How It Works - Lathe Alignment

How the L-703S Lathe & Spindle Alignment System Works

The setup and use of an L-703S Lathe & Spindle Alignment system is quite easy and begins by following Lathe10's on-screen instructions to enter the dimensions, number of points, and tolerances. Next the laser is "qualified" or made parallel to the axis of rotation (AOR) of the spindle. Then Lathe10 measures the lathe bed (tailstock and saddle guideways) for straightness and parallelism to the spindle's AOR. If out of tolerance, Lathe10 offers a real-time alignment screen to align the headstock to the lathe bed.

Once the spindle is aligned to the lathe bed, Lathe10 measures the headstock spindle alignment to the tailstock or subspindle following an easy 3-step process. If out of tolerance, Lathe10 offers a real-time 4-axis alignment screen to align the spindles horizontal and vertical centers (offsets) and horizontal and vertical angles. After aligning the tailstock, Lathe10 offers a printed report showing the lathe bed straightness, spindle parallelism to the bed and the headstock-tailstock alignment.
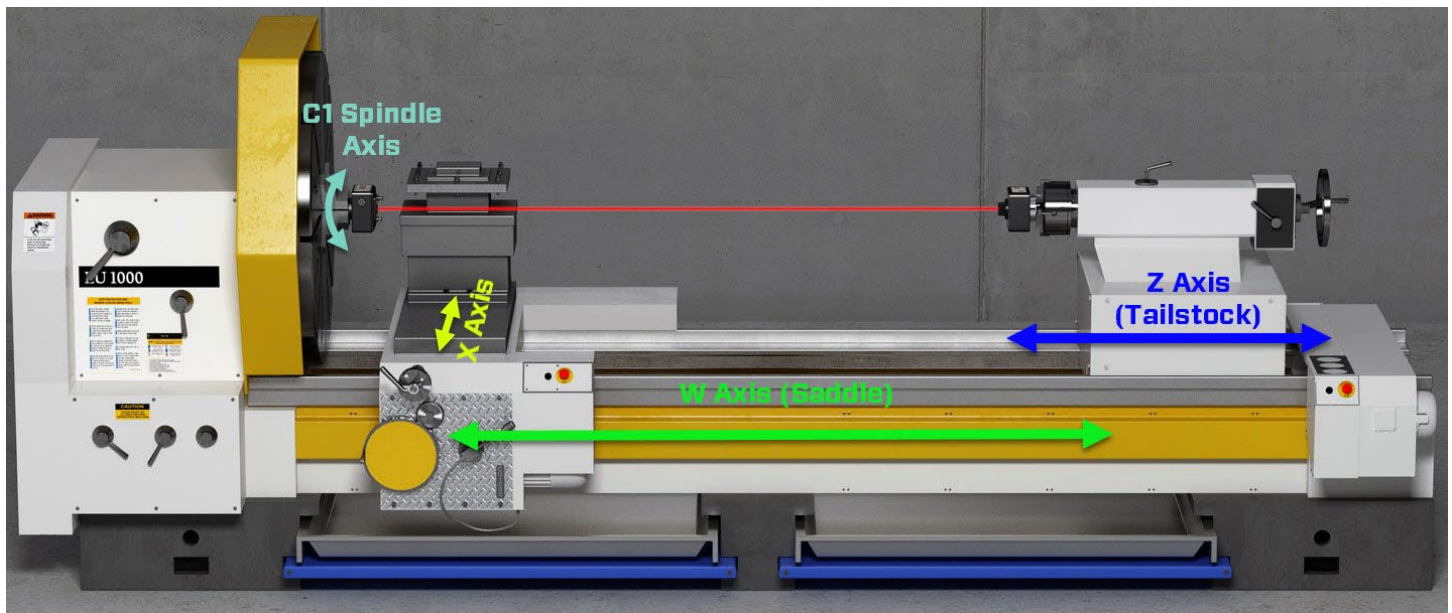
Below is a step-by-step procedure for checking the alignment of a lathe with the L-703S and Lathe10 Software.

Step 1 – Setup

Enter the number of points to measure on the bed, the distance between points, the headstock and tailstock dimensions, and the alignment tolerances.

Step 2 - Qualify Laser - Spindle Inverted

To do the alignment checks, the laser must be aligned to the rotation axis (AOR) of the spindle. Then we can measure the bed for straightness and parallelism.
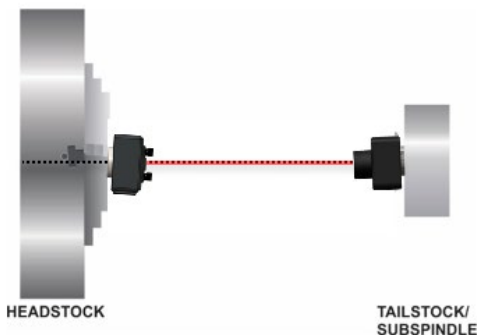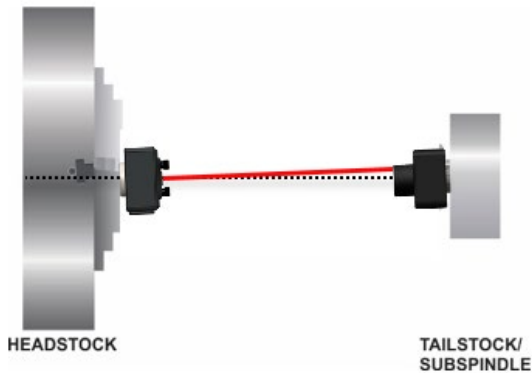
a. Insert the L-703S Laser into headstock spindle, the T-1296 into the tailstock or subspindle, and rotate the main spindle so the L-703S is in the inverted position.
b. Click **Record**.
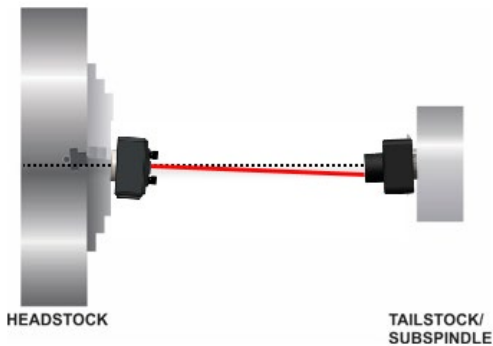
Step 2 - Qualify Laser – Spindle Normal.

c. Rotate the spindle so the laser in in the NORMal position.
d. Click **Record**. Offsets are immediately applied to displays so the laser can be adjusted to the spindle's AOR by adjusting the values to zero.
e. Using Pitch and Yaw adjustment, tilt the laser beam until the V & H Angular displays are zero.

Note – In angular mode, the values are either in in/ft or mm/m, so if the value on the display is, say, .0002 in/ft. (0.017 mm/m) then this means at 10 feet (3 m) the laser beam will be off center by .002 in. (0.05 mm). To get better angular resolution, you can take the lens out and repeat the NORMIN in <u>Center Mode</u> with the target at whatever distance away from the laser that you want. So in this case if you put the target at 10 feet away from the laser, and do the NORMIN in Center Mode, you would steer the laser as close to zero as you can and this will take out that last bit of angular error of .002 in. (0.05 mm) at 10 ft. (3 m).
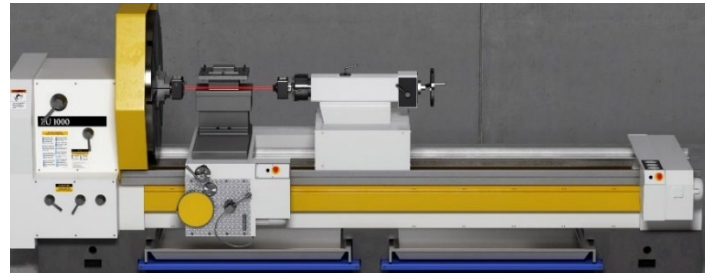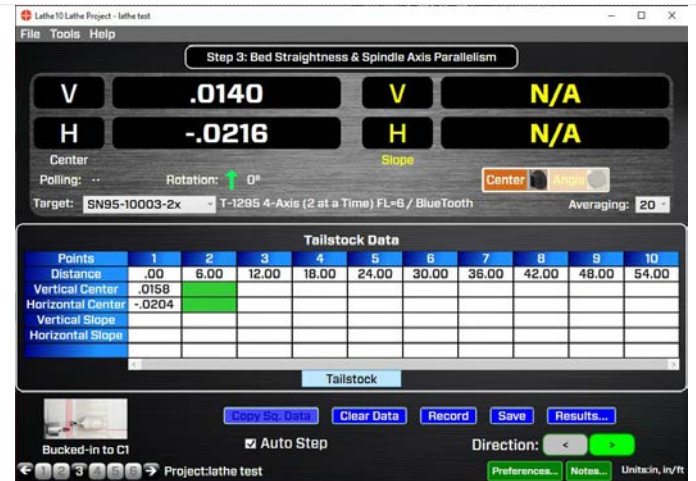

HEADSTOCK   TAILSTOCK/
                   SUBSPINDLE

HEADSTOCK   TAILSTOCK/
                   SUBSPINDLE

Note – we only worked on the angular part of the laser setup. The laser does not have to be perfectly <u>centered</u> to the rotation axis, it just needs to be <u>parallel</u> to it. When the spindle to subspindle alignment check is done in Lathe10 Step 5, the remaining mounting errors will be measured and subtracted out of the data.

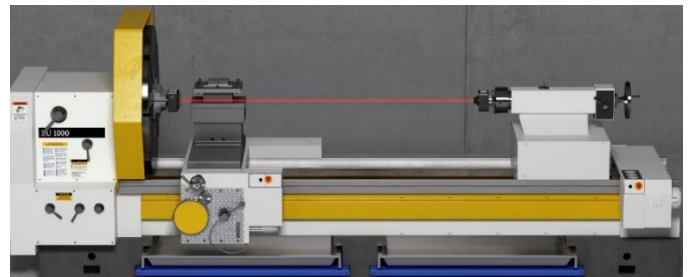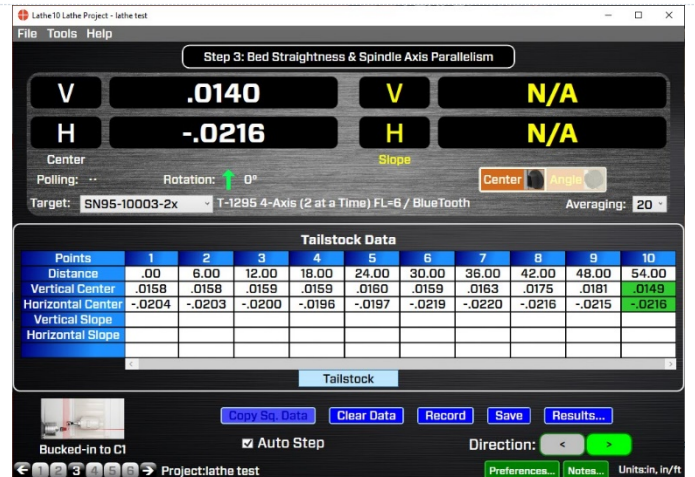**Step 3 – Tailstock Guideway Straightness and Spindle Axis Parallelism**

Now that the laser is aligned to the C1 rotation axis, we can measure the bed for straightness and from that data Lathe10 will calculate the parallelism of the C1 spindle axis to the guideways.

a. Put T-1296 Target on lathe tailstock (Z axis) and move it to point #1 at the distance from the headstock specified in for Point #1 in Step 1.
b. Click **Record** to record the first data point.

Tailstock Data

Points	1	2	3	4	5	6	7	8	9	10
Distance	.00	6.00	12.00	18.00	24.00	30.00	36.00	42.00	48.00	54.00
Vertical Center	.0158									
Horizontal Center	-.0204									
Vertical Slope										
Horizontal Slope										

Step 3 – Tailstock Guideway Straightness and Spindle Axis Parallelism

c. Move the tailstock away from the spindle to point #2 and click **Record**.
d. Continue to record data for the entire axis.

Tailstock Data

Points	1	2	3	4	5	6	7	8	9	10
Distance	.00	6.00	12.00	18.00	24.00	30.00	36.00	42.00	48.00	54.00
Vertical Center	.0158	.0158	.0159	.0159	.0160	.0159	.0163	.0175	.0181	.0149
Horizontal Center	-.0204	-.0203	-.0200	-.0196	-.0197	-.0219	-.0220	-.0216	-.0215	-.0216
Vertical Slope										
Horizontal Slope										

Step 3 – Saddle Guideway Straightness and Spindle Axis Parallelism

e. Move the T-1296 Target to the Saddle either using a fixture or perhaps using the T-242 Target Stand.
f. Follow the same process to take data for the Saddle Axis (W axis)

Step 3 - Record Tailstock & Saddle Axis Pitch/Yaw Angular Data

If the pitch and yaw angular measurements are desired for the tailstock and saddle guideways, then it's a simple change by inserting the lens into the target and changing the displays to Angular Mode. Then take the data as before:

g. Set the tailstock axis at the same location as in Step 3 above. Insert the lens into the T-1296 Target. Make sure the lens focal length (FL=?) matches the target type in the drop-down list in Step 3. There is an overlay on the lens identifying the focal length.

h. Change the display to the Angle Mode by clicking the Angle button (you should see the numbers in yellow in the displays on the right).
i. Hit Record to record first value. Move the axis as before to take the angular values for all the points for both the Tailstock and Saddle axes.


5
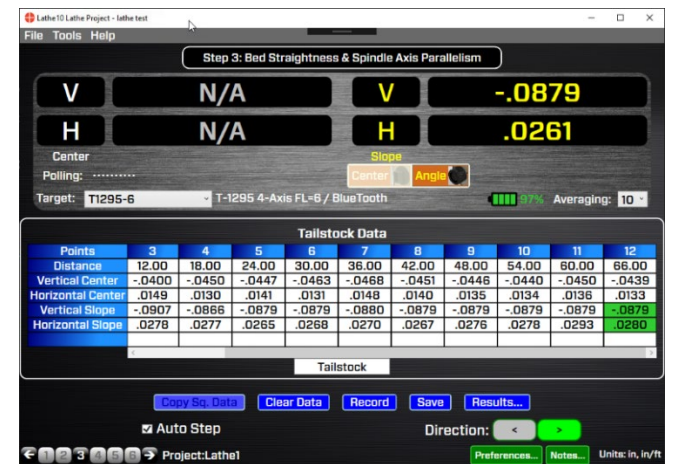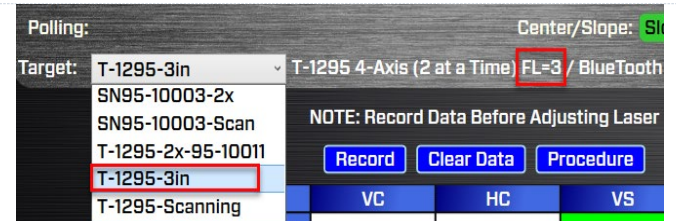
Step 3 – Alignment Results
Click on the Results button to see a summary of the straightness

Ok, the data is all taken, so now it's time to look at the results with the tolerances applied from Step 1.

Click on **Results** to see a summary of the straightness and pitch/yaw alignment results. You can scroll over a parameter to see which way the spindle is sloping relative to the alignment parameter.
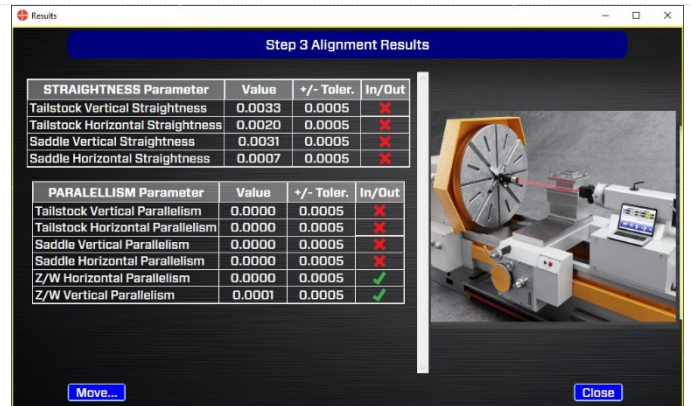
Step 3 - Real-Time Spindle-to-Bed Alignment Move Screen

If the parallelism values are out of tolerance and you want to re-align the headstock, then click **Move button** in Step 3 to open the **Spindle-to-Bed Alignment Move** screen. This shows a real-time display of the vertical and horizontal parallelism (angular) values relative to the lathe's machine guideways or bed. The data can be shown relative to the tailstock bed, saddle bed or an average of both.

Lathe10 automatically calculates the shim values to align the headstock spindle to the tailstock or saddle beds and on-screen graphics and display values update continuously as the shim is added. The on-screen graphics are color-coded and when they turn green, the alignment is complete. Click **Close** to return to Step 3 to retake the data and confirm the alignment.


Step 4 – Lathe-Bed Guideway Straightness Graphical Results

To view the Lathe-Bed Guideway Straightness results in a graphical format, click **Next** or (**Step 4** button from the Move Screen) and Lathe10 displays a graph of the Vertical and Horizontal straightness results for the lathe's bed.

The summary shows:

- The overall Vertical and Horizontal Straightness TIR for the tailstock guideways and for the saddle guideways (if the saddle has separate rails) and if the data is in or out of tolerance.
- Parallelism of the headstock spindle to the tailstock bed (guideways) and if in or out of tolerance.
- Parallelism of the headstock spindle to the saddle (if separate from tailstock bed) guideways and if in or out of tolerance.

The straightness data can be plotted for the tailstock guideways, saddle guideways or both. The plot can use the Best-Fit line as the reference (the Best Fit slope is subtracted from the data and it is plotted with the best fit line being the X axis), or the laser beam (raw data). The graph also shows tolerance bands, the Best-Fit line.
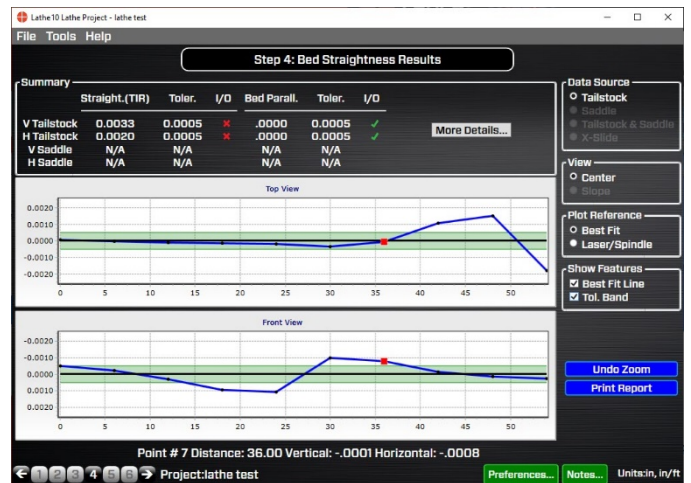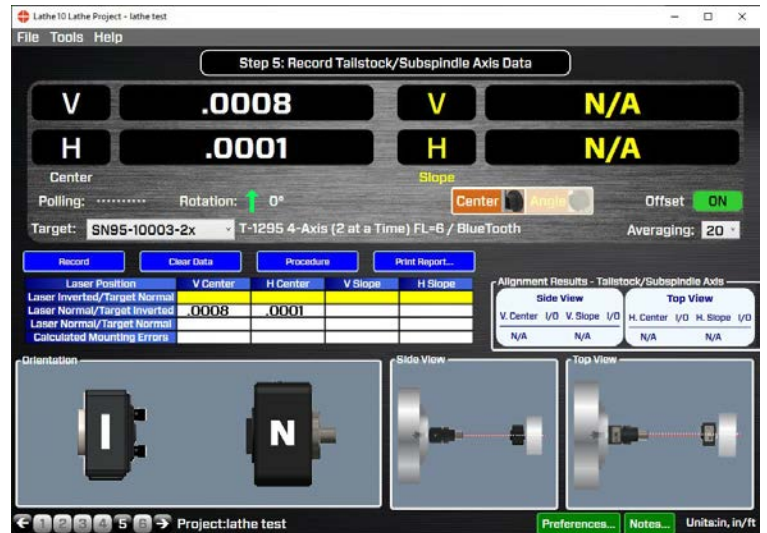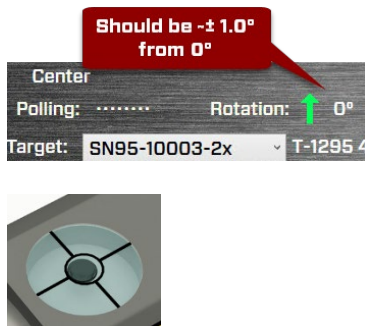
Step 5: Record Data-Spindle: Laser Inverted & Target Normal

Now that the tailstock and saddle guideways have been check for straightness and the headstock spindle axis has been checked for parallelism we can check the tailstock or subspindle alignment to the main spindle axis.

a. First, insert the T-1296 into the tailstock or subspindle in the *NORMal* position and ensure the rotation angle is 0° ±1°. Now rotate the headstock spindle + L-703S so they are in the *INverted* position, making sure the laser's <u>level</u> is centered. Click **Record**.

Step 5: Record Data-Spindle – Center Values: Laser Normal & Target Inverted

b. Rotate the headstock spindle 180°, so the Spindle/L-703 are in the *NORMal* position, making sure the L-703S is level. Then rotate the tailstock chuck (subspindle) + T-1296 Target 180° to the *INverted* position and make sure the *Rotation* angle is 180° ±1 °

Note: if the tailstock doesn't rotate, then loosen the chuck and rotate the T-1296 within the chuck and re-tighten it.

Click **Record**.

Step 5: Record Data-Spindle – Center Values: Laser Normal & Target Normal

c.   Rotate the tailstock chuck (subspindle) + T-1296 180°, so they are in the *NORMal* position, making sure the *Rotation* angle is 0° ±1° Click **Record**.

d.   The headstock to tailstock (subspindle) alignment <u>center</u> results are calculated and displayed in the **Alignment Results** area in Step 5.


Step 5: Record Data-Spindle – Angular Values: Laser Inverted & Target Normal

Now that the center values are recorded, we put in a lens and repeat the same sequence to take the angular data.

e.   First put the 3 in. or 6. in. lens in place in the T-1296 Target. Then switch the display from *Center* to *Slope* using the Center/Angle Button. The right hand displays will show the data in yellow.

f.   Then follow the procedure as outlined above to gather the angular data. When done recording the values, the <u>angular</u> measuring errors are calculated and subtracted from the raw data to produce the results which are displayed in the **Alignment Results** area in Step 5. The tolerances in Step 1 are applied to show if it's in or out of tolerance. Alignment graphics are displayed to interpret the results.
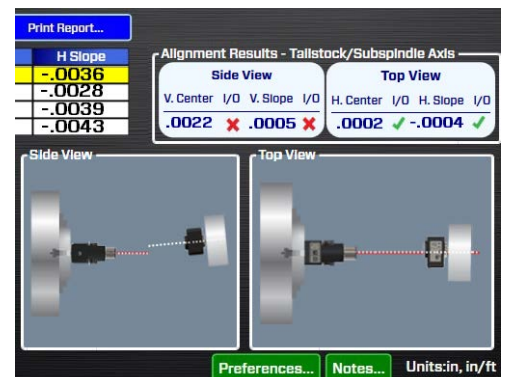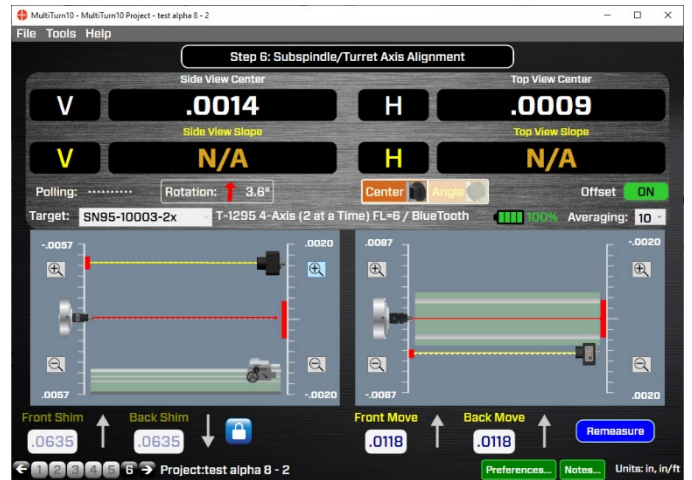
Step 6 – Subspindle/Turret Alignment Screen

a. After taking the spindle alignment data in Step 5, click **Next** to go to the *Step 6: Subspindle/Turret Axis Alignment*. In this screen, the mounting errors collected from Step 5 are applied as offsets to the 4 data displays, showing the actual alignment in 4 axes: Side View, showing the Vertical Center and Vertical Angle and Top View, showing the Horizontal Center and Horizontal Angle.

The data is real-time and on-screen graphics illustrate either the tailstock or turret spindle alignment relative to the headstock's spindle axis (AOR). Shim and Move values are also calculated to fix the alignment. An on-screen bar graphic turn red when the alignment is out of the tolerance selected in Step 1 or green if in tolerance.
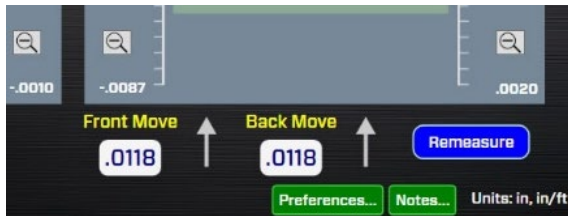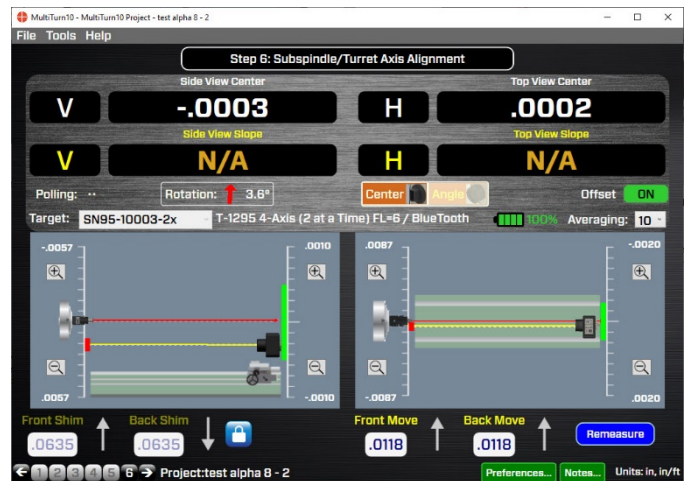

b. Add the shim and spacers or make the horizontal move, watching the display update as you make each move. When the graphical bar indicators turn green, it's aligned!

Note: it is best to first adjust the angles with the angular lens in place. Then fix the Center values.


Step 6: Subspindle Alignment Screen showing Center Values out of tolerance

Step 6: Subspindle Alignment Screen showing Center Values in tolerance

Step 6 – Subspindle/Turret Alignment Screen

c. It's always a good idea to confirm the alignment after making adjustments to the subspindle, turret or tailstock, so hit **Remeasure** to go to Step 5 and retake the data.
d. If the data looks good, then it's time to print the report!
e. Click Tools and Print Report to get the data and graphs. See sample report below.
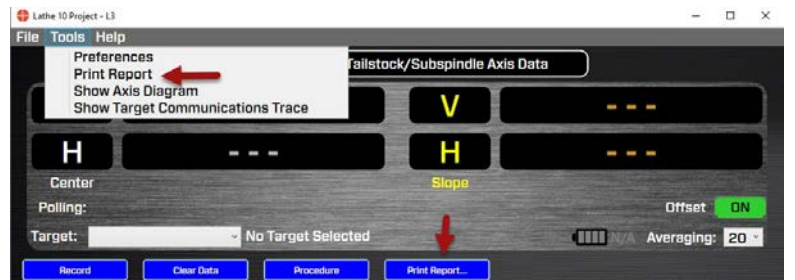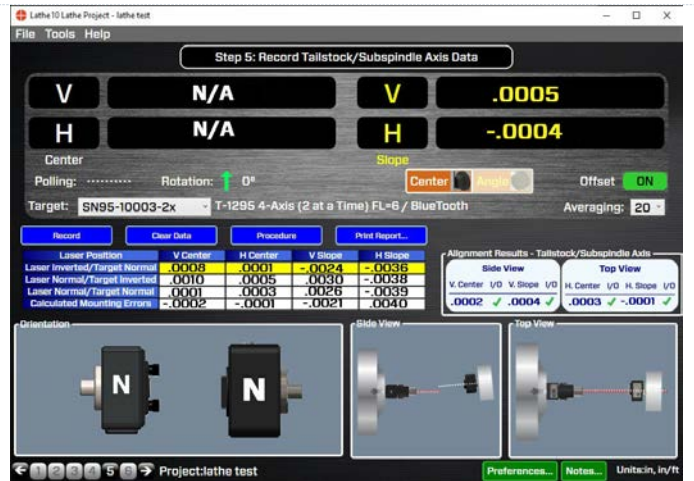
Lathe10 Sample Report

Lathe Report

Project Name: L3

Date Printed: 4/8/2022 at 10:48 AM

Report Issued By:

Company Name:
Address:
City, State, ZIP:
Email:

Machine Information:

Factory:
Machine:
Notes:

Setup Information:

Spacing and Dimensions

Units:	in, in/ft	Headstock A:	.00
Starting Point:	1	Headstock B:	.00
Tailstock Points:	5 x 1.00	Tailstock A:	.00
Saddle Points:	5 x 1.00	Tailstock B:	.00
X-Slide Points:	5 x 1.00		

Tolerance Bands

Straightness:	.0010	Spindle-Axis Parallelism:	.0030
Tailstock Center:	.0010	TS/Saddle Axis Parallelism:	.0020
Tailstock Angular:	.0010	Squareness:	.0040

Target Information

Target Name:	Maint-2
Interface:	T_1296_2_AXIS_MODE
Serial Number:	22-395723
Calibration Date:	01/01/0001
Description:	T-1296 4-Axis FL=6 / BlueTooth

Axis Data

Axis	Point	Distance	V Straightness	H Straightness	Pitch	Yaw
Tailstock	1	.00	.0032	.0102	.0067	-.011
Tailstock	2	1.00	.0038	.0109	.0072	-.010
Tailstock	3	2.00	.0478	.0140	.0487	-.007
Tailstock	4	3.00	.0148	.0092	.0174	-.011
Tailstock	5	4.00	.0039	.0104	.0073	-.010
Saddle	1	.00	.0041	.0104	.0076	-.010
Saddle	2	1.00	.0049	.0108	.0083	-.010
Saddle	3	2.00	.0039	.0106	.0073	-.010
Saddle	4	3.00	.0039	.0108	.0073	-.010
Saddle	5	4.00	.0035	.0101	.0074	-.010
X-Slide	1	.00	.0035	.0101	.0074	-.010
X-Slide	2	1.00	.0216	.0115	.0239	-.009
X-Slide	3	2.00	.0476	.0115	.0483	-.009
X-Slide	4	3.00	.0592	.0051	.0589	-.015
X-Slide	5	4.00	.0616	.0029	.0610	-.017

Straightness/Parallelism/Squareness Results

STRAIGHTNESS	Value	Tolerance	I/O
Tailstock-Axis Straightness In Y	.0464	.0010	✖
Tailstock-Axis Straightness In X	.0047	.0010	✖
Saddle-Axis Straightness In Y	.0009	.0010	✔
Saddle-Axis Straightness In X	.0006	.0010	✔
X-Slide-Axis Straightness In Z	.0056	.0010	✖

PARALLELISM	Value	Tolerance	I/O
Tailstock Vert. Parallelism	.0149	.0020	✖
Tailstock Horiz. Parallelism	-.0016	.0020	✔
Saddle Vert. Parallelism	-.0025	.0020	✖
Saddle Horiz. Parallelism	-.0008	.0020	✔
Tailstock-Saddle Horizontal Parallelism	-.0008	.0020	✔
Tailstock-Saddle Vertical Parallelism	.0175	.0020	✖

ANGULAR	Value	Tolerance	I/O
Tailstock Max Pitch Error Overall	.0420	.0000	✖
Tailstock Max Pitch Error Point-Point	.0415	N/A	✖
Tailstock Max Yaw Error Overall	.0038	.0000	✖
Tailstock Max Yaw Error Point-Point	.0032	N/A	✖
Saddle Max Pitch Error Overall	.0007	.0000	✖
Saddle Max Pitch Error Point-Point	.0007	N/A	✖
Saddle Max Yaw Error Overall	.0003	.0000	✖
Saddle Max Yaw Error Point-Point	.0003	N/A	✖
X-Slide Max Pitch Error Overall	.0535	.0000	✖
X-Slide Max Pitch Error Point-Point	.0244	N/A	✖
X-Slide Max Yaw Error Overall	-.0065	.0000	✖
X-Slide Max Yaw Error Point-Point	.0011	N/A	✖

Squareness/Parallelism Images
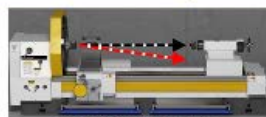
Tailstock Vert. Parallelism (.0149)

Tailstock Horiz. Parallelism (-.0016)

Saddle Vert. Parallelism (-.0025)

Saddle Horiz. Parallelism (-.0008)

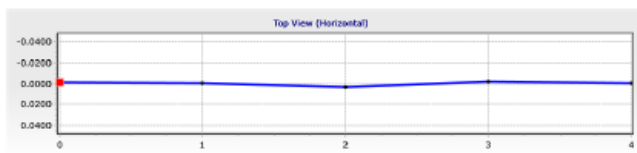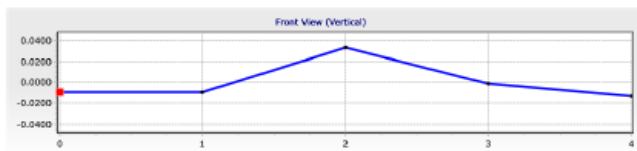
Tailstock-Saddle Horizontal Parallelism (-.0008)

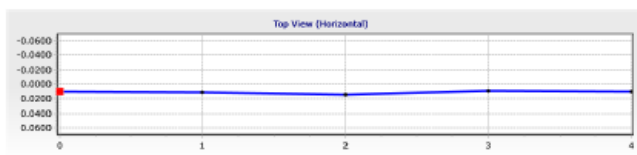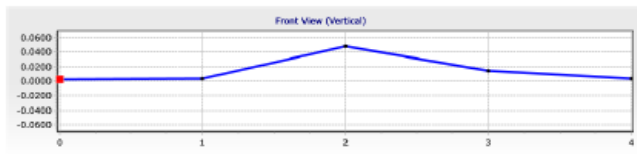Tailstock-Saddle Vertical Parallelism (.0175)

Bed Straightness Results

Axis: Tailstock   **View:** Center

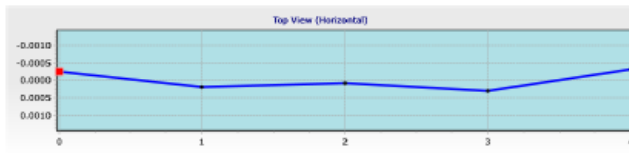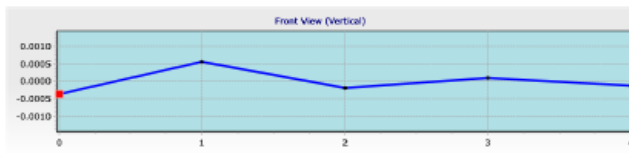**Plot Reference: Best Fit**

Plot Reference: Laser/Spindle

Bed Straightness Results

Axis: Saddle   **View:** Straightness

Plot Reference: Best Fit

Plot Reference: Laser/Spindle