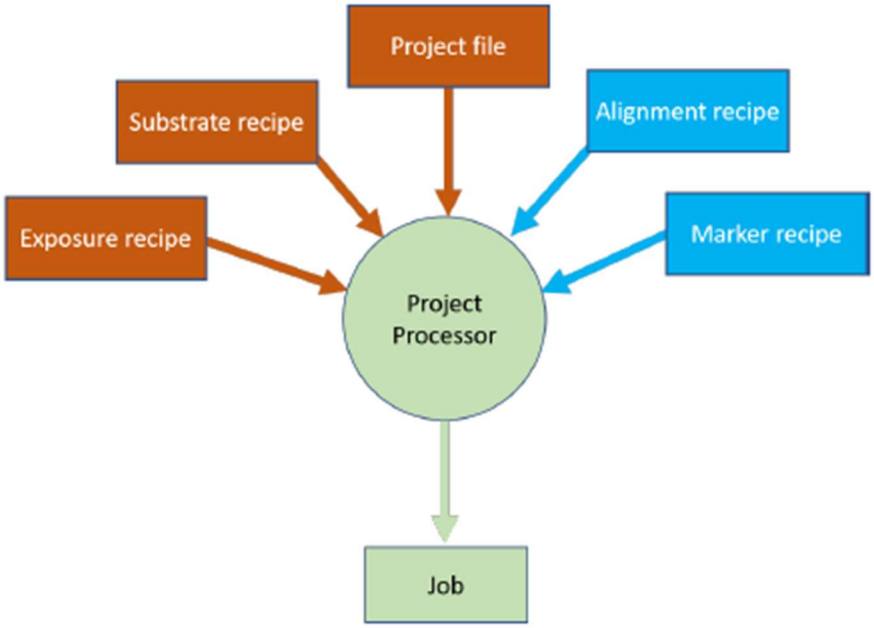
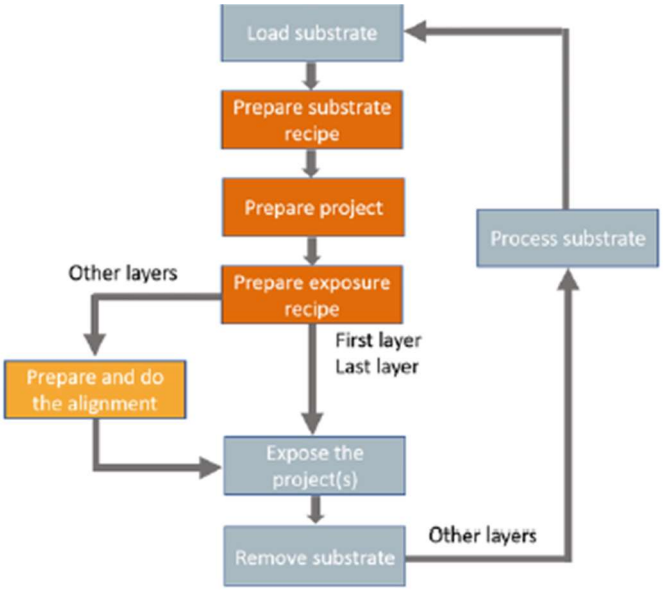
System Info

Projects and recipes

To start a project, the user needs to select several parameters before the project can be started. The project processor in the PICOMASTER system combines these parameters internally to a job. **17 below**



System Operation Flow



Machine coordinate system

The machine coordinates for the step and scan axes are given with reference to the default (0,0) position of the writing module, see **Figure 2-8 below**.

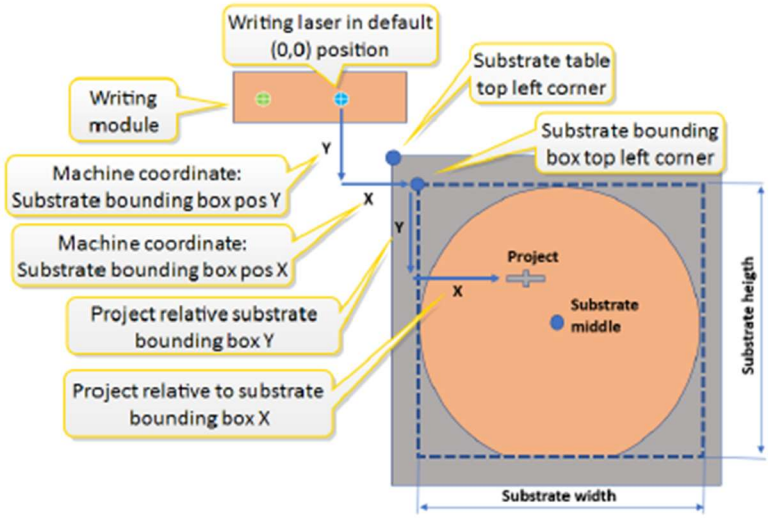


Figure 2-8 Coordinate system indicating the writing laser position with reference to the default position

Note: In **Figure 2-8 above**, the writing laser seems to move in X and Y direction. In the real situation, the writing module makes steps in X direction and the vacuum chuck scans in Y direction.

The writing module default (or origin) position is at the left machine side behind the vacuum chuck. These coordinates indicate the position of the writing laser. The writing module moves to the default position automatically on many occasions. It also moves to de default position after pressing the STOP button on the right side of the screen.

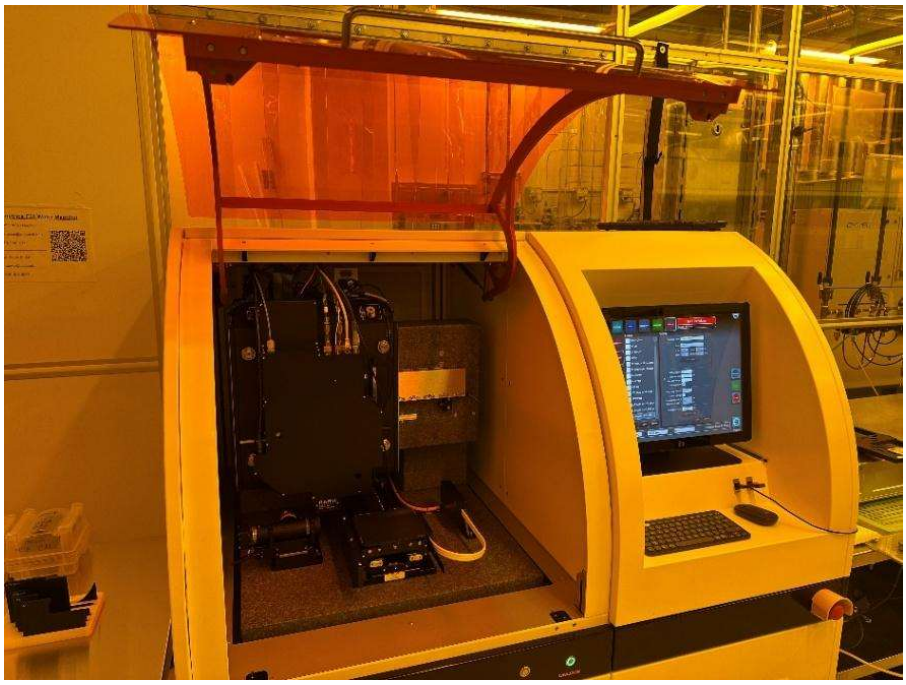
Project coordinates in substrate recipes are relative to the top left corner of the substrate bounding box. The position of the substrate bounding box top left corner is given in machine coordinates.

Substrate Loading

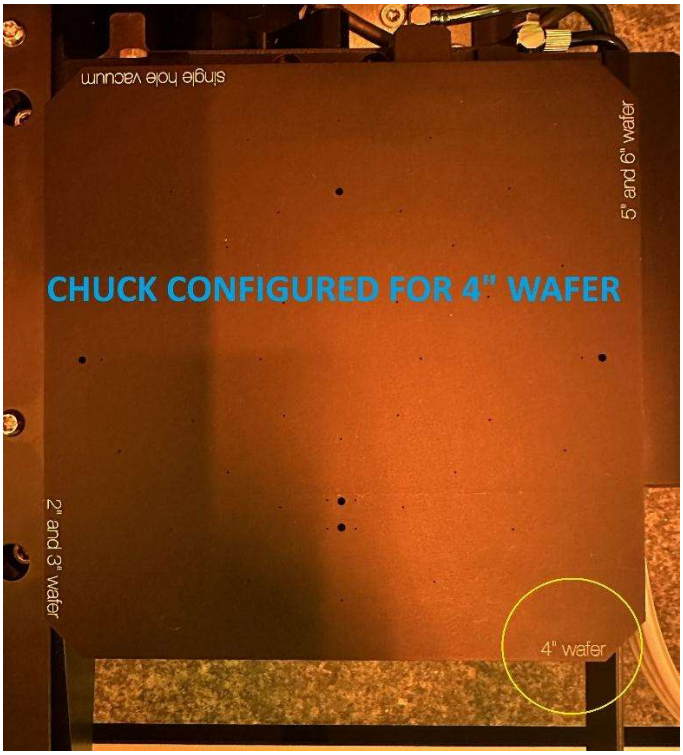
1. Verify the tool's status at the top of the screen is **Waiting** and that the system status bar at the bottom of the screen is not showing, this indicates the system is ready to use and there are no issues:

If there is an issue, the system status bar will appear along the bottom of the screen with the item(s) that are experiencing issues in red. In this example, the system's **Suspension** has a problem:

2. Press the **Unlock** button located on the front of the tool below the amber cover, it will illuminate green, then open the amber cover by lifting it up.



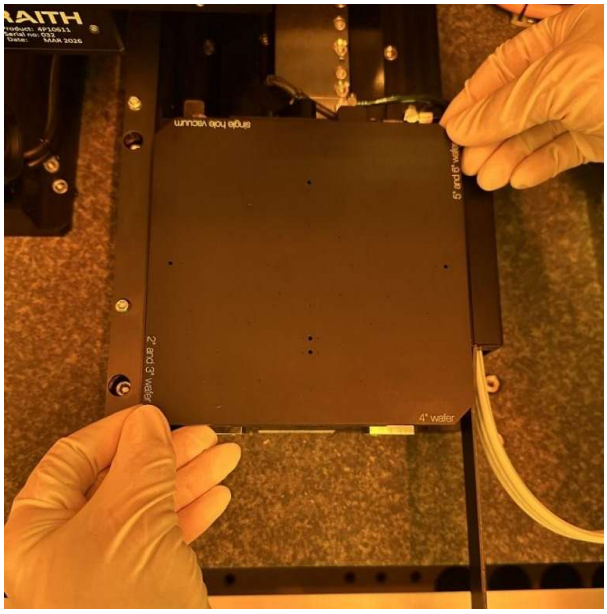
3. Check the current chuck configuration. This is shown on the lower right corner of the chuck (with you facing the tool).



The available chuck configurations are:

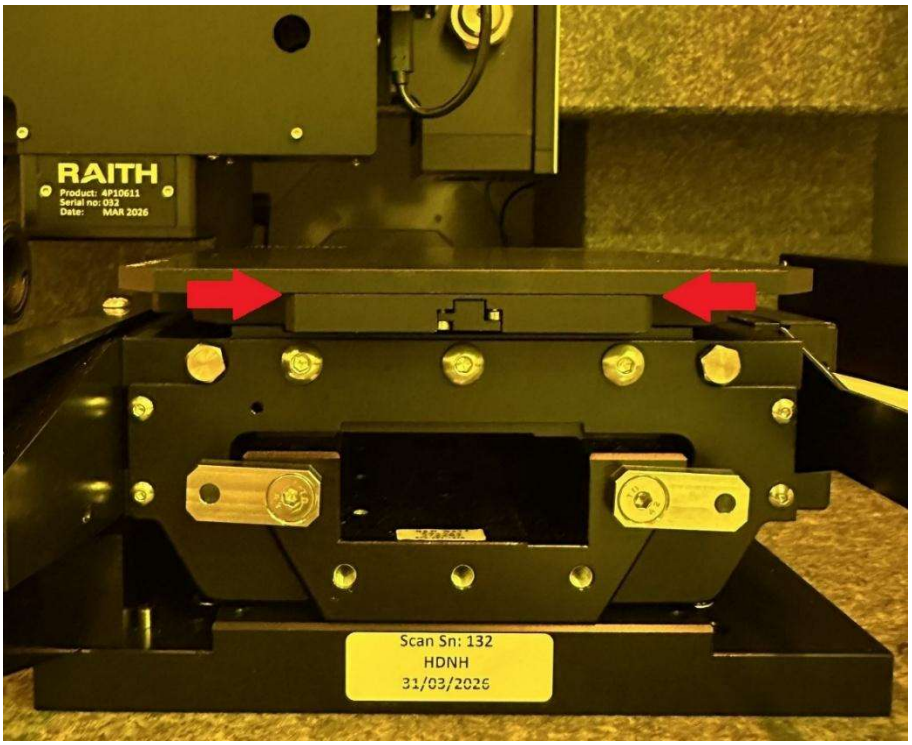
- **singe hole vacuum**: pieces > 10 mm^2
- **2" and 3" wafer**
- **4" wafer**
- **5" and 6" wafer**

4. If you need to change the chuck configuration, perform the following:
    a. Carefully lift the chuck up off the stage by grabbing the opposing corners, as shown in this photo:

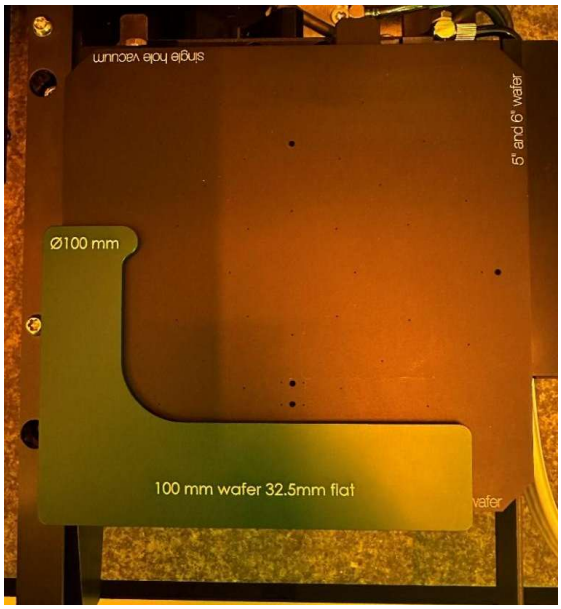


b. Rotate it to the configuration you need (label in the lower right corner).
c. Carefully place it back on the stage. There are a set of pins on the back of the chuck that need to be inserted into a set of holes on the stage. You can use the sides of the chuck as a visual aid to help with proper placement. The sides of the chuck line up with the sides of the stage as shown here:

d. Once you feel you have installed it correctly, lower yourself such that your eyes are in line with the chuck and stage interface and inspect to make sure the chuck is fully seated onto the stage. There should be no gap between the chuck and the stage, like this:



5. Retrieve the correct alignment tool for your sub and place it on the left corner of the chuck like this:

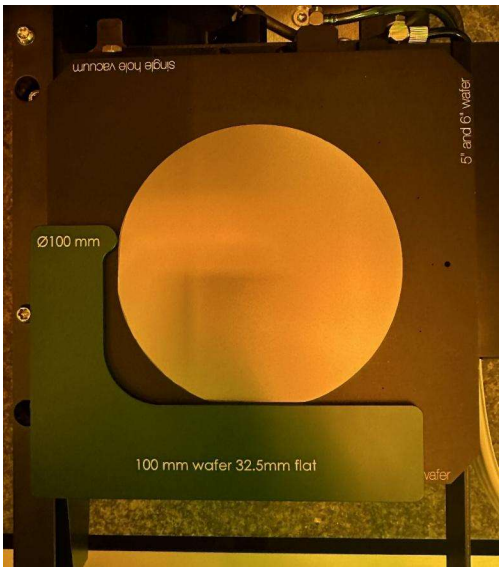


The available alignment tools are:

- **2” wafer**
- **3” wafer**
- **100 mm wafer**
- **125 mm wafer**
- **150 mm wafer**
- **12 x 12 mm square**

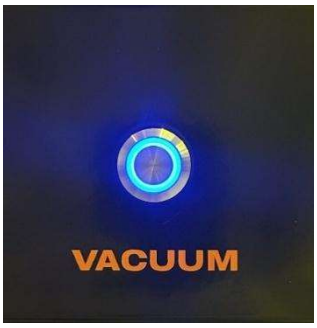
6. Make sure the backside of your substrate is clean and place it onto the chuck with the flat(s) or edges pushed against the alignment tool.

!! DO NOT USE METAL TIP TWEEZERS!!



!! DO NOT USE METAL TIP TWEEZERS!!

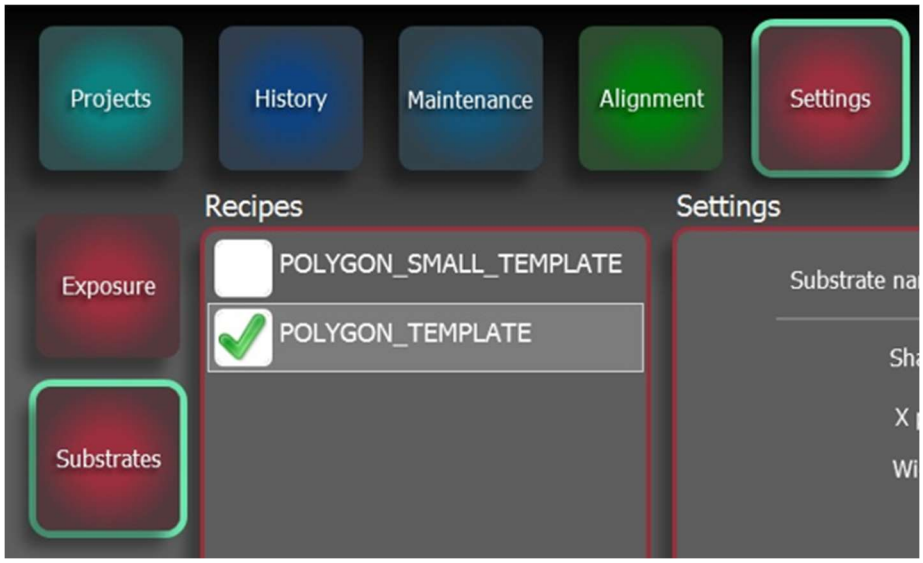
7. Press the VACUUM button, it will flash for a few seconds and then stay illuminated.



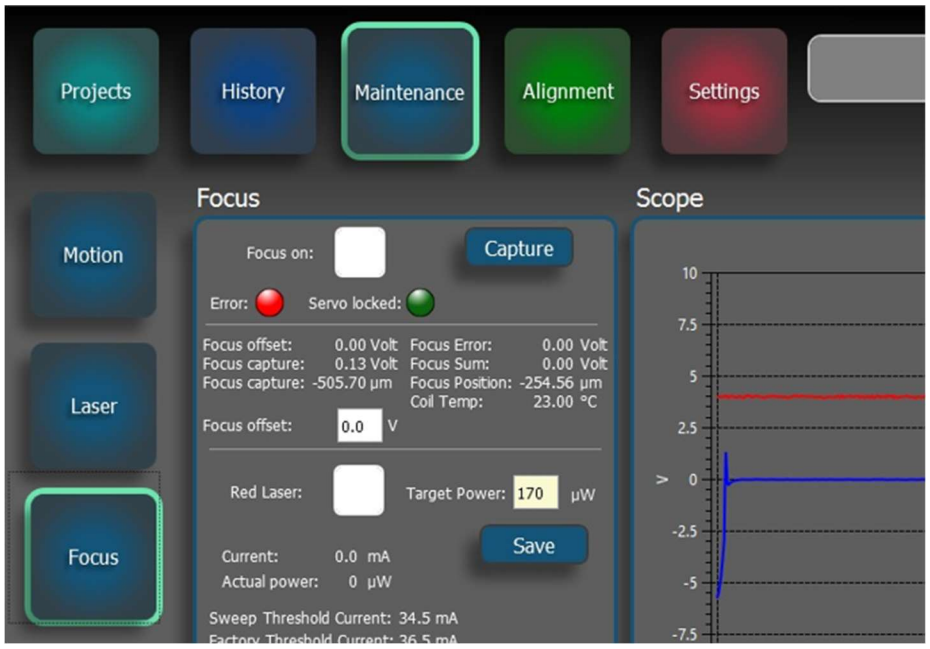
8. **REMOVE THE ALIGNMENT TOOL!**
9. Close the amber cover, it will lock automatically.

Setting up The Substrate Recipe

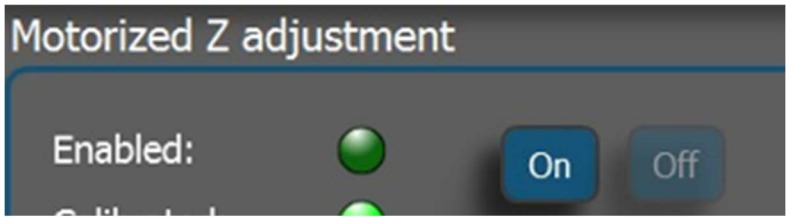
1. In the software go to the **Settings** page and then the **Substrates** tab to select one of the 2 substrate recipes. They are:
    - **POLYGON_TEMPLATE – Used for 2” and larger substrates**
    - **POLYGON_SMALL_TEMPLATE – Pieces > 10 mm^2**



2. Select the **Maintenance** page and then select the **Focus** tab.



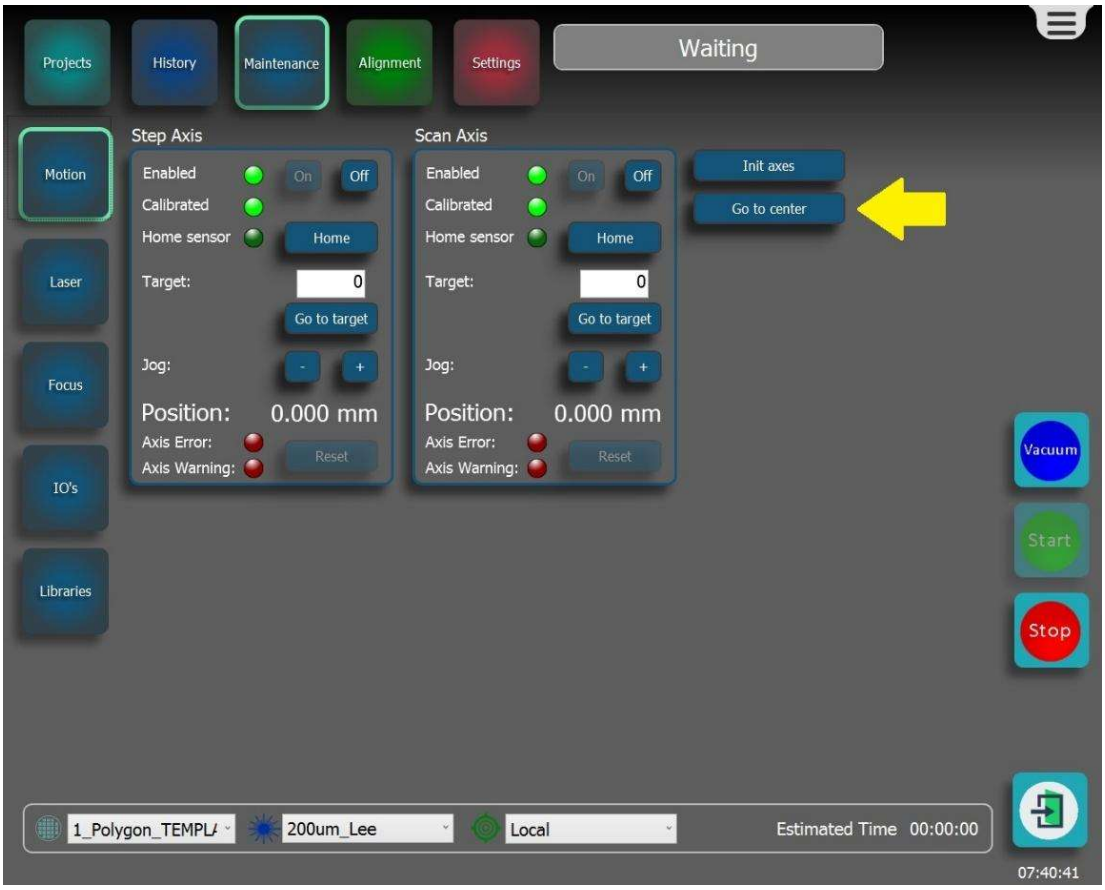
3. In the **Motorized Z adjustment** section, select **On** to turn on the Z drive motor.



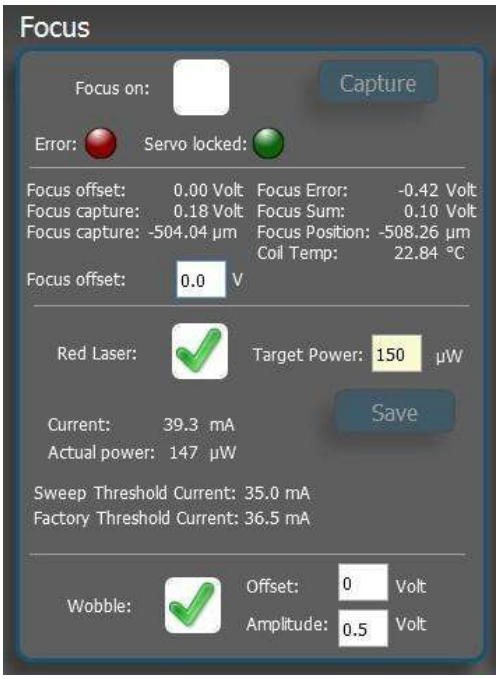
4. If the **Calibrated** light is **OFF** (uncommon), Select **Home** and wait until the **Position** reading stops changing (20.205 mm).
   If the **Calibrated** light is **ON**, enter **4** in the **Target** field and then select **Go to target**. The WH module will move to the specified height of 4 mm.

IMPORTANT: Inputting an incorrect value here can make the writing module touch the substrate, which can result in damage to the tool and your substrate!!!

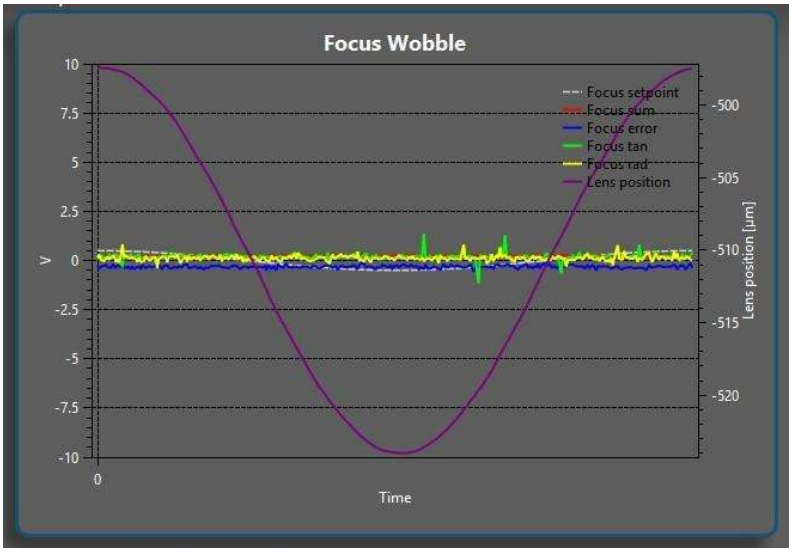
5. Select the **Motion** tab and then select **Go to center**, the WM (working module aka write head) will move to the center of the substrate (as defined in the substrate recipe).



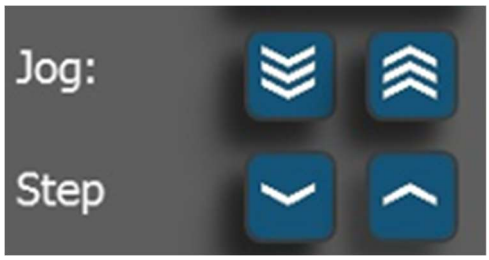
6. Go back to the **Focus** tab and enter your substrate thickness **IN MM WITH AN ADDED 0.5 MM** in the **Target** Field. For example, if your substrate is 500 µm (0.5 mm) thick you would enter 1 mm.
   IMPORTANT: Inputting an incorrect value here can make the writing module touch the substrate, which can result in damage to the tool and your substrate!!!
7. Select **Go to target**, the WM will move down to the specified height.
8. Once the WM gets to the target position (see **Position** field), set the **Red Laser Target Power** to **150 µW** and verify that the other values are the same as what is depicted in this screenshot of the **Focus** panel (correct if needed):



Now check the box next to **Wobble**, this will also power on the **Red Laser** and bring up real-time noise signals in the **Focus Wobble** scope graph. Your initial graph will look something like this:

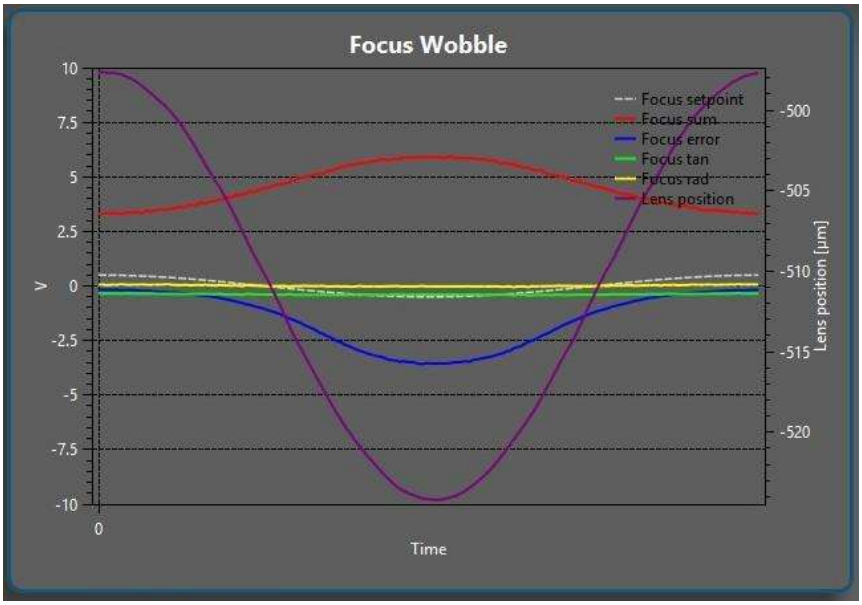


9. You now need to manually move the WM down to the focal point for your substrate. You will be using the **Jog** and **Step** arrow keys in the **Motorized Z adjustment** section to do this in conjunction with monitoring the **Focus Wobble** graph. These arrow keys should be used in a single click fashion, **DO NOT HOLD THEM DOWN!**



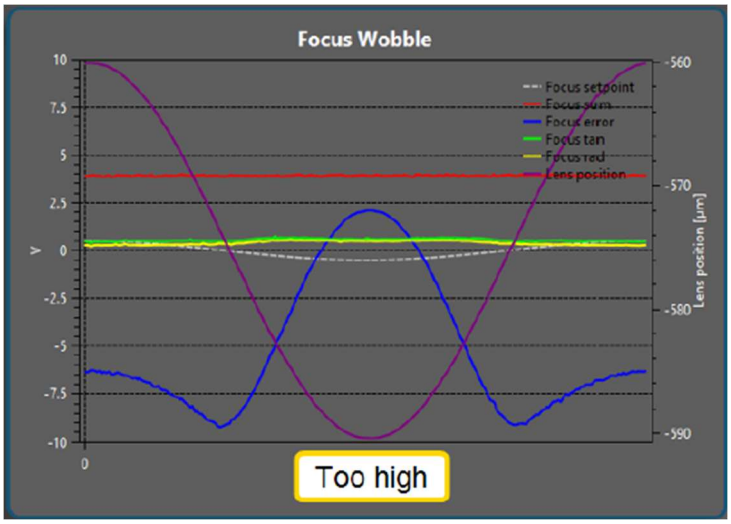
Step, single click = 0.025 mm
Jog= varies, quick click about 0.01mm
IMPORTANT: Holding down the arrow keys can make the WM touch the substrate, which can result in damage to the tool and your substrate!!!

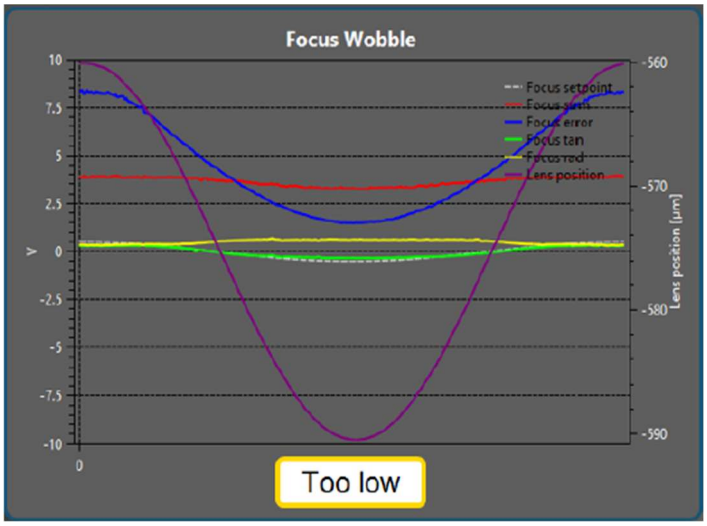
10. Start off by moving the WM down with the **Step** down arrow (**SINGLE CLICKS!**) until the noise signals in the Focus Wobble graph turn into smooth lines. Additionally, the blue **Focus Error** line on the graph will start to dip down. The WM is now approaching the substrate.

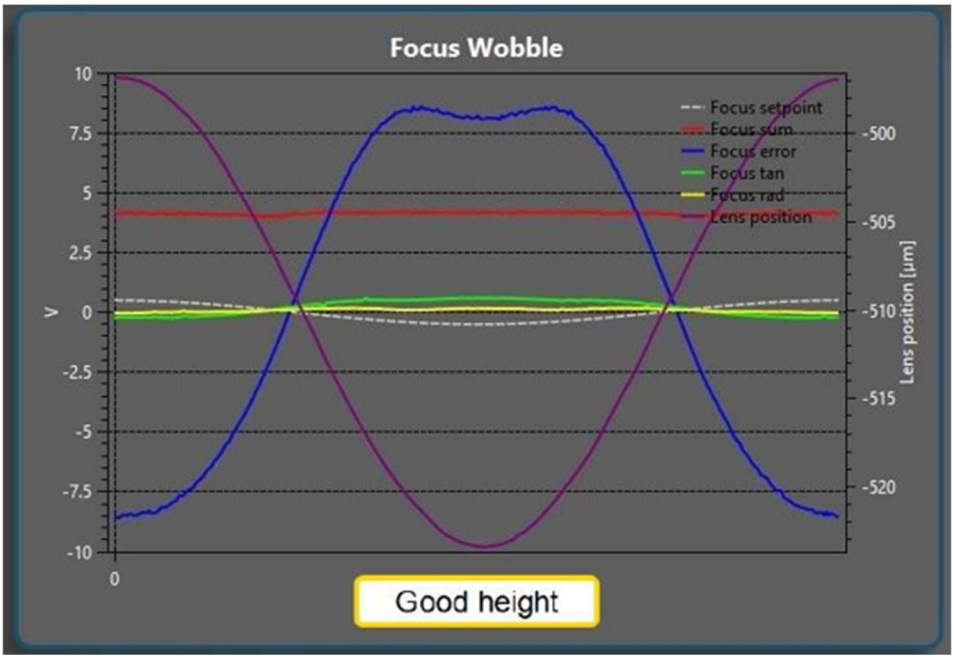


11. Carefully move the WM down a bit more using the **Jog** or **Step** down arrow (**SINGLE CLICKS!**) until the **Focus Sum** signal (red line) starts to increase (starts lifting).
12. **STOP** moving the WM down once that happens. You want this red line to be right around 4V (left side scale on graph). If it is below 4V increase the **Red Laser Target Power** in the **Focus** panel by 20 µW increments, if it is above 4V then decrease power.
NOTE: This edits in real time. The red line should be in the range of 2.5 - 7.5V on the graph, but ideally it should be 4- 5V, as running it near the limits can result in substrate scan errors.

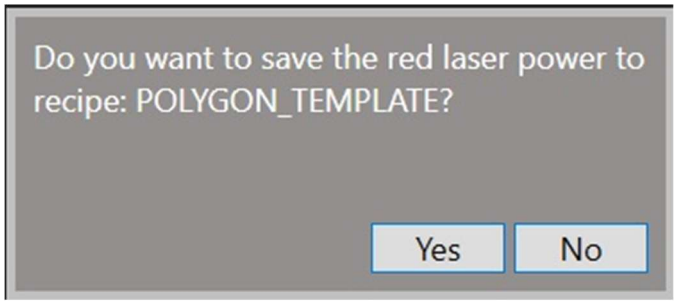
13. Continue to carefully move the WH down until both the **Focus error** (blue) and the **Lens position** (purple) lines intersect with the **Focus setpoint** (grey dashed) line at 0V.







14. Turn off the **Wobble** and **Red Laser**.
15. Select **Save** under **Target Power**; a verification pop up window will appear, select **Yes**. This will save the power setting to the currently selected substrate recipe.

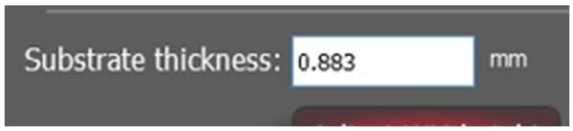


16. Note the **Position** value in the **Motorized Z adjustment** panel.

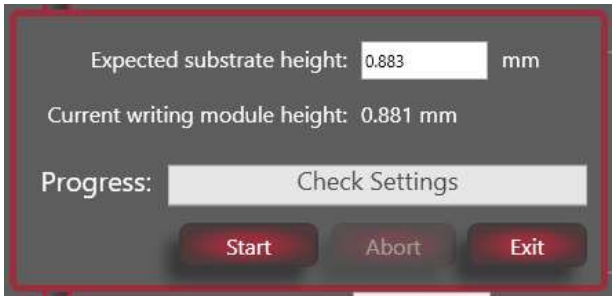
IMPORTANT: This value will be referred to as the **Substrate thickness** in the **Substrate Recipe**. This is a misnomer; it is the focal point for your substrate and will be different than the actual substrate thickness.

17. Select **Stop** (right side of the screen).

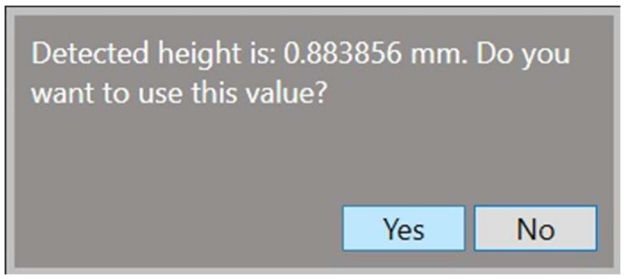
18. Go back to the **Settings** page, **Substrates** tab.
19. Enter the **Position** value from Step 14 in the **Substrate thickness** field and press **Enter** on the keyboard.



20. Select **Save**.
21. Select **Adjust WM height**. A pop-up window will appear, select **Start**.

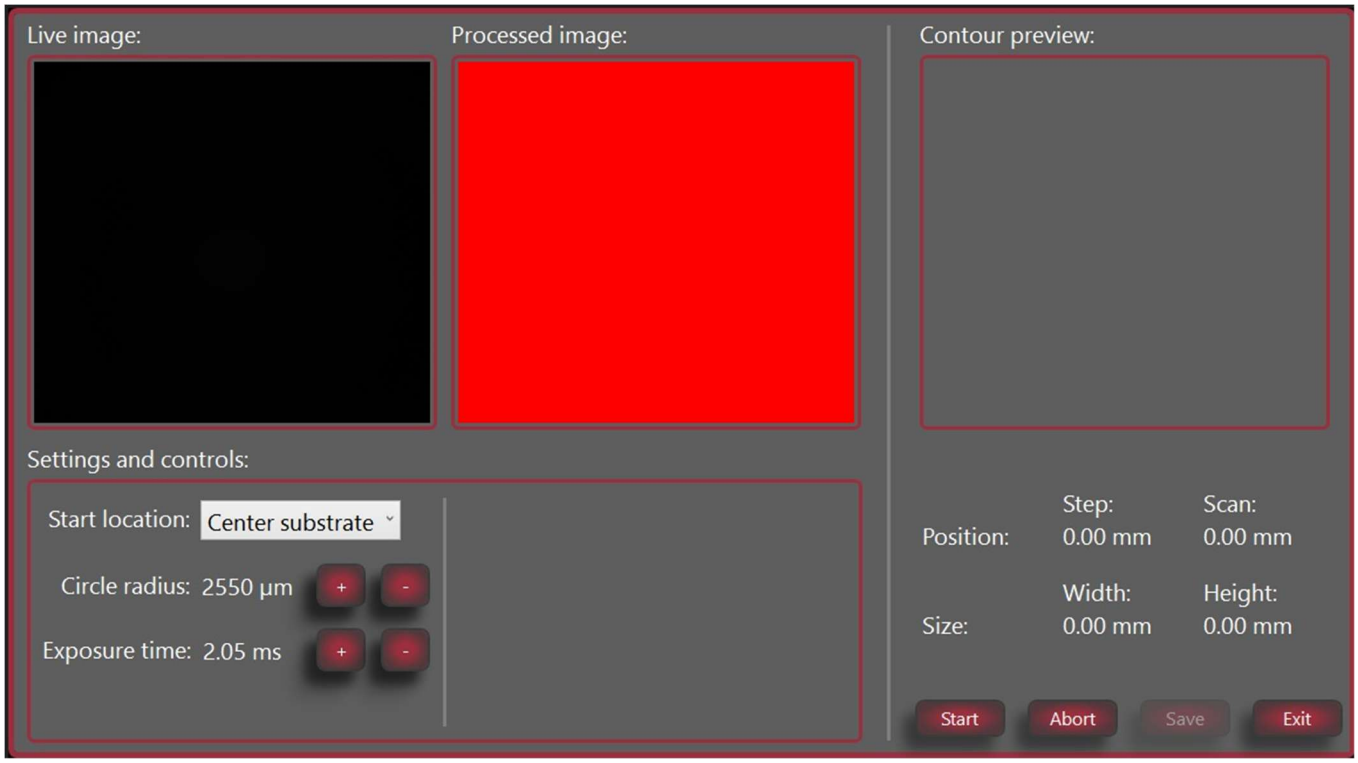


22. The system will verify the height and provide a new value in pop-up window, select **Yes** to confirm the new value.

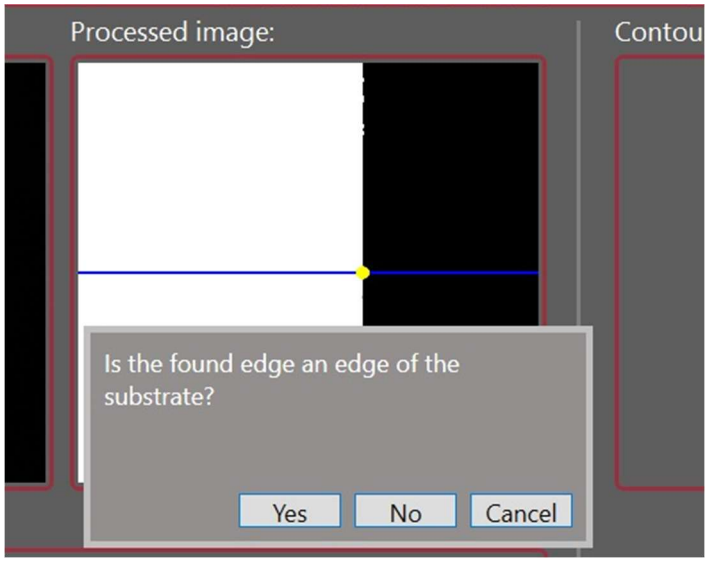


IMPORTANT: Although the software refers to this as the **Substrate thickness**, it is a misnomer. It is the focal point for your substrate and will be different than the actual substrate thickness.

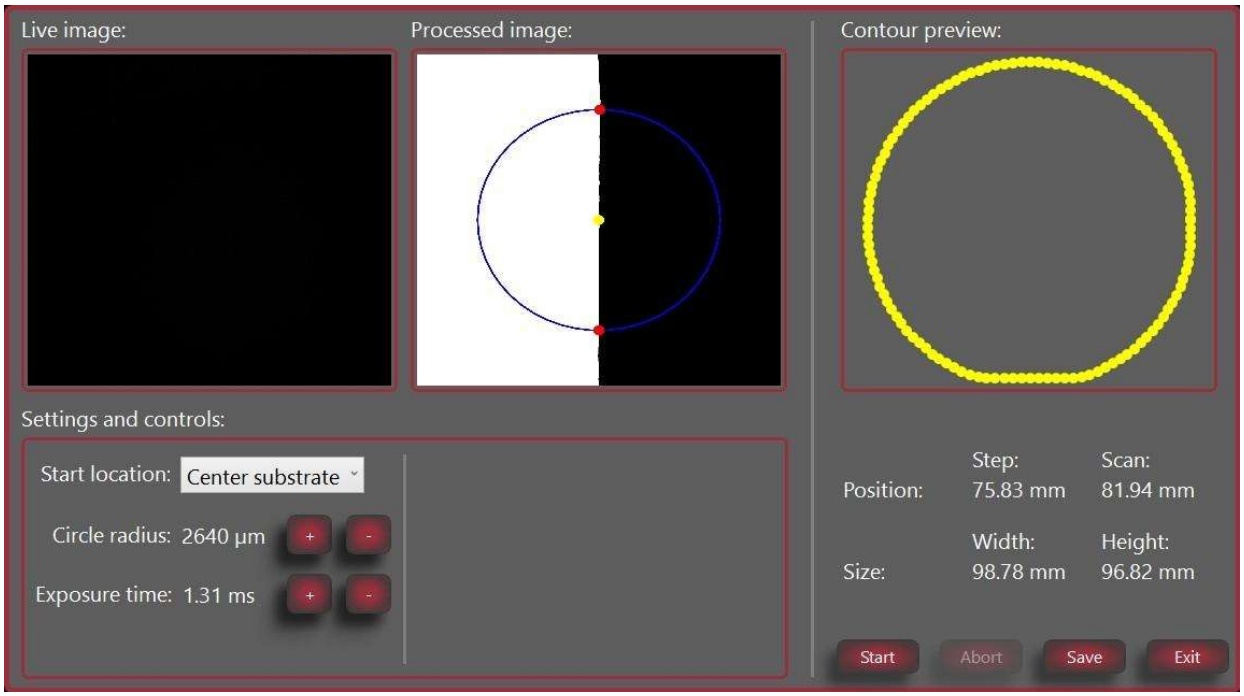
23. Select **Scan contour**. A pop-up window will appear with some settings you can change. It is recommended to just proceed with the default settings for your first attempt:
    - **Start location** should be set to **Center Substrate**
    - The **Circle radius** setting changes the number of scan points. Higher value= faster scan and lower accuracy. Small value= Slower scan and higher accuracy.
    - **Exposure time** changes the light intensity; **+** = brighter and **-** = darker.



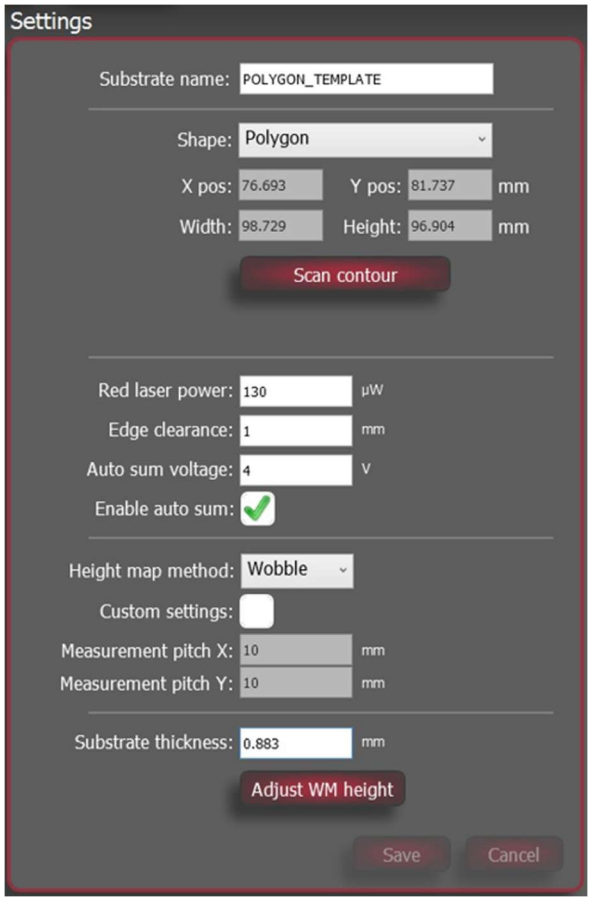
24. Select **Start**, the system will scan out to an edge and ask you to verify it the edge really was detected, answer accordingly. If the system is not detecting the substrate edge or detecting a pattern on the substrate, will need to adjust the **Exposure time**.



25. The system will now scan outline of the substrate. Once completed, **Save** will be available, select it and the pop-up window will close.



26. Verify all the other substrate recipe settings are correct for your job, adjust as needed.



Here's a list of what you can and cannot change and what it does:

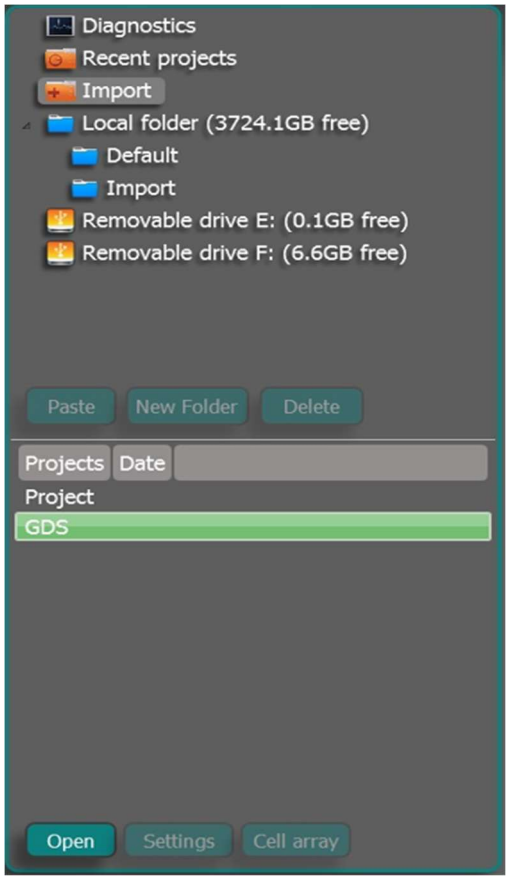
- **Substrate name**: DO NOT CHANGE
- **Shape**: DO NOT CHANGE. Should be set to **Polygon**, correct if needed and inform Staff it was changed.
- **X and Y pos**: DO NOT CHANGE, this value defines the substrate center and is defined during **Scan Contour**.
- **Width and Height**: DO NOT CHANGE, this value defines the substrate size and is defined during **Scan Contour**.
- **Red laser power**: DO NOT CHANGE, you set this in Step 13.
- **Edge clearance**: This is the part of the substrate where nothing is exposed, enter the desired value.
- **Auto sum voltage**: DO NOT CHANGE. Should be set to **4 V**, correct if needed and inform Staff it was changed.
- **Enable auto sum**: DO NOT CHANGE. Should be selected, correct if needed and inform Staff it was changed.
- **Height map method**: DO NOT CHANGE. Should be set to **Wobble**, correct if needed and inform Staff it was changed.
- **Custom settings**: During the start of an exposure, the system scans your substrate and makes a height map. Selecting this allows you to change the height map grid cell size from the default values by entering custom values in the **Measurement pitch X** and **Y** fields**.** Please consult with Staff before using this option.
- **Measurement pitch X** and **Y**: See above.
- **Substrate Thickness:** DO NOT CHANGE. This value defines the substrate thickness and is defined during **Adjust WM height**.

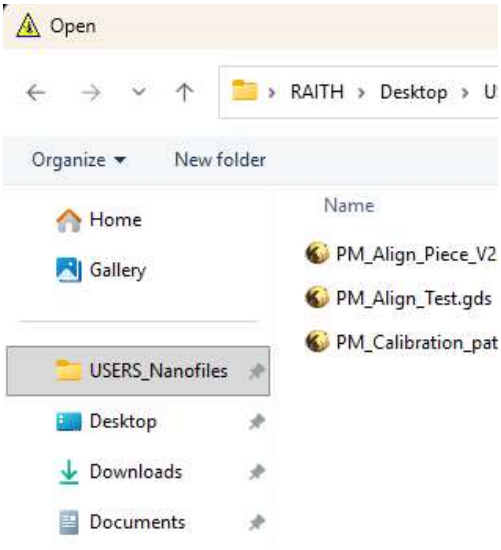
NOTE: You need to press Enter on the keyboard after changing values.

27. Select **Save**.

Setting up and Running a Project with No Alignment

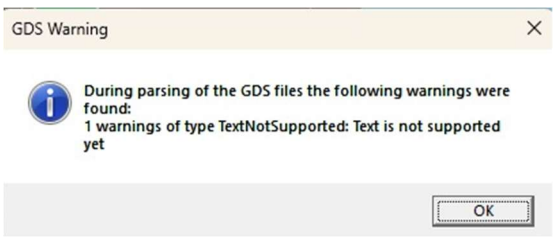
1. Select the **Projects** page.
2. Open your drawing file:
    - If your file is new (never run on the system before) select the orange **Import** folder from top half of the panel, then **GDS** from the bottom half, and then **Open**. A Windows File Explorer pop-up window will appear; make sure you are in the ***USERS_Nanofiles*** folder. Now locate your group's folder, select your drawing file, and select **Open**.

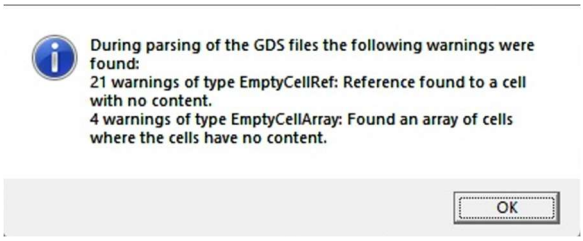




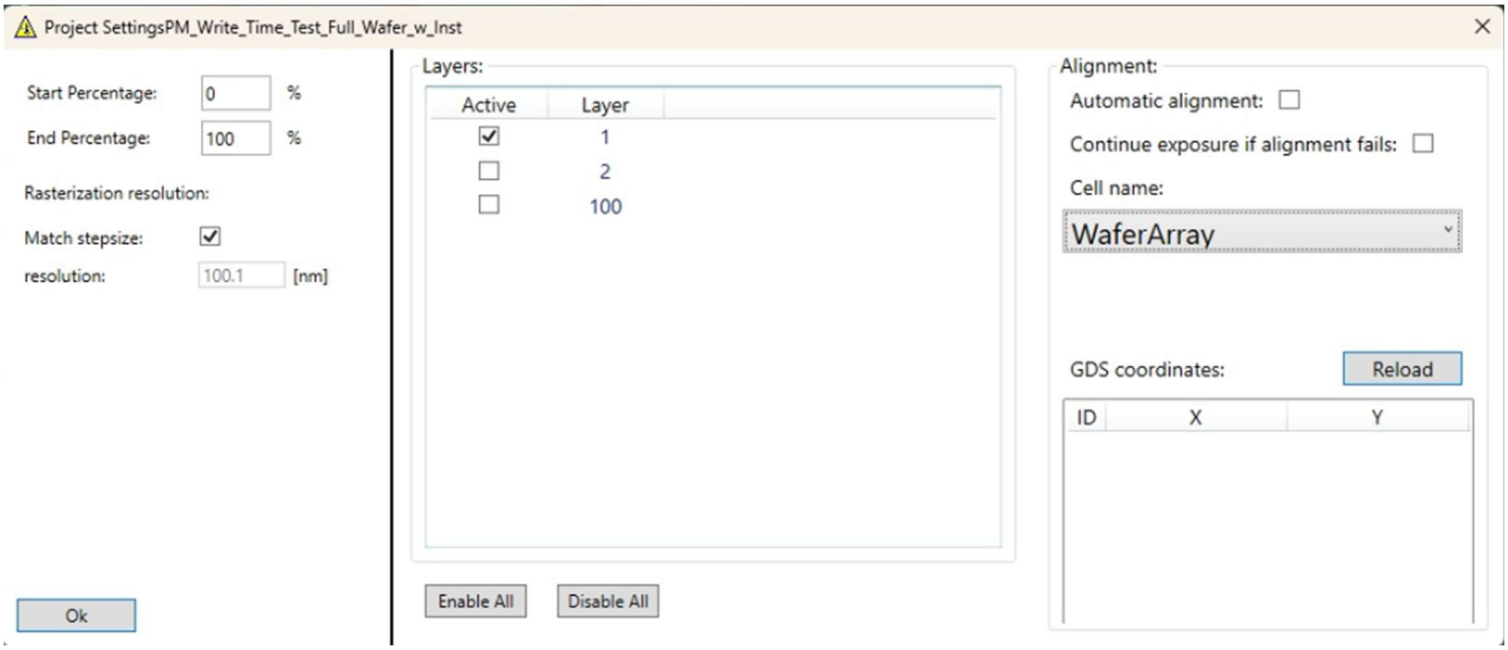
    - If you have already run your drawing file before; select the blue **Import** folder under the blue **Local** folder, highlight your file from the list (in the lower half of the menu) and select **Open**.

NOTE: When you open your file, will may get a GDS warning for unsupported text or empty cells. Acknowledge by selecting **OK**.

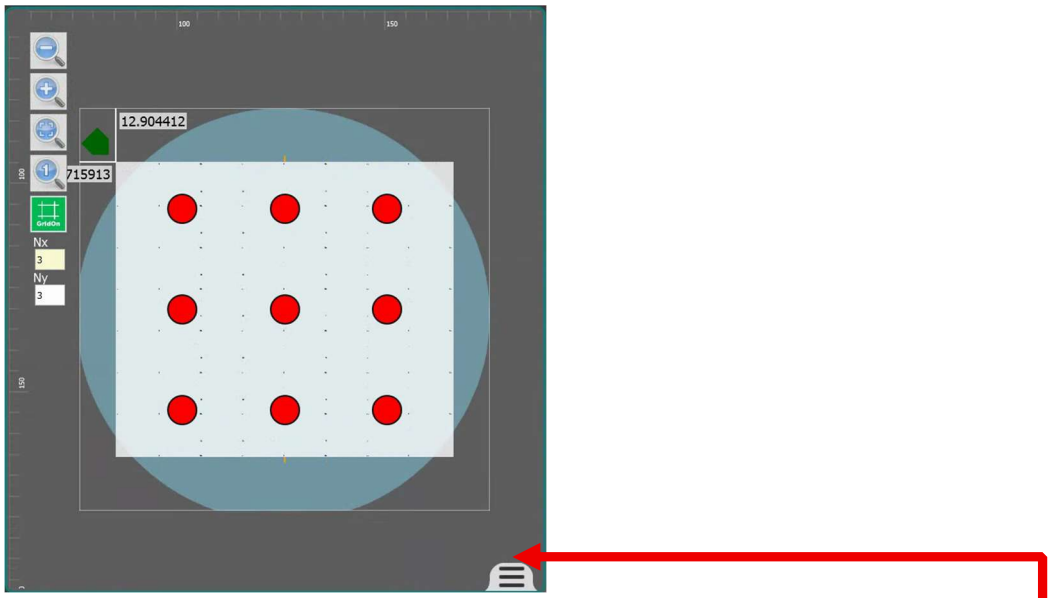




3. Once you open your file and acknowledge any warnings, a **Project Settings** pop-up window will open. You only need to select the correct layer(s) you want to expose by selecting (or de-selecting) the box next to them in the **Active** column. Leave all other settings to their default settings (as depicted below) and select **Ok**.
   NOTE: If the **Project Settings** pop-up window does not open when you select **Open**, select **Settings** (right next to open).



4. A low-resolution graphic of your design, its boundaries, and its current position on the substrate will appear on the substrate animation.



NOTE: If the job queue is in the way click on the folder tab to minimize it.

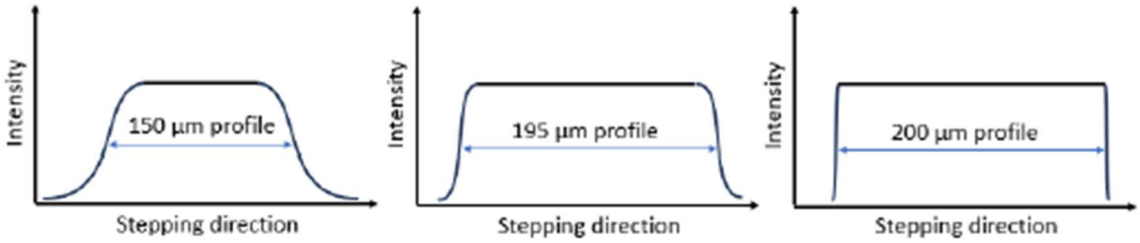
5. This graphic may have a grid of red dots on it (see above). These red dots allow you to manipulate your design's position on your substrate. For example, selecting the center red dot on the graphic would center the design on substrate.
6. If the red dots are not present and you need to use them, select **GridOn**. Additionally, you can change the array of these dots by changing the values in the **Nx** and **Ny** fields. The default setting for these fields is **3**.

NOTE: In some instances, your design will appear on top of the red dots and you will not be able to select them. To resolve this, select **GridOn** twice.

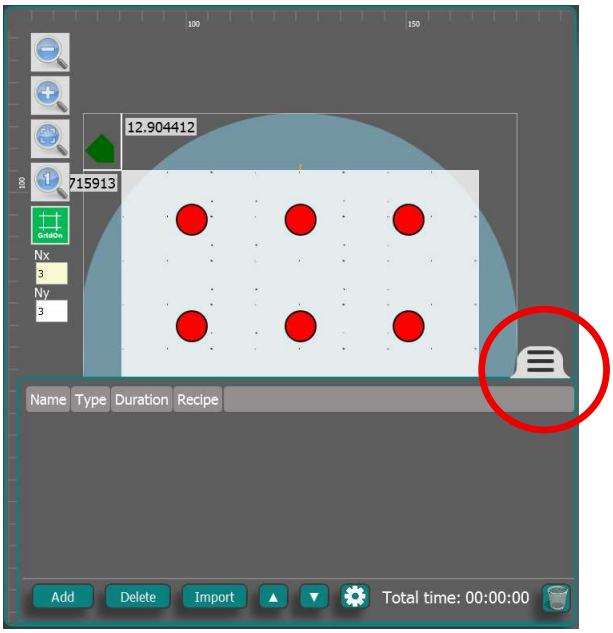
7. Look at the quick start bar at the bottom of the screen, it has three sections with drop down menus; **Substrate Recipe**, **Exposure Recipe** and **Alignment Type**. You do not have to change the **Substrate Recipe** as you already set this up earlier and the **Alignment Type** should always be set to **Local**. However, you need to verify the correct **Exposure recipe** is selected and, if needed, select it from the dropdown menu.

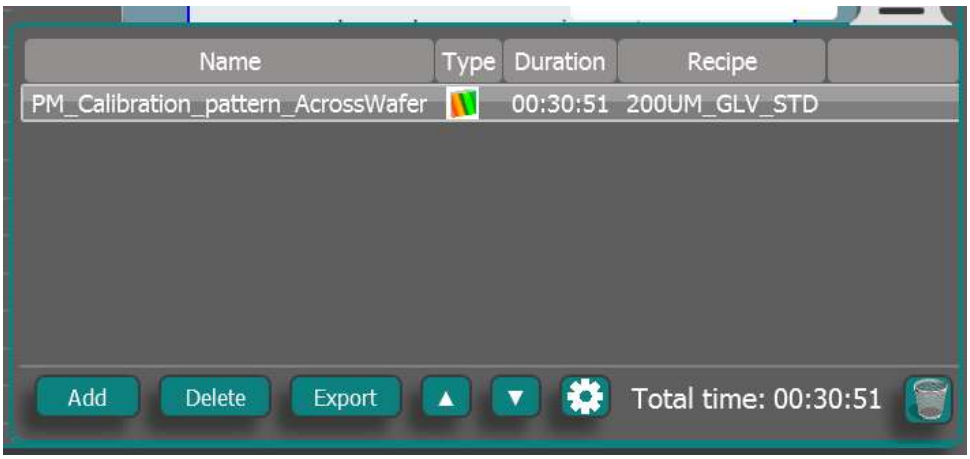
We have four Exposure Recipes to select from, but **200UM_GLV** is considered the standard recipe. Per the manufacturer, the best GLV profile in the tradeoff between lowest stitching and highest throughput is **195UM_GLV**.

GLV stands for Grating Light Valve. The Grating Light Valve in the writing module produces an illuminated slit. On the substrate, this slit has a size of approx 200 µm x 0.1 µm (stepping direction x scanning direction). Within the slit, 2048 sections can be illuminated between 0% and 100%. For GLV profiles with smooth edges (see next page), the stitches between scan lines can be smoothened out. This comes at the cost of reducing the effective width of the light profile, so more scan lines are needed at the cost of through-put.

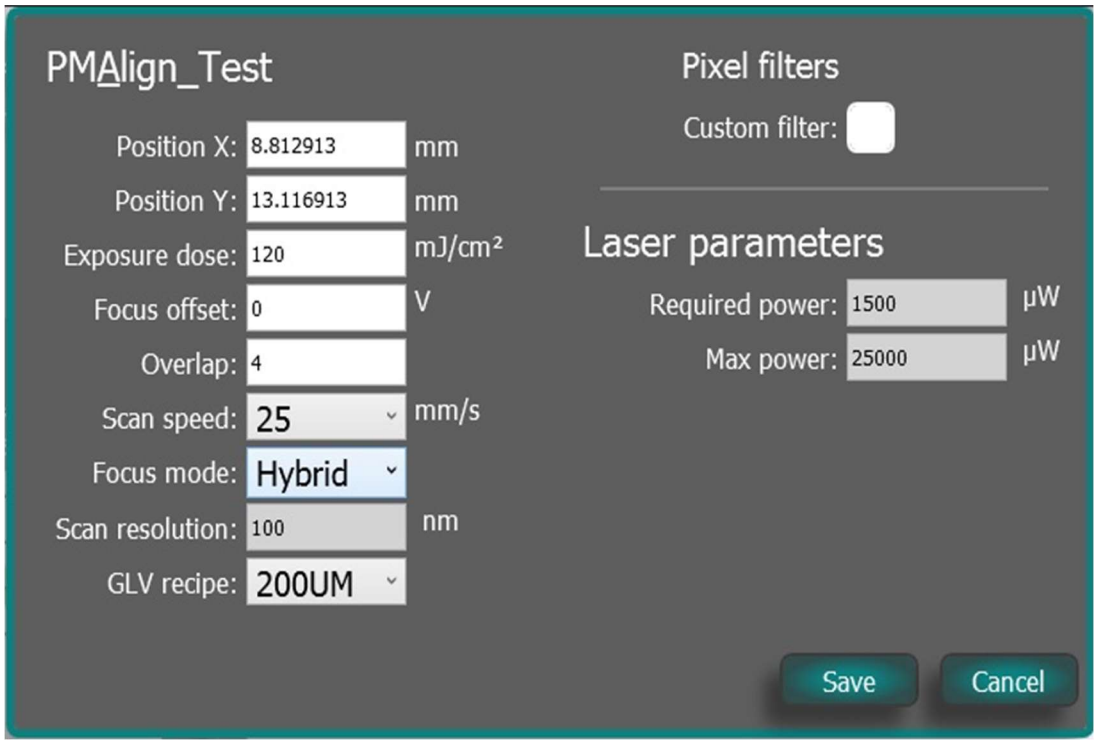


8. Select job folder tab to bring up the job queue and then select **Add**, this will add your exposure job to the queue.





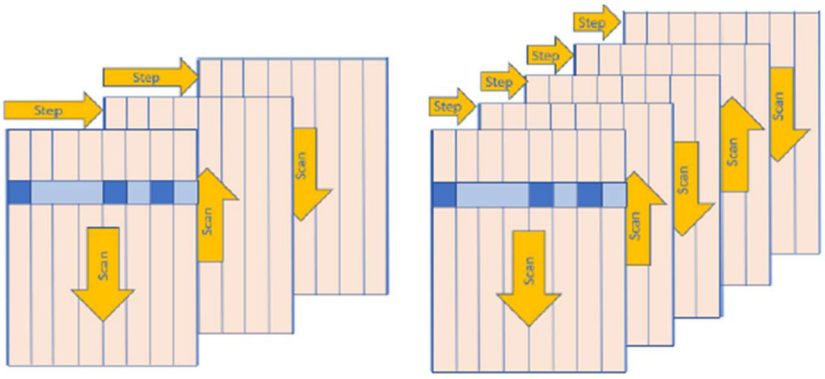
9. Select the Gear Icon  to open the **Exposure Settings** window.



Verify the settings are correct for your job, adjust as needed. Here's a list of what you can and cannot change and what it does:

a. **Position X and Y:** DO NOT CHANGE.
b. **Exposure dose:** The optimal exposure dose for your photoresist and substrate as determined by the Wiki or by running a series exposure test.
c. **Focus offset:** The optimal focus offset voltage for your photoresist and substrate as determined by the Wiki and/or by running a series exposure test. The range for the value is -7 to +7.
d. **Overlap:** The optimal value for this setting is determined by the **GLV recipe** being used. For example, **200UM_GLV** is 200 µm wide, using a setting of 4 for **Overlap** makes the step size < 50 µm. This makes stitching invisible to the human eye. Increasing the **Overlap** value will increase uniformity, however your exposure will be slower as you add more overlaps. Thus, an overlap of 4 would be the setting with the lowest number of overlaps that results in good stitching uniformity. The Minimum **Overlap** setting that will result in good stitching uniformity and are as follows:
    - **100UM_GLV**= 2
    - **150UM_GLV**= 3
    - **195UM_GLV**= 4
    - **200UM GLV**= 4

MORE INFO: It is possible to make smaller steps in between exposure lines, so that each part of the project is exposed twice or even more times. The default value for this is determined by the Exposure Recipe you selected in Step 7 of this section. The influence of Overlap settings of 2 and 4 is illustrated here:



On the left side, the Overlap Factor was set to 2. On the right side, it was set to 4.

The advantages of exposing a substrate multiple times are:

- Improvement of light uniformity. The GLV does not have a fully smooth light distribution, as it consists of 2048 gates. A higher Overlap Factor will improve overall intensity uniformity.
- Exposures with high doses. When the dose requires a laser intensity that is outside its range, the Overlap Factor can be set to a higher value to make the exposure possible.
- Making a finer address grid in the stepping direction.

The disadvantage of exposing multiple times is an increasing exposure duration.

e. **Scan speed:** For now, the standard setting is **25 mm/s**. This setting is the speed at which the vacuum chuck moves forward and backward under the writing module (Y axis). Selecting a certain **Scan Speed** will result in a specific Scan **Resolution**. You want to select the speed that results in a Scan Resolution that's a multiple of your critical dimension. For example, if your CD= 500nm, a 25 mm/s scan speed will result in a 100 nm scan resolution, which is a multiple of 500 nm.

f. **Focus mode**: DO NOT CHANGE. **Hybrid** is the preferred mode per the manufacturer.

g. **Scan resolution:** This value is determined by the **Scan speed** setting and cannot be edited directly.

Scan Speed (mm/s)	Scan Resolution (nm)
2.5	10
5	20
10	40
12.5	50
15	60
20	80
25	100
50	200
100	400

Here is some more information on this:

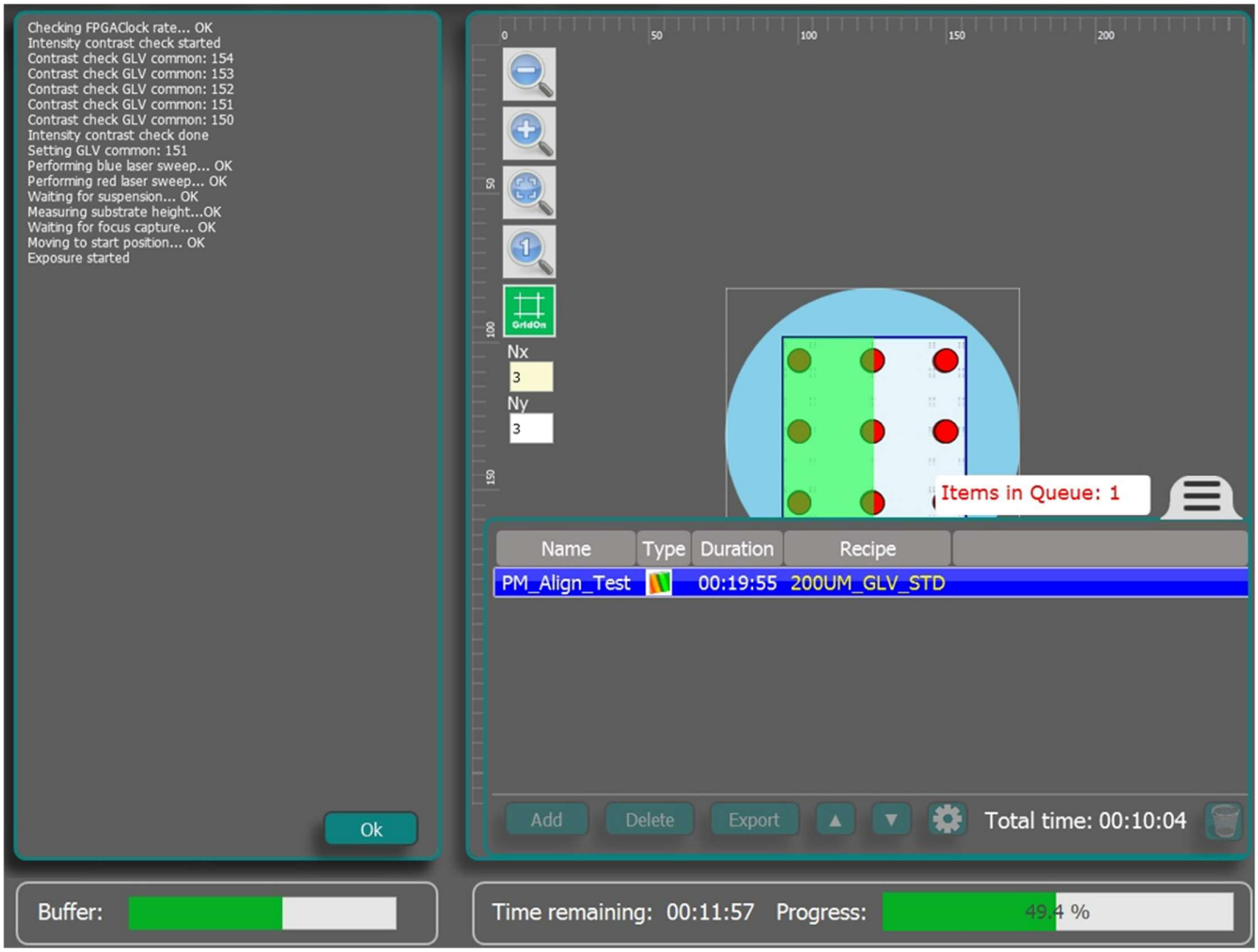
The positions on the substrate where the sections of the Grating Light Valve (GLV) will pass during an exposure are called the address grid. The address grid is built by scanning the GLV forward and backward while making side steps in between. The address grid consist of grid cells (also called grid pixels). The size of a grid cell can be calculated:

- *In stepping direction, the cell size is determined by the stripe width of the GLV (200 µm) divided by the number of GLV pixels, and divided by the overlap factor. Higher overlap factors give smaller cells and subsequently a higher resolution in stepping direction.*
- *In scanning direction, because the light source that feeds the GLV sections is controlled by a 250 kHz signal, the minimum cell size is equal to the scan speed divided by 250 kHz. For a typical scan speed of 25 mm/s, the minimum cell size is 100 nm.*

h. **GLV recipe:** DO NOT CHANGE. This is the Grating Light Valve profile and is determined by the Exposure Recipe you selected in Step 7 of this section.

i. **Custom filter:** Under construction.

10. Select **Save** once you have made the necessary changes.
11. Select **Start** to begin your exposure. A dialog box will appear on the left side of the screen showing what actions the system is performing. The system will run a variety of checks and scan the surface topography of your substrate before starting the exposure.



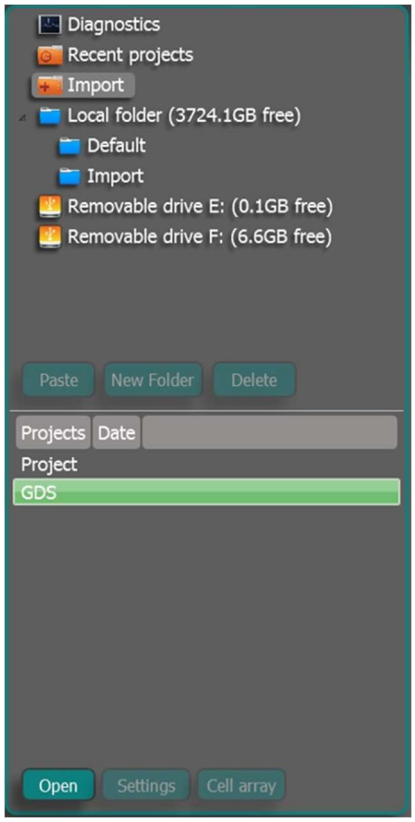
At the bottom of the screen, you will see a progress bar. During the exposure, the write area on the substrate graphic will fill in green to show the exposure progress.

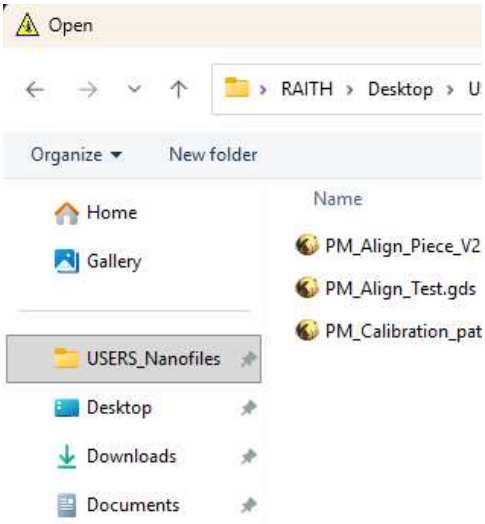
12. The dialog box will indicate when your exposure has completed, select OK to close it, and perform the following steps:
    j. Press the **Unlock** button, it will illuminate green, open the amber cover by lifting it up.
    k. Press the **VACUUM** button, it will flash for a few seconds.
    l. **WAIT 6 seconds** to allow the vacuum to release your substrate from the chuck. **Failure to wait could result in you scratching your substrate.**
    m. Remove your substrate and close the amber cover.

Setting up and Running a Project with Alignment

!!IMPORTANT: You need at least 3 alignment marks!!

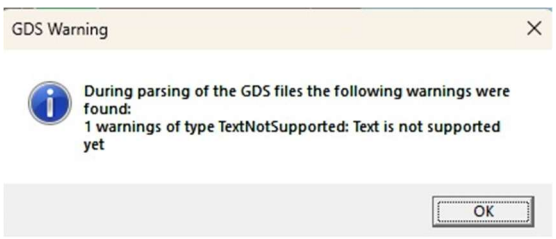
1. Select the **Projects** page.
2. Open your drawing file:
    a. If your file is new (never run on the system before) select the orange **Import** folder from top half of the panel, then **GDS** from the bottom half, and then **Open**. A Windows File Explorer pop-up window will appear; make sure you are in the ***USERS_Nanofiles*** folder. Now locate your group's folder, select your drawing file, and select **Open**.

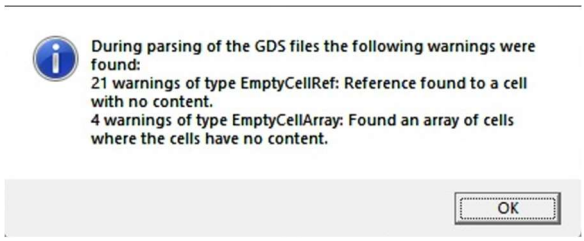




    b. If you have already run your drawing file before; select the blue **Import** folder under the blue **Local** folder, highlight your file from the list (in the lower half of the menu) and select **Open**.

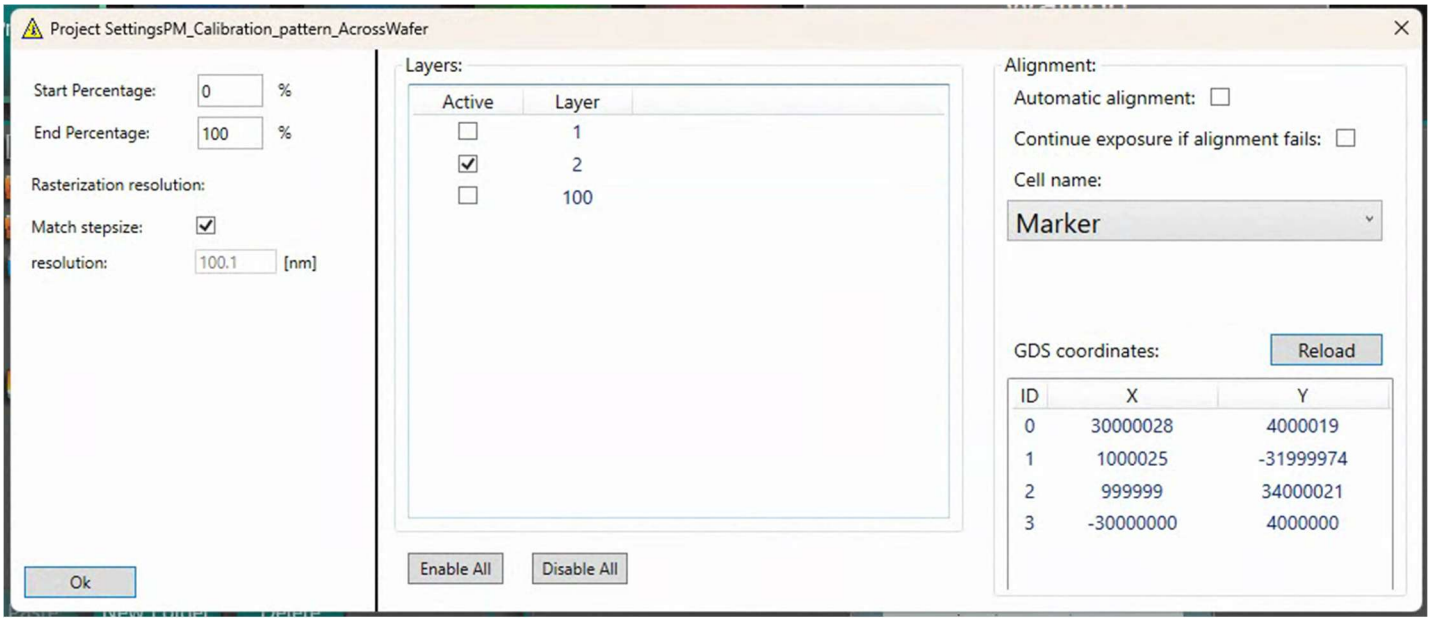
NOTE: When you open your file, it may get a GDS warning for unsupported text or empty cells. Acknowledge by selecting **OK**.



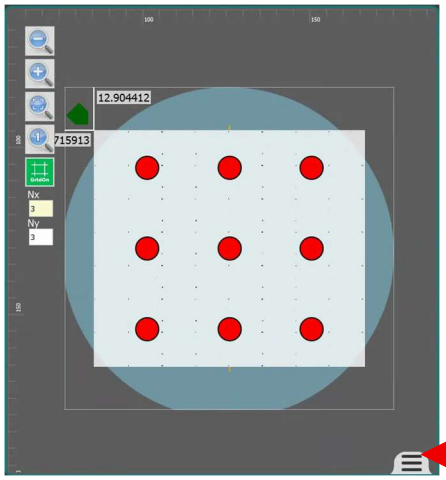


3. Once you open your file and acknowledge any warnings, a **Project Settings** pop-up window will open. Perform the following on this screen:
    a. Select the correct layer(s) you want to expose by selecting (or de-selecting) the box next to them in the **Active** column.
    b. Select the cell in your GDS file that contains your alignment mark instances from **Cell name** dropdown list. The **GDS coordinates** table will populate with the location of your alignment marks (in nm). If it does not, consult with Staff.
    c. Leave all other settings to their default settings (as depicted below) and select **Ok**.

    NOTE: If the **Project Settings** pop-up window does not open when you select **Open**, select **Settings** (right next to open).



4. A low-resolution graphic of your design, its boundaries, and its current position on the substrate will appear on the substrate animation.



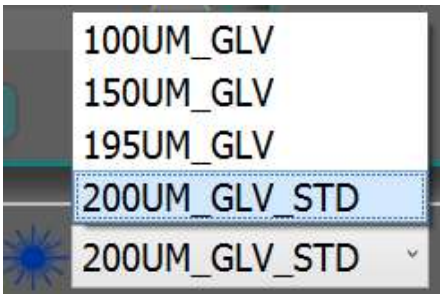
NOTE: If the job queue is in the way click on the folder tab to minimize it.

5. This graphic may have a grid of red dots on it (see above). These red dots allow you to manipulate your design's position on your substrate. For example, selecting the center red dot on the graphic would center the design on substrate.
6. If the red dots are not present and you need to use them, select **GridOn**. Additionally, you can change the array of these dots by changing the values in the **Nx** and **Ny** fields. The default setting for these fields is **3**.

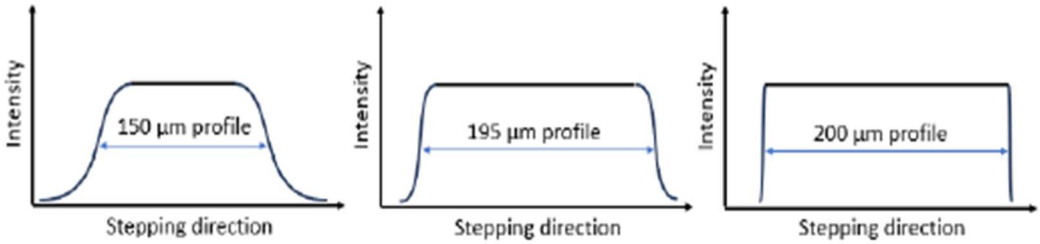
NOTE: In some instances, your design will appear on top of the red dots and you will not be able to select them. To resolve this, select **GridOn** twice.

7. Look at the quick start bar at the bottom of the screen, it has three sections with drop down menus; **Substrate Recipe**, **Exposure Recipe** and **Alignment Type**. You do not have to change the **Substrate Recipe** as you already set this up earlier and the **Alignment Type** should always be set to **Local**. However, you need to verify the correct **Exposure recipe** is selected and, if needed, select it from the dropdown menu.

We have four Exposure Recipes to select from, but 200UM_GLV_STD is considered the standard recipe.



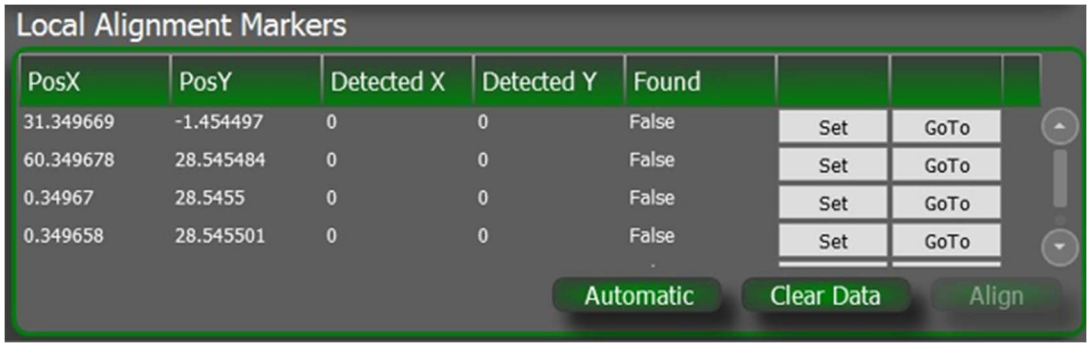
GLV stands for Grating Light Valve. The Grating Light Valve in the writing module produces an illuminated slit. On the substrate, this slit has a size of approx 200 µm x 0.1 µm (stepping direction x scanning direction). Within the slit, 2048 sections can be illuminated between 0% and 100%. For GLV profiles with smooth edges (see next page), the stitches between scan lines can be smoothened out. This comes at the cost of reducing the effective width of the light profile, so more scan lines are needed at the cost of through-put.



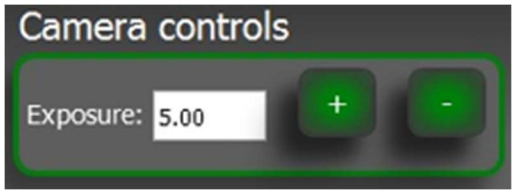
8. Select the **Alignment** page and, if needed, select the **Alignment** tab.

9. If not selected already, select **Substrate** from the Alignment View panel.

10. In the **Local Alignment Markers** table select **GoTo** for the first alignment mark. The camera will go to Overview mode and scan over to the alignment mark.

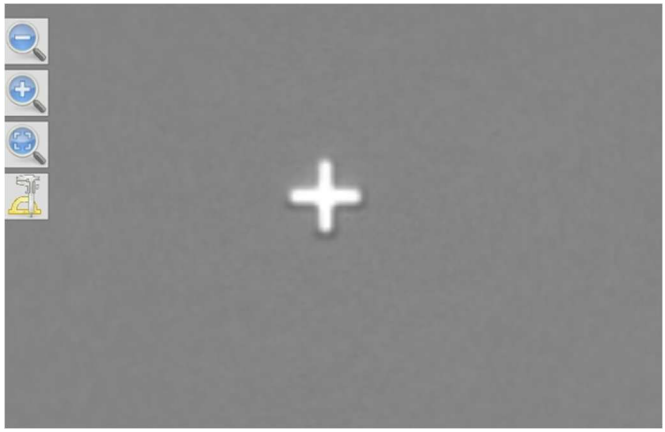


11. You may need to adjust **Exposure** (under **Camera controls**) if the on-screen image is too dark or bright. Ideally it should be light grey.

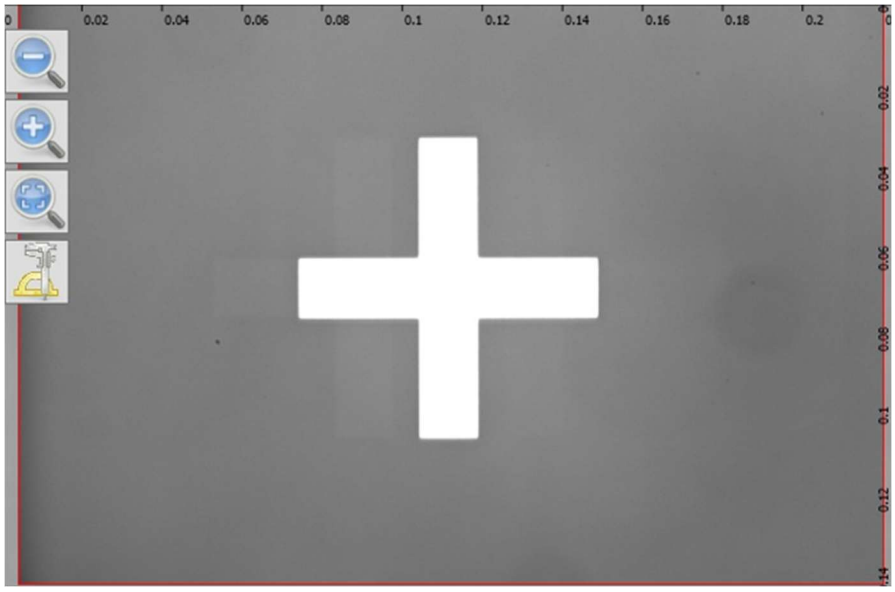


12. You should see your alignment mark on the screen somewhere. Using the mouse, select the center of alignment mark and it will center on the screen. The alignment mark for the example below is circle in red.

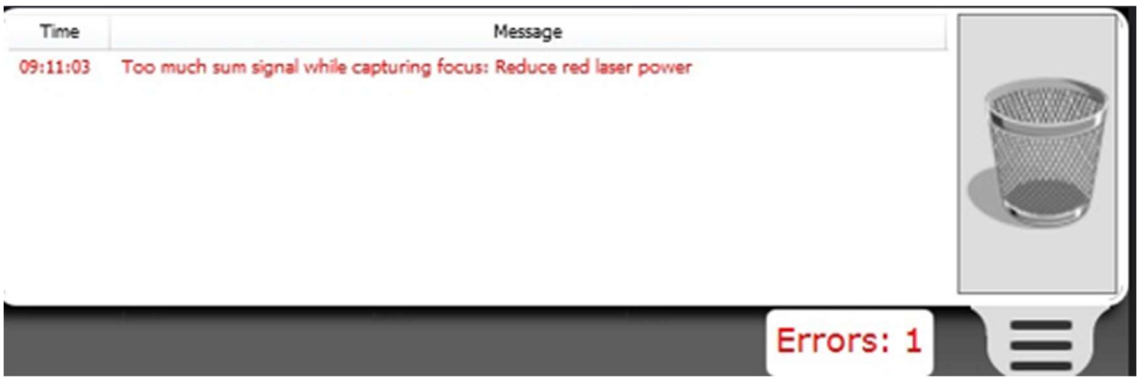
13. Now use the mouse wheel to zoom in on the alignment mark. Once you have zoomed in, select the center of the alignment mark.



14. Select **Details**, the system will switch to that camera mode and focus on the alignment mark. You may need to adjust **Exposure** (under **Camera controls**) if the on-screen image is too dark or bright. Ideally it should be somewhere between dark and light grey. Now select the center of the alignment mark to center it on the screen.



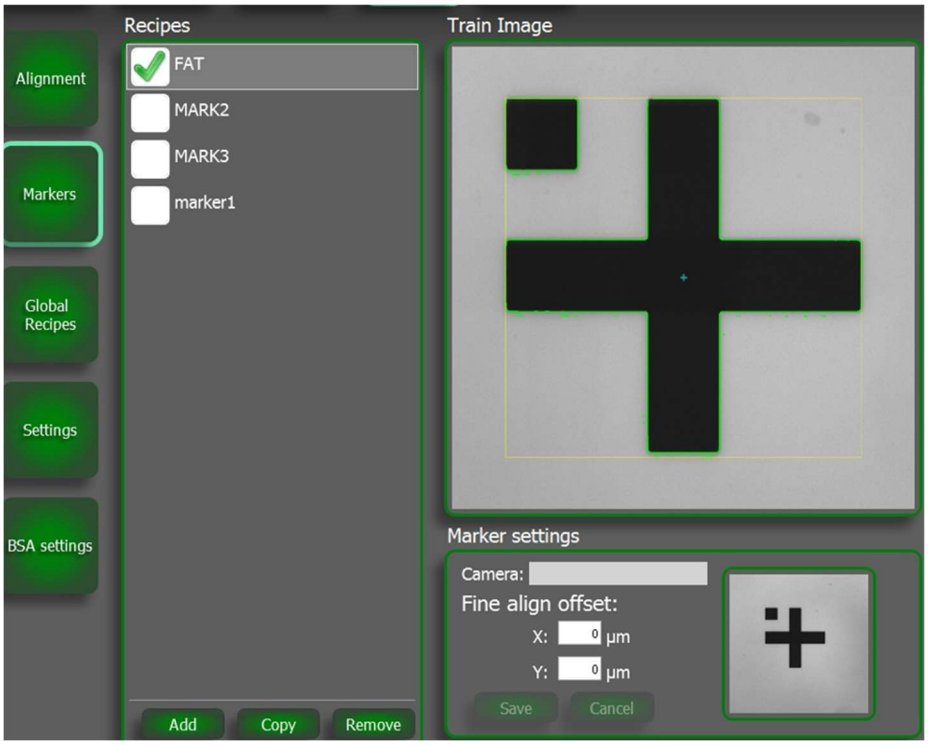
- If you get a **Failed Focus Capture** message, check for an error message by selecting the folder tab at the top right of the screen. Typically, the error is:



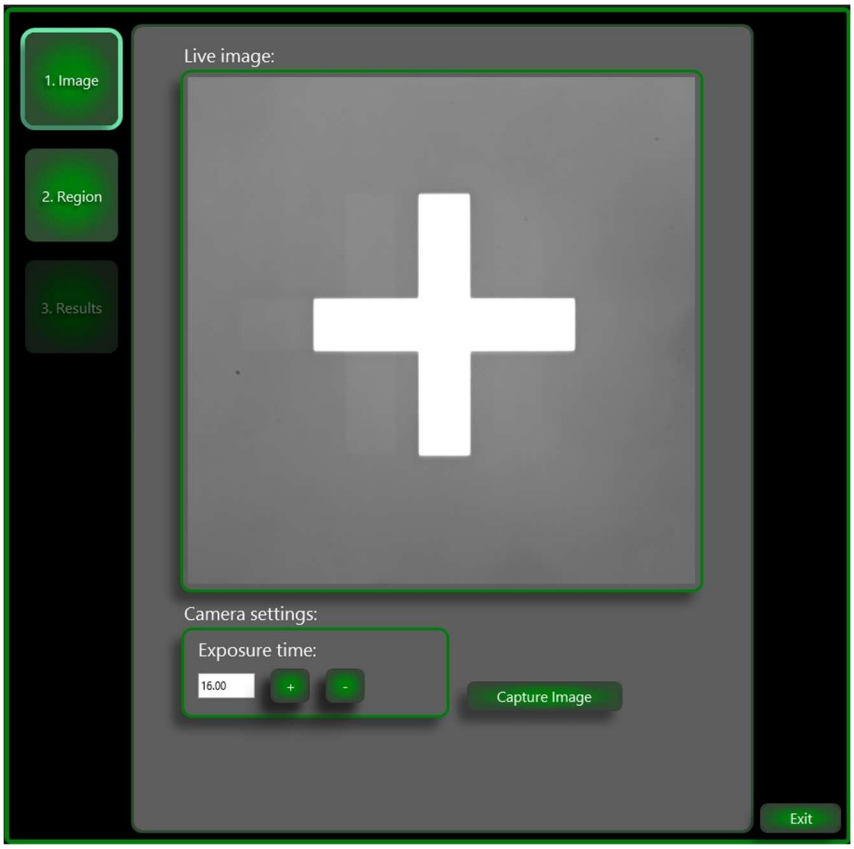
There are 2 solutions to this: 1) If your alignment mark is highly reflective, move the camera position (by selecting an on-screen position with the cursor) to a less reflective area and select **Focus**. If focus is successful, move the camera back to your alignment mark. If unsuccessful, proceed to the second solution. 2) Perform the steps in the **Setting Up The Substrate Recipe** section again. However, this time reduce the red laser power so that the **Focus Sum** line (red line) is at about 2.5 – 3 volts.

- If your alignment mark is out of focus, use solution #1 above.

15. If you have your alignment mark trained, proceed to Step 9. If you need to train your alignment mark, perform the following steps:
    a. Select the **Markers** tab.

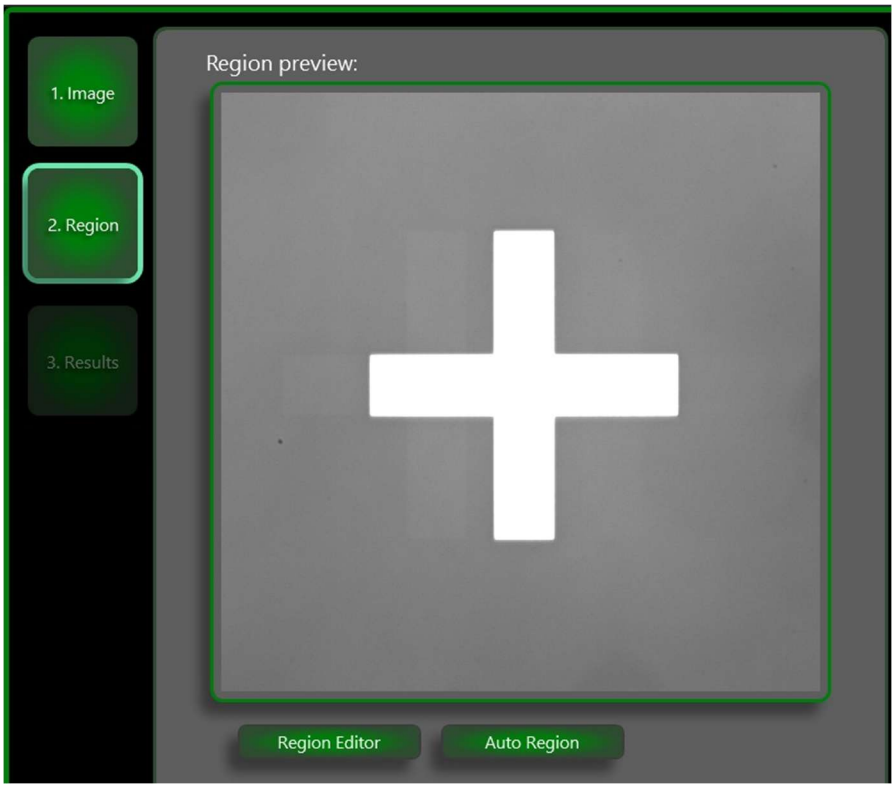


    b. Select **Add**, the **Live Image** window will appear with the camera view of your marker.

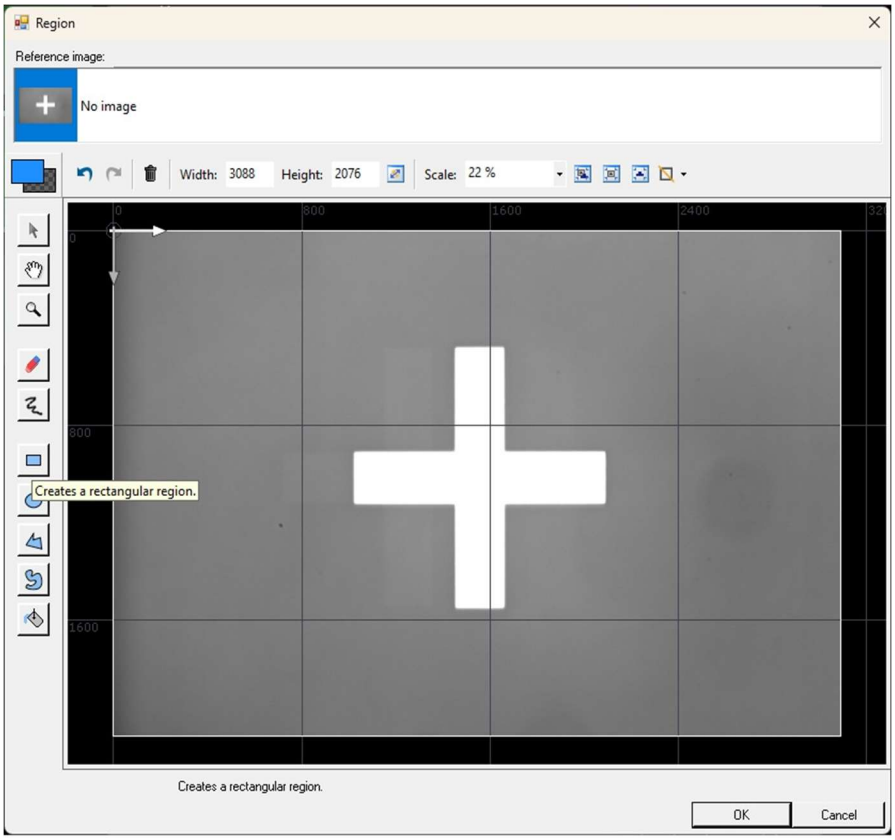


c. Adjust the Exposure time so that the image is somewhere between dark and light grey.

d. Select **Capture Image**, the **Region preview** window will appear.

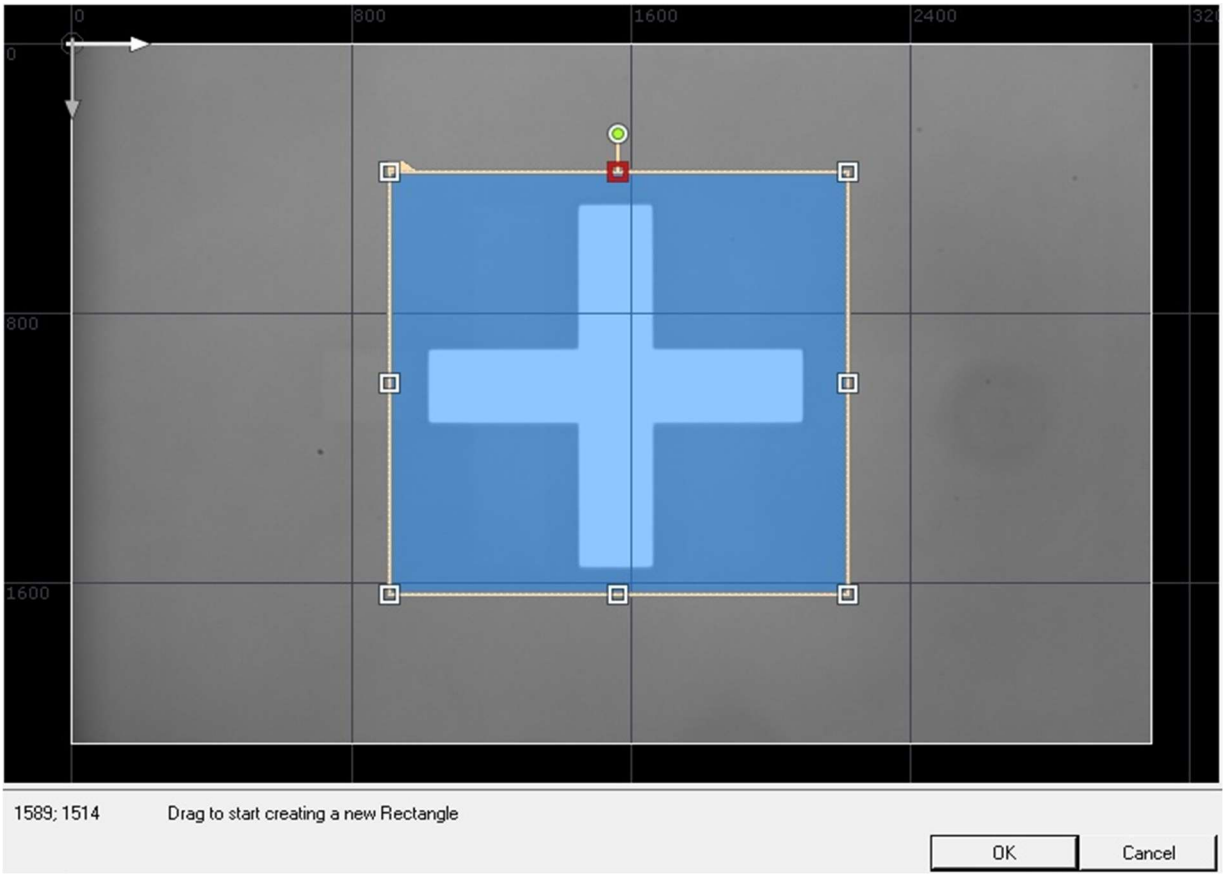


e. Select **Region Editor**, the **Region** window will appear.



f. Select the **Creates a rectangular region** icon from the toolbar on left of screen.

g. Use this tool to highlight your mark. Adjust size as needed, then click **OK**.



h. You will return to the **Region preview** screen, select **Create edge model**.
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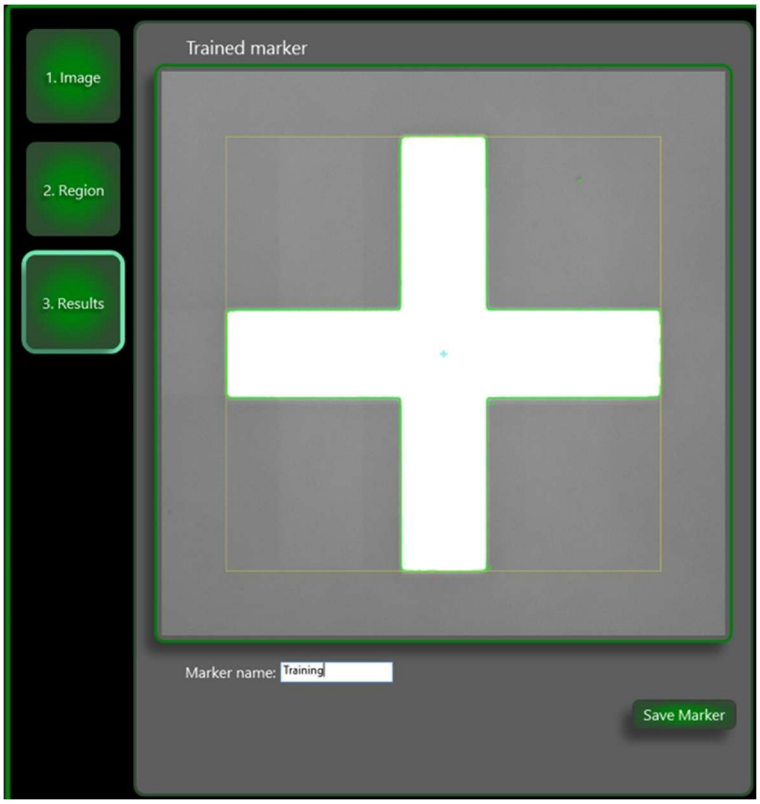
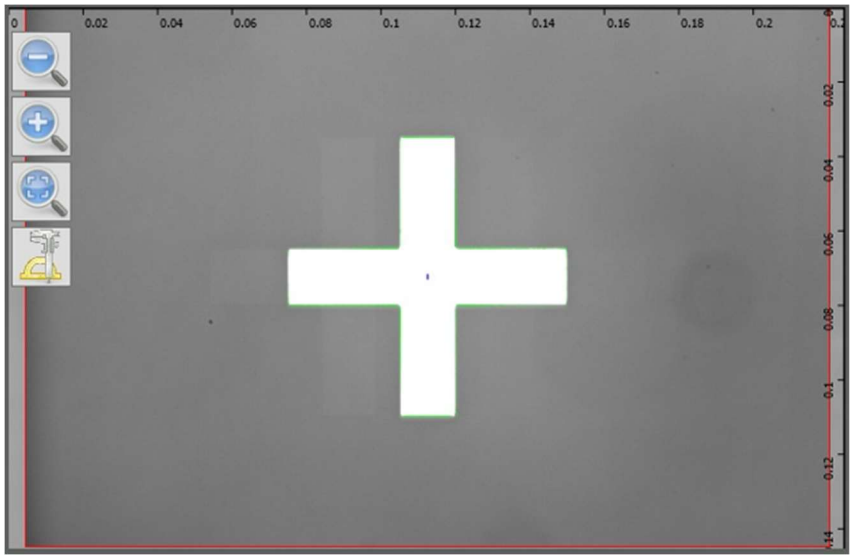
i. Your trained marker will appear, name it, and select **Save Marker**.



j. Return to the **Alignment** page and, if needed, select the **Alignment** tab.

16. Select your trained alignment mark from the **Marker** drop down menu in the **Marker detection** panel. **Marker Detection** should be set to **Automatic** and **Auto Detect** and **Auto Center** should be selected.

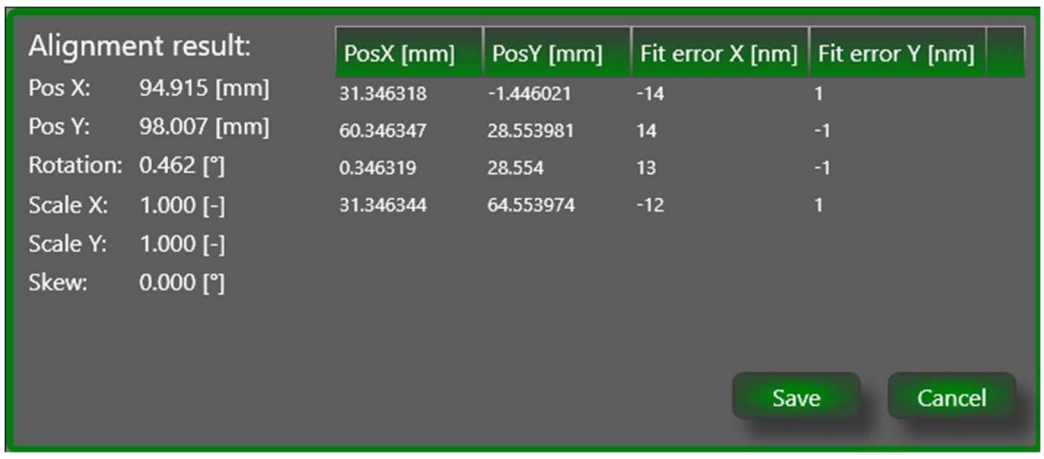
If your alignment marker is properly detected a green circle will appear next to **Marker Found** and your alignment marker will be highlighted with a green border in the on-screen view. If your alignment mark is not being detected you will have to train it again.



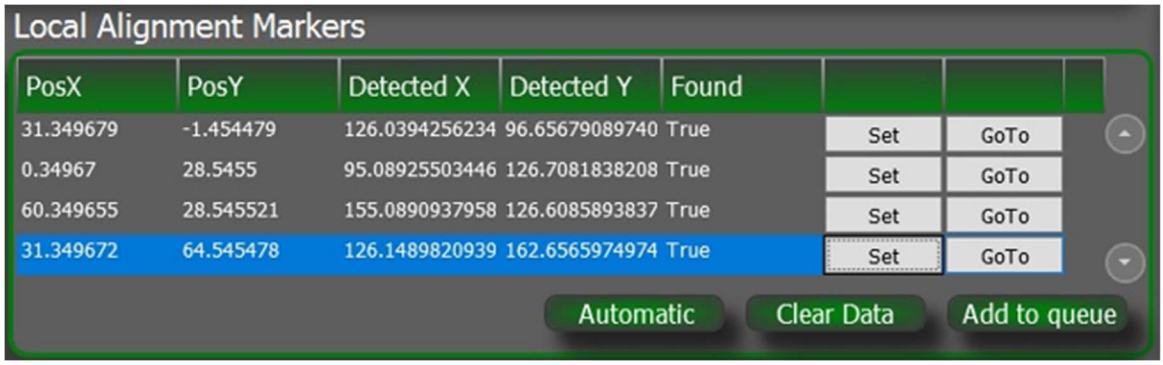
17. Select **Set** in the **Local Alignment Markers** table for the first alignment mark. The **Found** column value for this mark should change from **False** to **True**.

PosX	PosY	Detected X	Detected Y	Found		
31.349679	-1.454479	126.0394256234	96.65679089740	True	Set	GoTo

18. Select **GoTo** for next alignment mark. Depending on the amount of rotation correction your substrate will need, you may need to return to the **Overview** camera to locate your alignment mark (see Step 5).
19. Select **Set**.
20. Repeat Steps 10 and 11 for the remaining alignment marks. All marks after the second one should appear on-screen and auto center.
    NOTE: If an alignment mark appears blurry, see the troubleshooting info in Step 7.
21. Once you have **Set** your last alignment mark to True, select **Align**. An **Alignment result** window will appear with data. Select **Save** or **Cancel**.

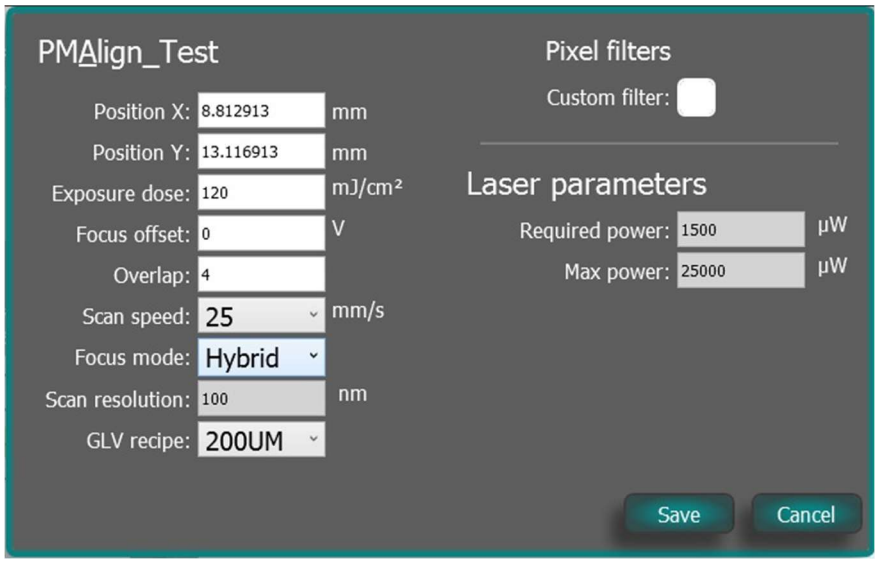


22. The **Add to queue** option will appear at the bottom of the **Local Alignment Markers** table, select it.

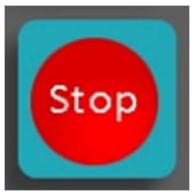


23. Go back to the **Projects** page and, if needed, select on the folder tab, your job should be in the queue.

24. Select the Gear Icon  to open the **Exposure Settings** window.



25. Verify the settings are correct for your job, adjust as needed, and select **Save**. See the **Setting up and Running a Project with No Alignment** section for detailed information about these settings.
26. Select **Stop**.



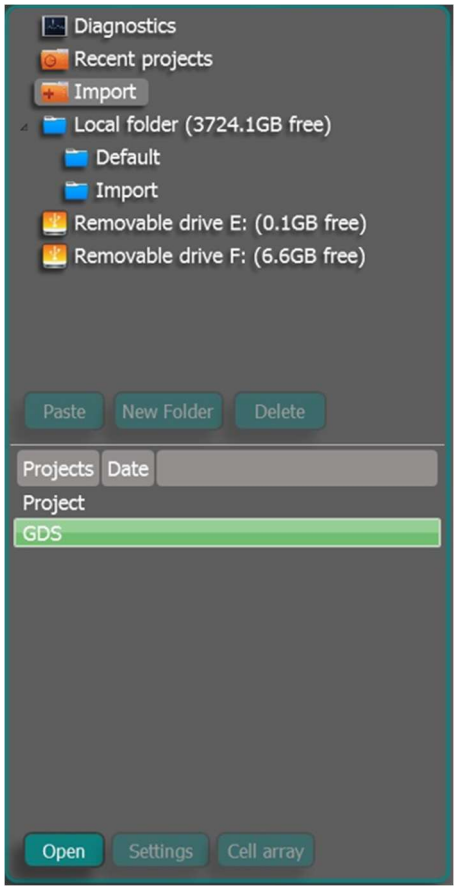
27. Once tool has stopped moving **Start** will become available, select it. A dialog box will appear on the left side of the screen showing what actions the system is performing. The system will run a variety of checks and scan the surface topography of your substrate before starting the exposure.

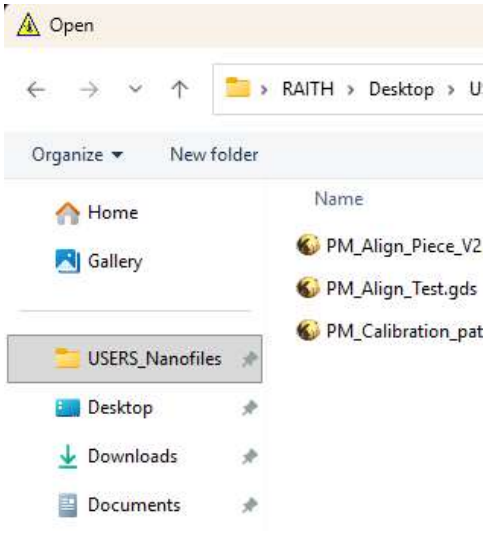
At the bottom of the screen, you will see a progress bar. During the exposure, the write area on the substrate graphic will fill in green to show the exposure progress.

28. The dialog box will indicate when your exposure has completed, select OK to close it, and perform the following steps:
    a. Press the **Unlock** button, it will illuminate green, open the amber cover by lifting it up.
    b. Press the **VACUUM** button, it will flash for a few seconds.
    c. **WAIT 6 seconds** to allow the vacuum to release your substrate from the chuck. **Failure to wait could result in you scratching your substrate.**
    d. Remove your substrate and close the amber cover.

Setting Up and Running a Series Project

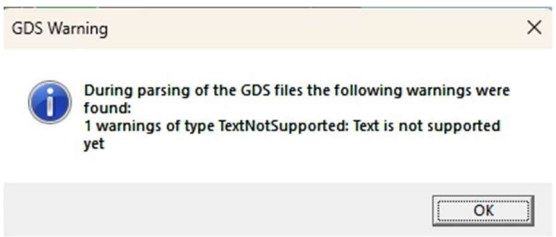
1. Select the **Projects** page.
2. Open your drawing file:
    - If your file is new (never run on the system before) select the orange **Import** folder from top half of the panel, then **GDS** from the bottom half, and then **Open**. A Windows File Explorer pop-up window will appear; make sure you are in the ***USERS_Nanofiles*** folder. Now locate your group's folder, select your drawing file, and select **Open**.

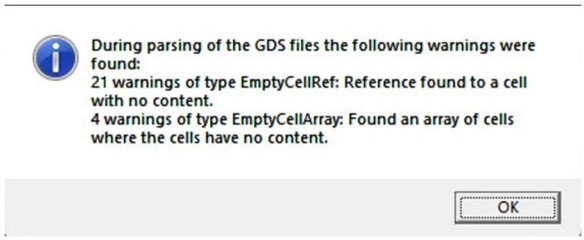




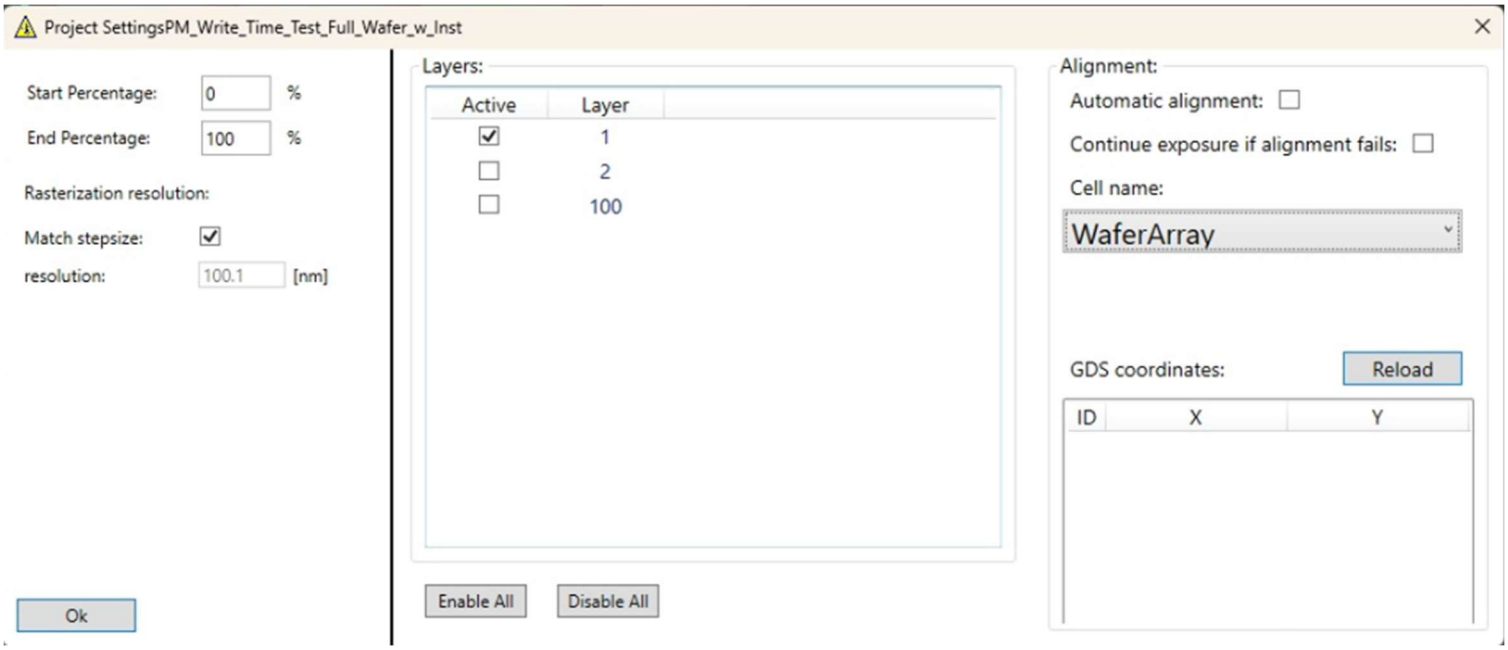
    - If you have already run your drawing file before; select the blue **Import** folder under the blue **Local** folder, highlight your file from the list (in the lower half of the menu) and select **Open**.

    NOTE: When you open your file, will may get a GDS warning for unsupported text or empty cells. Acknowledge by selecting **OK**.

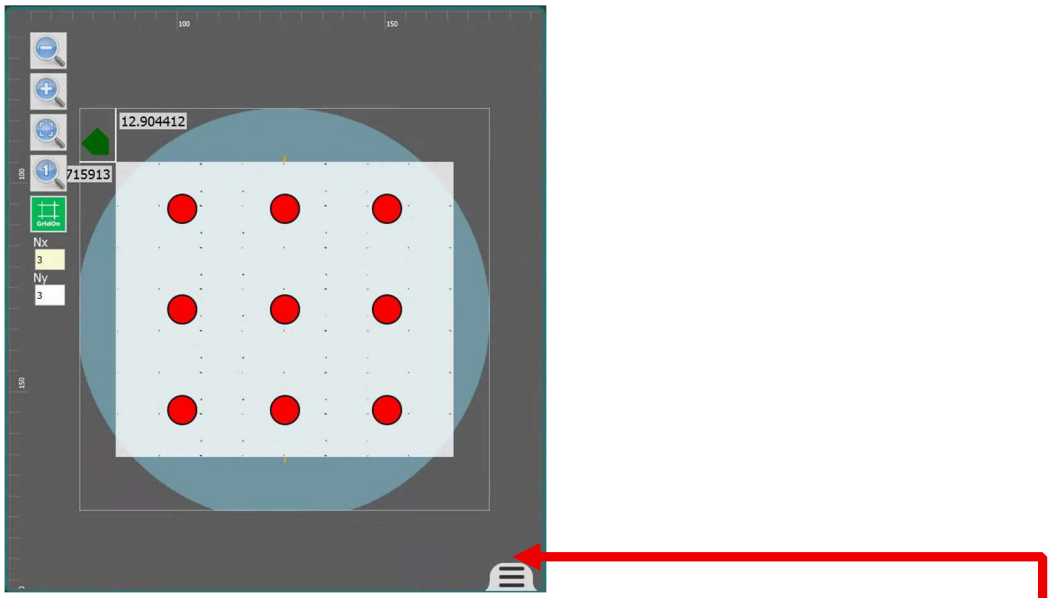




3. Once you open your file and acknowledge any warnings, a **Project Settings** pop-up window will open. You only need to select the correct layer(s) you want to expose by selecting (or de-selecting) the box next to them in the **Active** column. Leave all other settings to their default settings (as depicted below) and select **Ok**.
   NOTE: If the **Project Settings** pop-up window does not open when you select **Open**, select **Settings** (right next to open).



4. A low-resolution graphic of your design, its boundaries, and its current position on the substrate will appear on the substrate animation.

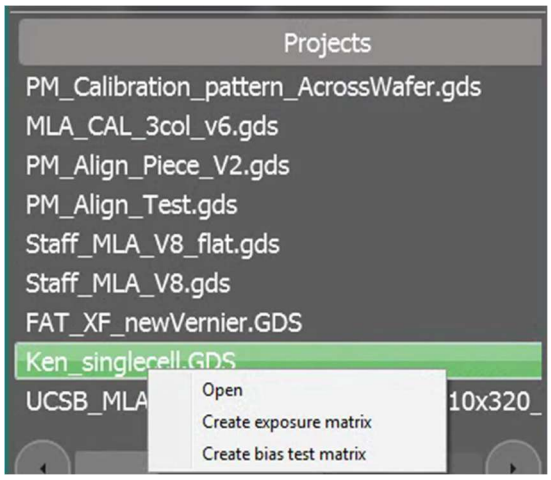


NOTE: If the job queue is in the way click on the folder tab to minimize it.

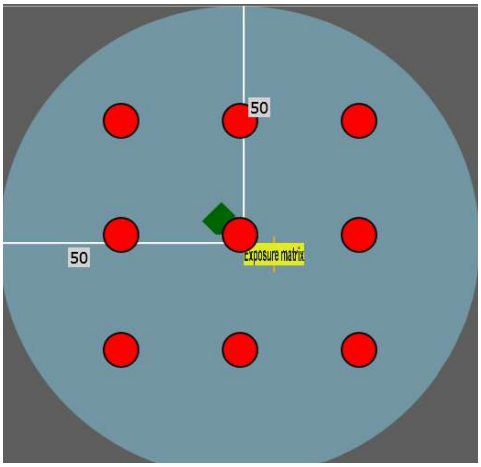
5. This graphic may have a grid of red dots on it (see above). These red dots allow you to manipulate your design's position on your substrate. For example, selecting the center red dot on the graphic would center the design on substrate.
6. If the red dots are not present and you need to use them, select **GridOn**. Additionally, you can change the array of these dots by changing the values in the **Nx** and **Ny** fields. The default setting for these fields is **3**.

NOTE: In some instances, your design will appear on top of the red dots and you will not be able to select them. To resolve this, select **GridOn** twice.

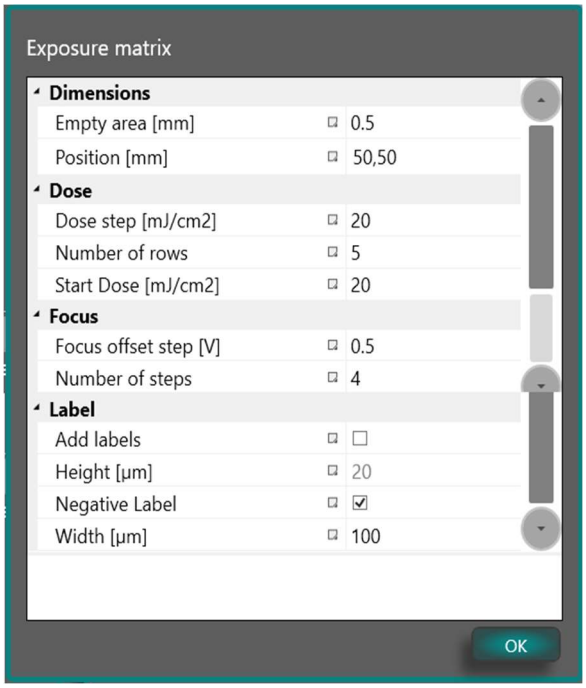
7. In the **Projects** panel, right click on the file you are using and select **Create exposure matrix**.



An **Exposure matrix** label will appear next to your design on the wafer graphic. It is used to depict the size of the series exposure area.



8. Select **Settings** from the **Projects** panel again and an **Exposure matrix** settings window will appear.



9. You will need to adjust these settings for your exposure matrix. Once you have all the settings properly input, select **OK**.
   Here's a list of the settings along with a description:
   Dimensions
   - **Empty area [mm]:** The gap between each exposure in the array.
   - **Position [mm]:** The coordinate position for the starting point of the exposure matrix (top left corner of the array relative to the left top of the substrate bounding box). In the above image the exposure matrix will begin in the center of the wafer and expose down and to the right.

   Dose
   - **Dose step [mJ/cm2]:** Increase in dose between rows of the array.
   - **Number of rows:** Number of rows in the array.
   - **Start Dose [mJ/cm2]:** Dose of the top row in the array.

   Focus
   - **Focus offset Step [V]:** Change in focus offset between columns of the array.
   - **Number of steps:** Number of steps in positive and negative direction. In total the matrix will have N*2 + 1 columns. The middle column is written with the focus offset defined in the exposure recipe. For example, if **Focus offset Step** is set to **0.5** (recommended), **Number of steps** is set to **4**, and **Focus Offset** (in exposure settings) is set to **0**, you will have 5 columns for Focus in this order: -1.0, -0.5, 0, 0.5, 1.0.

Labels

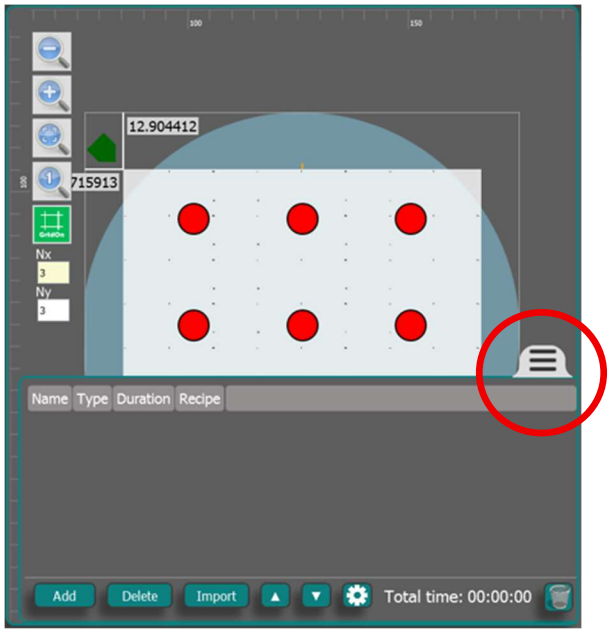
- **Add labels:** Select this to add a label with dose and focus offset information to each exposure.
  NOTE: Labels are written using the default settings in the exposure recipe, so that they are visible, even if the item itself is over/underexposed.
- **Height (µm):** The height of the label, this is automatically scaled to 1/5 of the width.
- **Negative Label:** Select this to write the label in negative mode.
- **Width (µm):** The width of the labels.

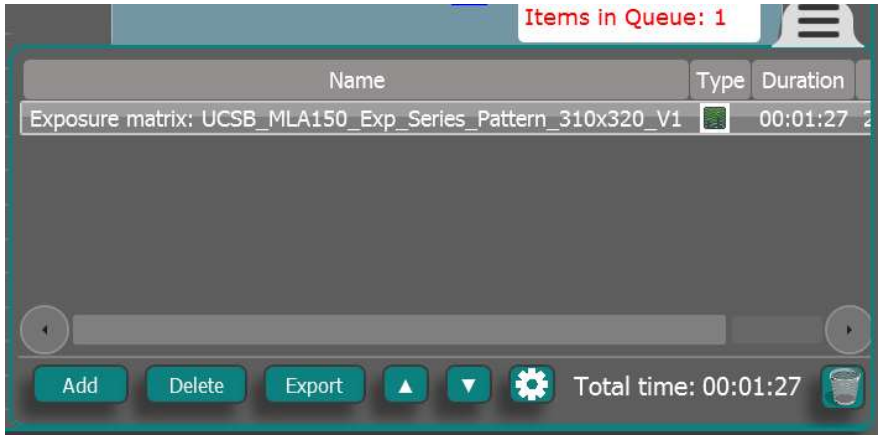
10. Verify that your setting changes did not cause the **Exposure Matix** area to run off of the substrate graphic. If it, did correct this by adjusting the exposure starting position (Step 5) and in some instances the **Exposure Matrix** settings as well.
11. Look at the quick start bar at the bottom of the screen, it has three sections with drop down menus; **Substrate Recipe**, **Exposure Recipe** and **Alignment Type**. You do not have to change the **Substrate Recipe** as you already set this up earlier and the **Alignment Type** should always be set to **Local**. However, you need to verify the correct **Exposure recipe** is selected and, if needed, select it from the dropdown menu.

We have four Exposure Recipes to select from, but **200UM_GLV** is considered the standard recipe. Per the manufacturer, the best GLV profile in the tradeoff between lowest stitching and highest throughput is **195UM_GLV**.

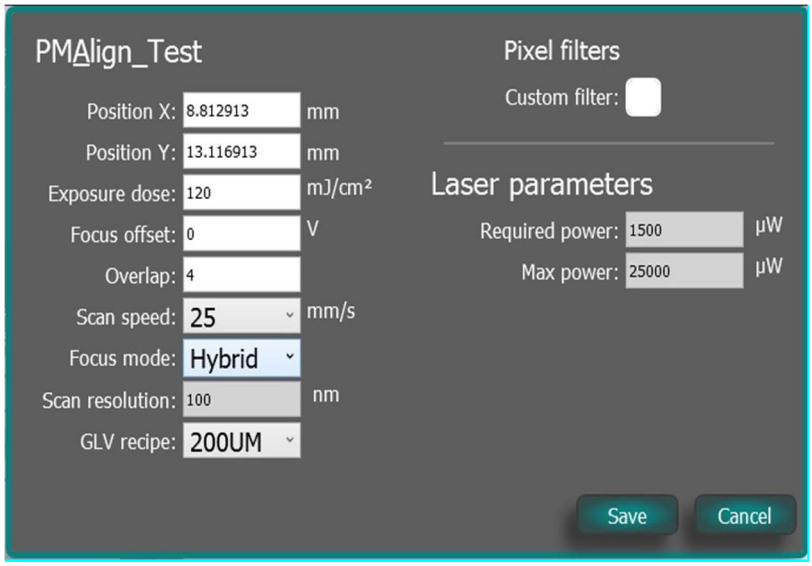
Reference the **Setting up and Running a Project with No Alignment** section for detailed information about this setting.

12. Select job folder tab to bring up the job queue and then select **Add**, this will add your exposure matrix to the queue.





13. Select the Gear Icon  to open the **Exposure Settings** window.



14. Verify the settings are correct for your job, adjust as needed, and select **Save**. See the **Setting up and Running a Project with No Alignment** section for detailed information about these settings.
15. Select **Start** to begin your exposure. A dialog box will appear on the left side of the screen showing what actions the system is performing. The system will run a variety of checks and scan the surface topography of your substrate before starting the exposure.

At the bottom of the screen you will see a progress bar and during the exposure, the write area on the substrate graphic will fill in green to show the exposure progress.

16. dialog box will indicate when your exposure has completed, select OK to close it, and perform the following steps:
    a. Press the **Unlock** button, it will illuminate green, open the amber cover by lifting it up.
    b. Press the **VACUUM** button, it will flash for a few seconds.
    c. **WAIT 6 seconds** to allow the vacuum to release your substrate from the chuck. **Failure to wait could result in you scratching your substrate.**
    d. Remove your substrate and close the amber cover.