Backside Alignment Technical Note (also read section 3.6 of the Picomaster Manual)

The key thing to making backside alignment work is having a single GDS file that contains 2 layers along with the alignment markers positioned correctly. Layer 1 is the frontside pattern and Layer 2 is the backside pattern and you can turn on Layer 1 or 2 before writing the GDS file depending on whether you are doing frontside or backside pattern.

For the alignment markers, they need to be positioned at exact coordinates before the write of the Layer 1 frontside layer (see Picture 1 from manual).

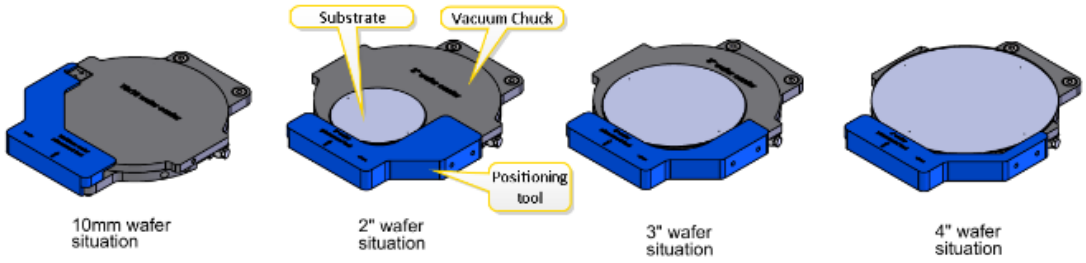


Figure 3-94 Backside alignment vacuum chuck with substrate positioning tools

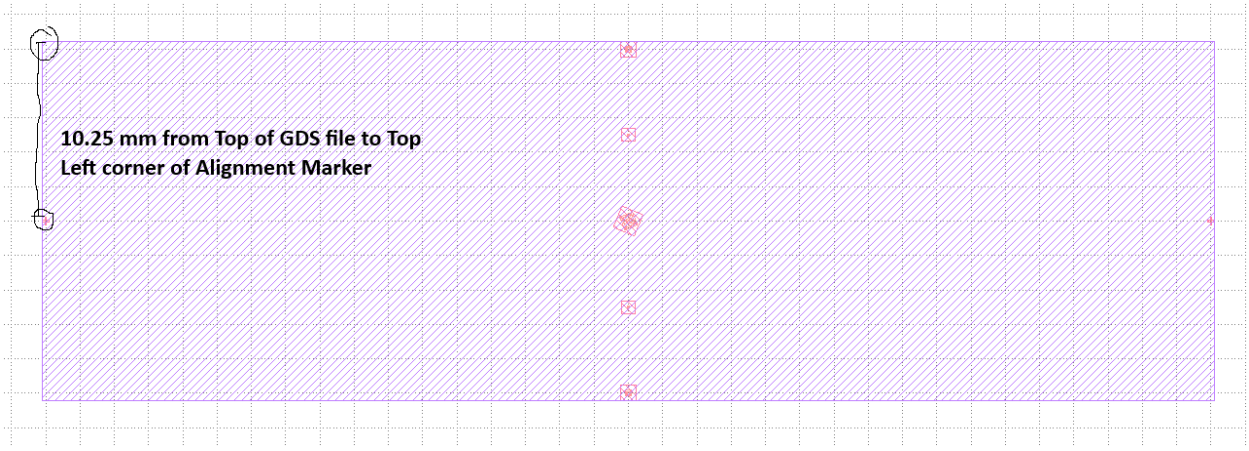
Marker positions for different substrate sizes are shown in the table below.

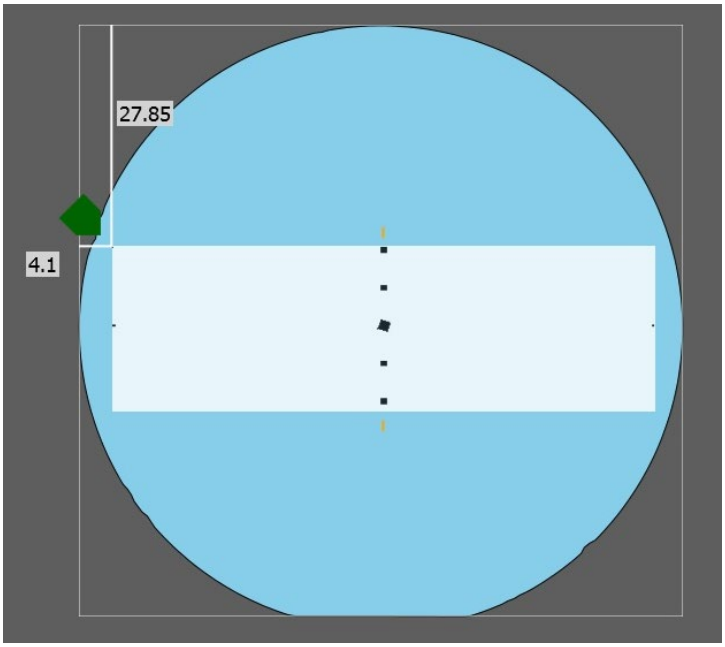
Wafer	M1 X position	M1 Y Position	M2 X position	M2 Y Position
4" Wafer	5	50	95	50
3" Wafer	4.1	38.1	72.1	38.1
2" Wafer	2.9	25.4	47.9	25.4
10mm Wafer chip	5	2.5	5	7.5

To get an image of the backside markers, the vacuum chuck has channels to let the light pass and mirrors to reflect the light. Marker positions cannot be choosen but are fixed with reference to the substrate.

Picture 1. Alignment marker positions

To demonstrate how to do this in practice, Figure 2 is a screenshot from Kplot for a merge.GDS file which we have used in the past successfully for backside alignment with 3 inch wafers. Notice the markers are at positions for a 3 inch wafer and there is a pattern for Layer 1 which is the frontside pattern and Layer 2 is the backside pattern. To get successful backside alignment the corner of a marker/fiducial must be exactly at (4.1, 38.1) for the left marker and (72.1, 38.1) for the right marker when the GDS file Layer 1 is written to the wafer. This is a fundamental assumption of the machine and to make this work you have to measure the distance from the top of the pattern to the top left of alignment marker in KLayout (in this GDS file it is 10.25 mm). When you load the merge.GDS file in the Picomaster software you need to place the corner of the pattern at 27.85 mm and 4.1 mm (38.1-10.25 = 27.85). Then when the pattern is written to the wafer the top left corner of the alignment marker will be exactly at 38.1 and 4.1 mm.



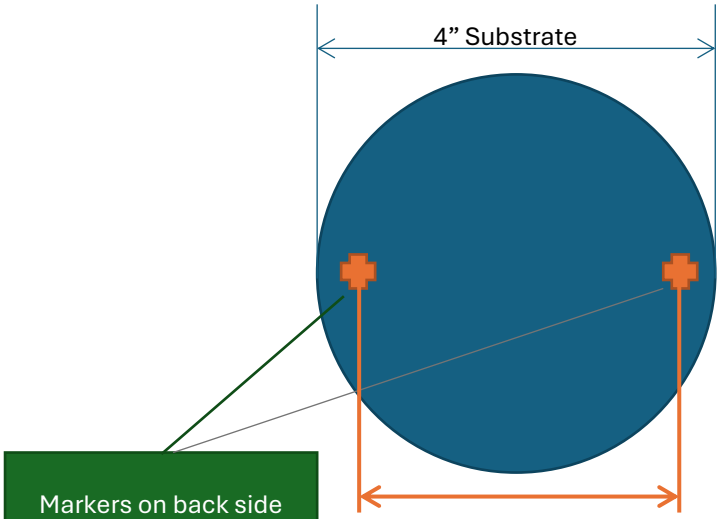


After writing Layer 1, the wafer is put in developer for the photoresist you are using. Now when the wafer is flipped over and put back on the wafer stage for writing on the backside there should be two alignment markers at the correct position for the Backside Alignment process. For marker training, the front and left cameras will move inward and the markers should be visible but it is usually necessary to turn off the vacuum and slightly move the wafer with your gloved hand to get both markers in the camera field of view. Then vacuum is reapplied and you should be able to do marker training. Now the crucial step is to train the markers using the Top Left as the alignment reference. In the region preview of the program, the user has to select a reference point which can be either Top Left or Center. In most cases you need to select Top Left.

BACKSIDE ALIGNMENT PM100

INTRODUCTION

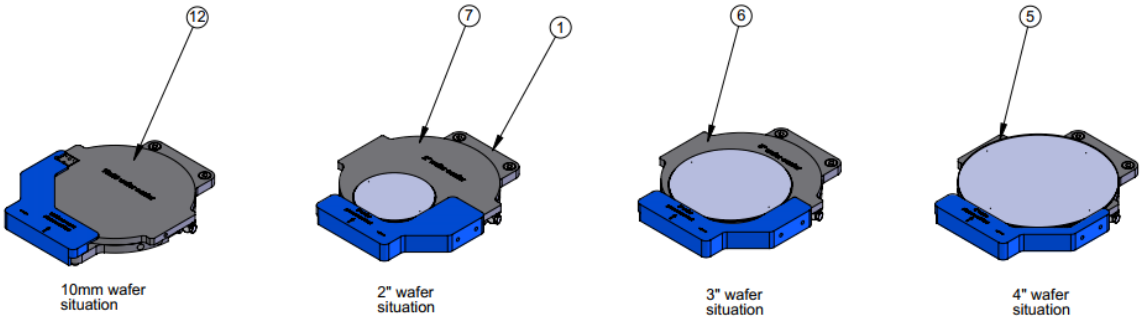
The back side alignment (BSA) on the Picomaster 100 (PM100) is performed by means of 2 cameras with telecentric illumination. The camera looks through channels / mirrors in the vacuum chuck to look at the bottom of the wafer.



90mm distance for 4 inch wafer
The 90 mm is from top left corner of left marker to top left corner of rigtht marker.

The backside alignment system of the PM100 supports 4 wafer sizes. For each wafer size, a specific substrate carrier and alignment tool should be used. It is important to use the correct substrate carrier since each carrier has holes at fixed positions and markers are expected by the software at those fixed positions.

- 4” Wafer
- 3” Wafer
- 2” Wafer
- 10mm Wafer chip



Note: The best way we have found to do backside alignment of a pattern with respect to frontside pattern is to create 1 GDS file with 2 layers. Layer 1 has the frontside pattern with the alignment markers at correct position based on top left of the marker. Layer 2 has the backside pattern. Layer 1 is written first on Picomaster, then developed, then photoresist is spun onto backside of wafer, then Layer 2 is written on backside after backside alignment.
For additional help/questions please send e-mail to Matthew Wright, matthew.wright@raith.com.

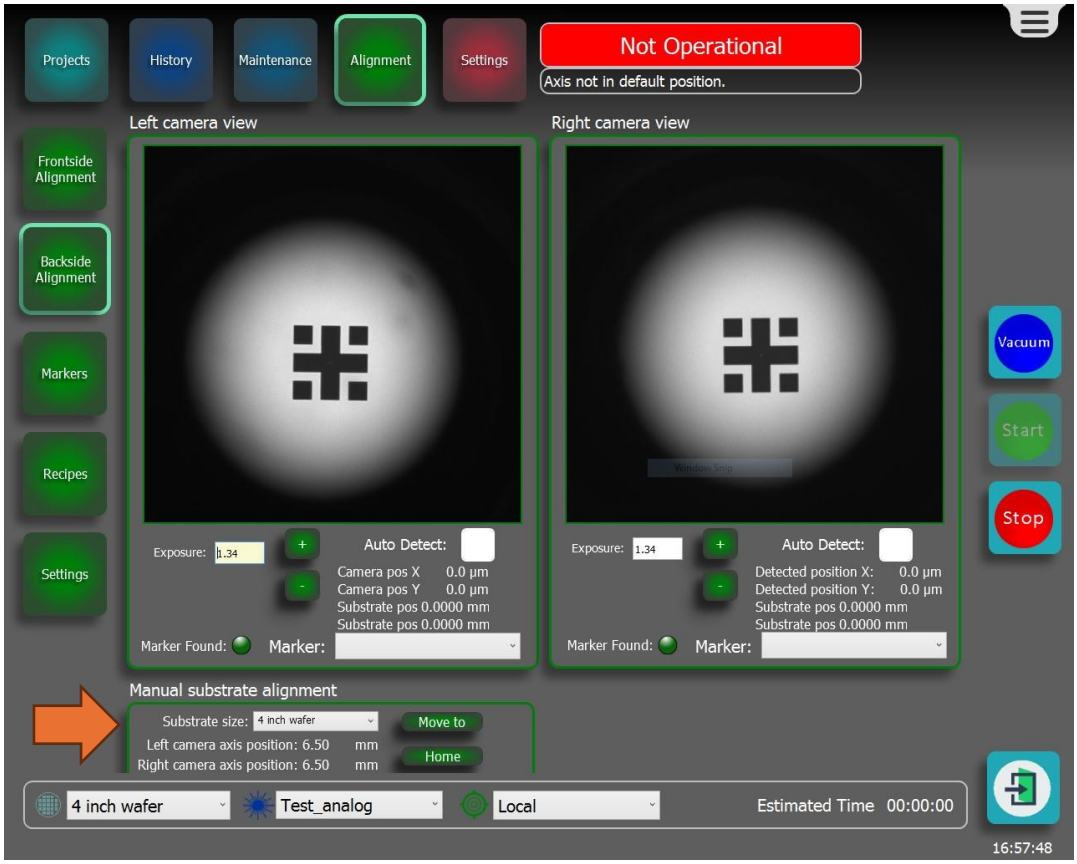
The top left of the markers in the GDS pattern file should be located at specific points on the wafer. The following table shows the required top left marker coordinates (with respect to the bounding box of the substrate). You can verify marker spacing in the GDS file by loading it in software such as KLayout.

Wafer	M1 X position	M1 Y Position	M2 X position	M2 Y Position
4” Wafer	5	50	95	50
3” Wafer	4.1	38.1	72.1	38.1
2” Wafer	2.9	25.4	47.9	25.4
10mm Wafer chip	5	2.5	5	7.5

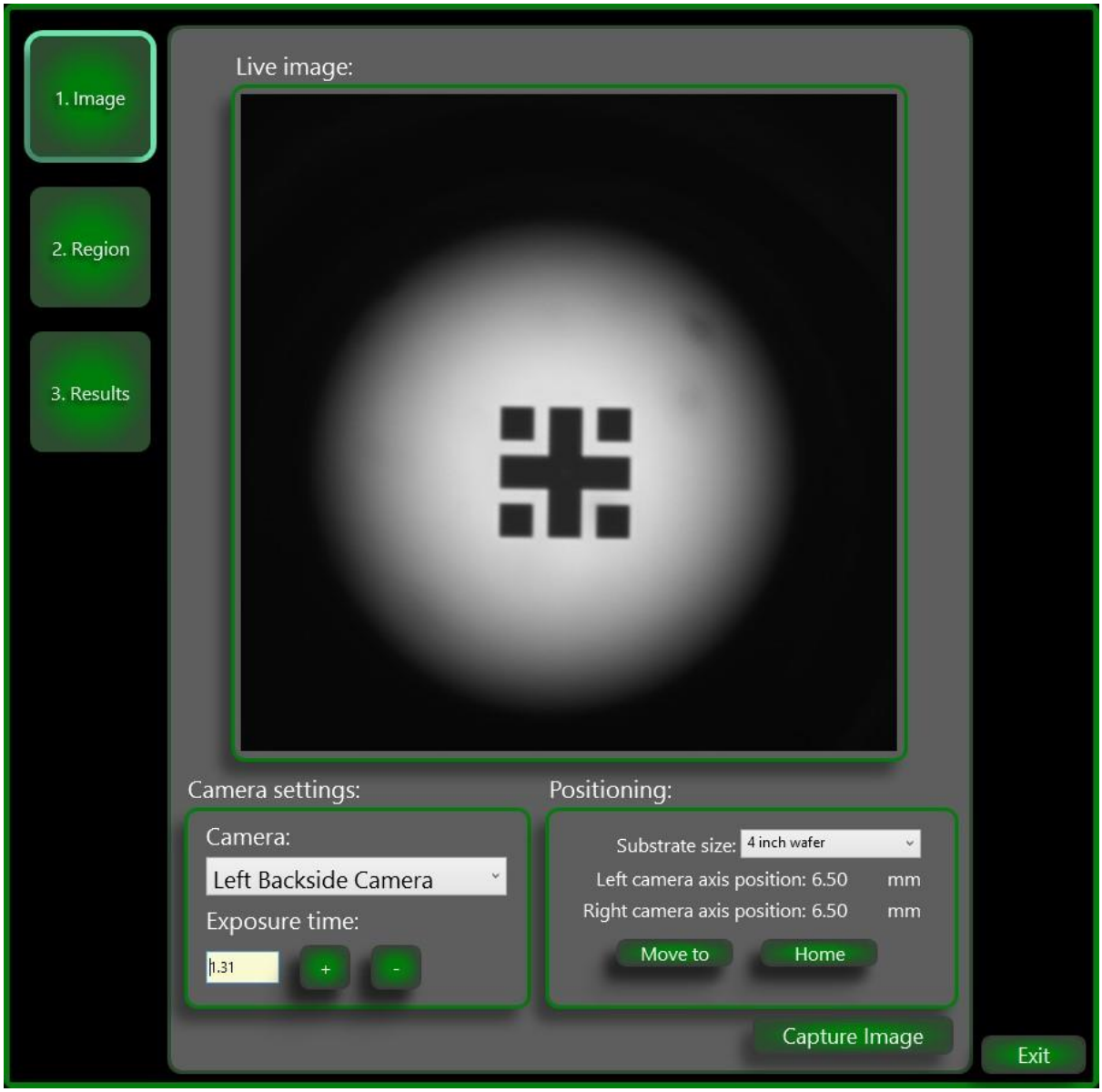
Note that the 10mm Wafer chip uses only the Left Camera

OPERATING THE BACKSIDE ALIGNMENT

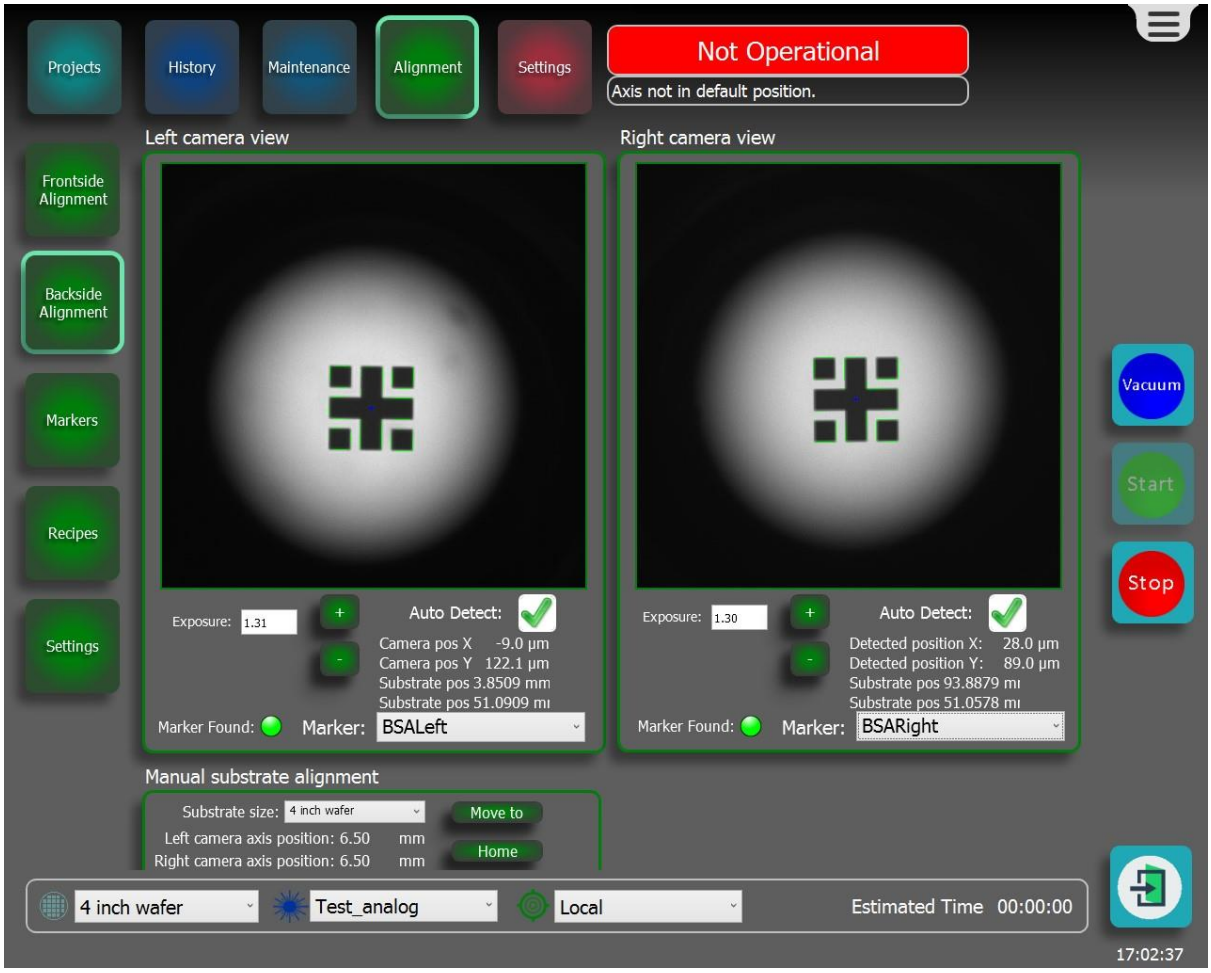
1. Place the correct substrate carrier in the PM100.
2. Place your wafer on the substrate carrier and adjust the optical module height.
3. Go to the backside alignment tab
    a. Select the desired substrate size in the ‘manual substrate alignment’ window.
    b. Click Move to. This moves the scan axis and camera axis to the correct position.
    c. You should now see two illuminated circles in the Left and right camera view. Adjust the camera exposure time for the left and right camera.
    d. Adjust your wafer position such that the markers are visible in both camera views.



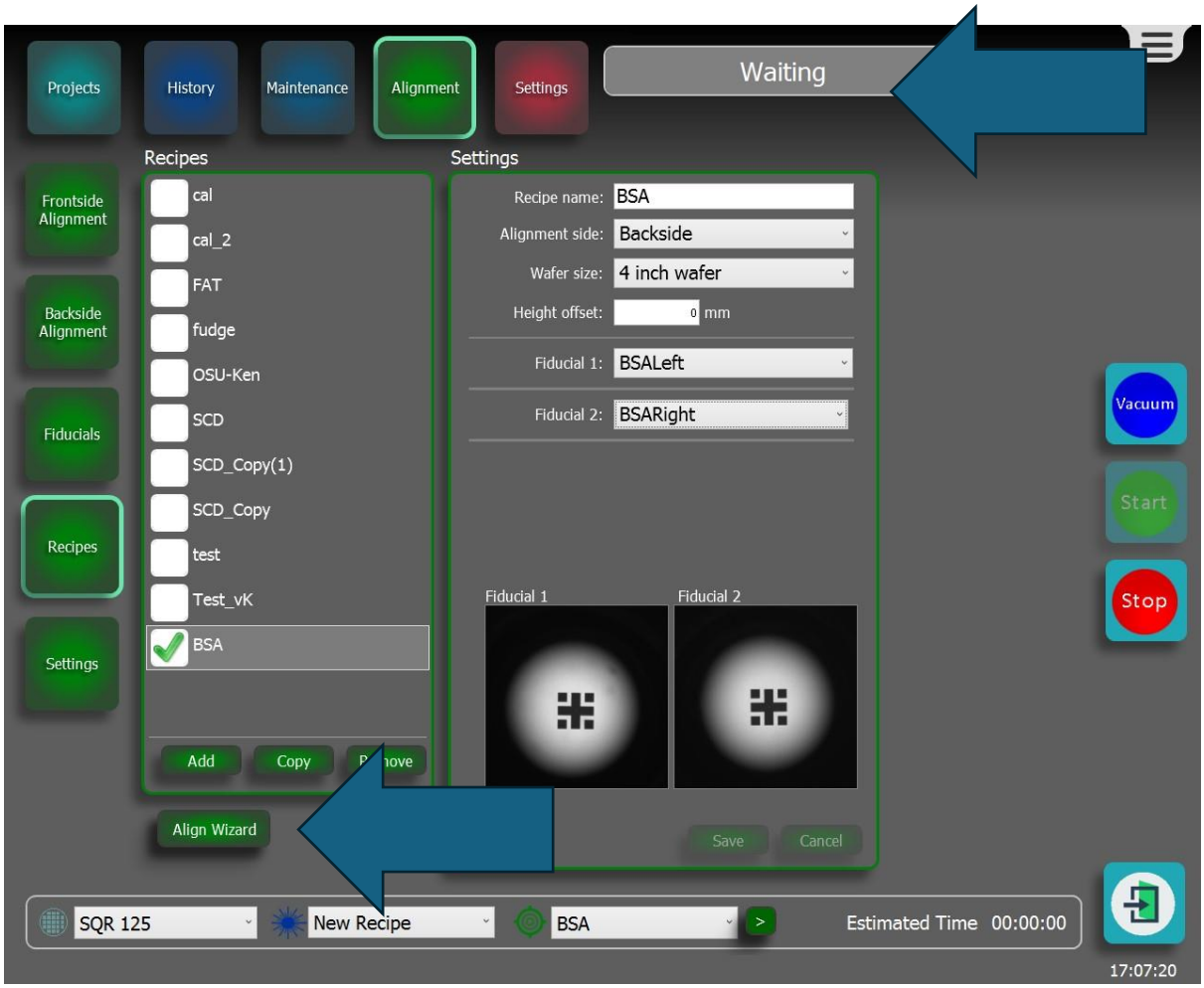
4. If you have not trained these markers previously follow this step.
    a. Train Left BSA marker:
        i. Go to the Markers menu and click Add
        ii. In the camera dropdown box: Select Left Backside Camera
        iii. Click “**Move to**” to move the scan-axis / camera axis to the correct position.
        iv. Adjust the camera exposure time
        v. Once the camera image looks good. Click Capture image and proceed with the marker training, always select Top Left for both Right and Left Marker Training.
    b. Train the Right BSA marker using the same steps but while selecting the Right Backside Camera.



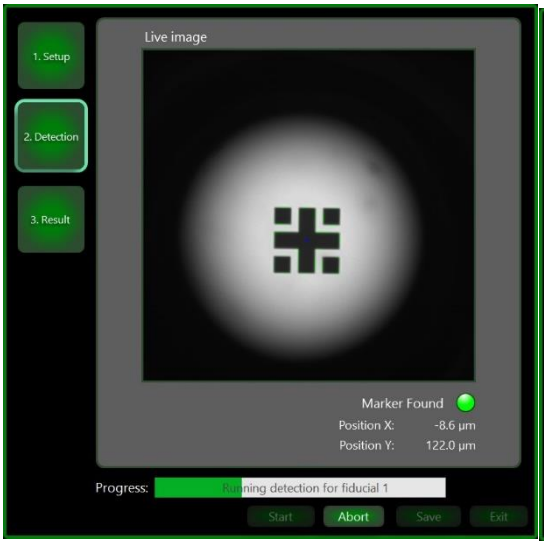
5. Verify if your markers are correctly detected in the BSA camera views
    a. Select the substrate size and click Move to
    b. In the left Camera view select your trained marker and enable Autodetect
    c. Verify that the marker position is detected in the camera image.
    d. In the Right Camera view select your trained marker and enable Autodetect
    e. Verify that the marker position is detected in the camera image.

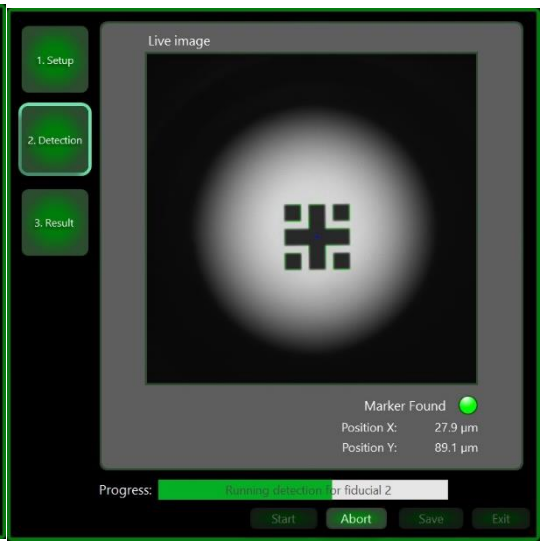


6. Set up the alignment recipe
    a. Create a new alignment recipe
    b. Select Alignment side: Backside
    c. Select the Wafer size
    d. (Optional) The height offset setting can be used to adjust the focus of the BSA cameras.
    e. Select Fiducial 1
    f. Select Fiducial 2



7. Run the alignment wizard
    a. Open the align wizard. Note that the align wizard can only be started when the scan axis and camera axis are in their default position. You can start the align wizard when the module state is Waiting. If the module state is not operational, press stop to move all axis to their default position.
    b. Start the alignment wizard
        i. The wizard will measure Marker 1
        ii. The wizard will measure Marker 2
        iii. The wizard will show the alignment result.
        iv. Press save to store the result.


1. Setup
2. Detection
3. Result
Live image
Marker Found
Position X: -8.6 µm
Position Y: 122.0 µm
Progress:
Running detection for fiducial 1
Start
Abort
Save
Exit


1. Setup
2. Detection
3. Result
Live image
Marker Found
Position X: 27.9 µm
Position Y: 89.1 µm
Progress:
Running detection for fiducial 2
Start
Abort
Save
Exit


1. Setup
2. Detection
3. Result
Substrate alignment
Step position: 6.97156 mm
Scan position: 7.87295 mm
Rotation: -0.22717 deg
Progress:
Finished
Start
Abort
Save
Exit