

## Application Notes

# Lathe Alignment

### System Recommendations

### L-700 Spindle Alignment System



Our patented 4-axis L-700 Spindle Alignment System is a powerful alignment tool that will help you to align boring mill, cylindrical grinding, lathe and turning-center applications up to 70% faster than conventional or interferometer methods. With a resolution of .00002" (.0005 mm), live data output and large, color computer graphics, the L-700 is the perfect tool to align headstocks, spindles, sub-spindles and tailstocks quickly and accurately.



### Turning Center Alignment Simplified Even on Large Lathes

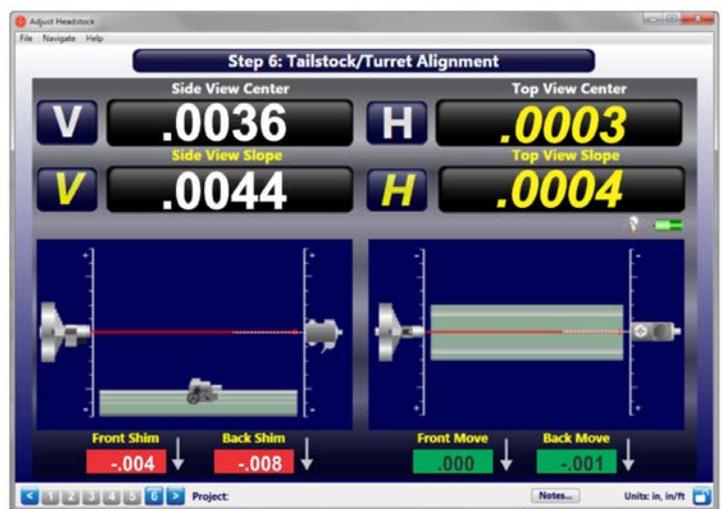
The critical alignment of a lathe or other turning-type machine is the parallelism of the axis of rotation (AOR) of the spindle to the machine bed and alignment to the tailstock, sub-spindle, turret or tool holder's AORs.

Conventional methods are very cumbersome and time consuming and are practically useless on large lathes. The L-700 vastly simplifies the task by inserting the laser right into the spindle chuck and the T-261 4-Axis Target into the sub-spindle or tailstock. The laser is aligned to the spindle axis of rotation out to 100' (30.5 M). This becomes the reference from which the ways, tool holder and tailstocks can be measured and aligned using the T-261. The software displays a live reading of the horizontal and vertical center (offset) readings and the horizontal and vertical angular (slope) readings of the tailstock to the headstock.

### Live Display of Misalignment Data in 10 minutes

The L-700 Spindle Alignment System is so easy to set up that you can have a quick measurement of misalignment data in 10 minutes. The Windows-based software speeds setup and data taking and even corrects for mechanical mounting errors!

As with all Hamar Laser products, the L-700 provides a live display in four axes of misalignment data, which means you can align the tailstock, sub-spindle, etc. while the laser is still in the machine. This is especially useful for tailstock alignment, as it requires 4-axis calibration (horizontal center and angle and vertical center and angle).



## High Resolution (.00002") Improves Part Quality

The L-700 has a resolution of .00001" (0.00025 mm) or better for center measurements and .00001"/ft (0.0008 mm/M) for angular measurements. This extremely high resolution provides the accuracy to dramatically improve your lathe's quality performance and improve its scrap rate. Also by periodically checking a lathes alignment can head off future quality problems *before* they hit the bottom line.

## Align Lathe Headstock to Its Bed up to 100 Feet

With the 100-foot (30.5 M) range of the L-700, even the largest lathes can be quickly aligned. Since the L-700 is aligned to the axis of rotation of the spindle, it projects that axis out to 100 feet (30.5 M), allowing the entire length of the lathe to be aligned without changing setups. This is of particular value to large lathes where alignment bars are not practical.

## Cross-Slide Squareness

<http://www.hamarlaser.com/index.php/product-index.html> With our P-405 Remote Optical Square or our L-741 Laser System, measuring the squareness of the cross slide is a simple task. The P-405 is placed into the laser beam and made perpendicular to it using the T-261 Target. A penta prism is then inserted into the P-405 fixture to bend the input beam 90° and produce an automatically rotating laser plane that is square to axis of rotation of the spindle. A single-axis target then measures the cross-slide squareness.

### Recommended System Configuration

- L-700 Spindle Alignment Laser
- T-261A 4-Axis Spindle Target
- R-358 Computer Interface w/.05 Micron (.00002") Resolution
- S-1403 Lathe9 Software for Win XP/7/8
- R-342 Laptop Computer
- A-814 Shipping Case

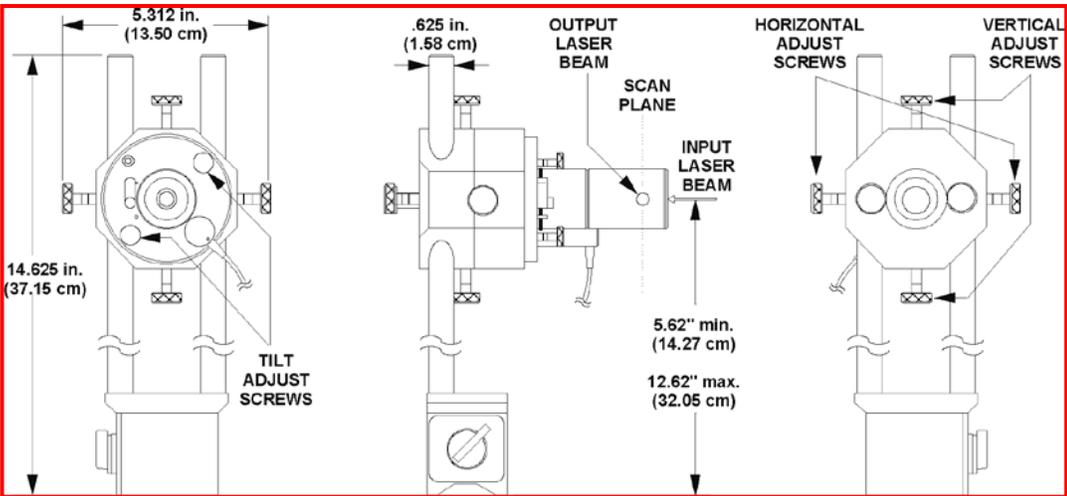
### Optional Accessories

- P-405 Remote Optical Square
- R-1342 Ruggedized Laptop Computer
- A-807 Calibration Fixture

### More Information Online

  
[Product Index](#)

  
[PDF Index](#)



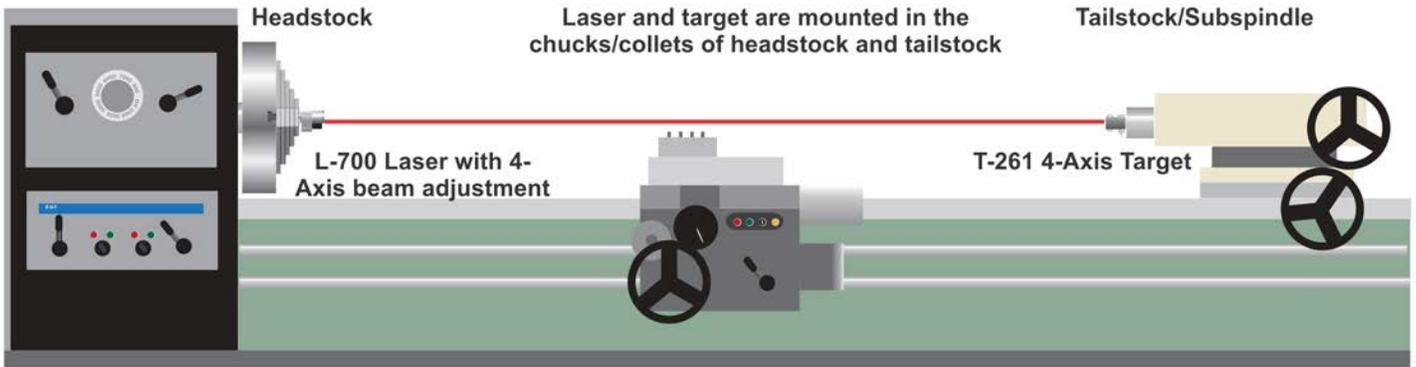
**P-405 Remote Optical Square**

## How the Alignment System Works

The setup and use of an L-700 is quite easy and begins by following Lathe9's on-screen instructions to enter the dimensions, number of points, and tolerances. Next the laser is "qualified" or made colinear (parallel and coincident), to the axis of rotation (AOR) of the spindle. Then Lathe9 measures the lathe bed for parallelism to the spindle's AOR. If out of tolerance, Lathe9 offers a live alignment screen to align the headstock to the lathe bed.

Once the spindle is aligned to the lathe bed, Lathe9 measures the headstock spindle alignment to the tailstock or subspindle following an easy 3 step process. If out of tolerance, Lathe9 offers a live 4-axis alignment screen to align the spindles horizontal and vertical centers (offsets) and horizontal and vertical angles. After aligning the tailstock, Lathe9 offers a printed report showing the lathe bed straightness, spindle parallelism to the bed and the headstock-tailstock alignment.

### L-700 Spindle Alignment System Basic Setup on a Lathe or Turning Center



### Lathe Spindle Alignment Procedure Using Lathe9 Software



#### Step 1 - Setup

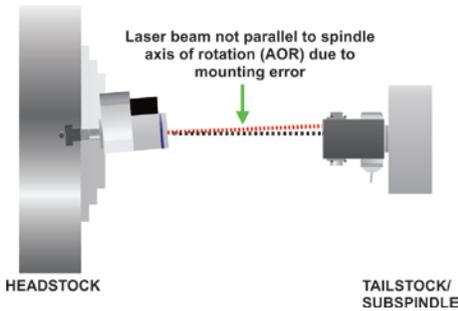
Enter the number of points to measure on the bed, the distance between points, the headstock and tailstock dimensions, and the alignment tolerances. Also select which side of the machine the laser is mounted in.



### Step 2 - Qualify Laser - Spindle Inverted

A) Insert laser into headstock spindle, the T-261A into the tailstock or subspindle, and rotate the main spindle so the L-700 is in the inverted position.

B) Click **Record**.



**Step 2: Qualify Laser**

V **.0005** V **.0015**  
H **-.0070** H **.0025**

Center Slope Offset Off

NOTE: Record Data Before Adjusting Laser

Record Clear Data Procedure

Orientation	VC	HC	VS	HS
Inverted Laser	.0005	-.0070	.0015	.0025
Normal Laser				
Calculated Offset				

Averaging 0

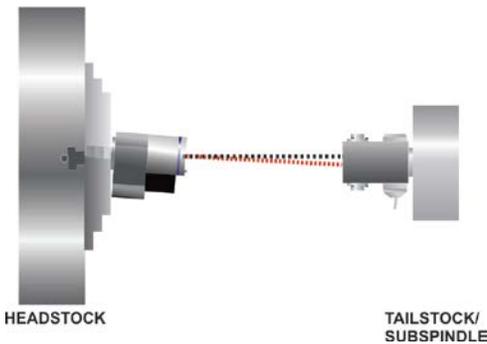
Orientation

Project: Notes... Units: in, in/ft

### Step 2 - Qualify Laser - Spindle Normal

A) Rotate the spindle/laser to the NORMAl position.

B) Click **Record**. Offsets are immediately applied to displays so the laser can be adjusted to the spindle's AOR.



**Step 2: Qualify Laser**

V **.0019** V **.0006**  
H **.0034** H **-.0012**

Center Slope Offset On

NOTE: Record Data Before Adjusting Laser

Record Clear Data Procedure

Orientation	VC	HC	VS	HS
Inverted Laser	.0005	-.0070	.0015	.0025
Normal Laser	.0043	.0046	.0003	.0002
Calculated Offset	.0024	.0012	.0009	.0014

Averaging 0

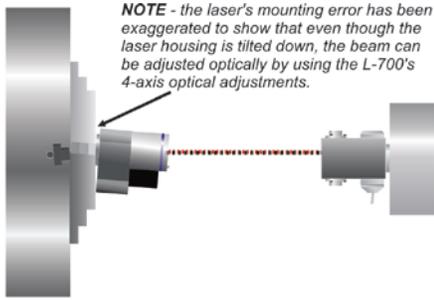
Orientation

Project: Notes... Units: in, in/ft

## Step 2 - Qualify Laser Showing the Laser Bucked-in to the Spindle AOR

A) Using Allen key, turn the angular adjustments until the V & H Angular displays are zero.

B) Using the Allen key, turn the center adjustments until the V & H Center displays are zero. The laser beam is not concentric to the Spindle AOR.

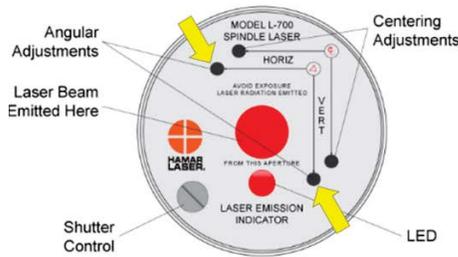


HEADSTOCK

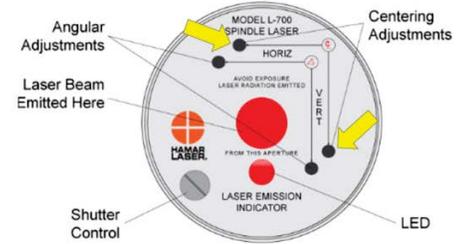
TAILSTOCK/  
SUBSPINDLE

**NOTE:**  
The laser does not have to be adjusted perfectly to zero since the final mounting errors will be removed in Lathe9, Step 5. This is because the target mounting errors also have to be measured and removed from the final alignment values.

Orientation	VC	HC	VS	HS
Inverted Laser	.0005	-.0070	.0015	.0025
Normal Laser	.0043	.0046	.0003	.0002
Calculated Offset	.0024	.0012	.0009	.0014



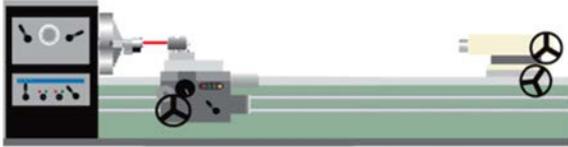
L-700 Angular Adjustments



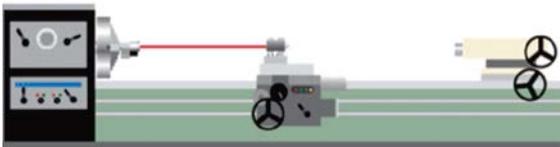
L-700 Centering Adjustments

### Step 3 - Spindle AOR Parallelism to Lathe Bed

- A) Put T-261A Target on lathe saddle and move it to a distance from the headstock specified in for Point #1 in Step 1.
- B) Click **Record** to record the first data point.



- C) Move saddle/T-261A to next point and click **Record**. Continue until all the points are recorded.



### Step 3 - Spindle AOR Parallelism to Lathe Bed Results

Click **Results** to display the Lathe Bed Parallelism Results table, which shows: a) lathe bed straightness, b) parallelism of the Spindle AOR to the lathe bed. If the Headstock Parallelism results are out of tolerance, click **Close** and then click **Move** to open the live Headstock Alignment screen.

**Note:** If the saddle and tailstock are on separate machine rails, the data can be taken a second time by moving the T-261A to the tailstock and taking a second set of lathe bed straightness data.



### Step 3 – Live Spindle-to-Bed Alignment Screen

Click **Move** in Step 3 to open the Spindle-to-Bed alignment screen, showing a live display of the vertical and horizontal parallelism (angular) values relative to the lathe's machine ways or bed. The data can be shown relative to the tailstock bed, saddle bed or an average of both.

Lathe9 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 shims 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.

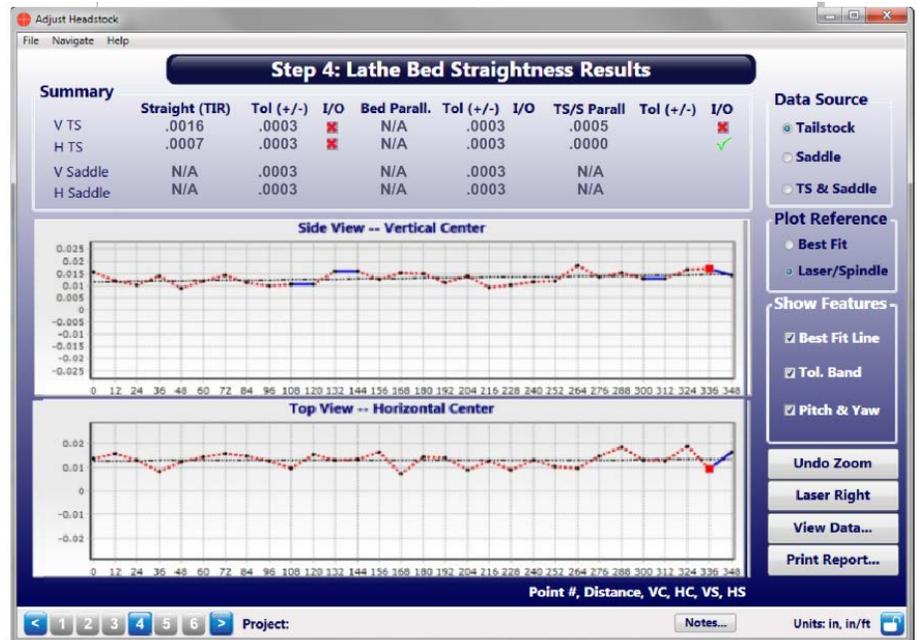


### Step 4 – Lathe Bed Straightness Results

To view the Lathe-Bed Straightness results, click **Next** and Lathe9 displays a graph of the Vertical and Horizontal straightness results for the lathe's bed. A summary shows:

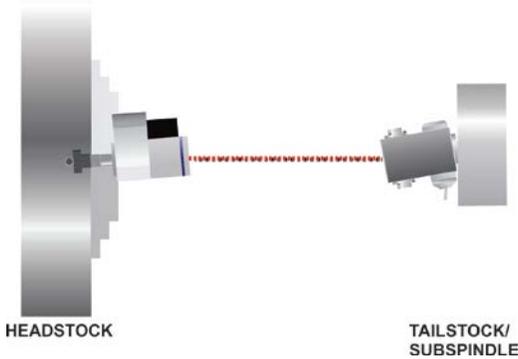
- The overall Vertical and Horizontal Straightness TIR for the tailstock rails and for the saddle rails (if the saddle has separate rails) and if the data is in or out of tolerance.
- Parallelism of the headstock spindle to the tailstock bed (rails) and if in or out of tolerance.
- Parallelism of the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

The straightness data can be plotted for the tailstock rails, saddle rails or both. The plot can use the Best-Fit line as the reference or the laser beam. The graph also shows tolerance bands, the Best-Fit line, or pitch and yaw data for each point.



**Step 5: Record Data-Spindle: Laser Inverted/Target Normal**

When the headstock is aligned to the bed, the tailstock (subspindle or turret) can then be aligned to the headstock. First, insert the T-261A into the tailstock or subspindle in the NORMAL position and ensure the bubble is centered in the vial. Rotate the headstock spindle so the L-700 is in the Inverted position, making sure it is level. Click **Record**.



Adjust Headstock

File Navigate Help

Step 5: Record Data - Spindle

V .0053 V .0003

H .0041 H .0002

Center Slope Offset OFF

Record Clear Data Procedure Print Report... Averaging 0

Laser Position	V Center	H Center	V Slope	H Slope
Laser Inverted/Target Normal	.0053	.0041	.0003	.0002
Laser Normal/Target Inverted				
Laser Normal/Target Normal				
Calculated Offset				

Side View			Top View		
V. Center	V. Angle	I/O	H. Center	H. Angle	I/O
.0000	.0000	✓	.0000	.0000	✗

Orientation

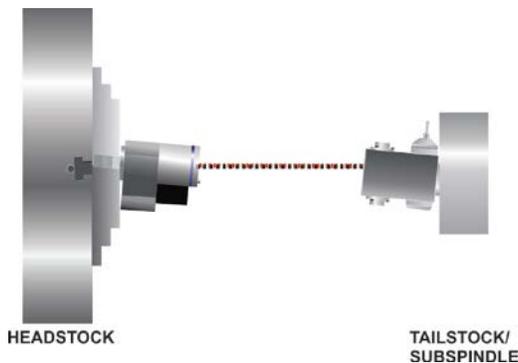
Side View Top View

Project: Notes... Units: in, in/ft



**Step 5 – Record Data-Spindle: Laser Normal/Target Inverted**

Rotate the headstock spindle so the L-700 is in the NORMAL position. Rotate the target in the tailstock chuck to the INverted position. Ensure both are level. Click **Record**.



Adjust Headstock

File Navigate Help

Step 5: Record Data - Spindle

V -.0020 V .0015

H .0081 H .0012

Center Slope Offset OFF

Record Clear Data Procedure Print Report... Averaging 0

Laser Position	V Center	H Center	V Slope	H Slope
Laser Inverted/Target Normal	.0053	.0041	.0003	.0002
Laser Normal/Target Inverted	-.0020	.0081	.0015	.0012
Laser Normal/Target Normal				
Calculated Offset				

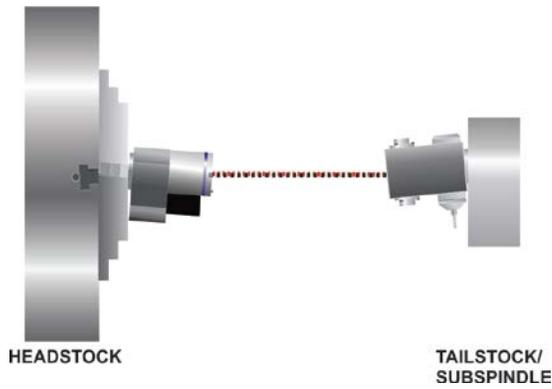
Side View			Top View		
V. Center	V. Angle	I/O	H. Center	H. Angle	I/O
.0000	.0000	✓	.0000	.0000	✗

Orientation

Side View Top View

Project: Notes... Units: in, in/ft





### Step 5 – Record Data

#### Spindle: Laser Normal/Target Normal

Rotate the target in the tailstock chuck to the NORMAL position. Click **Record**.

**Step 5: Record Data - Spindle**

V **-.0015** V **.0005**  
H **.0071** H **.0008**

Center Slope Offset OFF

Record Clear Data Procedure Print Report... Averaging 0

Laser Position	V Center	H Center	V Slope	H Slope
Laser Inverted/Target Normal	.0053	.0041	.0003	.0002
Laser Normal/Target Inverted	-.0020	.0081	.0015	.0012
Laser Normal/Target Normal	-.0015	.0071	.0005	.0008
Calculated Offset	-.0039	.0025	.0011	.0007

Side View			Top View	
V. Center	V. Angle	I/O	H. Center	H. Angle
.0000	.0000	✓	.0000	.0000
				✗

Orientation: Side View, Top View

Project: Notes... Units: in, in/ft

### Step 5 - Record Data Spindle: Results

After taking the data, Lathe9 calculates mounting-error offsets and applies them to the display values. It also calculates the spindle alignment results and applies the tolerance. On-screen graphics illustrate the vertical axes of the alignment (Side View) and the horizontal axes of the alignment (Top View). If it is out of tolerance, click **Next** and go to Step 6 -- Tailstock/Turret Alignment Live Move Screen.

**Step 5: Record Data - Spindle**

V **.0024** V **-.0006**  
H **.0046** H **.0001**

Center Slope Offset OFF

Record Clear Data Procedure Print Report... Averaging 0

Laser Position	V Center	H Center	V Slope	H Slope
Laser Inverted/Target Normal	.0053	.0041	.0003	.0002
Laser Normal/Target Inverted	-.0020	.0081	.0015	.0012
Laser Normal/Target Normal	-.0015	.0071	.0005	.0008
Calculated Offset	-.0039	.0025	.0011	.0007

Side View			Top View	
V. Center	V. Angle	I/O	H. Center	H. Angle
.0024	.0006	✓	.0046	.0001
				✗

Orientation: Side View, Top View

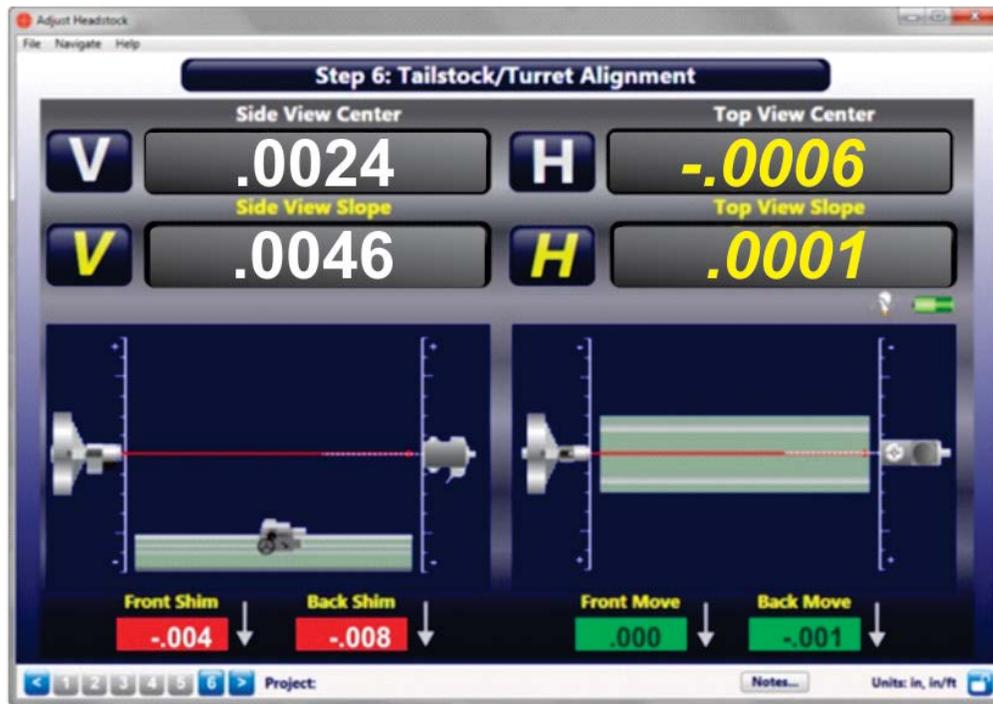
Project: Notes... Units: in, in/ft

**Step 6 – Tailstock/Turret Alignment Live Move Screen**

After taking the spindle alignment data in Step 5, click **Next** to go to the Tailstock/Turret Live Move Screen. In this screen, the mounting errors collected from Step 5 are applied as an offset to the data displays, showing the actual alignment in four axes: Side View, showing the Vertical Center and Vertical Angle and Top View, showing the Horizontal Center and Horizontal Angle.

The data is live 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. The displays turn red when the alignment is out of the tolerance selected in Step 1 or green if in tolerance.

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

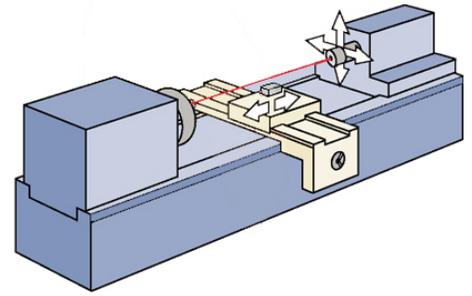


It is always a good idea to go back to Step 5 and retake the data to confirm the alignment. After confirming the alignment, click **Print Report** for a report of the entire alignment.

Laser Position	V Center	H Center	V Slope	H Slope
Laser Inverted/Target Normal	.0053	.0041	.0003	.0002
Laser Normal/Target Inverted	-.0020	.0081	.0015	.0012
Laser Normal/Target Normal	-.0015	.0071	.0005	.0080
Calculated Offset	-.0039	.0025	.0011	.0007

## Cross Slide Squareness

Squareness of the cross slide can be easily checked by setting up a remote optical square (P-405). The optical square is put on a target stand and adjusted, using a 4-axis target, until it is exactly perpendicular to the input beam from the laser in the spindle. The optical square has an automatically rotating head that sweeps a laser plane that is perpendicular to the input beam. A single-axis target is placed on the cross slide and zeroed in the closest position to the spindle centerline. It is then traversed along its axis, and any deviation from zero is a squareness error. The straightness of the cross slide travel is also checked at the same time.



## Alignment System Features

- Simple fixturing for mounting the laser and target
- L-700 mounts in the spindle to project its axis of rotation out to 100' (30.5 M)
- Visible-light beam aids setup
- Compact and rugged (4" L x 2.9" H x 1.75" W)
- Center resolution of 0.00002" (.0005 mm) and angular resolution of .00002"/ft (.002 mm/M)
- Vertical and horizontal controls for both angle and center adjustment of the laser to the spindle's precise axis of rotation
- Needs only 10" (250 mm) of space between spindle and tailstock or subspindle.
- Laser runs for up to 8 hours on a standard, replaceable 9-volt battery
- Windows-based software with large color graphics that corrects mounting errors and calculates shim values

