

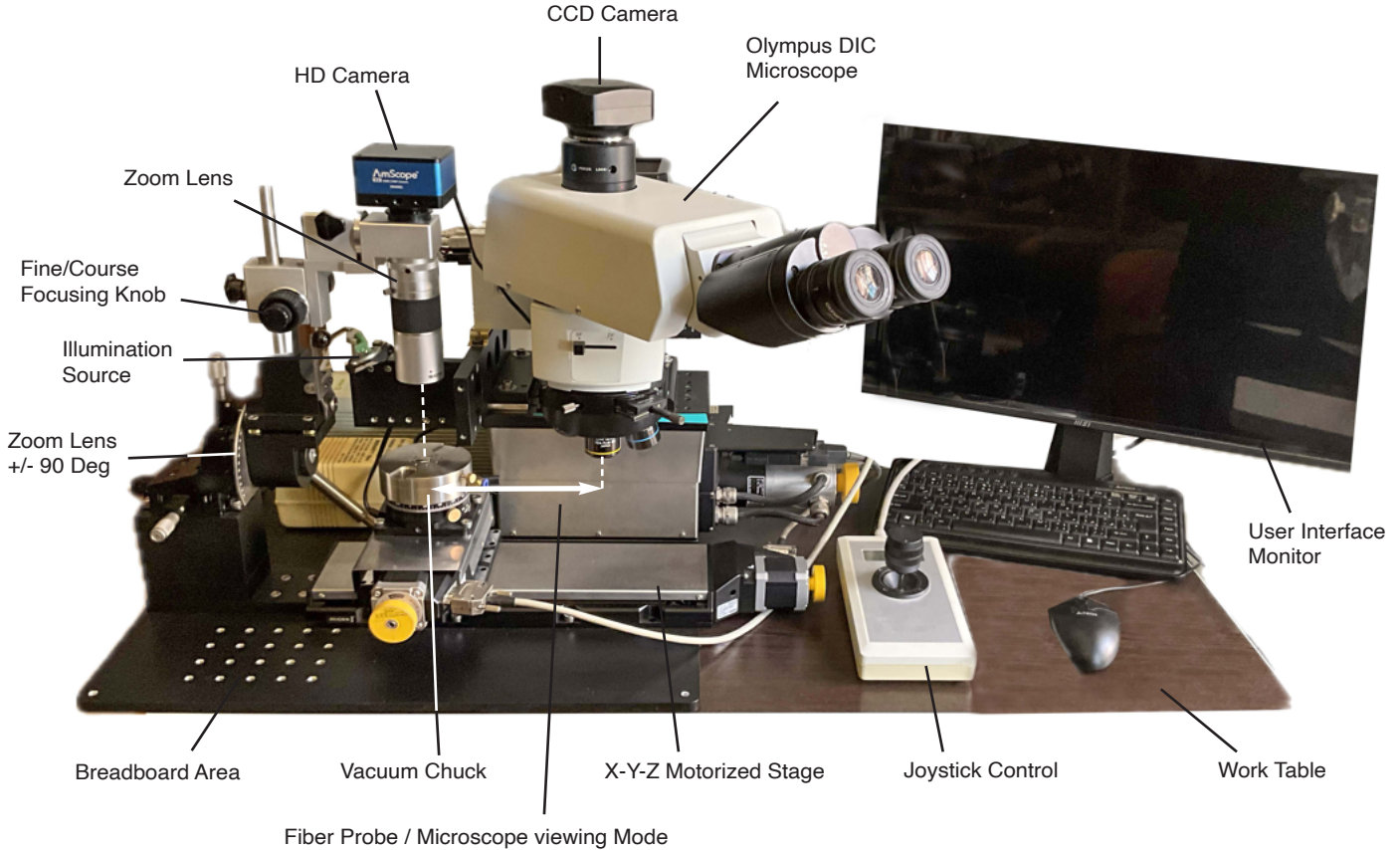
Fiber Probe Station With DIC Inspection Microscope

User's Manual 2026

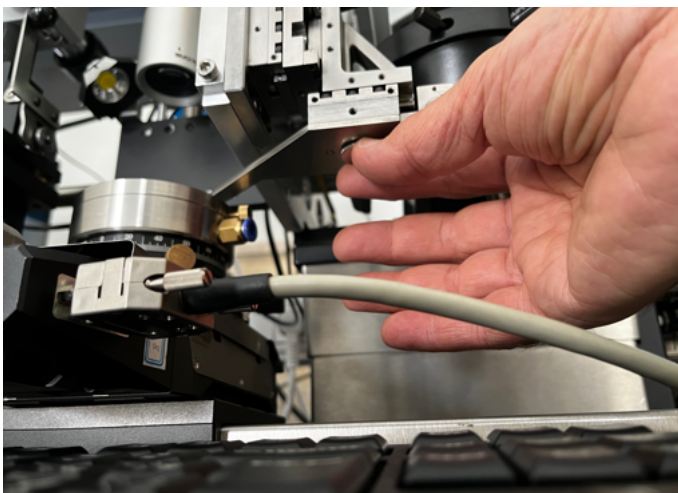
Optomechanix www.optomechanix.com

Probe Station Design concept

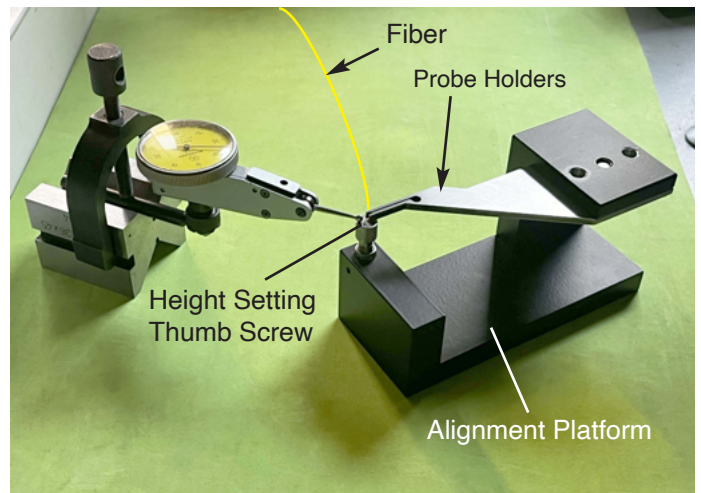
The design of probe station is based on 20 years' experience in development of microscope-based inspection systems for FA labs. Our patented solution for both AFM, and Fiber Probe Stations is to integrate them with a high resolution DIC microscope to provide an instant high resolution view of the sample. Ordinary long working distance lenses will not offer the image quality of a high power DIC microscope. Our entry level R&D workstation could inspect dies as large as 2" in diameter. The software is written in Python, and may be readily interfaced with user's detection system to perform automated fiber to grating alignments.



Above, Microscope / Probe Station standard configuration (HD monitor for probe view mode is not shown)



The interchangeable fiber holders may be replaced by a single thumb screw (above). The holders have registration pins for their accurate replacement after removal.



Utilizing our alignment platform, or a granite table for adjusting fiber probe tip to have a consistent height, hence saving time during probe to wafer interface.

Microscope / Probe station Graphical User Interface Software



Fiber Probe positioning

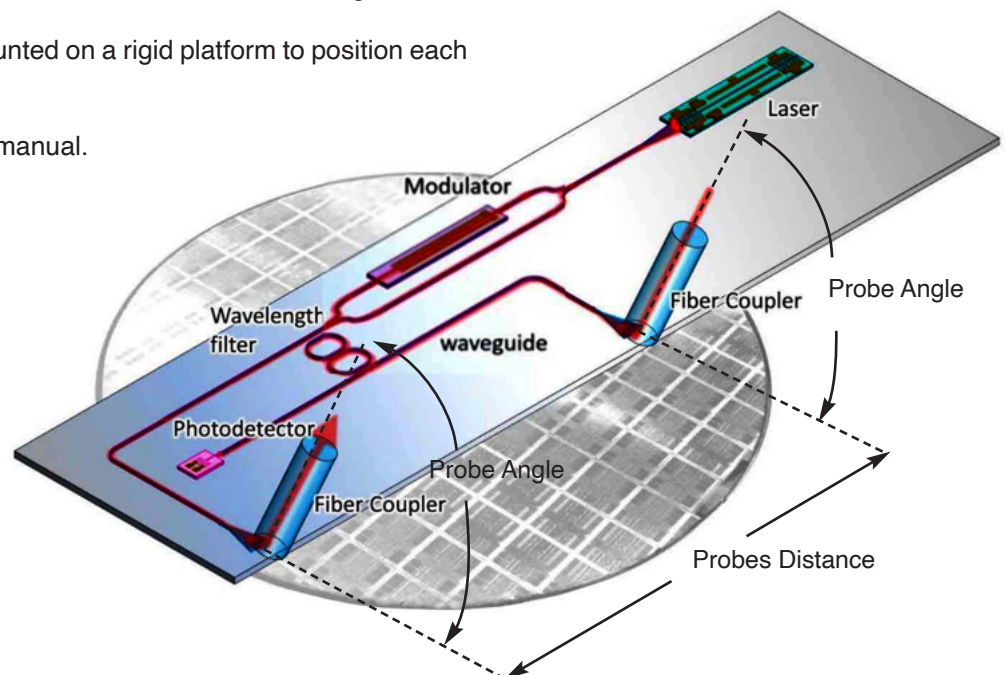
The user-friendly graphical user interface (above) allows navigating across the wafer to approach with fiber probes. In reference to the illustration (below, right), there are two possible modes of operation:

- 1) Two probes having a fixed distance (i.e., 125 μm standard): In this case, it is recommended that both fibers be installed on the same X-Y-Z stage .
- 2) Two separate X-Y-Z stages are mounted on a rigid platform to position each probe on the wafer.

We will cover both techniques in this manual.

Probe Angle, and Approach Distance

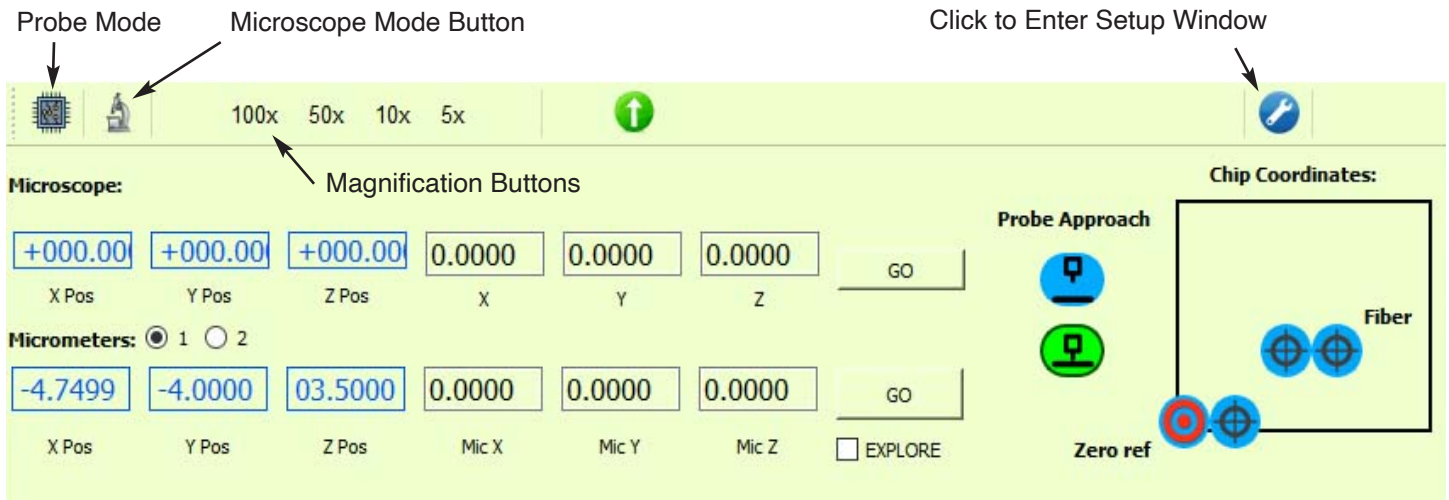
Probe distance is set utilizing a probe alignment platform (opposite page), and probe angle is set utilizing glass blocks that the fiber probes are bound to. Probe holders could easily be fabricated via wire EDM to secure the fiber probes at any orientation. Sample dimensional drawings are included for our standard probe holders on the back of this manual.



Powering up the system

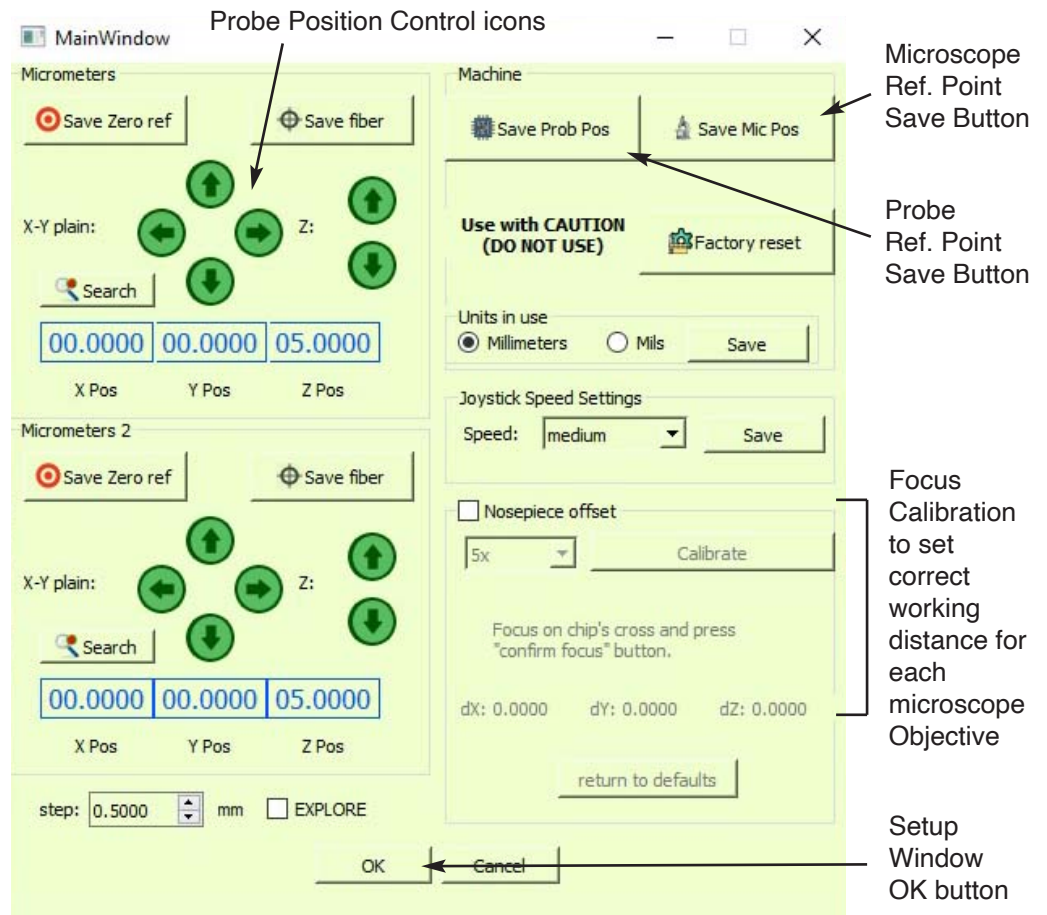
To set up the probe station, first boot up the computer, and both monitors, then turn on the motion controller, micrometer control system power supply, motorized turret controller, Air chuck, and the LED light source, etc. The probe station consists of two motion control systems: The main X-Y-Z motion control and the motorized X-Y-Z micrometer control. After running the program, the workstation automatically initializes both motion control systems, switches the motorized nosepiece to 10X, and ask the user to focus to the sample, and to click ok. The user could then load the chip at the center of the air chuck, and using the joystick, focus to the chip surface, and press ok. This process might take 1 to 2 minutes.

The initial X-Y location of the microscope is the reference point that was memorized from last session the system was utilized. There are two modes of operation: The microscope mode, and fiber probe mode. The first step is to horizontally align the chip under the microscope via the rotary stage located below the air chuck. The end user can utilize the joystick to scan the chip under the microscope, spotting any horizontal line, and keeping it centered while moving the stage to left and right. The chip can be horizontally aligned by rotating the chuck first by hand, and then utilizing a fine alignment micrometer at its side.



This will facilitate fiber alignment during the probe mode of operation.

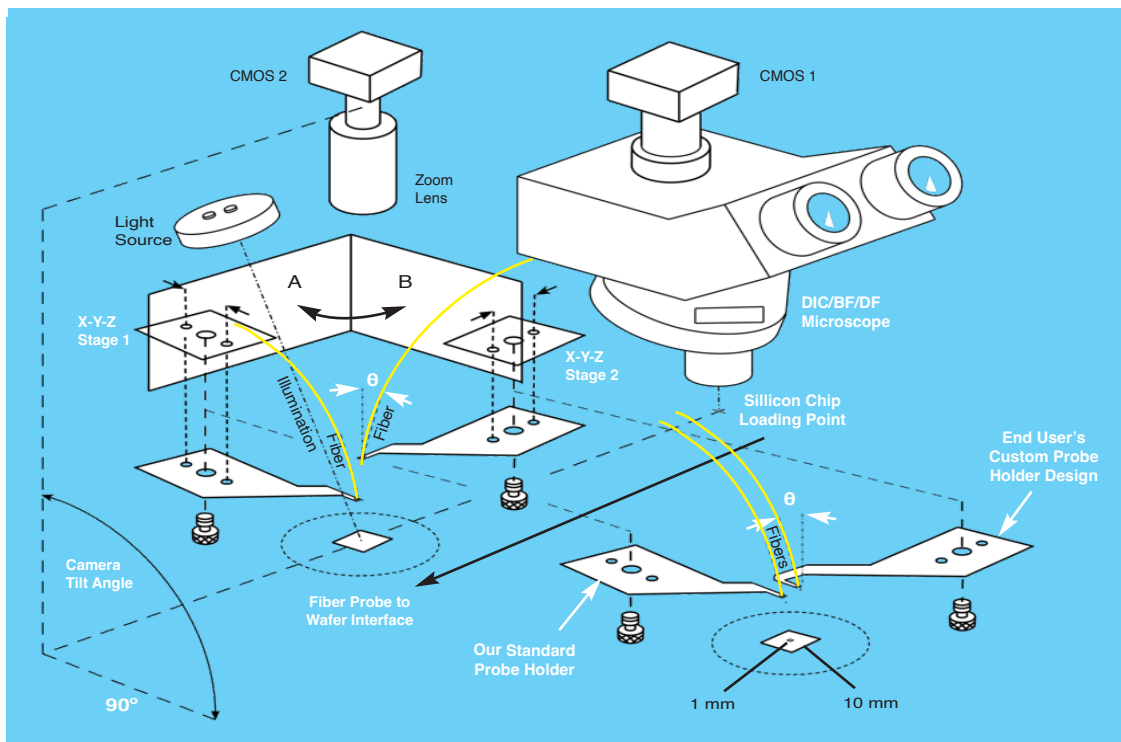
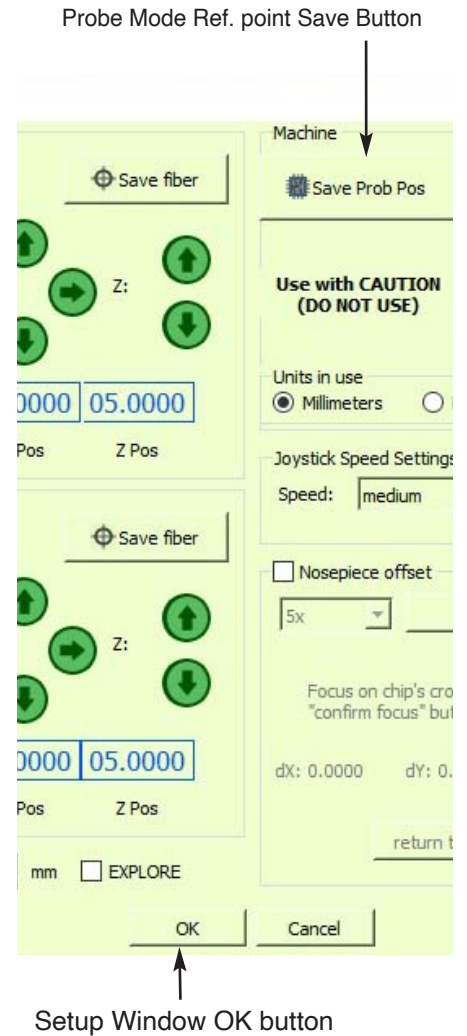
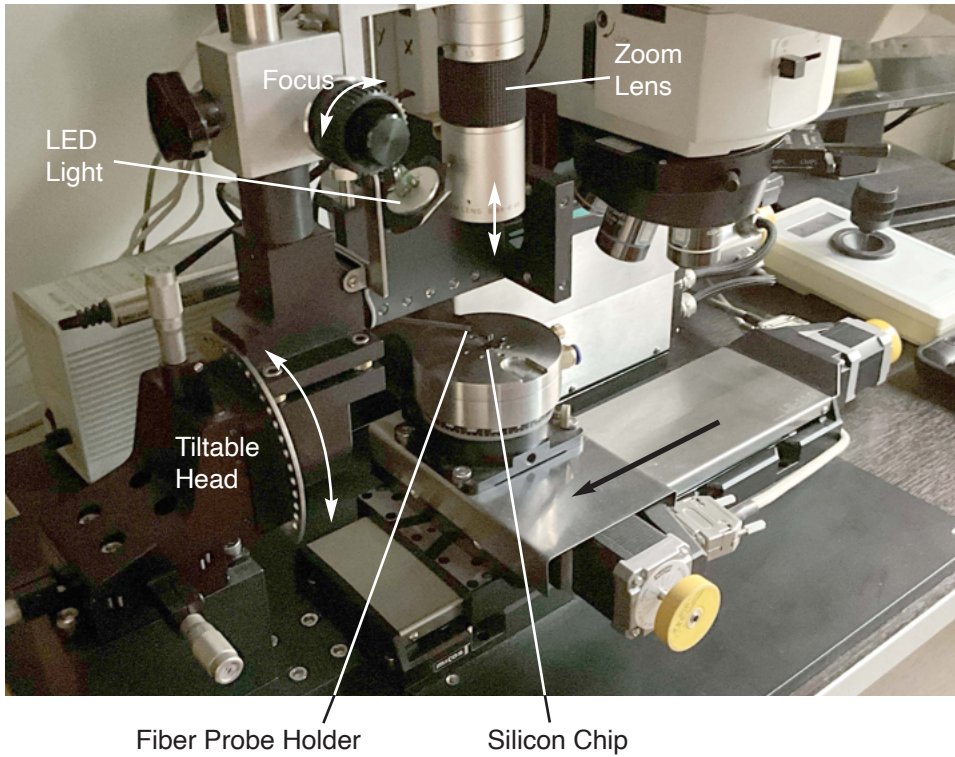
Once the chip is aligned horizontally, use the 10X objective to center the bottom-left corner of your reference point, then click on set up window (above-right), and click on microscope align button to set its reference point, then click OK button at the bottom to switch back to the main window. You are now ready to switch to probe mode to align the fiber probes to the chip. To accomplish this, first click on probe mode button. The microscope lifts up to clear from the chip, and translates the chip to the left beneath the zoom lens, and lowers the fiber probes to the chip using the 0.5 mm stand off. It is so crucial to focus to the chip surface before switching to the probe mode (next).



Fiber Probe Mode

When switched to probe mode, the coordinates are the saved values from its last use. You could update new coordinates utilizing the probe positions using the zoom lens, and aligning to the new reference point, then clicking on the Setup button (right) to save it. First view the probes through the CCD camera utilizing the cross hair to view the reference point, and fiber probes.

The probe mode allows fiber optics probes to be aligned/coupled to any pre-known locations on the Silicon chip. You could accomplish this by first setting the cross hair of the viewing camera to the lower left edge of the chip, then moving the lower

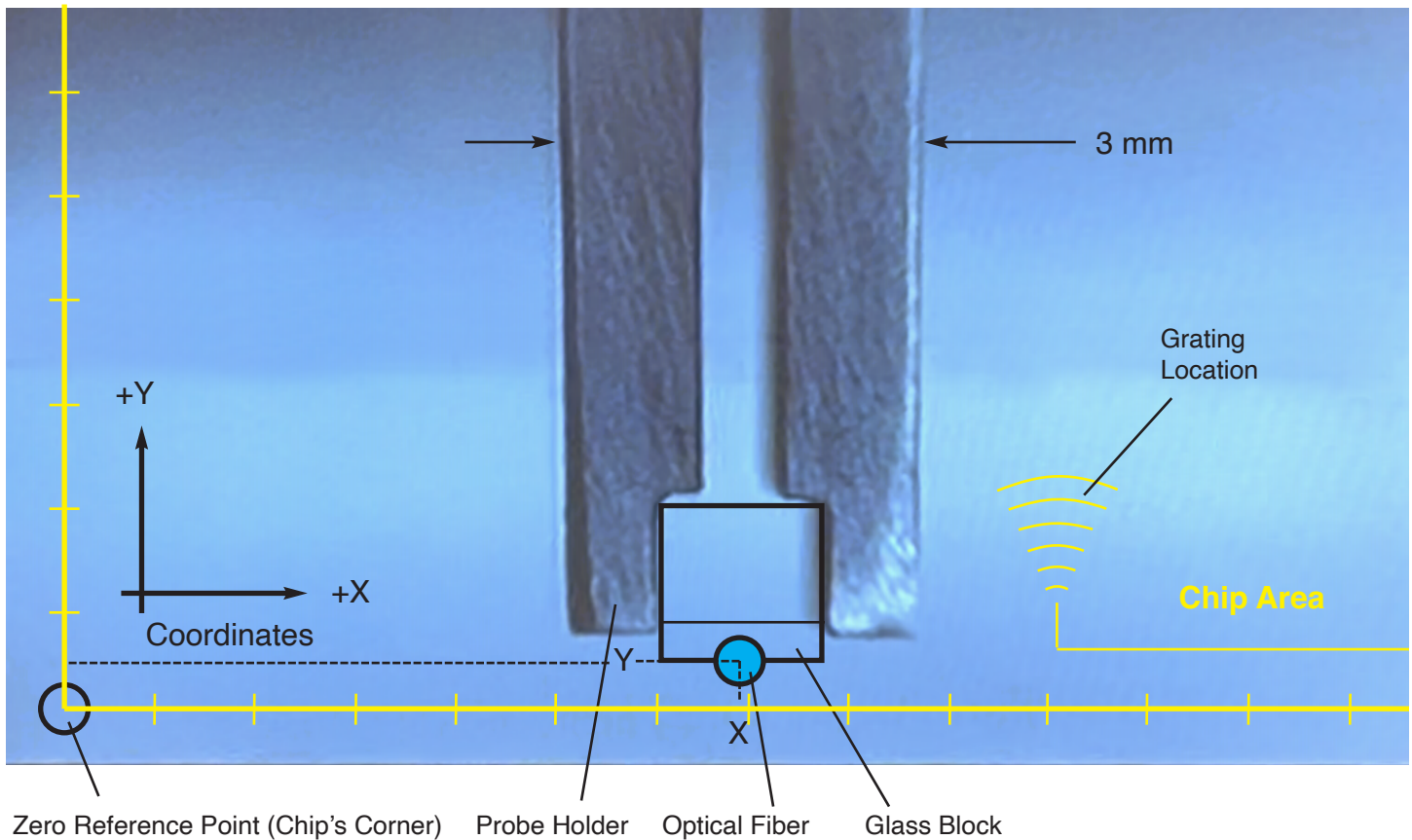
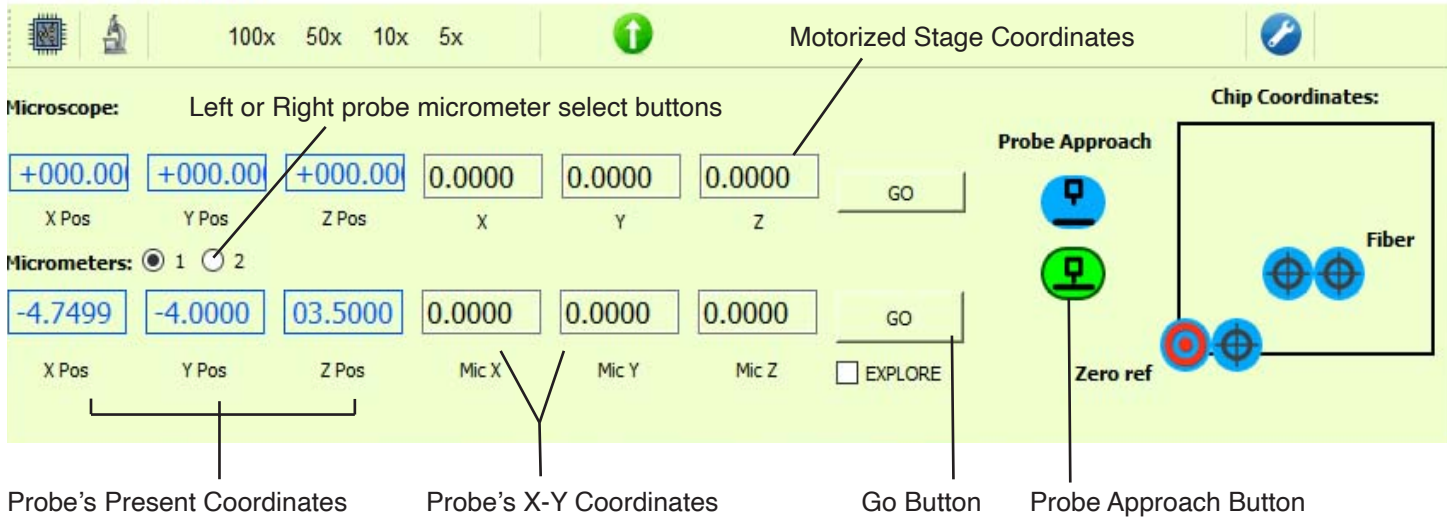


Probe holder for your application

Probe station utilizes two X-Y-Z stages carrying a pair of probe holders (1 & 2).

Probe holders may be designed by end user, and fabricated with wire EDM to secure fiber probes at any desired angle or orientation. Several examples of probe holder design are shown for your reference.

the fiber tip on the probe arm on your screen (image below) to the lower edge of the chip (or the already aligned cross hair). This would allow positioning the fiber tip to any X-Y coordinates by typing its exact coordinates, and clicking on the Go button (bellow). Fiber positions are also possible via step position of the fibers across the chip and monitor the fiber input/outputs. This is accomplished by accessing the setup menu, and clicking on the positioning arrows.



The step value can be typed in the range of 0.001 Microns to 4 mm. The entire positioning rang of micrometers is 12 mm in both X and Y directions. This is why the zero reference point (above, left) must be placed on the edge of the chip (shown as the yellow line) so the entire chip area may be reached fiber probes.

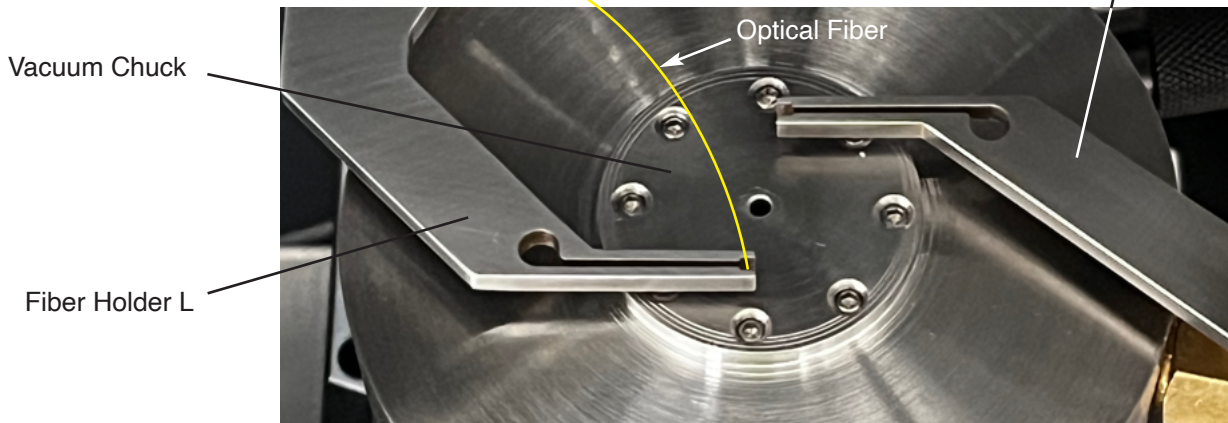
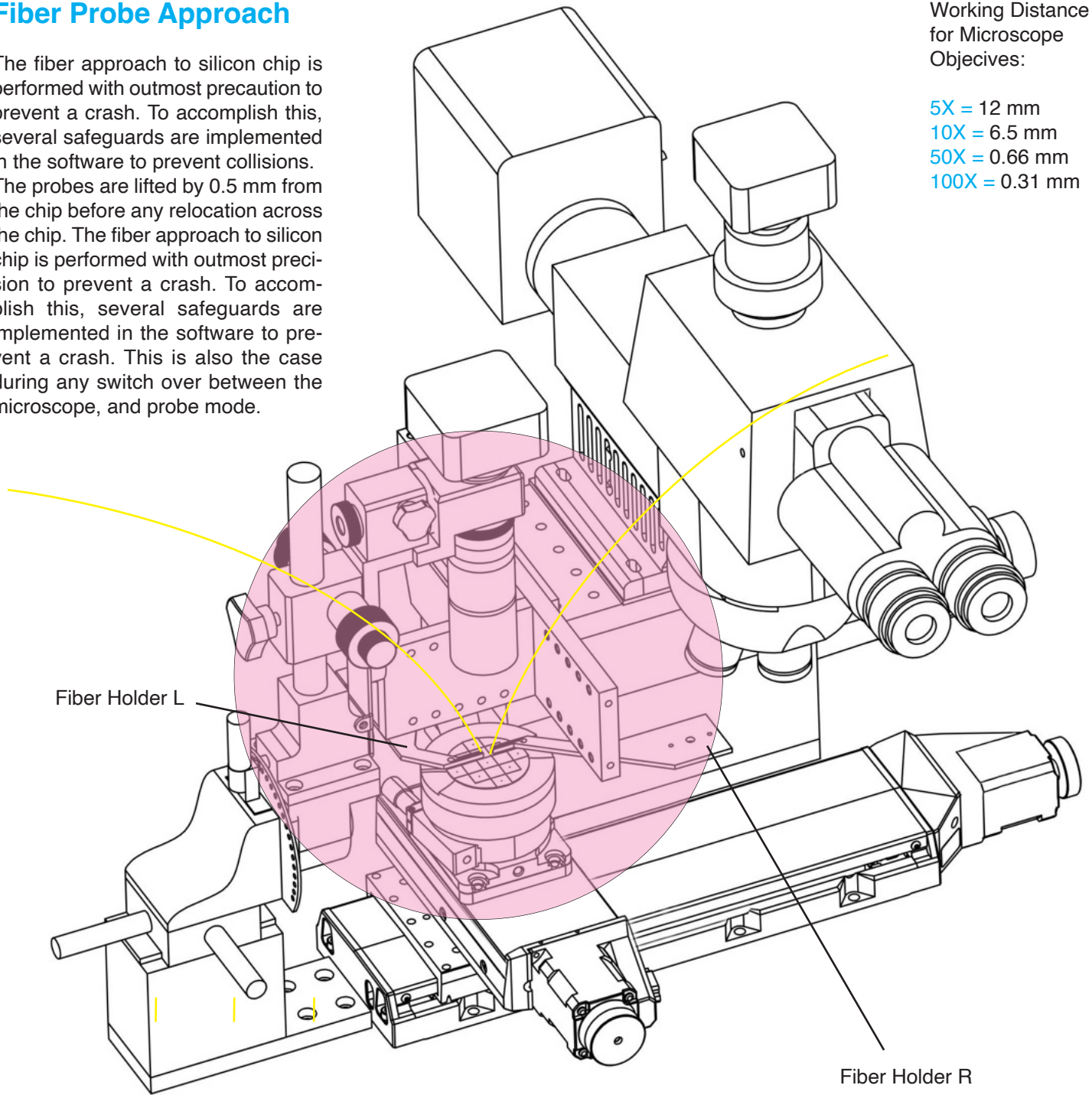
Finally, the fiber alignment with the grating area should be time saving, and therefore, fully automatic. In other words, the coordinates should be used to position the fibers in approximate locations across the chip area, and then the automatic mode should take over. This is exactly how our software is set up to perform.

Fiber Probe Approach

The fiber approach to silicon chip is performed with utmost precaution to prevent a crash. To accomplish this, several safeguards are implemented in the software to prevent collisions. The probes are lifted by 0.5 mm from the chip before any relocation across the chip. The fiber approach to silicon chip is performed with utmost precision to prevent a crash. To accomplish this, several safeguards are implemented in the software to prevent a crash. This is also the case during any switch over between the microscope, and probe mode.

Working Distance
for Microscope
Objectives:

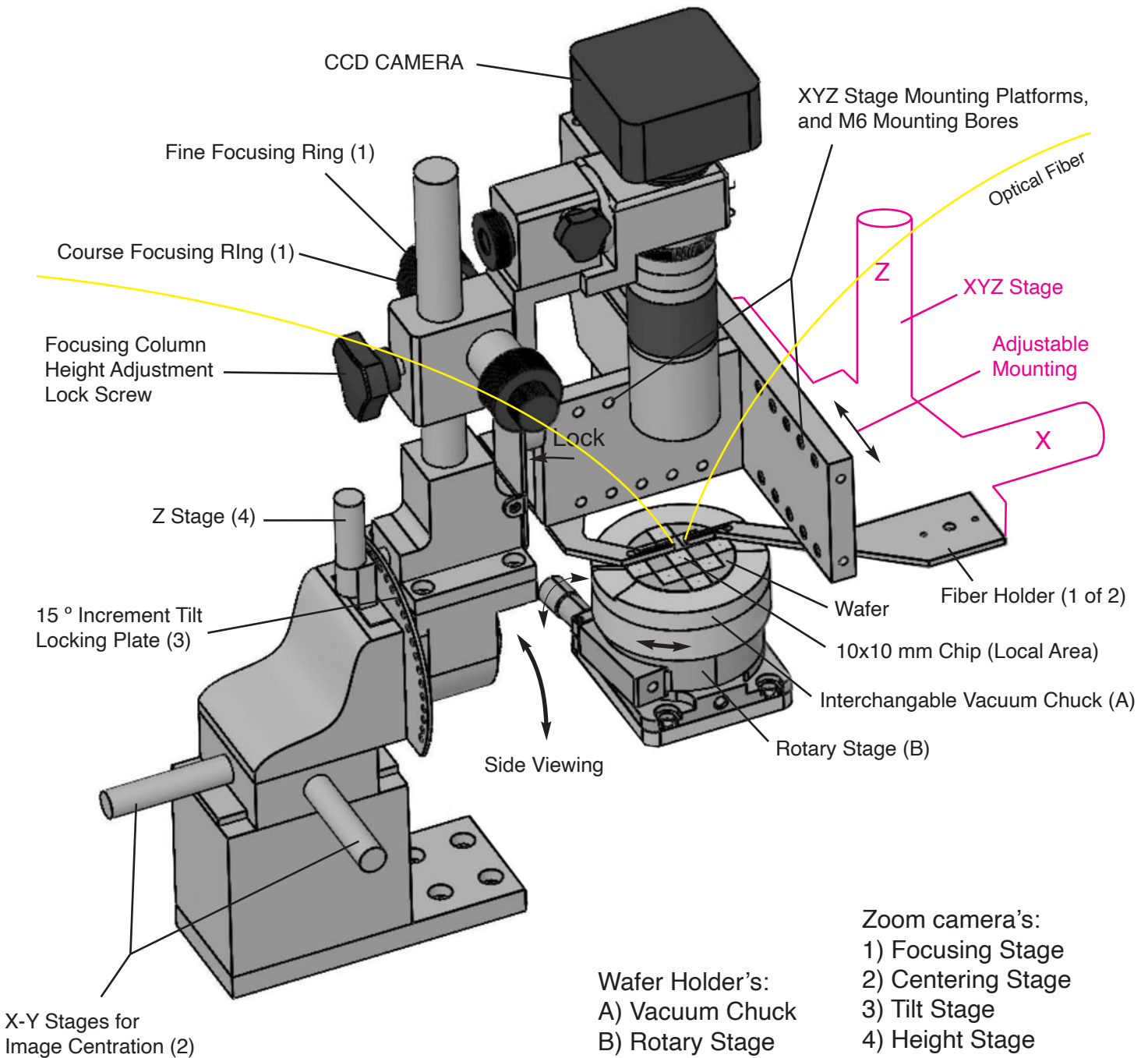
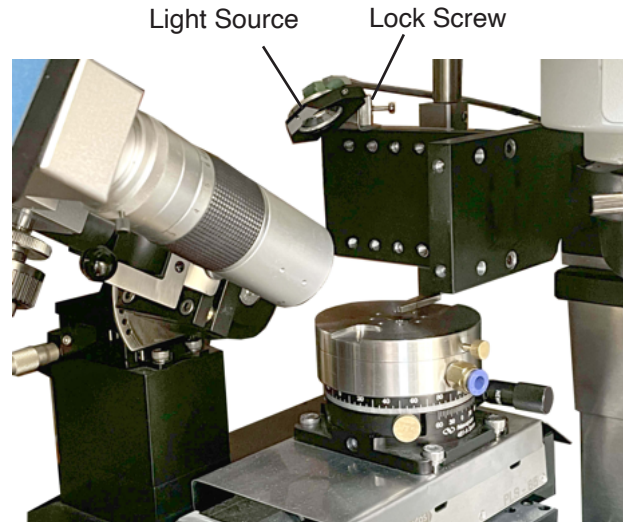
5X = 12 mm
10X = 6.5 mm
50X = 0.66 mm
100X = 0.31 mm



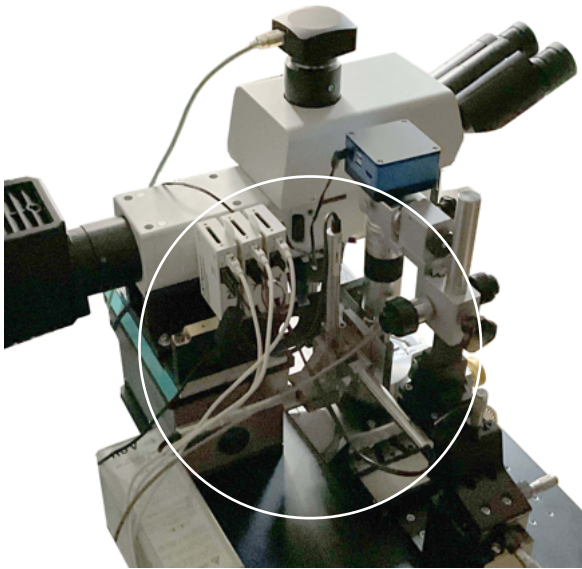
Tiltable Camera Platform with 8X Zoom Lens

The zoom lens is mounted on a translation platform capable of both course, and fine focusing. The image should normally be focused using this stage. There is also a Z micrometer to set its height. This is intended for centering the lens on the sample for its 90° side viewing. To set the height stage, first tilt the lens to its 90 degree position, then adjust the Z stage (4) to center to the sample onto the HD screen. For the rest of its use, this micrometer can be left alone. The XY micrometers may be utilized to center the lens onto the sample, while the zoom function (38X ~ 300X magnification) is utilized.

The light source (right) is designed for uniform lighting across the sample stage. It provides consistent illumination throughout the adjustable 90 degree viewing of the sample stage.



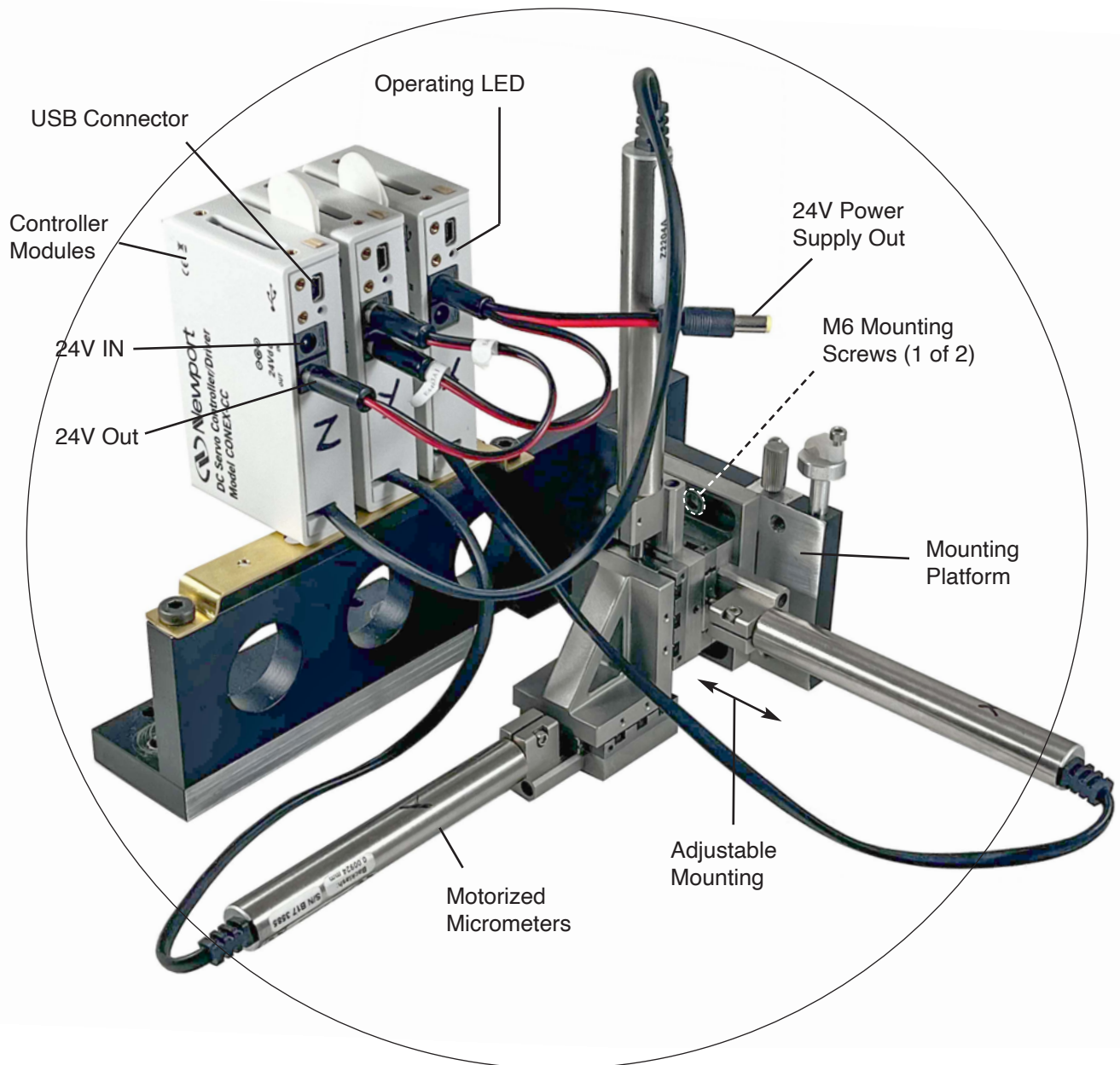
Fiber Probe's Motorized XYZ Micrometers



Motorized Micrometers are controlled by three independent controllers via USB interface. They each have 12 mm travel range, but their effective coverage may be centered on the Silicon Chip in two ways:

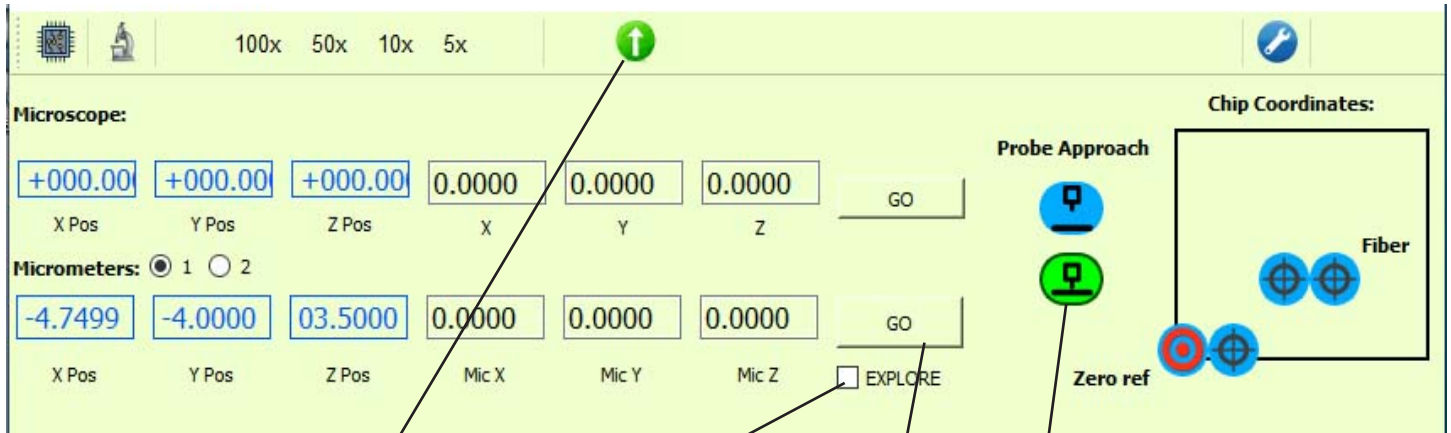
1) By changing/setting their reference point inside the Setup Window. Whatever the reference point is set to, the software will take that as the go position when switching between the Probe mode, and the Microscope mode.

2) By physically changing their position along their mounting platforms. Two M6 screws lock the stages in place. By loosening these screws, the stages have an approximately 15 mm adjustment range. To further adjust their position, the M6 screws may be transferred to adjacent positions. It is important to keep the probe holder as horizontal as possible before securing the M6 screws.



Using the Microscope, Joystick, and Moton Control System

Proper use of the motorized stages is required to prevent damage to the objectives as well as to the end end-user. The powerful Z stage supports both the microscope, and motorized micrometers for fiber probe positioning. The probe station is designed to handle Silicon wafers of up to 100 mm in diameter, and < 0.5 mm in thickness. The microscope's working distance is set to < 0.5 mm wafer thickness, and although larger objects may be fit beneath the objectives, during magnification change, there is always the danger of the next objective crashing onto the sample. The software is written to learn the focus position before magnification change to prevent crashes, but we highly recommend not to use the microscope for inspecting other objects. Furthermore, the motorized stage also features an internal break mechanism for its Z stage. The break is permanently disabled using an external power supply. If this power is somehow unplugged, the Z axis will stop functioning.

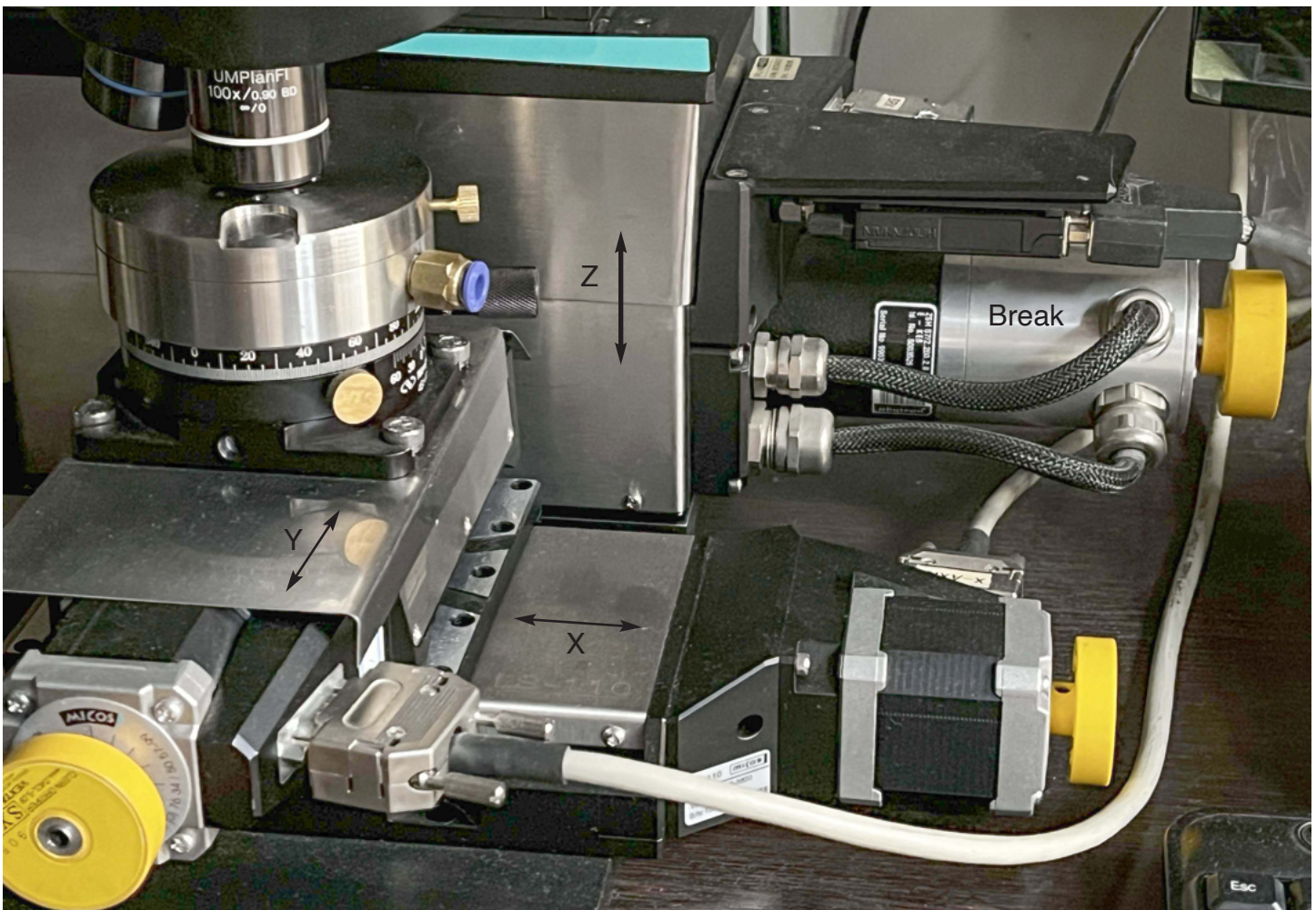


Wafer Load or Quick UP Button

Explore Button

Go Button

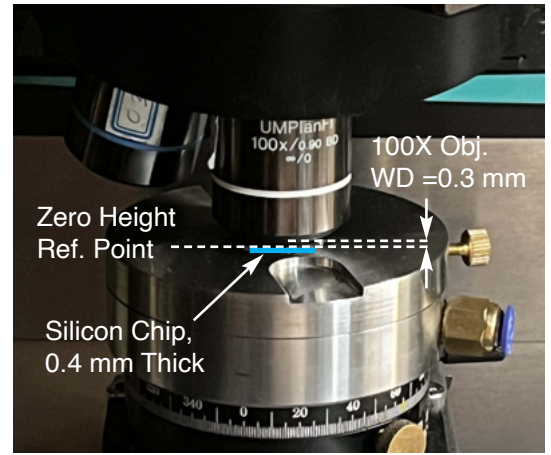
Probe Approach Button



During the initial running of software, and focusing the 10X objective to the wafer, the system is set to the working distance of the 10X objective. This working distance also sets the height when switching to the probe mode. In the probe mode, the probes will approach the wafer using a 0.5 mm stand off. During the probe mode, the motorized stages are switched off, and motorized micrometers take over for probe positioning.

Focus Calibration

In the microscope mode, when each objective icon is selected, the Z stage lifts up to activate the motorized turret, while the software sets the right distance for the next objective as the Z stage travels back down. The focus distance for each objective is pre calibrated in the setup menu (below). After each magnification change, the image can be fine focused via the joystick. The software takes this new focus position as the new working distance before going to the next objective, or when transferring the wafer beneath the fiber probes. Proper focus calibration is crucial before going to the probe mode. The user should check the focus for each objective before attempting to go to the probe mode. One way to check this is when the 100X objective is focused, all other objectives must also be in focus.



Zero Ref. point is the top surface of the chip

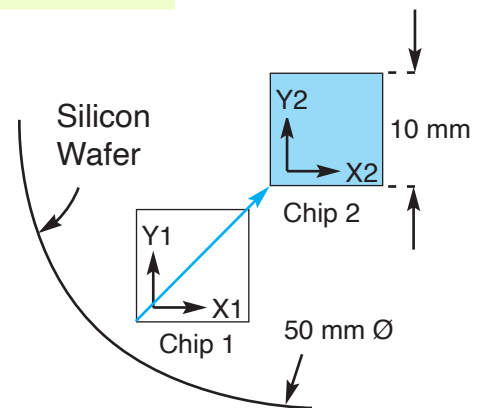
Annotations for the software interface:

- Probe Navigation Arrows Z
- Probe Navigation Arrows X, Y
- Search Button (see Search Function in the next Page)
- Setting Zero Coordinate position for Probe R
- Saving fiber position navigated across the chip
- Current probe position
- Setting micro steps for XYZ arrows: 0.001~ 4 mm
- Setting Ref Point for Probe or Microscope modes
- Do Not Use!
- Units: mm or 1/1000,000 "
- Joystick Speed

Focus Calibration: The focus for each objective may be set individually or entirely. The menu will take you through the every step to focus each objective.

Updating Chip Coordinates in Probe Mode

While loading wafers, there is an UP icon to quickly raise the Z stage (above), but there is no Down function to prevent crashes. After loading the wafer, first center the disc on the chuck, then activate the vacuum pump. The range of coverage is equally spaced between the microscope, and the probe micrometers, each capable of scanning a 50 mm square area (right). While in the probe mode, the local coverage of the micrometers is limited to 12x12 mm, or around 10 mm square chip coverage. To move to another area of the disc, click on the explore button on Setup menu to scan the disc using the Zoom lens. Once you find the next local region, click on the Explore icon again to disable the motorized mode. The motorized micrometers will take over for positioning the probes. A new reference point can be set, i.e., from chip 1 to 2 (right) so any probe position could again be reached by its local X-Y coordinates.



Switching local coordinates from chip 1 to 2

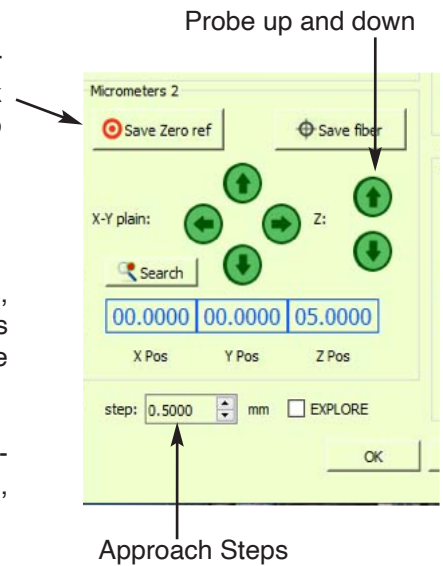
Navigating within the local chip area

If you know the coordinates of the grating from the reference point of the chip, you'll find this function so useful. As mentioned, just align the chip's bottom edge corner to the reticle on the screen, then click Save Position on the setup menu, and click OK. Then on the main menu you could type in the coordinates, and click on Go button (below) to position the probe above the grating as previously set (above).

The Approach Button

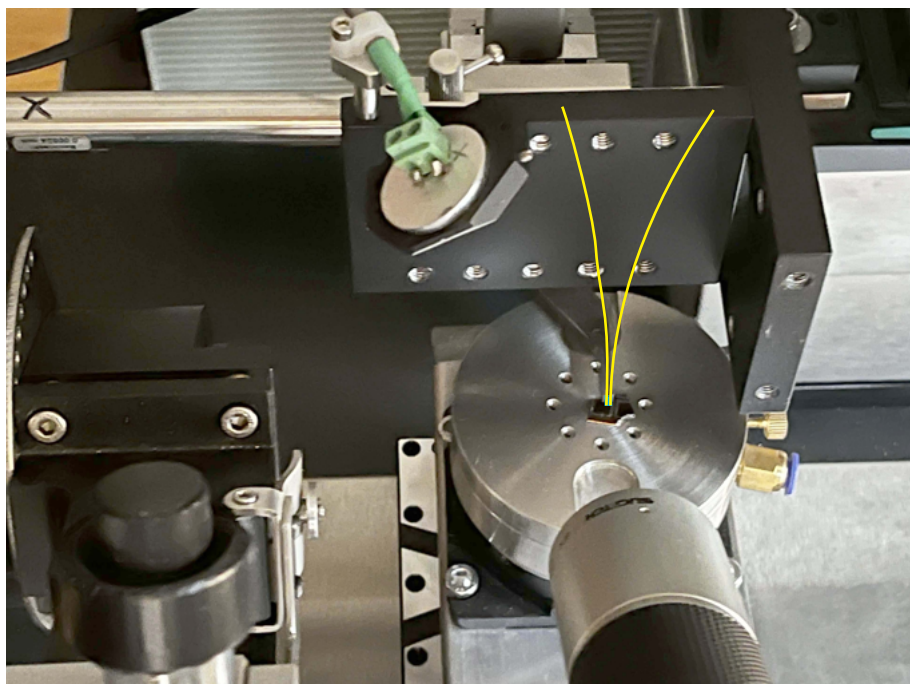
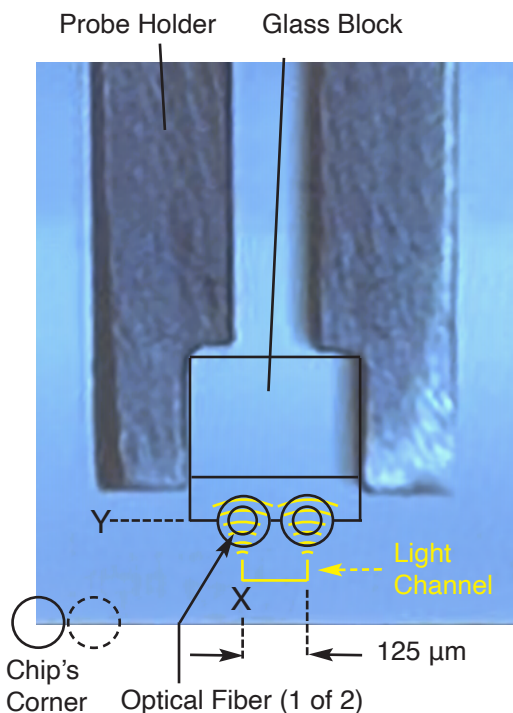
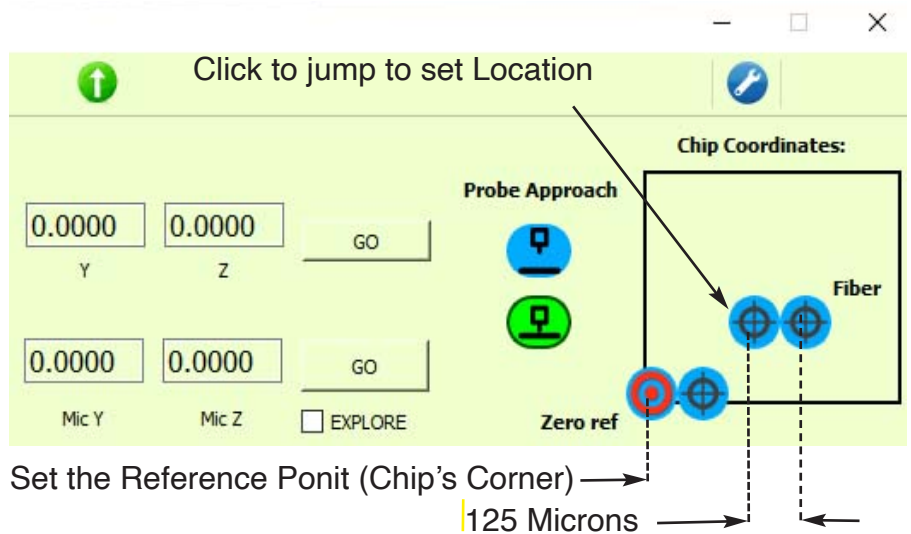
As explained earlier, when the control is turned over to the motorized micrometers, their clearance distance to the chip is set by the microscope. The probes are always held up by a default height of 0.5 mm. When the Approach button is clicked on, the probes are lowered to approach the chip, but not touching it.

The approach distance may be then tweaked to the desired level in micro steps inside the setup menu to be memorized by software. In the automatic search mode, this could also be a factor to determine the best alignment.



Test Function

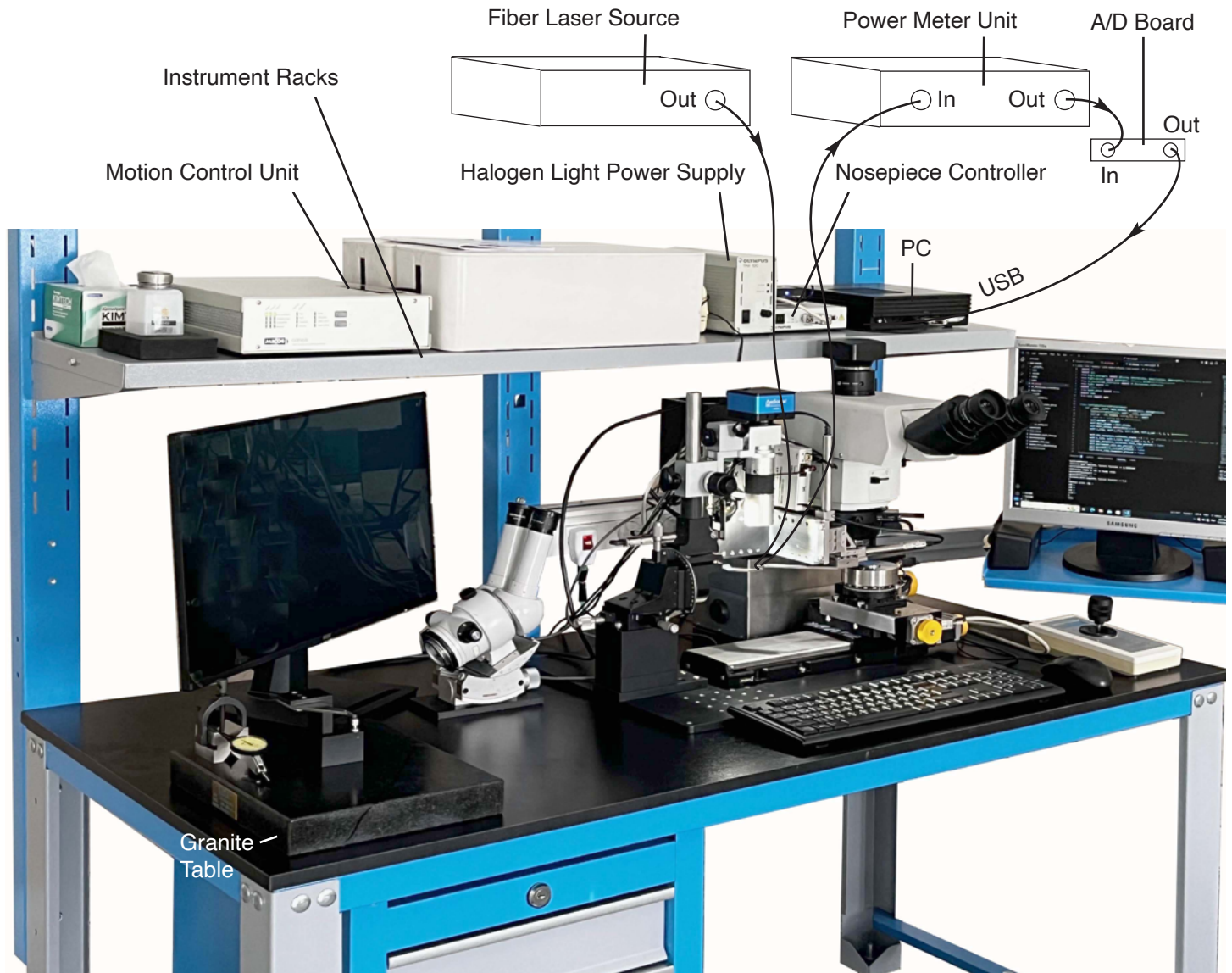
A simple test setup uses two fibers separated by a 125 μm standard distance to send and receive a test signal. To accomplish this, two optical fibers are bound to a glass block at around 8 ~ 10° angle. The main window has an easy to use icon set for this test procedure (below). After the reference point (Zero Ref), and the coordinates for the gratings are set in the setup menu, their position can be reached by a simple click on the screen icons (There are only two icons to click on). The probe positions are set at the bottom of the Setup Menu.



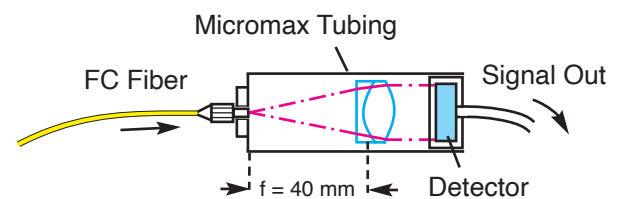
The Search Function

The software has a search function to find the optimum probe position on the grating. The search routine starts by first scanning a 200 μm square area around the initially found position on the receiving probe. When the maximum response spot is detected, the receiver probe returns to the maximum signal spot. Then it's scanning the transmitting fiber around its found position by the user. After the maximum response is found, the fiber returns to its maximum spot. The software is written in python (last page of this manual) and can work with the end user's code to interact their detector device.

The basic wiring for the search function to work is shown below. The signal is generated by a solid-state laser via a FC connector output (i.e., Thorlabs), the left fiber (below) transfers this signal to the chip. The feedback is collected by the receiver probe, and fed to a detector (i.e., a Newport power meter). The output is fed to an A/D board via a USB output to PC (right).



Above, the workstation is shown that secures all the necessary cabling, PC, power supplies, controllers, and vacuum pump. Also shown are a mini granite table, and fiber probe holders to mount the fibers. The wiring diagram for the laser source, and power meter, as well as the A/D convertor are shown. If the power meter does not have an input fiber connector, a basic schematic for converting the light output of the receiving probe to the detector is shown. In most cases, a 40 mm lens is appropriate to cover entire face of detector.

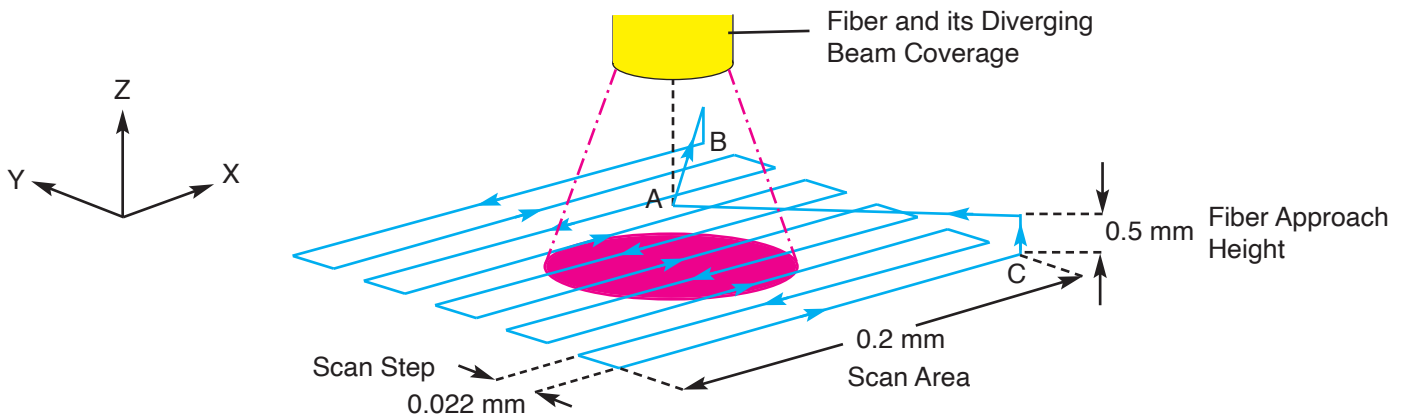


Focusing fiber output to a detector

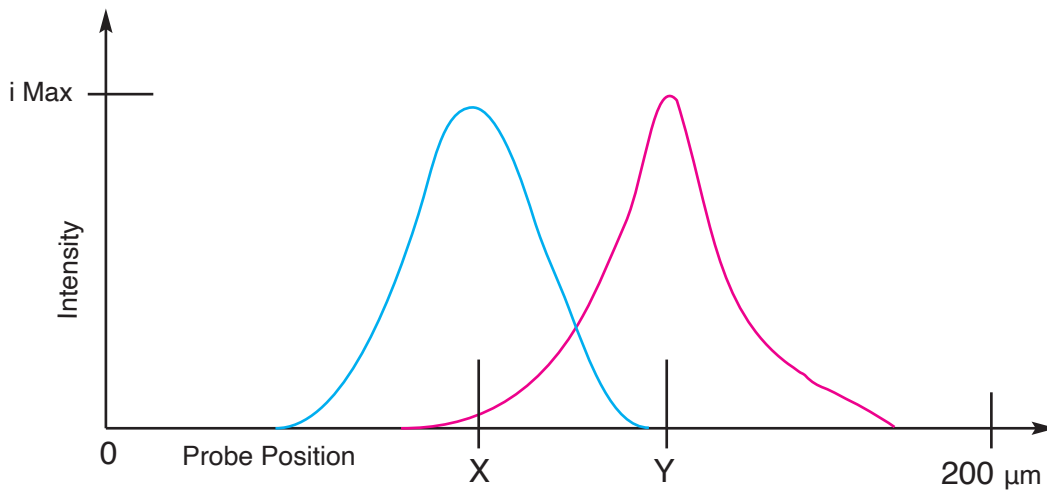
micrometer_search_funcs.py > ...

```
1
2 def action_search_1(self):
3     x,y,z = self.manager.micrometer_get_position()
4     x_course = 0.2
5     y_course = 0.2
6
7     xmin = x-(x_course/2)
8     xmax = x+(x_course/2)
9     ymin = y-(y_course/2)
10    ymax = y+(y_course/2)
11    step = self.ui.doubleSpinBox_step.value()
12
13    self.manager.micrometer_relative_move(-(x_course/2),-(y_course/2),0.2)
14    self.manager.micrometer_relative_move(0,0,-0.2)
15    self.manager.searching_mechanism_micrometer(xmin,xmax,ymin,ymax,step)
16    self.manager.micrometer_relative_move(x_course/2,y_course/2,0.2)
17    self.manager.micrometer_relative_move(0,0,-0.2)
18
19 > def action_search_2(self): ...
35 |
36
37 def searching_mechanism_micrometer(self,xmin,xmax,ymin,ymax,step):
38     """Using micrometers to search on the chip surface"""
39     if step > (xmax-xmin) or step > (ymax-ymin):
40         print("use smaller step")
41         return
42     x_num_steps = int((xmax - xmin) / step)
43     y_num_steps = int((ymax - ymin) / step)
44     x_direction = 1
45     max_value = 0
46     max_value_pre = 0
47
48     for j in range(y_num_steps):
49         for i in range(x_num_steps):
50             self.micrometer_relative_move(x_direction*step,0,0)
51             value = 1 # put your func here
52             max_value = max(value,max_value)
53             if max_value != max_value_pre:
54                 x_max_pos,y_max_pos,z_max_pos = self.micrometer_get_position()
55                 max_value_pre = max_value
56             self.micrometer_relative_move(0,step,0)
57             x_direction *= -1
58     return x_max_pos,y_max_pos,z_max_pos
59
60 > def searching_mechanism_micrometer2(self,xmin,xmax,ymin,ymax,step): ...
82
```

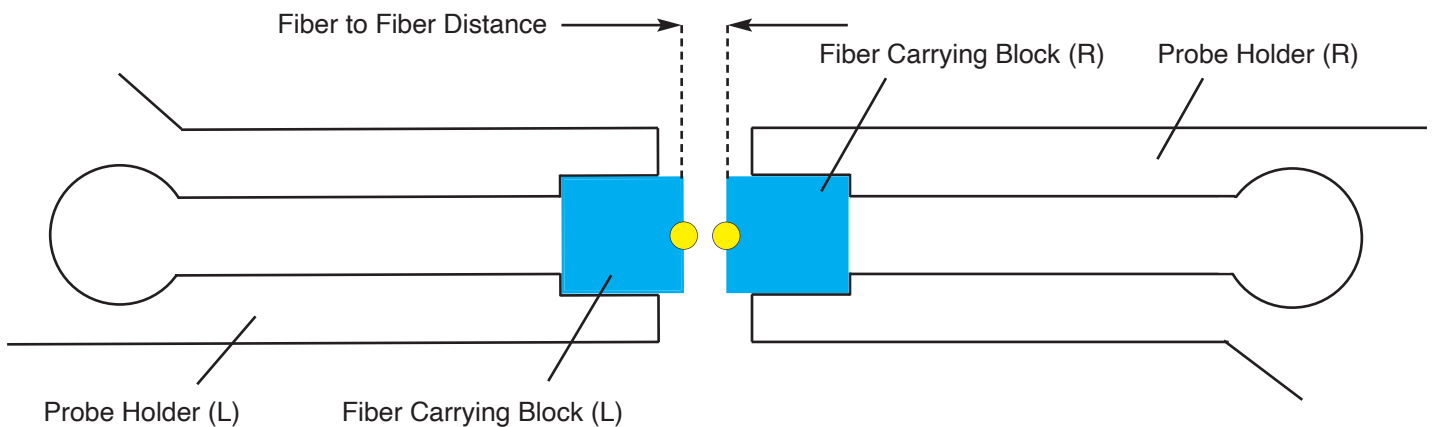
Opposite page, the Python code for the search function is shown. The programmed search path for fiber probes is also shown below, covering a 200 μm are. The end user may also add in the Z micrometer in the search code to explore the signal output at several probe heights. The scan width may be typed in to control the scan resolution. As it can be observed from the code (lines 3, 4), the end user can change the scan area to any desired size, and a Z parameter may also be added for depth scan. Precautions must be made in programming the micrometers to avoid fiber to fiber collisions (bottom).



The scan function is set to 0.2 mm while the scan step can be typed in to change the resolution. The scan path starts from where the fiber is originally positioned above the grating (at point A). There is first a 0.5 mm lift to clear from the chip, then the probe tip is moved to the corner of the scan area, and drops down by 0.5 mm. The scan begins at point B, and ends at point C. The probe tip is lifted up again, and returns to point A.



The fiber output intensity recorded by the detector across the scan area in the X, and Y directions. From this scan, the X, and Y positions of the probe for maximum alignment can be concluded. Additional scans by varying the Z height can be explored to achieve even higher readings.

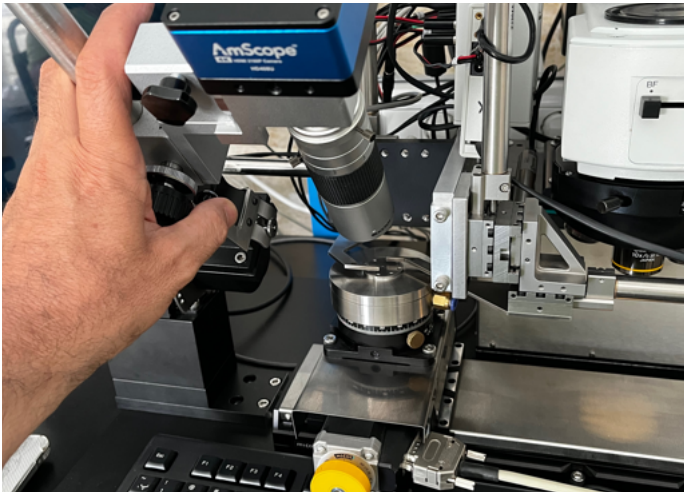




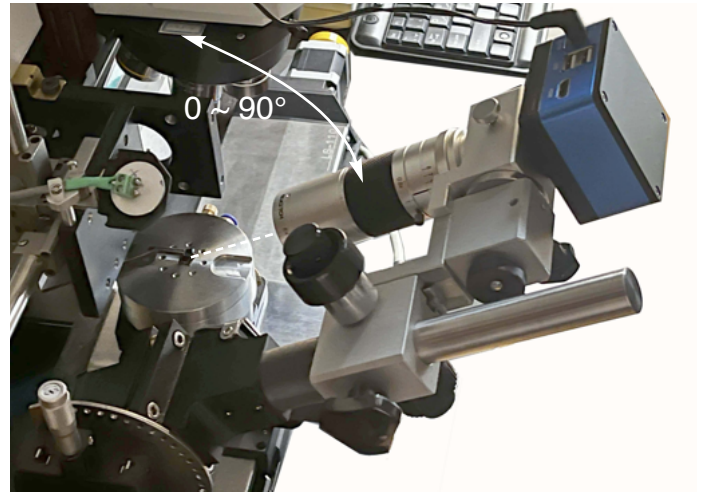
The probe station is set up with an ergonomic user interaction in mind. This modular system allows adding a stereo microscope for viewing fiber probes during alignment.



There are nine precision motorized stages with high performance 0.1 micron resolution for increased reliability, and durability. It is designed for class 100 grade clean-rooms.



Adjustable LED illumination source allows superb image quality in the probe-station mode. Optional Stereo Microscope attachment for stereo viewing of probe orientation.



The zoom lens may be tilted from vertical to horizontal position, and locked in 7.5 degree increments. The release lever is perfectly positioned for reliable/convenient locking.



High resolution DIC objectives for inspecting wafer surface for manufacturing flaws. The microscope is equipped with darkfield illumination for quick defect detection.



Modular X-Y-Z Motorized stages can be configured to secure fibers at any orientation or angle across the chip area.