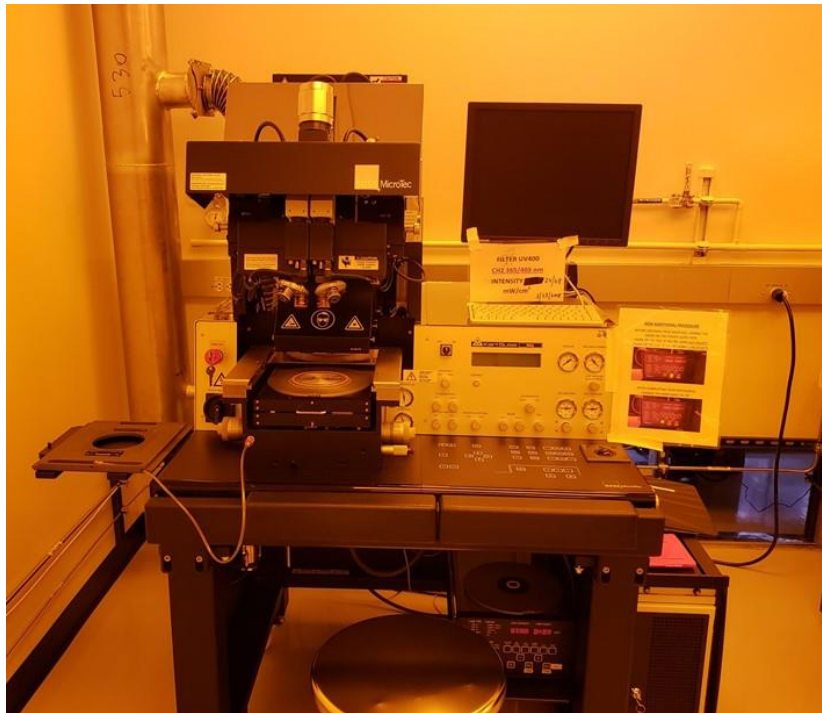




# Karl Suss MA6 DUV Mask Aligner Standard Operating Procedure



These instructions are intended for reference only, and will *not* replace the thorough training required for proper system operation. Contact a clean room staff member with questions or to report a system problem.

For ease of reading, LCD messages are bolded in **red** text. Operator actions, buttons to press, and knobs to turn are italicized and capitalized in *BLACK* text. Backside alignment starts in step 16.

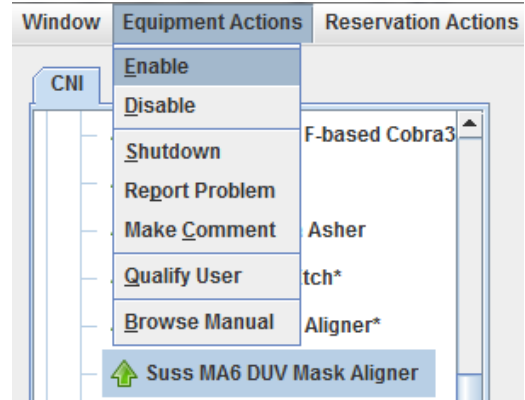
Based on the MA6 SOP written by Dr. Scott Trocchia, written by Dr. Jaeun Yu  
Backside alignment written by Gaurang Bhatt





## 1. BADGER:

Enable the tool in badger.



## 2. VERIFY SYSTEM STATUS:

When you first approach the tool, the lamp is on, indicated by the appearance of the number 0.0 in the LIGHT INTENSITY field, and a nominal lamp wattage **827** in the LAMP POWER field. The CP button should be lit, as well.

NOTE: if the lamp is off, press *POWER ON*. Once the display shows **-READY-**, press the *CP* button. The display shows **WAIT**, and then, **>>> START**. Click *START* and wait for 15 min for the lamp warm-up before the exposure.

Check the current channel:

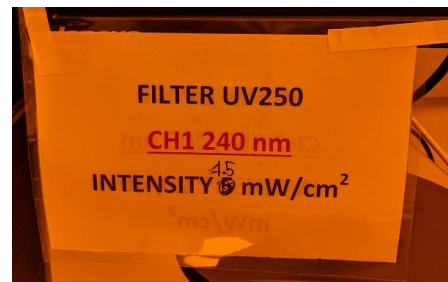
- CH1 240 nm
- CH2 365/405 nm

You can change the filter at **step 5**.

Initially, the front control panel should be in the off state.



**CP button**





<p><b>3. TURN ON TOOL:</b> Turn on the MA6 power switch by rotating the green key on the control panel clockwise.</p>	
<p><b>4. INITIALIZE MACHINE:</b> Press the <i>LOAD</i> button to initialize the machine. The LCD on the main operator's panel should read <b>Ready for Load ...</b>, when the tool is in its quiescent state.</p>	
<p><b>5. CHANGE UV FILTER:</b> Please contact the super user or cleanroom staff to get trained.</p> <p>UV filters are inside the cabinet next to the aligners: UV250 filter for 240 – 260 nm UV400 filter for 360 – 460 nm</p> <p>Press the <i>LAMPTEST</i> key. The display message will be <b>Change Filter: OPTION key or Lamp Test: ENTER key.</b></p> <p>Press the <i>OPTION</i> key.</p>	





	<p>The mirror house will move forward. Open the side panel by pressing the button. Carefully replace the filter on the correct slot. Place the previously loaded UV filter back to the box. Close the side panel. <u>Change the channel sign on the monitor accordingly.</u></p> <p>Press the <i>LAMPTEST</i> key to finish the filter change and to proceed with the program.</p>	
<p><b>6.</b></p>	<p><b>TOPSIDE ALIGNMENT:</b> Press the <i>BSA MICROSCOPE</i> key to bring the tool in TSA mode. The switch light should turn off on pressing, and the LCD should read <b>TSA/AI.</b></p>	



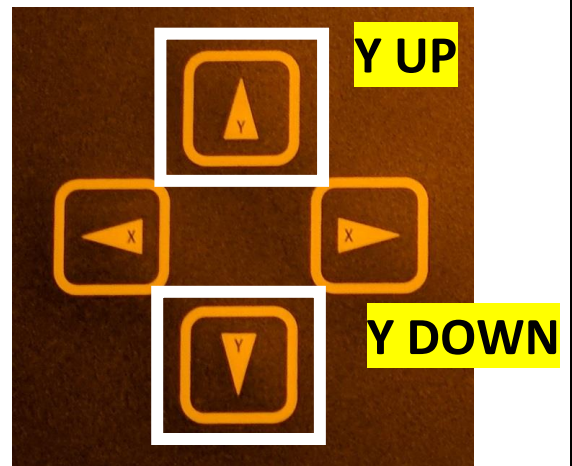
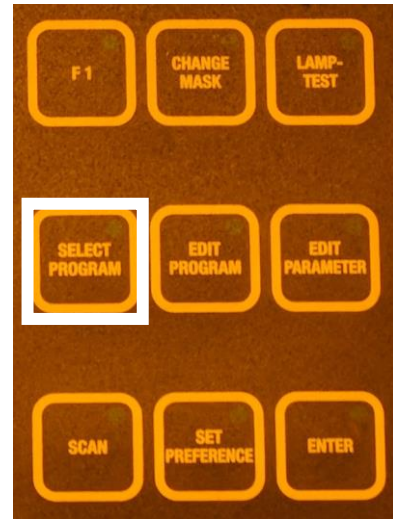


**7. SELECT EXPOSURE PROGRAM:**

Begin by pressing the *SELECT PROGRAM* button. The display message will change to **Exposure Type:[exposure selection]**, where *exposure selection* is the contact mode to be used in your process.

Use the *Y UP/DOWN* keyboard keys to cycle through contact choices. Only **Soft**, **Hard**, and **Prox** (shorthand for proximity) contact types are available to users. Press *SELECT PROGRAM* to confirm your contact mode selection and to exit this operation mode.

**Flood-E** is the only non-contact mode currently available. If you used Flood-E program, you must change it back to either Soft or Hard program for the next user. Please contact the super user or cleanroom staff for further information.



**8. SET EXPOSURE PARAMETERS:**

The display will subsequently show **Align Substrate**. Next, press the *EDIT PARAMETER* button to bring up a display of exposure parameter options.

Use the *X LEFT/RIGHT* keys to step through the choices. Set **Exp.**





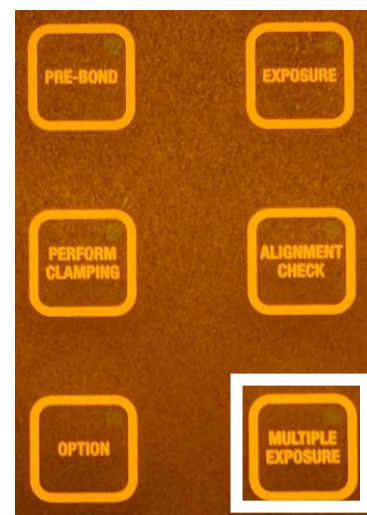
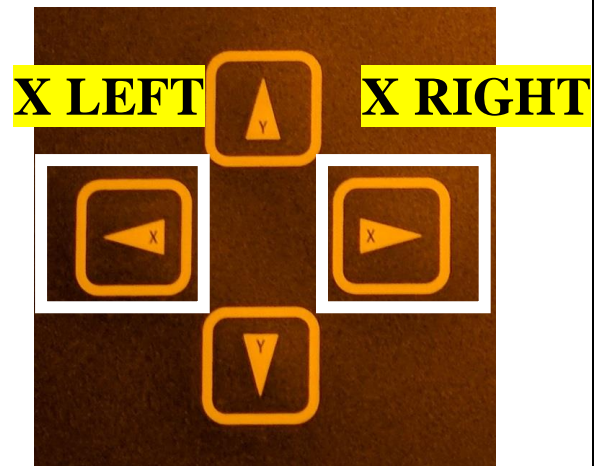
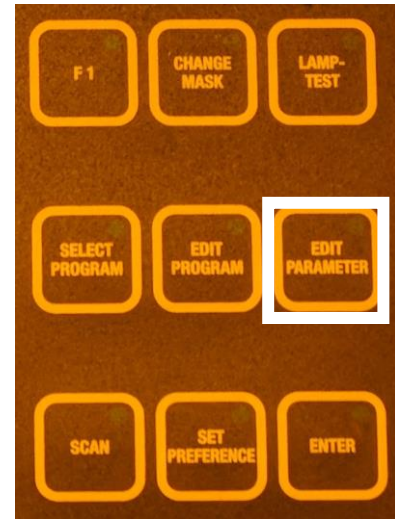
**Time[s]:** to the desired exposure time value using the *Y UP/DOWN* keys. Accept the defaults for other selections (if you want to change the Alignment gap, **Al Gap [um]:**, from its default value of 100 microns, please contact the super user or cleanroom staff first.)

If you need to make a long exposure (e.g., for PMMA), the exposure can be split into several intervals.

First, press the *MULTIPLE EXPOSURE* key. Once the key is activated, press the *EDIT PARAMETER* key.

Use the *X LEFT/RIGHT* keys to step through the choices. Set **wait time[s]:** and **number of cycles:** to the desired values using the *Y UP/DOWN* keys.

Following selection of your exposure parameters, confirm your choices by pressing *EDIT PARAMETER*. The display message will return to the **Ready for Load ...**, state.





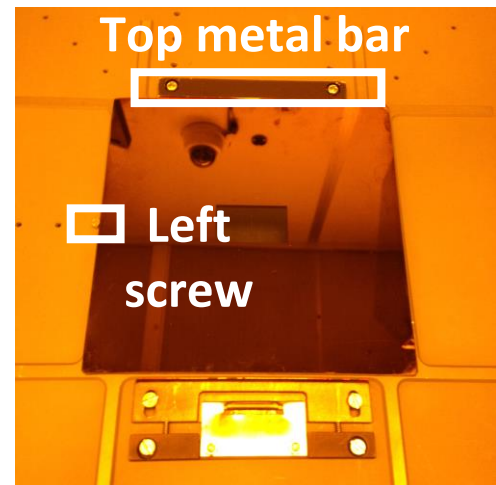
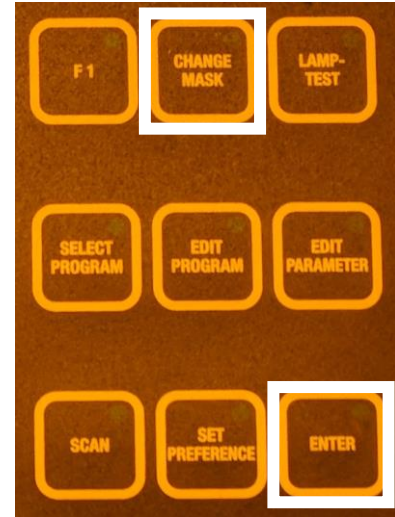
## 9. INSTALL MASK:

To continue, press the *CHANGE MASK* key. The display message will be **Change Mask – Press ENTER to toggle mask vacuum: [OFF/ON]**.

Ensure mask vacuum is off (use the *ENTER* key to toggle the vacuum state).

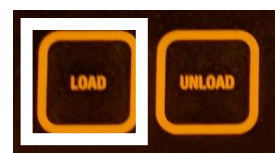
Remove the mask chuck from the stage area and turn it face up on the small table to the left of the tool. Install and mechanically clamp the mask using the left screw and top metal bar on the mask chuck. Toggle the vacuum state to “ON” by pressing the *ENTER* key.

Re-install the mask chuck into the stage area, and press the *CHANGE MASK* key to complete mask installation. The display will return to the **Ready for Load ...**, state.



## 10. LOAD SUBSTRATE:

Press the *LOAD* key. The display message will change to **Pull slide and load substrate onto chuck**. Pull the sample holder out until it stops.



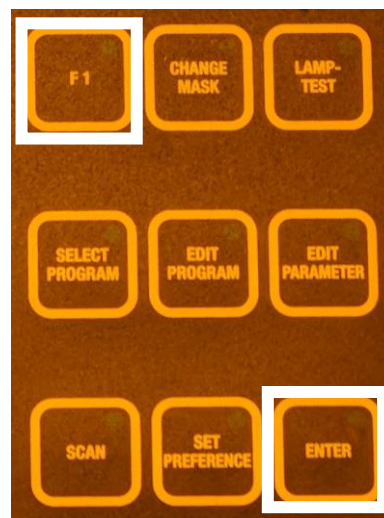


Change sample chuck if necessary.

Load your sample carefully, and apply the vacuum by pressing the *ENTER* button. Test that your sample does not significantly move around on the chuck by poking at it with tweezers. Push the sample holder back into the machine. Press *ENTER* to confirm, as instructed.

The display will change to **Performing WEC! Please Wait ...** as the mask makes contact with the sample underneath. The display will then change to **Microscope moving. Please Wait ...**, and finally **Align substrate.**

\*In case you forgot to switch to TSA mode at **step 6**, the microscope won't move down. Press the *BSA MICROSCOPE* key to turn off the BSA mode. Press the *F1* key, and then press the *ENTER* key to bring the microscope down.



**11. ALIGN SUBSTRATE:**

Use the keyboard's *X LEFT/RIGHT* and *Y UP/DOWN* keys to move the microscope. You can press the *FAST* button to enable faster microscope movements.



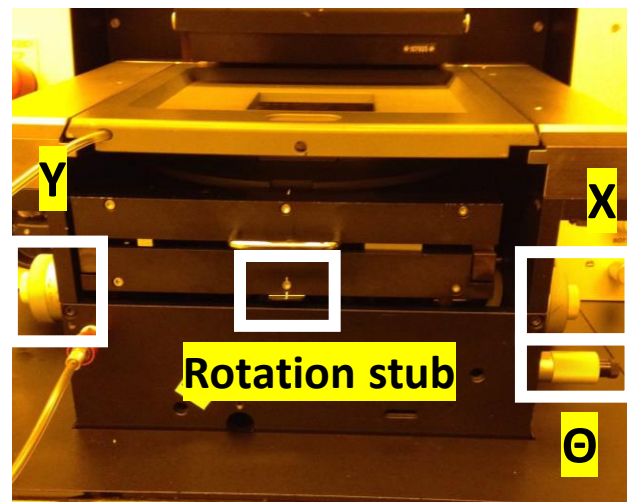
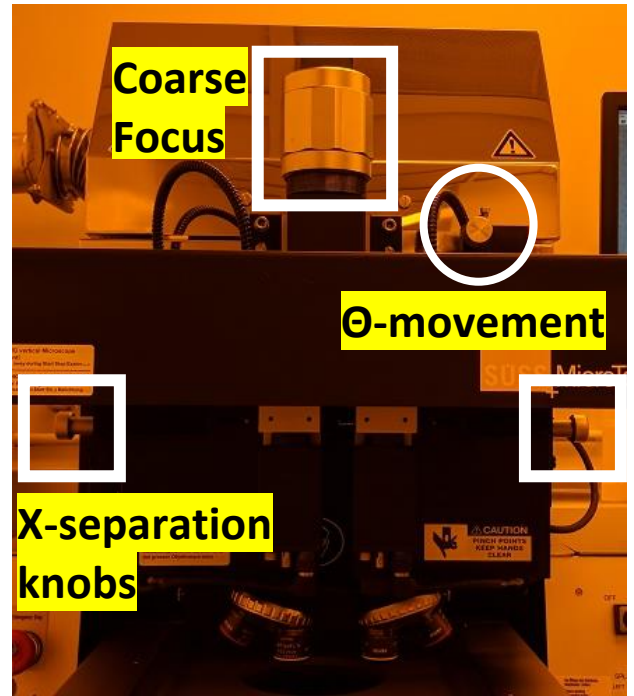




You can adjust microscopes to the mask alignment marks using  $\Theta$ -movement knob and X-separation knobs.

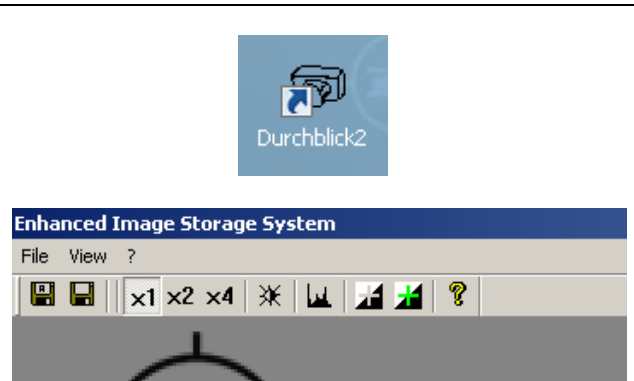
Use the stage X, Y, and,  $\Theta$  (theta) rotation micrometers to adjust the sample positioning.

Note the little rotation stub which indicates the degree of rotation of the stage. Before loading the sample, the solid white line of this piece should face out towards the user. This position indicates 0 degrees of rotation.



**12. MICROSCOPE IMAGING:**  
Open **Enhanced Image Storage system** software.

Turn the ILLUMINATION switch to TSA.






<p>You can select the camera using the SPLITFIELD switch.</p> <p>Coarse focus is possible by using Z-movement knob on top of the TSA-microscope. Adjust the fine focus separately using the TOP SUBSTRATE LEFT/RIGHT regulators.</p> <p>Before the exposure, you can check the exact alignment using the <i>ALIGN CONT/EXP.</i> key. Click again to detach the sample from the mask.</p>	<p><b>Splitfield</b></p> <p><b>ILLUMINATION</b></p> <p><b>Fine Focus</b></p>
<p><b>13. EXPOSE:</b></p> <p>When alignment is complete, switch the lamp power supply over to CH1 or CH2. The tool is calibrated to a static intensity of <b>4.5 mW/cm<sup>2</sup></b> at 240 nm for CH1 and <b>40 mW/cm<sup>2</sup></b> at 405 nm for CH2.</p> <p>Subsequently, <u>press the <i>EXPOSURE</i> key</u>. Make sure the <i>MULTIPLE EXPOSURE</i> key is activated if you're doing exposures in cycles.</p> <p>The display will show <b>Microscope moving Please wait ...</b>, then the Z axis (indicated by the <b>Z [um]</b> value) will gradually decrease until the mask comes into contact with the sample. A timer counts down the</p>	





<p>exposure time.</p> <p>For safety reasons, <u>you must wear the UV protective safety glasses.</u></p> <p>Glance at the lamp power supply box, and jot down the LIGHT INTENSITY and LAMP POWER values. <b>Report to the cleanroom staff if the lamp power has reached 1200 W.</b></p> <p>Wait for all exposure actions to complete (i.e. the UV light apparatus retracts, the microscope moves back to the down position, all mechanical parts stop moving, etc.), and for the display message to change to <b>Pull slide and unload exposed substrate.</b></p> <p>Pull the slide out to retrieve your sample; the vacuum will automatically release. Remove your substrate and push the sample tray slide back in. The display will return to the <b>Ready for Load ...</b>, state.</p> <p><b>After you finish your exposure(s), go back to CP mode on the lamp power supply.</b></p>	
<p><b>14. MASK REMOVAL:</b> Press <i>CHANGE MASK</i> to enter this mode. Release the mask holder from the machine and position it face up on the small table to the left of the</p>	





	<p>machine.</p> <p>Press the <i>ENTER</i> button to toggle mask vacuum off. Slide the mask away from the left screw and remove it from the holder.</p> <p>Return the holder to its place in the stage assembly. Or you can leave the holder on the small table.</p> <p>Press <i>CHANGE MASK</i> again, and – perhaps after a brief complaint about loss of mask vacuum, which you can ignore – the display will return to <b>Ready for Load ....</b></p>	
<p><b>15.</b></p>	<p><b>CLEAN UP:</b></p> <p>Clean up any debris. Be sure to take your sample and mask with you.</p> <p>Turn the green key to the system to the off position.</p>	
<p><b>16.</b></p>	<p><b>BADGER LOGOUT:</b></p> <p>Don't forget to disable the tool in badger after you're done.</p>	





## **REFERENCES:**

- [1] <https://www.inrf.uci.edu/wordpress/wp-content/uploads/sop-dry-karl-suss-ma6-notebook.pdf>
- [2] <https://louisville.edu/micronano/files/documents/standard-operating-procedures/mask-aligner-ma6a6-extended-sop-2>
- [3] [https://nanolab.berkeley.edu/public/manuals/equipment\\_manual.shtml](https://nanolab.berkeley.edu/public/manuals/equipment_manual.shtml)





## BACKSIDE ALIGNMENT

The alignment is done using the alignment pattern on the back of the substrate to align a mask on the top of the substrate. This is done using the back microscopes placed under the substrate chuck. The exposure always happens from the top side.

<p><b>17. BADGER:</b> Enable the tool in badger.</p>	
<p><b>18. BACKSIDE MODE:</b> Follow <b>steps 2-5</b>.</p> <p>When you turn on the tool, the <i>BSA MICROSCOPE</i> key is initially activated, indicating the tool is in the BSA mode.</p> <p>If you are switching from the TSA mode, press the <i>BSA MICROSCOPE</i> key to enable the BSA mode. The switch light should turn on, and the LCD should read <b>BSA/AI</b>.</p> <p>To move the top microscope up, press the <i>F1</i> key, and then press the <i>ENTER</i> key.</p>	





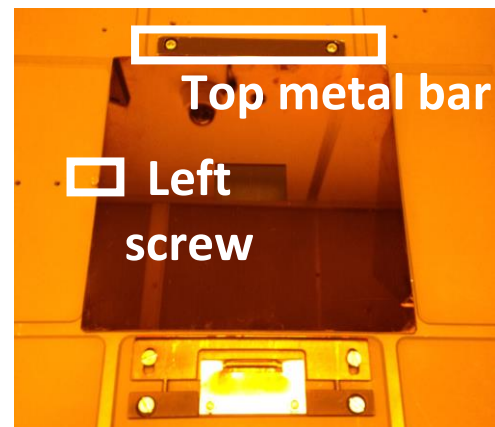
## 19. INSTALL MASK:

To continue, press the *CHANGE MASK* key. The display message will be **Change Mask – Press ENTER to toggle mask vacuum: [OFF/ON]**.

Ensure mask vacuum is off (use the *ENTER* key to toggle the vacuum state).

Remove the mask chuck from the stage area and turn it face up on the small table to the left of the tool. Install and mechanically clamp the mask using the left screw and top metal bar on the mask chuck. Toggle the vacuum state to “ON” by pressing the *ENTER* key.

Re-install the mask chuck into the stage area. Press the *CHANGE MASK* key to complete mask installation. The display will return to the **Ready for Load ...**, state.



## 20. CHUCK FOR BSA:

Change the sample chuck to backside alignment wafer chuck.

Move the transport slide into the machine. Don't press any keys.





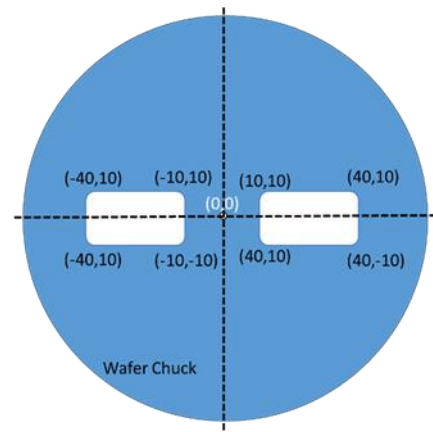
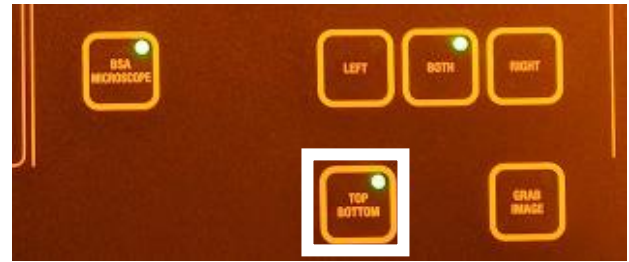
## 21. LOCATE ALIGNMENT MARKS:

Press the *TOP BOTTOM* key, if not already on. The LED on the switch should be on.

You can move either objective separately or both by selecting *LEFT*, *BOTH*, or *RIGHT* keys.

Use the microscope direction arrow keys to search for your alignment marks on the mask. You can press the *FAST* button to enable faster microscope movements.

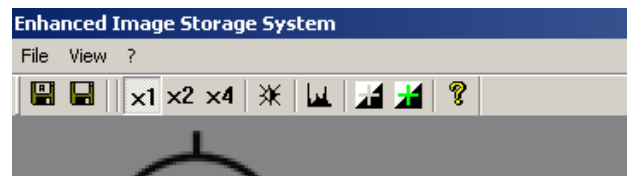
The (x,y) positions are shown on the LCD screen. Ensure to have your pattern and marks within these limits when you prepare the mask.



## 22. MICROSCOPE IMAGING:

Open **Enhanced Image Storage system** software.

Turn the ILLUMINATION switch to BSA/IR.







<p>You can select the camera using the SPLITFIELD switch.</p> <p>Adjust the fine focus separately using the TOP SUBSTRATE LEFT/RIGHT regulators.</p> <p>Magnification can be changed by MAGINIFICATION BSA switch.</p> <p>Once the required pattern or marks are found, press the <i>GRAB IMAGE</i> button to capture the screen images. The <i>TOP BOTTOM</i> switch will automatically turn off. The <i>GRAB IMAGE</i> switch will remain on until you unload the sample.</p>	
<p><b>23. LOAD SUBSTRATE:</b></p> <p>Press the <i>LOAD</i> key. The display message will change to <b>Pull slide and load substrate onto chuck</b>. Pull the sample holder out until it stops.</p> <p>Load your sample carefully. <u>Make sure that the wafer alignment marks fall within the open window holes on the substrate chuck</u>. Apply the vacuum by pressing the <i>ENTER</i> button. Test that your sample does not significantly move around on the chuck by poking at it with tweezers. Push the sample holder back into the machine. Press <i>ENTER</i> to confirm, as instructed.</p>	 






The display will change to **Performing WEC! Please Wait ...** as the mask makes contact with the sample underneath. The display will then change to **Microscope moving. Please Wait ...**, and finally **Align substrate.**

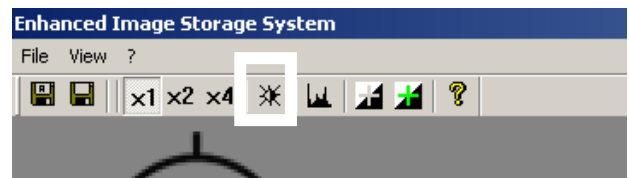
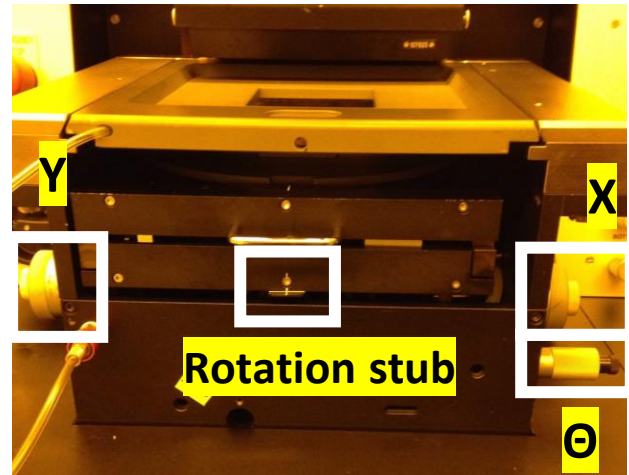
## 24. ALIGN SUBSTRATE:

Using the substrate micrometers ( $X$ ,  $Y$ , and,  $\Theta$ ) move the substrate to find the alignment marks on the bottom side of the sample. Align it with the overlaid stationary image of the mask.


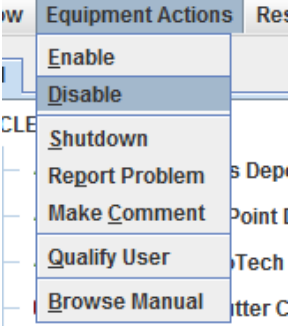
Note that you cannot move the BSA microscope, it is fixed at the position of the grabbed image.

Adjust the fine focus separately using the BOTTOM SUBSTRATE LEFT/RIGHT regulators.

Click on  icon on the software to alter the contrast between the captured image and the live image. Use the third slider named Alpha. By moving it up (increases the stored image contrast) and down (increases





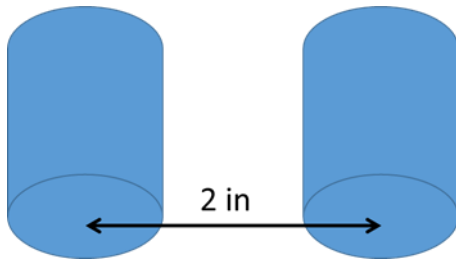
	<p>the contrast of the live image).</p> <p>You can check the exact alignment using the <i>ALIGN CONT/EXP.</i> key. Click again to detach the sample from the mask.</p>	
<p><b>25. EXPOSE:</b></p>	<p>Once alignment is achieved proceed with standard exposure procedure.</p>	
<p><b>26. UNLOAD SUBSTRATE:</b></p>	<p>Once the exposure is finished or when the <i>UNLOAD</i> key is pressed, the grabbed mask image will be automatically removed from the computer screen and the tool storage.</p> <p>In order to do second exposure, <b>steps 21-25</b> need to be repeated.</p> <p>To finish, follow <b>steps 14-15</b>.</p>	
<p><b>27. BADGER LOGOUT:</b></p>	<p>Don't forget to disable the tool in badger after you're done.</p>	





## APPENDIX: ALIGNMENT MARK SPACING FOR MASK DESIGN

Top side alignment microscope minimum spacing



Back side alignment wafer chuck window opening dimensions

