

# Application Note

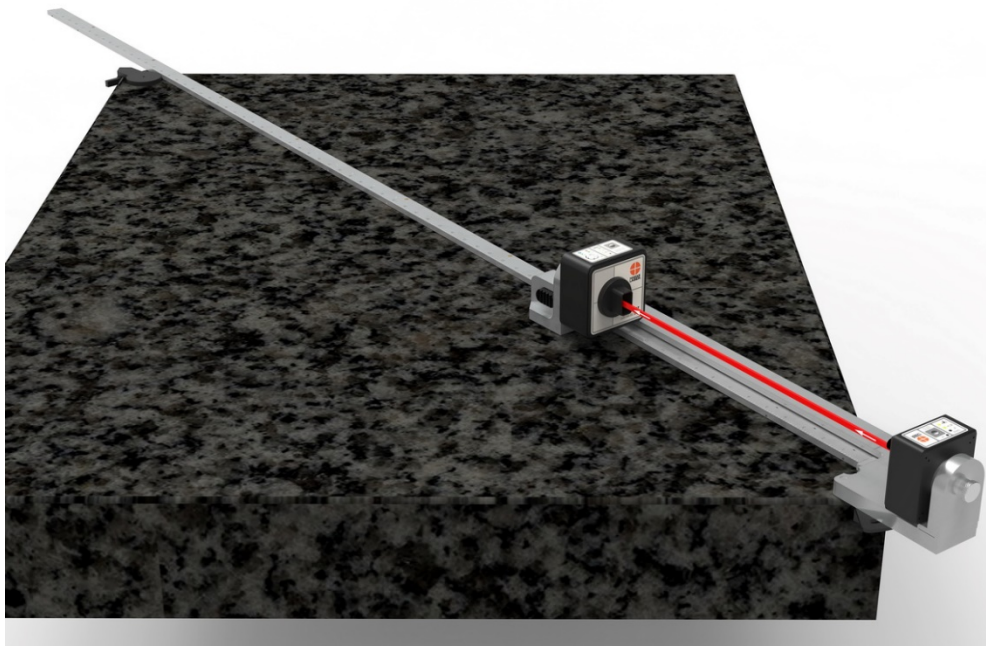
## How It Works – Surface Plate Calibration

### *System Recommendation*

**L-703SP Surface Plate Calibration System**

The setup and use of an L-703SP Surface Plate Calibration System is quite easy. The L-703S Laser is attached to the L-703SP-LM Laser Mounting Fixture that sits right on the plate. The A-703SP-SE Straight Edge is aligned to the line segment to measure using a corner/midpoint locating tool and the T-1297 Target runs along the straight edge to keep it on the line segment when taking data. The laser is quickly aligned to straight edge, which holds its alignment for the next 7 segments, so there is very little setup each time the laser fixture is moved to another segment.

To start the check, Plane6 is opened to Step 1 Surface Plate Layout and the relevant parameters are entered, such as the plate dimensions, number of points on each segment, and plate's grade tolerance etc. Next, we go to Step 2 Data Collection and place the T-1297 target at the far point on the straight edge. Looking at the real time display, the laser beam is tilted so the values are near zero, which aligns the laser to the straight edge. The laser is now ready to take data. The target moved to the first point (next to laser) on the straight edge and the data is then recorded. The dimension on the ruler for the next point is then displayed in on the screen to aid in the positioning of the target. This process is repeated for all 8 line segments and the results are calculated using the Moody Method per the ASME-B89.3.7 Standard for calibrating surface plates.



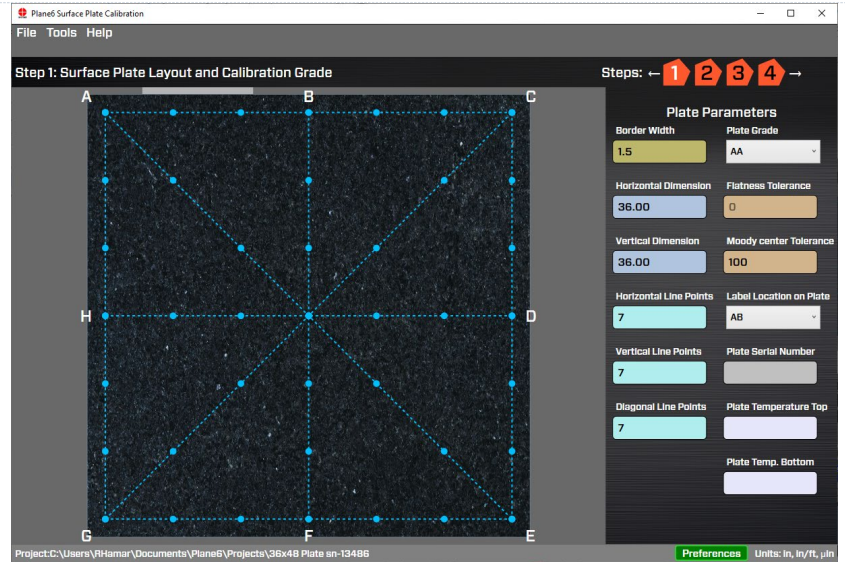
Below is a step-by-step procedure for checking the calibration of a surface plate with the L-703SP and Plane6 Software.

## L-703SP Surface Plate Calibration Procedure Using Plane6 Software

### Step 1 – Plate Setup

These parameters need to be entered:

- the plate border size,
- the plate grade,
- the plate size in X & Y,
- the number of points to measure for the horizontal, vertical and diagonal line segments,
- pick the label location,
- the plate serial number,
- the temperature for the top and bottom of the plate and,
- the alignment tolerance.

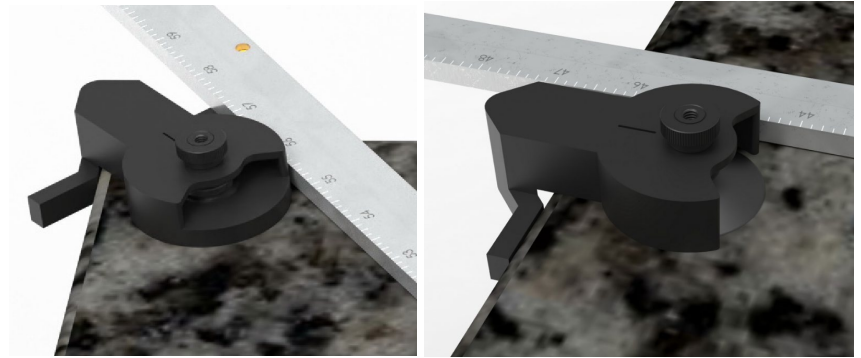


### Step 2 – Set Corner and Mid-Point Locating Tools

To make the process go faster, a corner-locating tool is supplied to help align the straight edge to the line segment.

**Note** - there are slightly different tools for a 1.5-in. border and a 2.5-in. border.

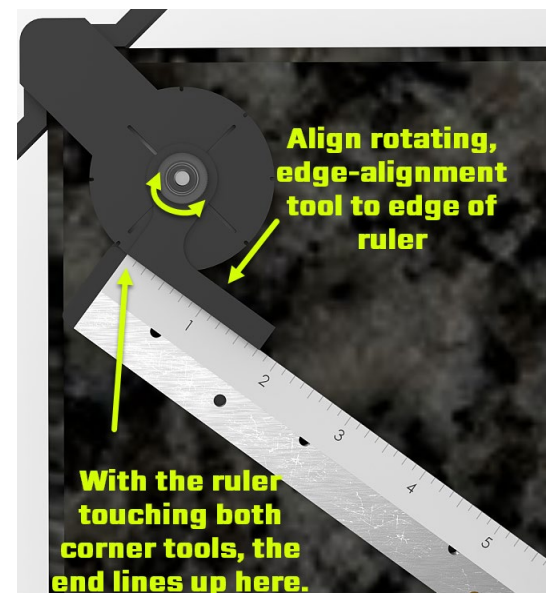
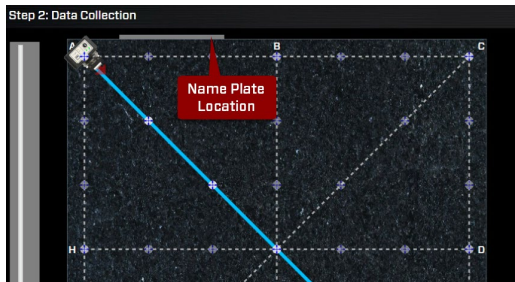
- The tool self-aligns to the plate's corner and the suction cup holds it in place.
- Next, use the locating tool to set the midpoint of the 4 outside segments of the plate and mark the point with a pencil.
- Place the midpoint location tool on the point for use when you get to this segment.



## Step 2 – Place Straight Edge on the Diagonal Segment

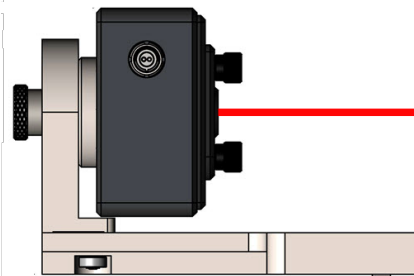
Plane6 preselects the line sequence that you will measure. This can be overridden but this sequence was selected to minimize the time it takes to take all the data. To measure the diagonal:

- Locate the correct diagonal segment using the plate label location to orient yourself (see screen below).
- Place the side of the straight edge with the ruler so it is to the right of the corner locator when viewed from the Laser End. See image. In other words, you always want the *scale side* of the ruler to be touching the locator tool.
- Position the end of the straight edge to line up with the line on the rotating-edge-alignment tool.
- Now the straight edge is located next to the line segment that you need to measure such that when the target is put down against the straight edge, it is directly over the line segment.



## Step 3 – Assemble Laser and Laser Mount

Insert the L-703S Laser into the L-703SP-LM Laser Mounting Fixture and tighten the thumb screw very tight and make sure to keep the top if the laser level.



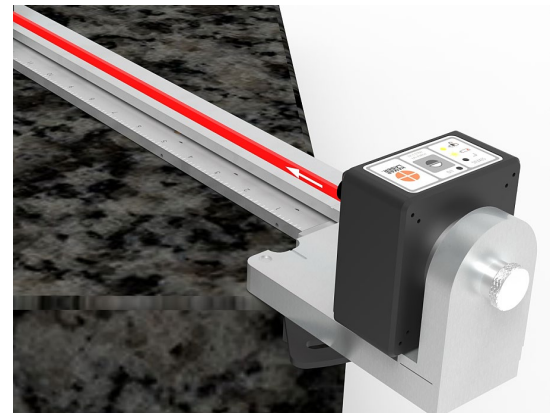
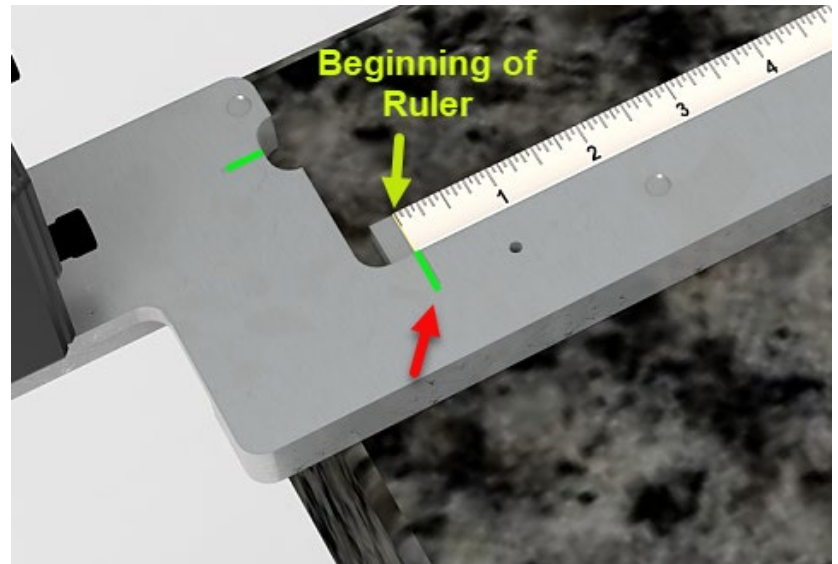
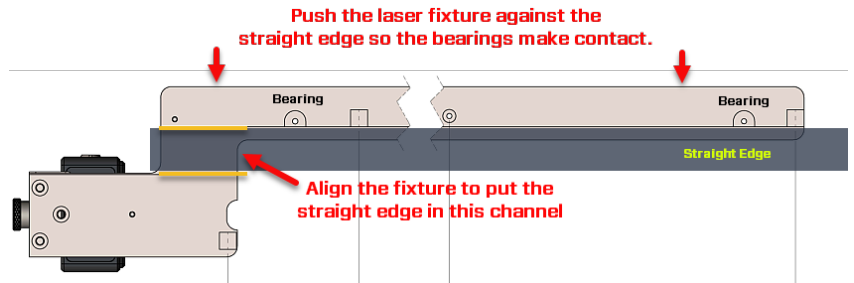


**Step 3a –Place Laser Mount+L-703S on top of the straight edge on the plate**

- a. Find the correct corner on which to place the A-703SP-LM from Plane6 Step 2 Measure Screen, keeping track of the name plate location.
- b. Place the A-703SP-LM on top of the straight edge, aligning the channel (cutout) on the bottom to the straight edge. Then, holding the straight edge, slide the laser fixture against the straight edge to make it parallel to the straight edge and line segment. You can actually just squeeze them together so the bearings on the bottom of the laser fixture make contact with the straight edge.

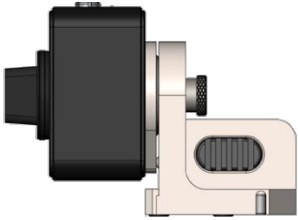
*Note: When putting the A-703SP-LM on the straight edge make sure to line up the green mark on the fixture with the beginning of the ruler scale.*

Place A-703SP-LM on top of the straight edge here



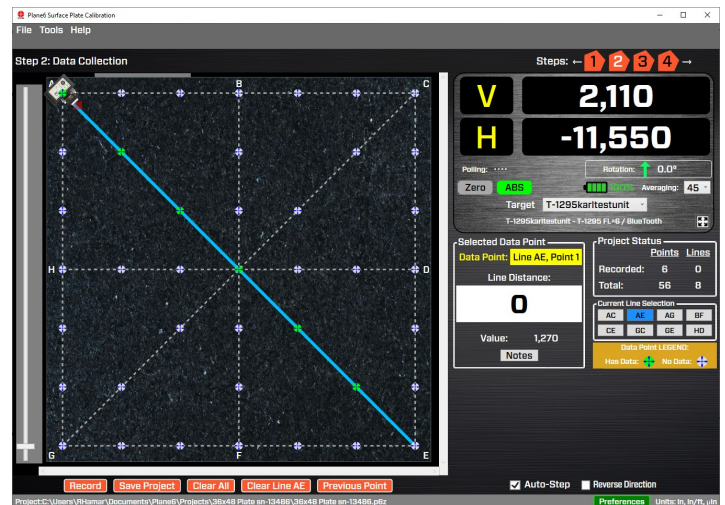
#### Step 4 – Assemble the T-1297 Target and A-1297-SP Measuring Base

Now assemble the T-1297 Target into the A-1297-SP Precision Measuring base. Notice that the T-1297 has an alignment ball. This will insert into the slot on the A-1297-SP to align the target to the A-1297-SP base's measuring feet. Tighten the thumb screw very tight.



#### Step 4a – Place T-1297 Target and Base on the Plate

Place the T-1297 Target and Base on the plate near the laser. Check to make sure the that the **H Axis** value is less than 30,000  $\mu\text{in.}$  (760  $\mu\text{m}$ ), which it normally is.



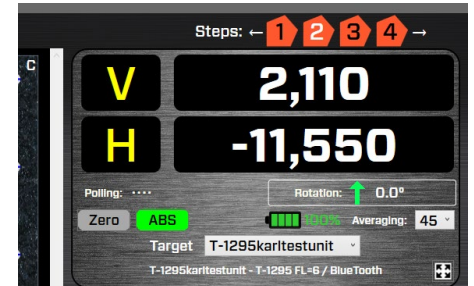
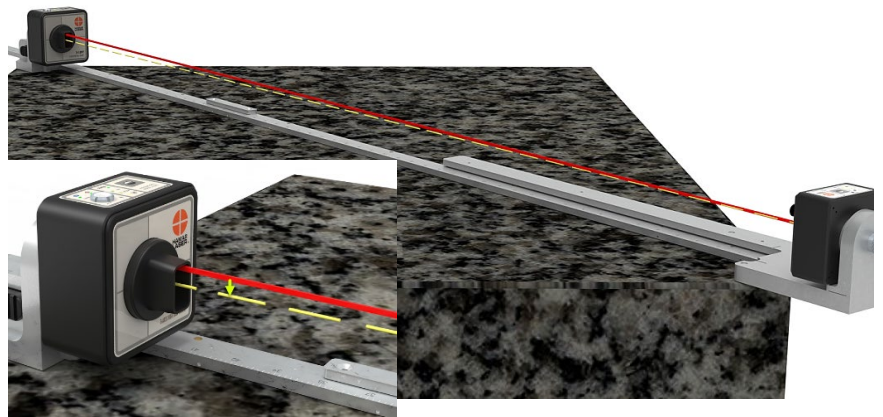
### Step 4b – Move the T-1297 Target+Base to the Far End of Straight Edge

- Move the T-1297 Target+Base to the far end of the straight edge.
- Adjust the H (yaw) and V (pitch) axis adjustments on the L-703S laser to tilt the beam until the values are less than:

**H Axis: 30,000**

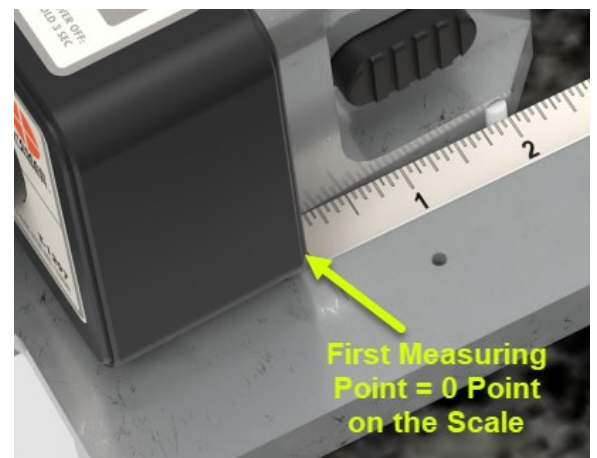
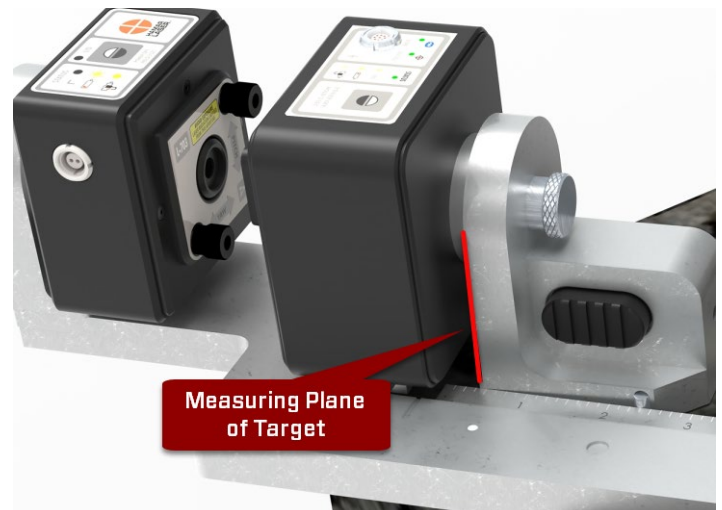
**V Axis: 10,000**

This aligns the laser beam to the straight edge and puts it on the most accurate part of the PSD sensor.



### Step 4c – Move the T-1297 back to Near Position and Start Recording

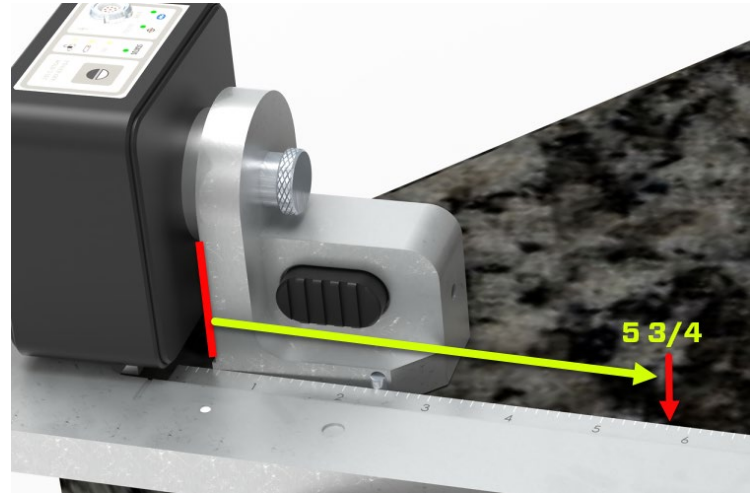
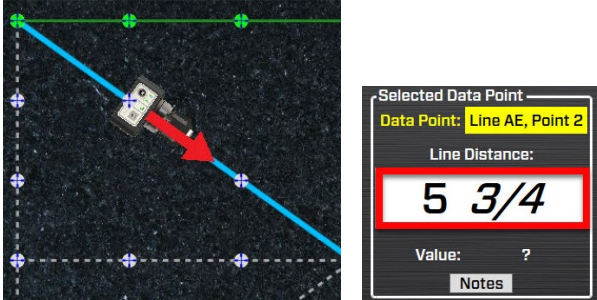
Move the T-1297 Target back to the near point and click **Record**. When positioning the target, line up the Measuring Plane (front edge of target base mounting surface) with the ruler dimension before hitting record. In this case it should be on the zero (0) point on the ruler.





### Step 5 – Move to Next Point and Continue Recording

Move to the next point by looking at the *Line Distance* display in **Plane6 Step 2** to tell you where to position the target. Click **Record**. Continue recording until all the points are taken.

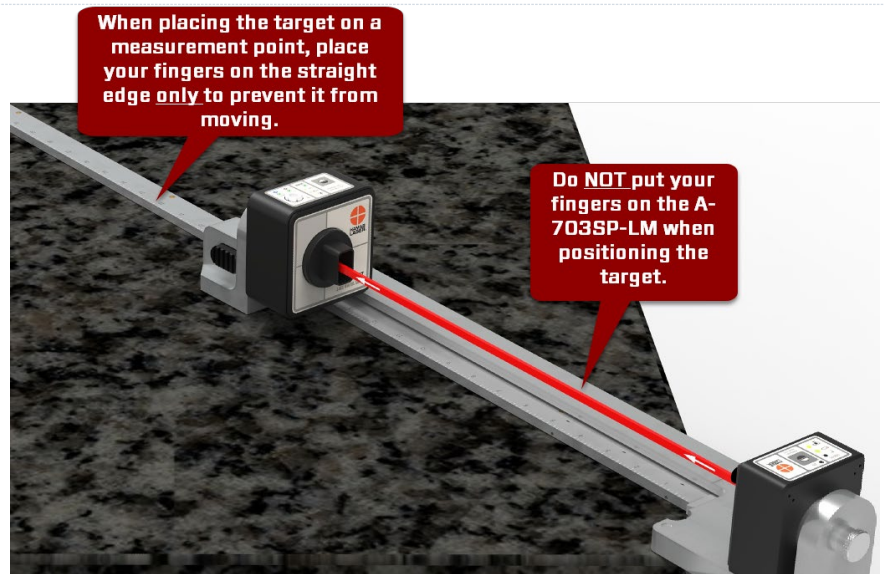


### Step 5a – Moving the Target when Taking Data

*Note-* when moving the target to the next point, it is important to only hold the straight edge to prevent it from moving. There are rubber feet on the bottom to help it from sliding, so light pressure on the straight edge will keep it from moving.

However, **DO NOT TOUCH THE L-703SP-LM** laser fixture since it does not have rubber feet and can be moved fairly easily. Moving the fixture can cause the laser beam to move, causing measurement errors.

*If the A-703SP-LM moves, we strongly recommend clearing the data the line segment and re-recording it.*

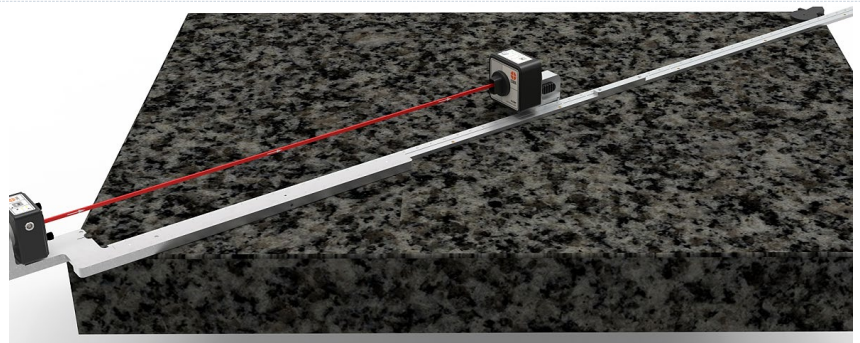


### Step 6 – Move Laser to Second Diagonal and Record Data

First take off the L-703SP-LM Laser Mount and set it aside. Then move the straight edge to the second diagonal using the corner locator tools to position the straight edge. Again make sure the straight edge is to the right of the corner locating tools and aligned with the mark as shown above.

Place the L-703SP-LM Laser Mount on the straight edge as shown Step 3a above. Place the target at the near position and you are ready to record.

*Note - you do not need to re-adjust the laser beam since it should hold its position and thus always be ready to take data.*



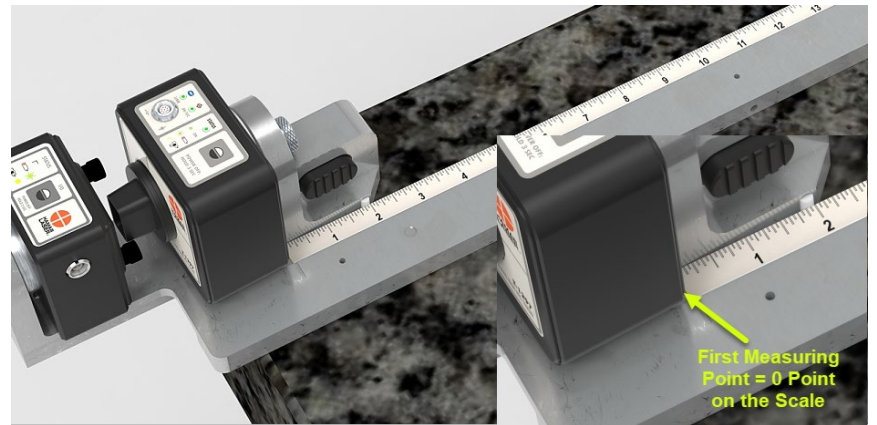
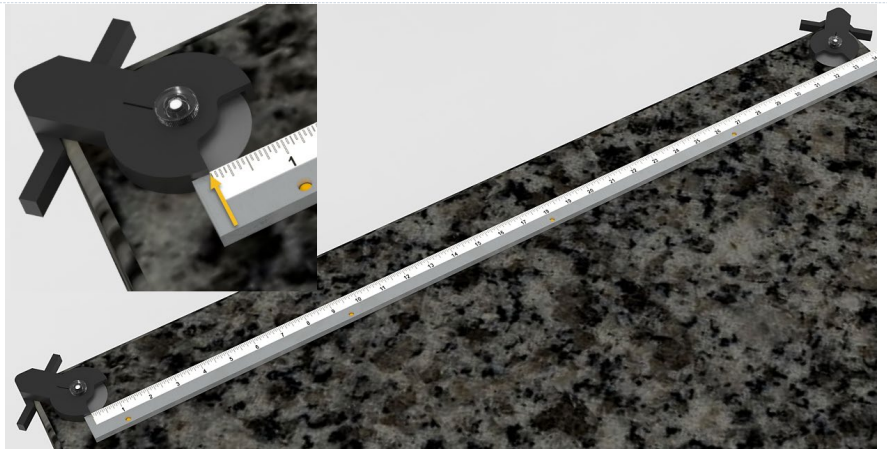
### Step 7 – Move Laser and Straight Edge to Plate Outside Edge and Record Data

Move to one of the 2 outside edge segments for the corner you are on. Plane6 will automatically move to the next line segment, so pay attention to which edge to record, always looking at the name plate locator to orient yourself. Find the straight edge that best matches the length of that side of the plate.

*Note – we recommend that the extra length of the straight edge be no longer than 1/3 of the edge of the plate. This is to ensure that the straight edge does not move around when you are taking data. This can happen because as the straight edge gets longer relative to the plate edge, it tends to want to fall off the plate.*

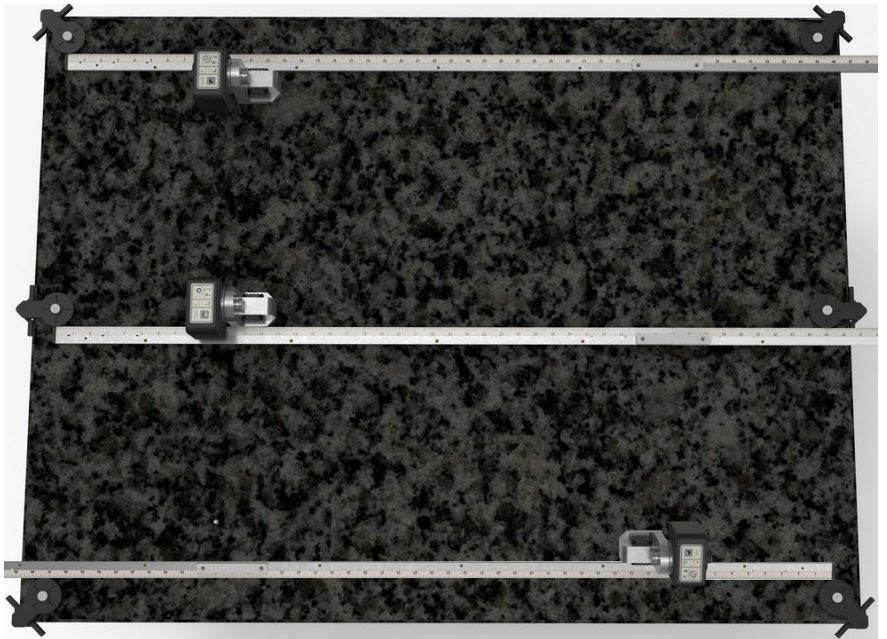
*Again when using the corner edge tool, always put the scale side touching the tool.*

Place the L-703SP-LM Laser Mount on the straight edge as shown Step 3a above. Place the target at the near position and you are ready to record.



### Step 7b - Record Second Outside Edge of Plate

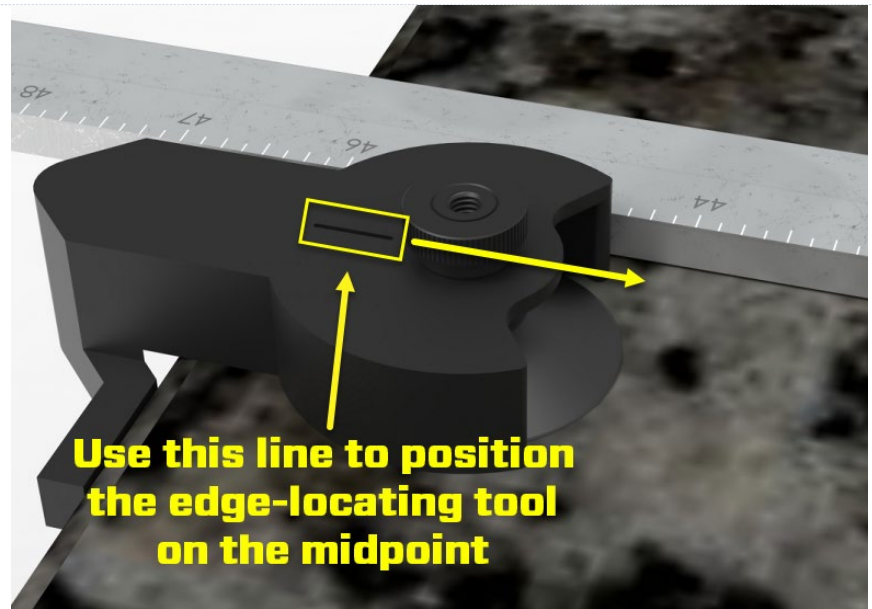
Locate the second outside edge recommended by Plane6 and repeat the process in Step 7a



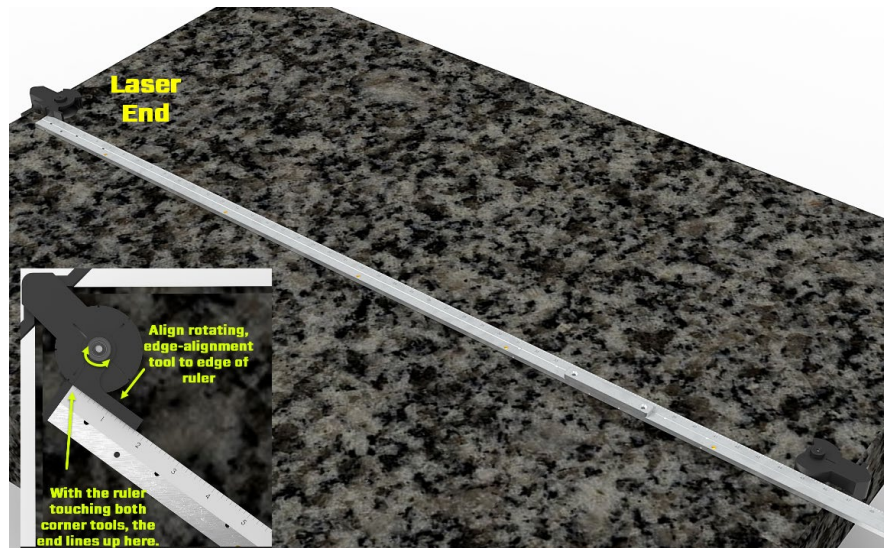


### Step 7c – Record Mid-Point Line Segment

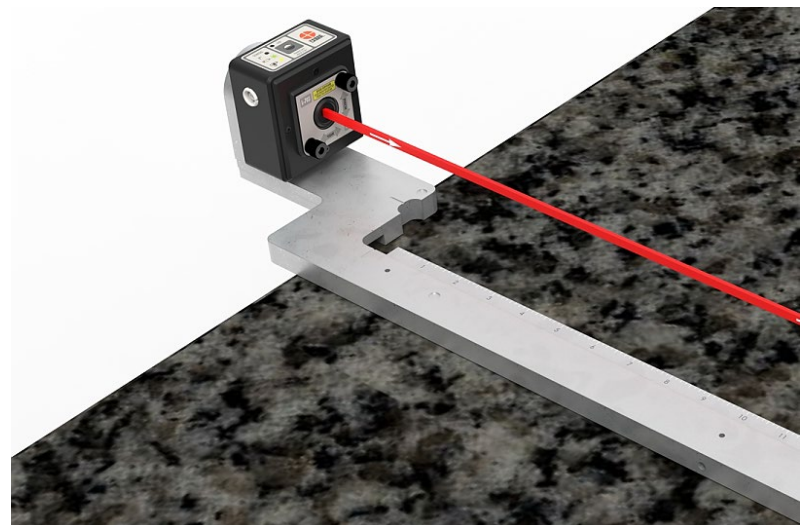
Using the mark made by the Mid-Point Marking Tool (see Step 1), position the Corner Locating Tool on the midpoint and align the mark on the locating tool with the mark on the plate.



Position the straight edge to the right of the Corner Locating Tool (when looking from the Laser End of the straight edge toward far end).



As before, place the A-703SP-LM fixture on the side recommended by Plane6 and place the target in the near position and hit Record. Continue taking data for the whole segment.



## Step 8 - Record the Rest of the Line Segments

Record the rest of the line segments, following the recommended sequence from Plane6.



Project Status		
	Points	Lines
Recorded:	96	8
Total:	96	8

Current Line Selection			
AC	AE	AG	BF
CE	GC	GE	HD

**Data Point LEGEND:**

Has Data:  No Data: 

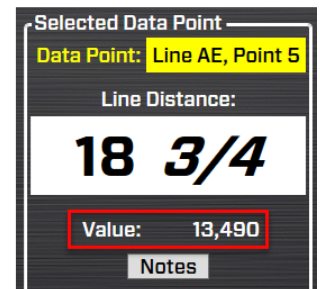
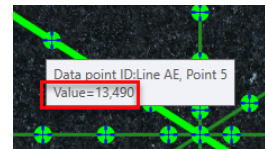
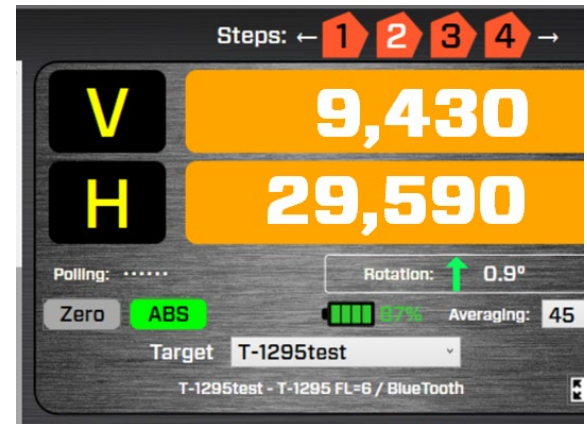
## Notes on taking data:

1. **Display Value Tolerance** - Pay attention to the H axis value. If the value gets higher than 30,000  $\mu\text{in.}$  (760  $\mu\text{m}$ ), then the Plane6 data display will turn orange indicating that this is too far off center in the horizontal axis. This may mean the laser fixture moved. Check to make sure the laser fixture is still against the straight edge. If not, then move them together again.

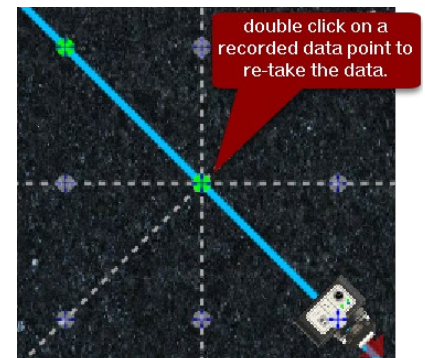
Move the target to the end of the straight edge and see if the orange color disappears. If so this means it's back in spec. Then hit **Clear Line XX** to restart the data taking for the line segment.

If it's still orange, you can simply adjust the H axis until it's less than 25,000. Then hit **Clear Line XX** and retake the data for that line.

2. **Checking Recorded Data Points** - You can always check data values for a given point by hovering over it and seeing the values or by clicking on it and seeing the values in the table.



3. **Retaking a Data Point** - You can also click on a point and retake the data point if you think it is wrong.



4. **Manually Picking Data Points** - You can turn off *Auto Step* if you want to move the target icon manually.
5. **Reversing Direction on a Line Segment** - You can also hit *Reverse Direction* to change the direction of a line if you need to.

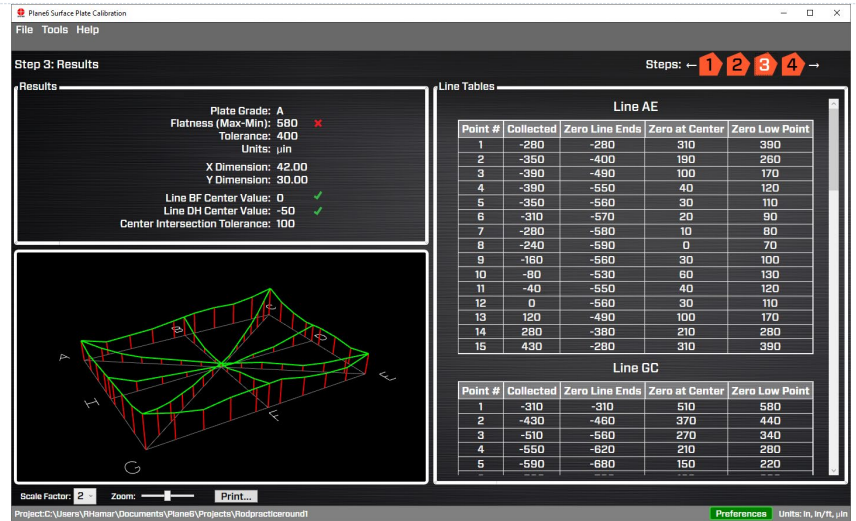


### Step 9 – Review Results in Step 3 Results

Now click on Step 3 to view the results. The plate grade is shown, the tolerance for that grade and the overall flatness results from the data. A green check mark or red X tells whether it's in or out of tolerance.

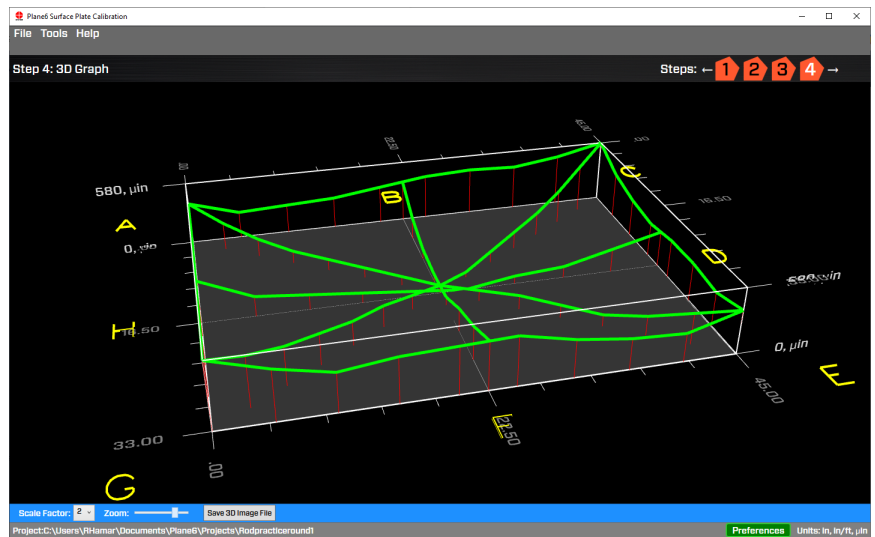
There is also an additional check for the center point elevation difference as is directed in the B89 Standard. The tolerance is also displayed.

Plane 6 also displays the data tables for each line segment. This is all displayed in the report.



### Step 10 – Review Graphical Results in Step 4 3D Graph

You can go to Step 4 3D Graph to look at an adjustable 3d graph of the results. You can zoom in/out and rotate the view to see the results. You can also magnify the elevation change to better show the results.





# Plane6 Sample Report



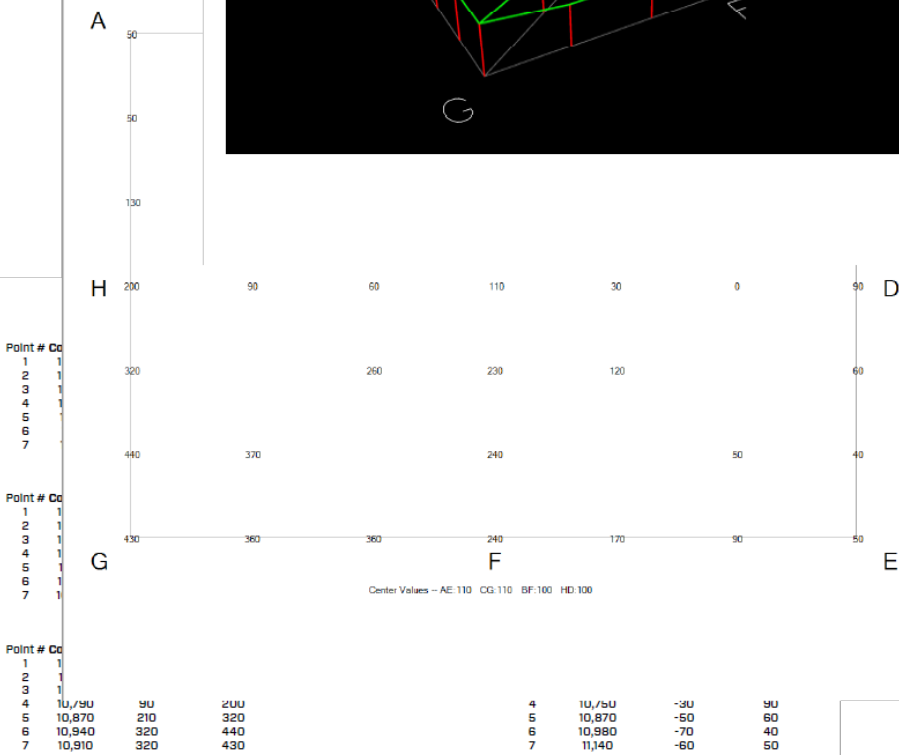
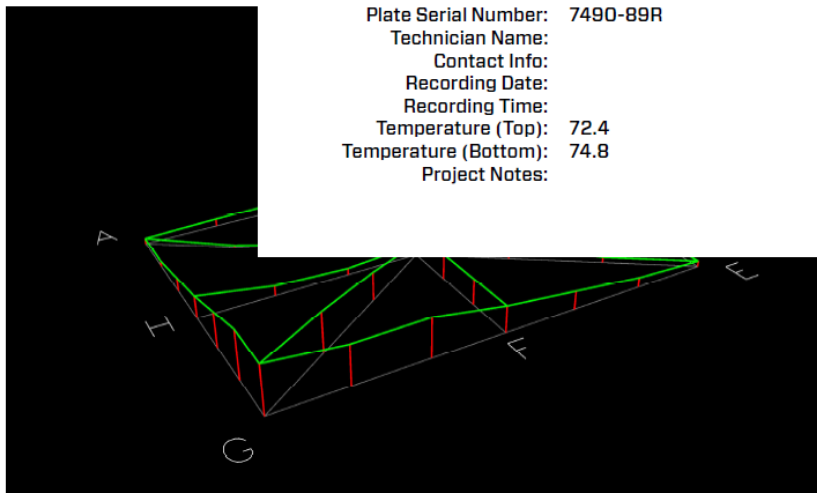
Plane6  
Repeat\_3 Results

Plate Grade: B  
Flatness (Max-Min): 440 X  
Tolerance: 200  
Units:  $\mu$ in

X Dimension: 39.13  
Y Dimension: 27.13

Line BF Center Value: -10 ✓  
Line DH Center Value: -10 ✓  
Center Intersection Tolerance: 100

Plate Serial Number: 7490-89R  
Technician Name:  
Contact Info:  
Recording Date:  
Recording Time:  
Temperature (Top): 72.4  
Temperature (Bottom): 74.8  
Project Notes:



Point #	Collected	Ends to Outer Center	Zero Low Point
1	10,750	90	200
2	10,830	-20	90
3	10,590	-50	60
4	10,630	-10	100
5	10,550	-80	30
6	10,510	-110	0
7	10,590	-30	90

Point #	Zero Line Ends	Ends to Outer Center	Zero Low Point
1	10,710	50	160
2	10,630	-60	50
3	10,670	-50	60
4	10,750	-10	100
5	10,910	120	230
6	10,940	120	240
7	10,980	130	240