposure [hh:mm] 0 0 (d)

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.

☑ Auto-Unload the Substrate (e)

Comment

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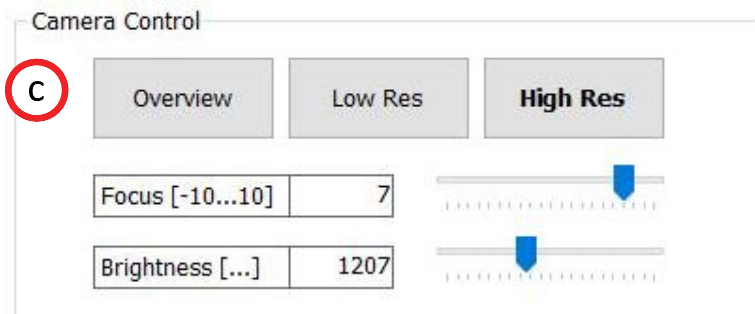
2) Standard with alignment

a) Control if alignment positions are correct and edit if needed

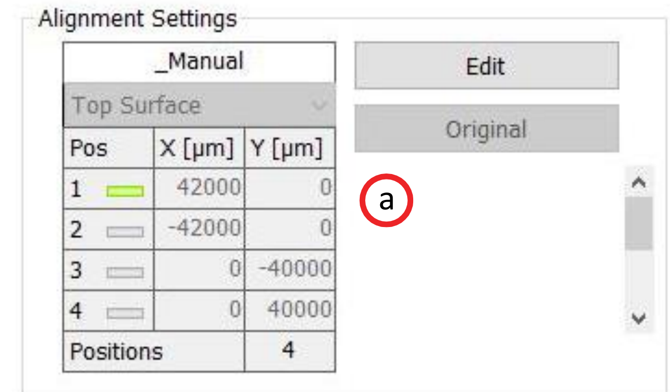
b) Click to start alignment procedure

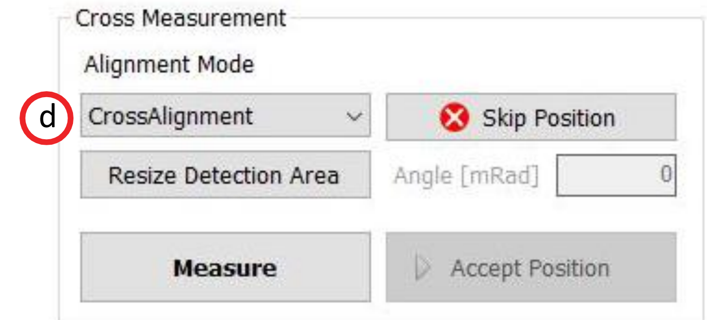
c) Overview and Low Res camera → move to your mark
High Res → for the measurement

d) Chose measurement mode :
- Automatic : CrossAlignment or RectangleAlignment
- Manual : ManualAlignment



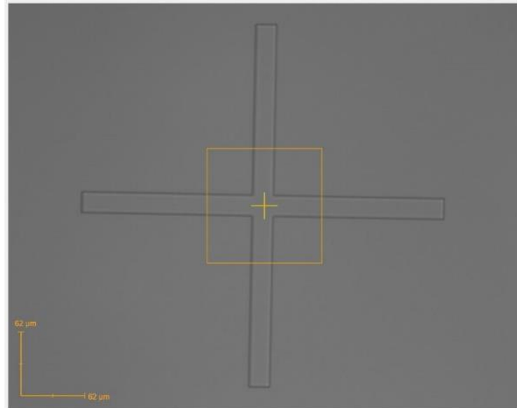
Alignment





2) Standard with alignment

e) For automatic detection, please make sure the feature to analyse is in the Detection area (Orange square). If you can't see it, press on *Resize/Maximize Detection Area* and select a zone on the camera window or slide the sides of the rectangle.



f) Measure:

- **automatic** detection of the feature
- **manual** selection of the position with the target tool

→ *Remeasure* or *Accept Position*

→ Repeat c-f for all the marks

Alignment

Alignment Settings

_Manual

Top Surface

Pos	X [µm]	Y [µm]
1	42000	0
2	-42000	0
3	0	-40000
4	0	40000
Positions		4

Edit

Original

Move To First Cross

Cross Measurement

Alignment Mode

CrossAlignment

Skip Position

e Resize Detection Area

Angle [mRad] 0

f Measure

Accept Position

Camera Control

Overview Low Res High Res

Focus [-10...10] 7

Brightness [...] 1207

2) Standard with alignment

Be aware that MLA-1 and MLA-2 have different Resist Tables

g) Set a dose and focus according to the Resist Table (Desktop) or from your own experience

h) Define which correction based on alignment you want to apply

i) Enable the exposition of bitmaps you set previously

j) Delay the exposure [hour:minutes]

k) Auto-unload the substrate if you want to expose only one layer

Alignment: Exposure

Exposure Settings

Design Name: D100_getter_wells
Laser [nm]: 405
Laser Power [%]: 100%
High Aspect Ratio: Off
Dose [mJ/cm²]: 260
Defoc [-10...10]: -2
g

3-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.

Alignment Correction Options

h
Rotation [mRad]: -19.501 ☑ Use
Scaling X / Y: 0.952387 / 1.000046 ☐ Use
Shearing [mRad]: -0.025 ☐ Use

☐ Auto-Unload the Substrate j
Comment

☐ Delay Exposure [hh:mm] k

☐ Expose the Bitmaps i

3) Series

a) Choose parameters to test :
dose / focus / dose + focus

b) Define starting value, step and how many lines (# of fields) should contain the matrix

c) Distance between 2 dyes in the matrix (stay orange if overlapping)

d) Label at the bottom left of each dye containing Dose and Focus

e) Delay the exposure [hour:minutes]

f) Auto-unload the substrate if you want to expose only one layer

Series

Parameters

Design Name	job_001
Laser [nm]	375
Series Mode	Dose and Defoc

(a)

Dose Series	
Number of Fields	11
Start Value [mJ/cm²]	450
Step Size [mJ/cm²]	25
End Value [mJ/cm²]	700
Fixed defoc value [-10...10]	0

(b)

Defoc Series	
Number of Fields	9
Start value [-10...10]	-4
Step Size	1
End value [-10...10]	4
Fixed Dose Value [mJ/cm²]	80

Number of Rows	1
Step Size in X [mm]	3.0
Step Size in Y [mm]	3.0
Total Range in X [mm]	39.0
Total Range in Y [mm]	65.0

(c)

Expose a Series of Designs:

A Series of just one parameter will be exposed horizontally, centered around the zero stage position. You can set the "Number of Rows".

A Series of both parameters will be exposed two-dimensionally, also centered around the zero stage position. Defoc variation in X, Dose variation in Y.

1) Double-check the Exposure Settings.

2) Select the Series Mode.

3) Enter the Parameters. For a Series of just one parameter, also enter the (fixed) value of the remaining parameter.

4) Enter the step size between two adjacent Designs in X and Y.

5) Optional: Check 'Expose Labeling' to expose the current Dose and Defoc values under each design.

6) Optional: Delay the Exposure.

☐ Expose Labeling (d)

☐ Auto-Unload Substrate (e)

Comment

☐ Delay Exposure [hh:mm] (f)

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Exposition information and position

a) Estimated maximum time for exposition

b) Position of exposed design. Hold-click on its side to move it on the substrate.

c) When using the camera to find the appropriate position for exposition, press *Set Zero* at the desired position for the design centre

→ If all information on the screen looks correct, press :

In case you have change the exposition position, an error message about not being in the centre will appear. You can acknowledge it !

1.D End

- If not automatically unloaded, your can restart your job in the main menu or expose a second layer

- If you are done, click

→ When back to the main menu:

1) open the windows
2) deactivate the vacuum
3) get back your sample
4) close the windows

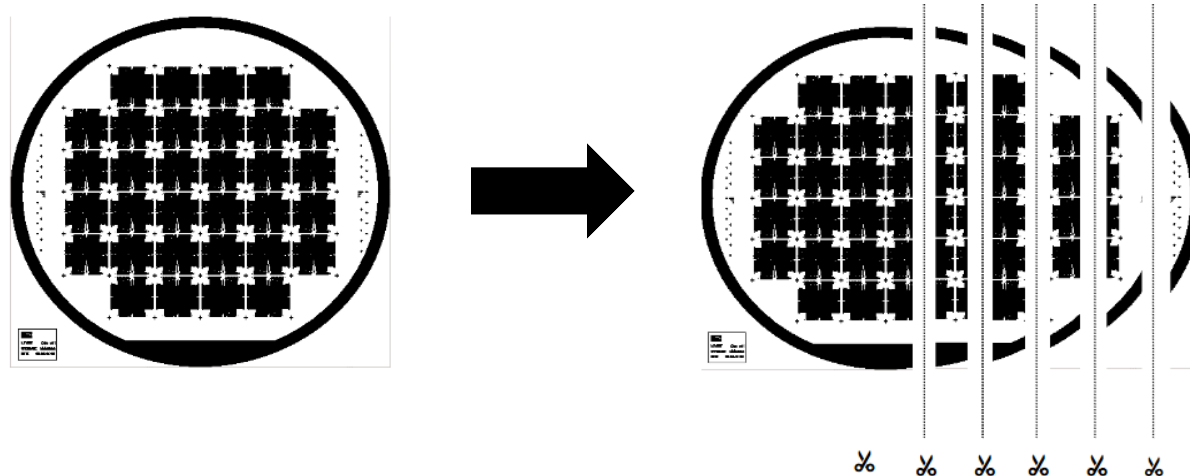
→ Press *New Job*

→ **Go to the Zone PC to <u>log out from the CAE</u>**

2. Design Conversion

2. Convert

- Goal : convert your design into a series of stripes than can be exposed by the MLA150



1. **Copy your design into the corresponding file extension folder**

Allowed extension : .gds , .cif , .dxf (no capital letter)

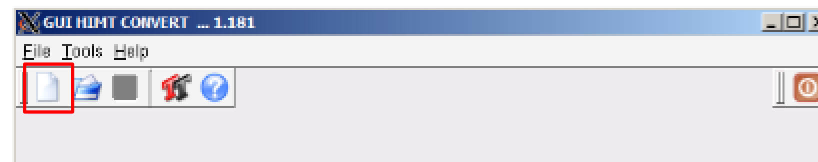
Allowed character for file name : a…z A…Z 0..9 _ (alpha numeric + underscore)

2. Convert your design

- In the job setup/Design → click on

- The GUI HIMT CONVERT will pop up

→ Press on the blank page icon to create a new job (or File/New Job)



→ Give a job name

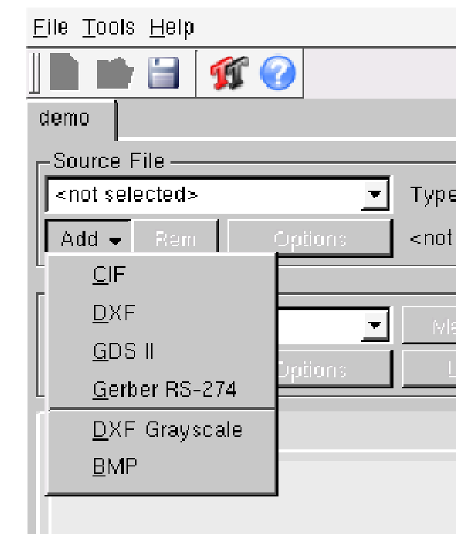
→ Click on *Add* to load your design

if you can't find your design, make sure :

1) The design is in the right folder

2) Extension without capital letters (i.e. ".gds", not ".GDS")

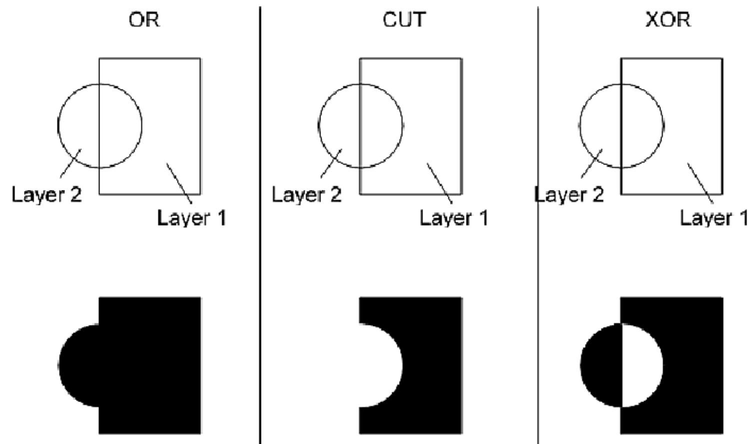
3) File name contain only accepted characters

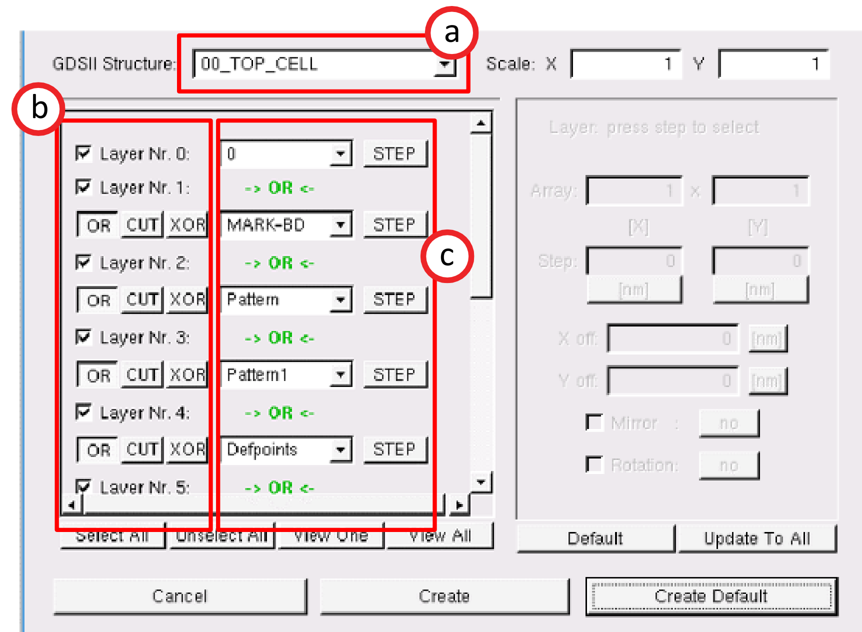


Following instruction are for GDSII files. Procedures with DXF and CIF are relatively similar but don't hesitate to contact a CMi staff if you have any doubt.

a) Select which cell from your design should be exposed

b) Select how many layers you want to expose



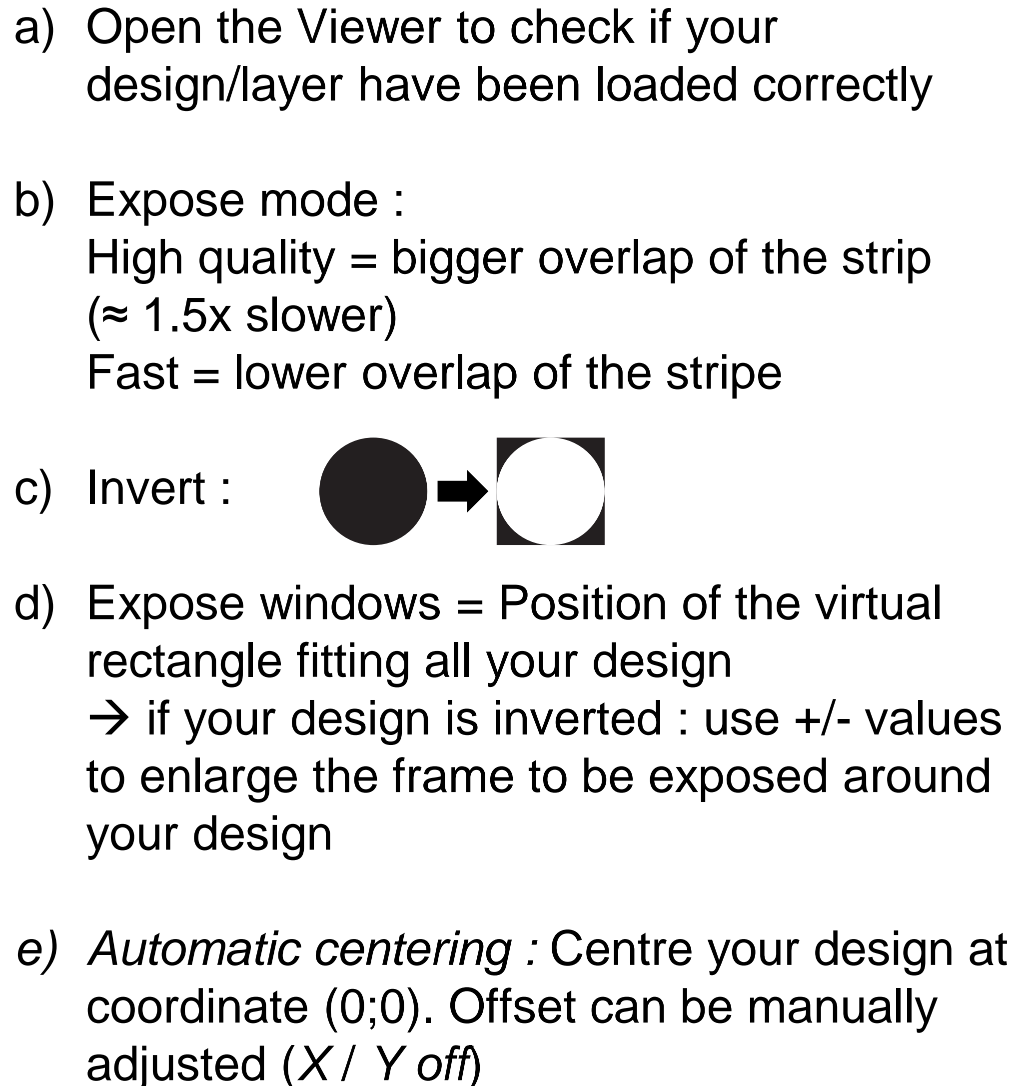


c) Select corresponding layers from your design

a) Open the Viewer to check if your design/layer have been loaded correctly

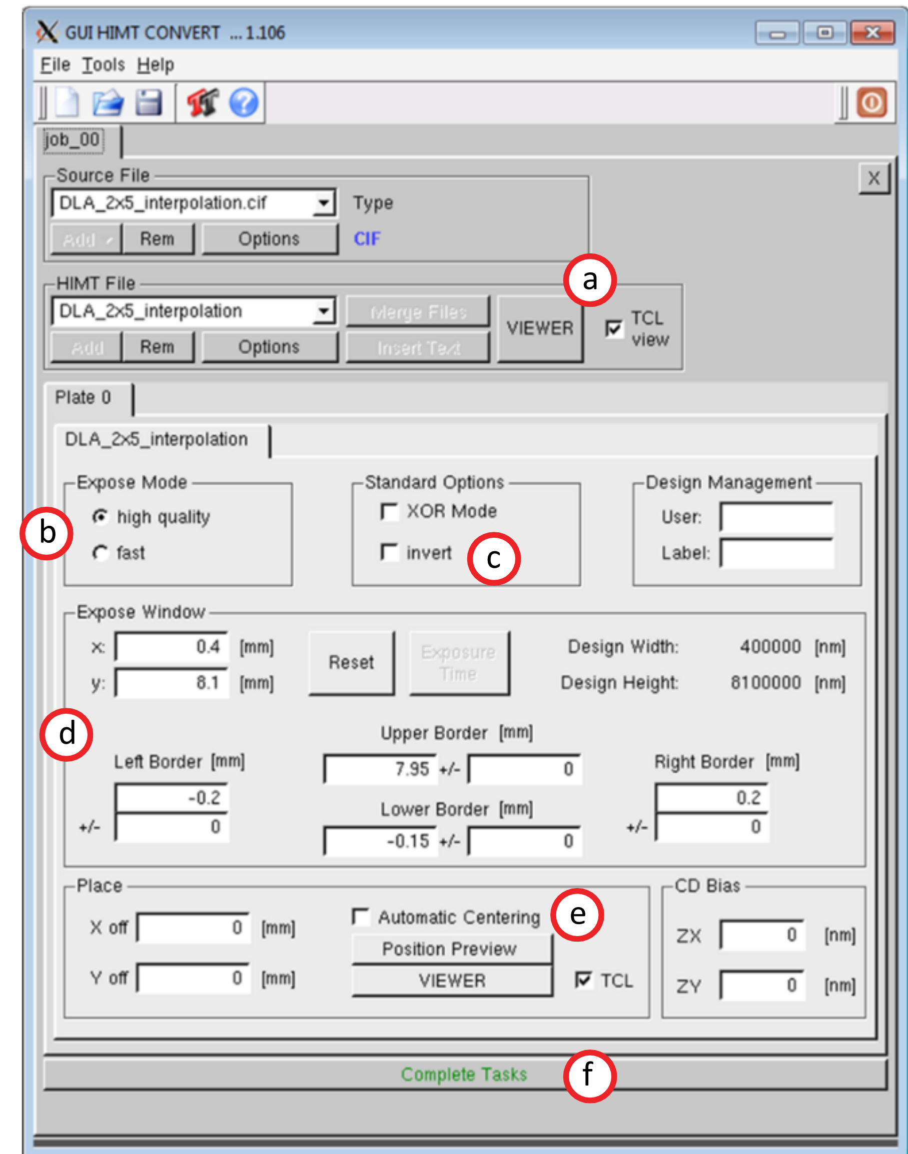
b) Expose mode :
High quality = bigger overlap of the strip (≈ 1.5x slower)
Fast = lower overlap of the stripe

c) Invert :



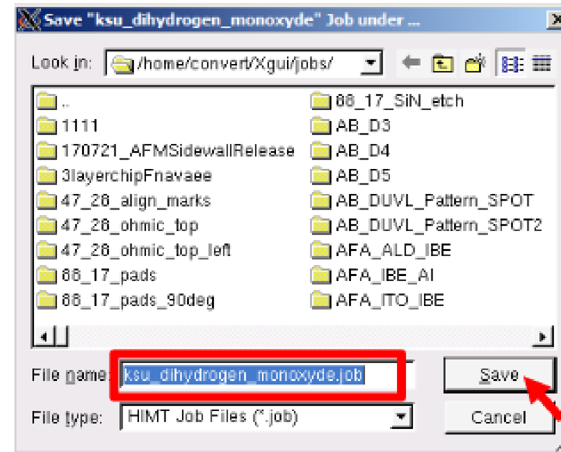
d) Expose windows = Position of the virtual rectangle fitting all your design
→ if your design is inverted : use +/- values to enlarge the frame to be exposed around your design

e) *Automatic centering :* Centre your design at coordinate (0;0). Offset can be manually adjusted (*X / Y off*)

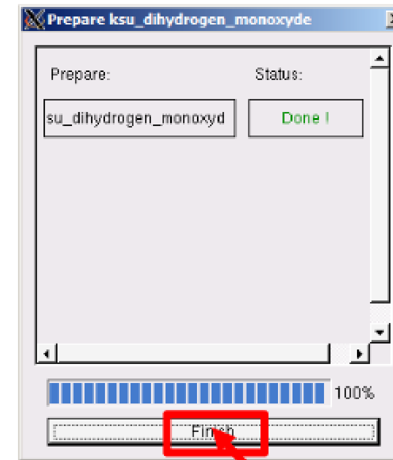


f) If all information are correct click on <u>*Complete task*</u>

- You will be ask to save the job (no need to change the name)



- Conversion will start and end



→ <u>do not forget to click on Finish</u>

- If your job does not appear in the list, please *Refresh* it

Prepare: Convert Design | Load: Load, Cancel, Refresh | Search: Search, Clear | Show: All, Next 100, Next | Loaded: 332 / 333

Name	Date	Time	Mode	Size X	Size Y	Source file	Prep Mode	Design Type	Bi Dir	Layer / Cell	Mirror
job_001	10/11/2022	1:49:42 PM	Quality	14.999998	35	SFL_toplayer_300um_30um_error	Prepared	Binary	True	CM	off
111022_DK_Toplayer_6x	10/11/2022	1:37:46 PM	Fast	74.999998	74.888788	SFL_toplayer_300um_30um_6x	Completed	Binary	True	CM	off
111022_DK_toplayer_8x	10/11/2022	1:35:10 PM	Fast	75.787522	75.155124	SFL_toplayer_300um_30um_8x	Prepared	Binary	True	CM	off
111022_DK_toplayer	10/11/2022	1:23:40 PM	Quality	154.62325	75.155124	SFL_toplayer_300um_30um	Prepared	Binary	True	CM	off

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