

# How Lasers Work

## Engine Block Bore Alignment with the L-706 Laser

### L-706 Applications

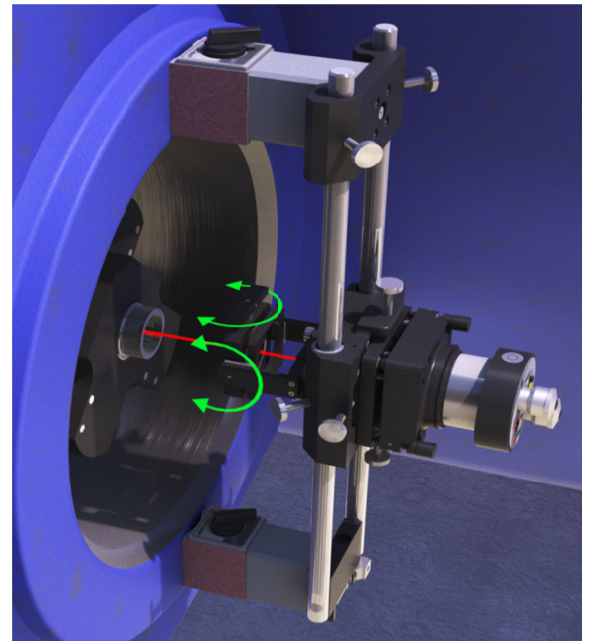
- Engine Crankcase Bores • Compressor Bores
- Cylinder Bores • Stern Tube Shaft Bearings
- Tube-Support-Plate Bores

## How the Alignment System Works – Engine-Block Crankshaft Bores

### General Setup

To perform alignments, the L-706 laser is mounted in the L-111 Laser Stand and the L-102 Laser Beam Translator is attached. The L-111 has coarse *angular* adjustment capabilities and the L-102 can *translate* (change the centering) the laser beam up/down and left/right without changing the angle.

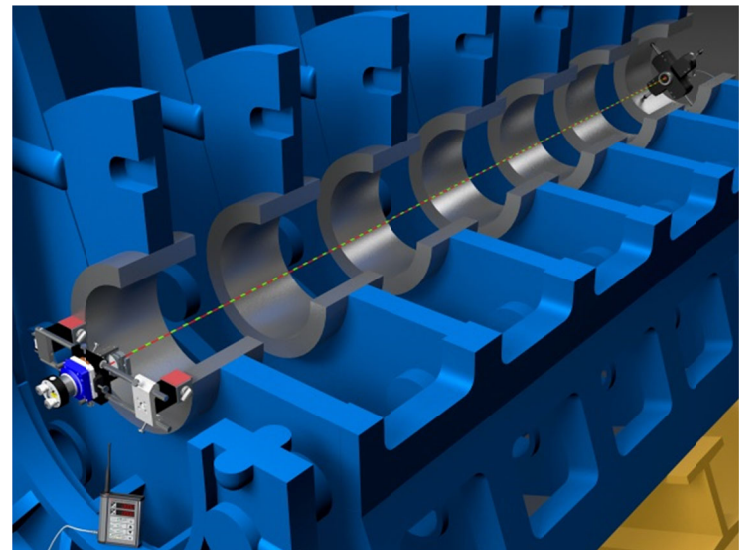
The entire assembly is then mounted either on an instrument stand near the first reference bore or on the face of the bore.



*The L-111 Laser Stand with L-102 Beam Translator mounted on the face of a bore.*

The A-512/A-514 target/adaptor is placed in the first bore and the L-102 Beam Translator is adjusted to center the laser beam to the target. The target is then moved to the far reference bore and the angular adjustments are used to tilt the laser to the center of the target. This process is repeated until the target reads zero at both locations.

The laser is now parallel to the end reference bores and the target can be moved to (or a second target can be placed in) the inner bores for alignment checks. In addition, boring-bar bearings can be installed and aligned using our T-218 Bore Alignment Target, which fits directly into the bearing.

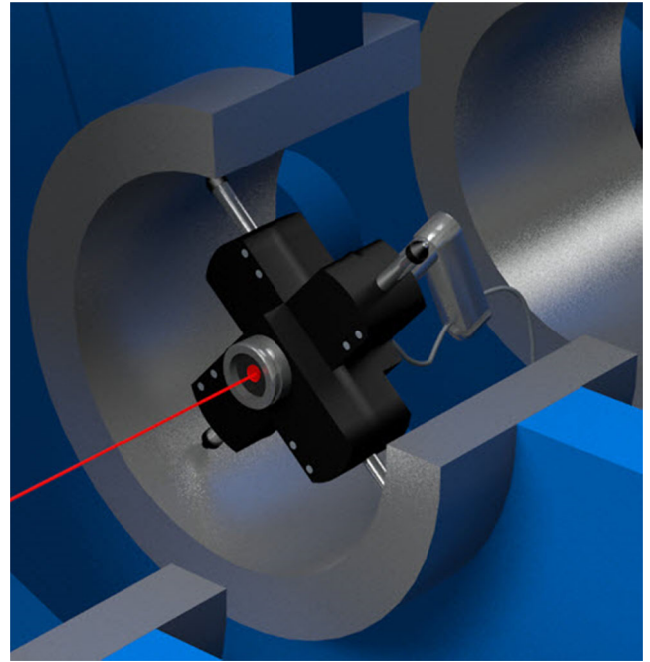


*L-706/L-111/L-102 with A-512/A-514 aligned to end bores*

## How the A-512 Target and A-514 Adapters Work

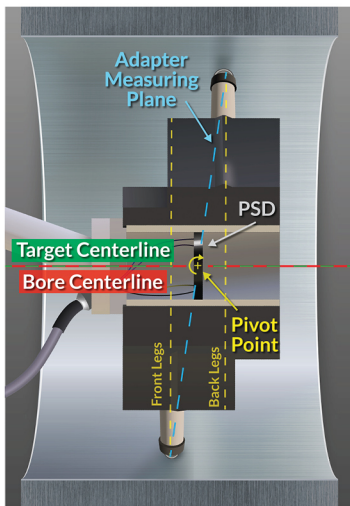
The A-512 Target is designed so that the PSD is centered axially between the 4 feet of the A-514 Adapter, 2 of which are offset axially from the other 2. This, in effect, puts the PSD on the pivot point of the adapter and allows the angle of incidence to the laser beam to vary by up to 45°. This means even if the bore diameter changes, the A-514 will still self-center giving an accurate measurement of the bore's alignment.

To insert the target into the bore, attach the handle/pole to the target and tip the target forward, which allows it to easily slide into the bore. Release the handle/insertion pole and the target/adapter "jam" into the bore, finding the center automatically. The weight of the handle/pole keeps the target centered in the bore.

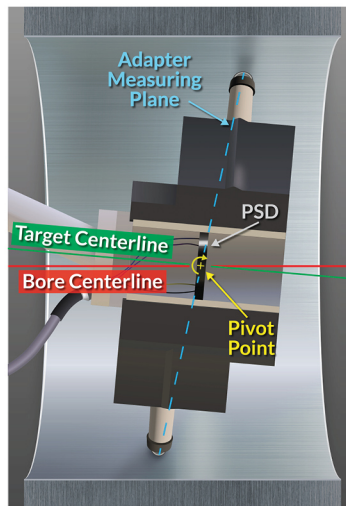


*A-512 Target in A-514B Self-Centering Bore Adapter mounted in a bore*

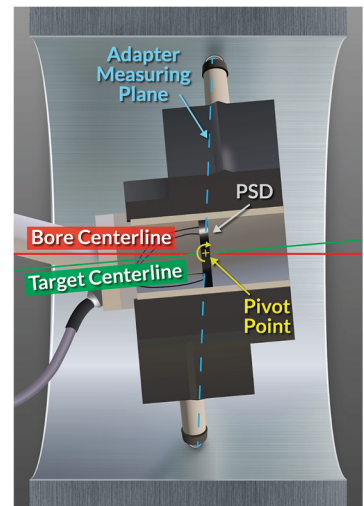
## How the A-512 and A-514 Self-Centering Adapters Work



**A-512/A-514 Target & Adapter  
Adapter OD = Nominal Bore ID**



**Bore ID > Nominal ID  
Target Tilts Forward  
PSD Is Still Centered**



**Bore ID < Nominal ID  
Target Tilts Back  
PSD Is Still Centered**

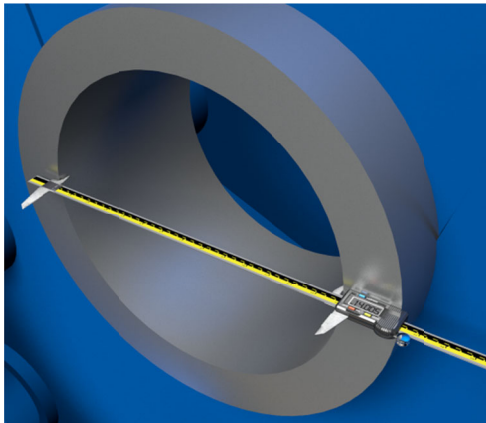
# Bore Alignment Procedure Using L-706, L-111, L-102 and Bore9

## Step 1: Setup

- Open Bore9 and select the target and computer interface.
- Enter the number of bores, the distance between the bores, the bore diameters, and select the alignment tolerances.

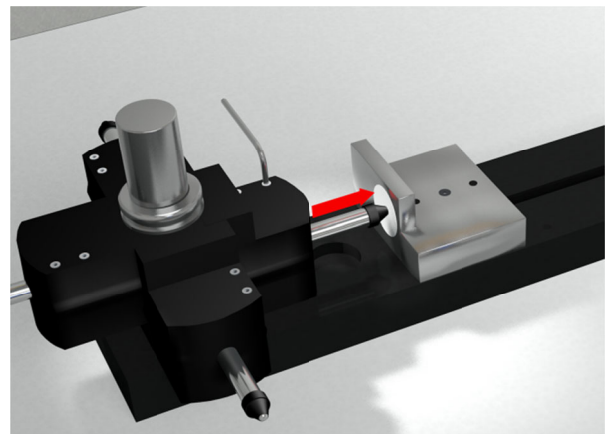
*Bore9 – Step 1: Setup*

- Measure the nominal bore ID. Use the A-514G Leg-Setting Gage to set the legs of the A-514 Bore Adapter to the nominal bore ID.



*A-514GS Leg-Setting Gage for A-514 Adapters*

- Push the leg against the stop and tighten the set screw. Repeat for all four legs.



*A-514GS Leg-Setting Gage - positioning the legs of A-514B Bore Adapter*

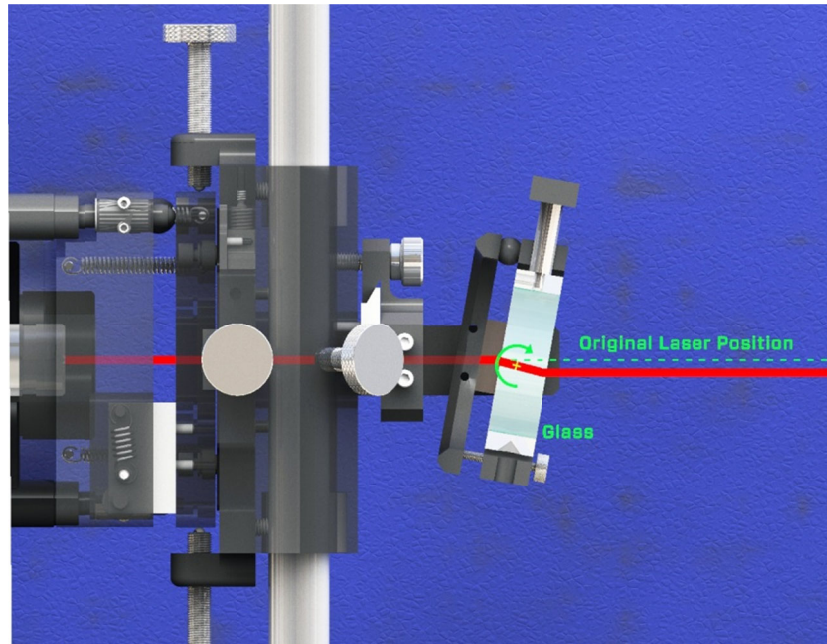


- e. Insert the A-512 into the A-514 Adapter and insert them into the near bore, making sure the adapter's level vial is level.



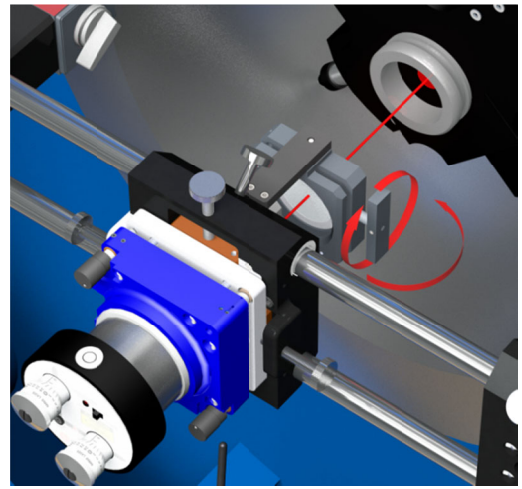
### How it Works – The L-102 Beam Translator

*The L-102 uses a parallel-sided piece of glass to redirect the laser beam to center it into a bore target. So the laser beam passes through the glass and reflects off entrance surface and goes up/down, or left/right, and comes out the exit surface with the beam parallel to the input beam. Therefore the angle of the beam is not affected by tilting the optic. The greater the tilt, the greater the amount the laser beam will move in position.*



*The L-102 has both coarse and fine centering adjustments and is used to center the laser beam to the A-512/A-514 Target in the near reference bore.*

- f. Adjust the L-102 Beam Translator to zero the R-1307 Readout and center the laser into the first reference bore (the graphic below shows how the L-102 moves the height of the laser beam, but not the angle).
- g. The laser is now centered in the near reference bore.



## Step 2: Remove Target Mounting Error (optional)

***Note:** Step 2: Remove Target Mounting Error of the Bore9 program may be skipped if measuring bore straightness only, or if aligning bores to .0005" (0.013 mm) or less.*

Press **Record** to record data for the target in the NORMAL position. Rotate the target 180 degrees (INVERTED position) and reinsert into the *near* bore. Press **Record** to record data for the target in the INVERTED position. Rotate target 180 degrees again back to the NORMAL position and reinsert into the *near* bore. The TSCE Mounting Error Offset is calculated and applied to each target reading. This removes any remaining centering errors in the target and adapter.



Step 3: Laser Buckin (Setup)

- a. Follow the on-screen instructions to enter distances from the laser to the *near* bore (D1) and from the near bore to the *far* bore (D2). If needed, insert the target into the *near* bore and re-adjust the L-102 to zero the display and center the laser into the bore. Press **Record** to record data for the *near* bore.



Bore9 - Step 3: Enter distances between end (reference) bores

Step 3c: Provide Distances

Enter distances for D1 and D2 then click 'Next'

Distance from Laser Pivot to Near Target D10

Distance from Near Target to Far Target D20

Step 3c: Enter distances between end (reference) bores

Results

Target	Vertical	Horizontal
Near Target	.0190	.0053
Far Target		
Set Point		

Retake Data

Step 3d: Results data showing near point

Results

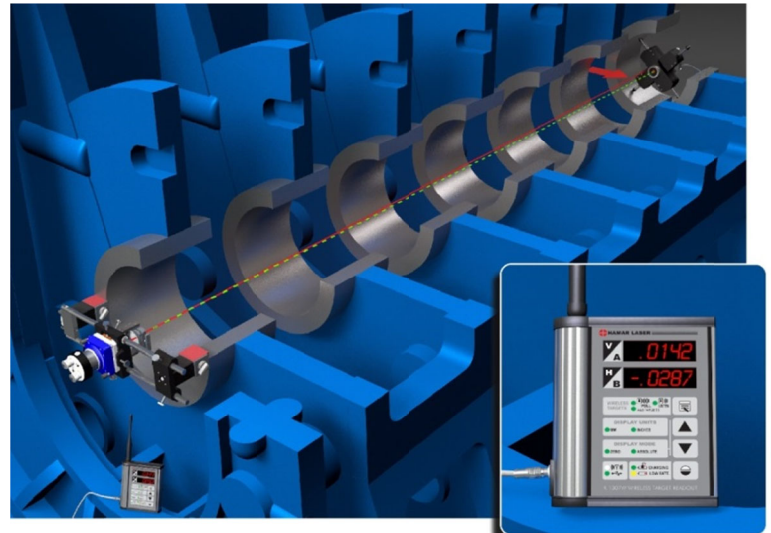
Target	Vertical	Horizontal
Near Target	.0190	.0053
Far Target	.0148	.0048
Set Point	.0048	.0035

Retake Data

Step 3e: Results data showing far point recorded and set point calculation

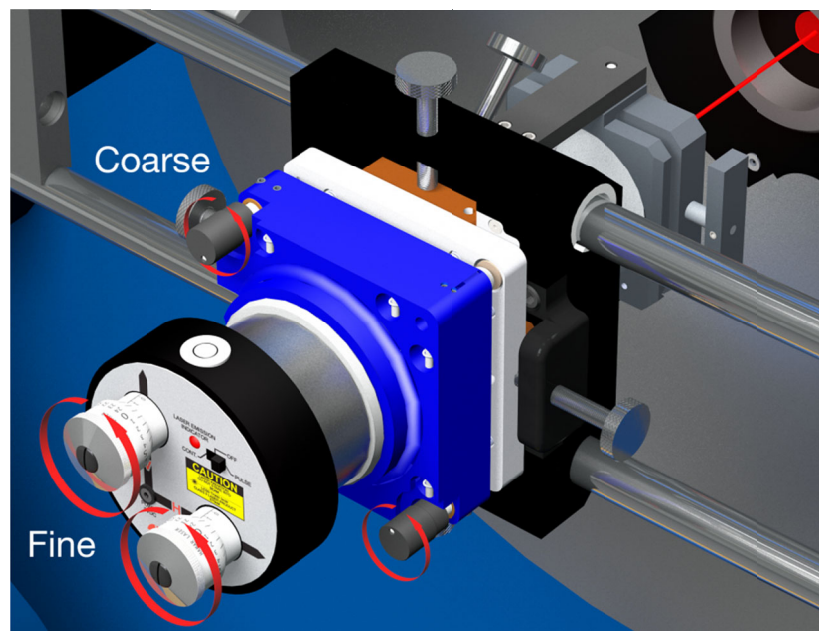


- b. Move the target to the *far* bore and press **Record**. A calculation of the laser **Set Point** will be made to aid the laser setup and offsets will be applied to on-screen live data.



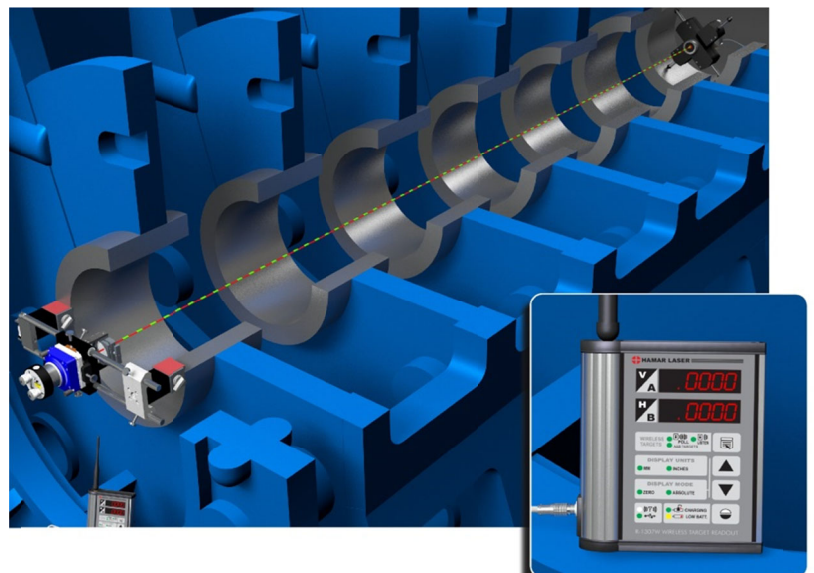
*Adjusting the angle of the L-706 to center it at the far bore.*

- c. With buckin offsets applied in the Bore9 software, steer the laser using the Pitch and Yaw knobs (angular adjustment) on the L-706 until the H and V displays are zero.



*L-706 Bore Laser and L-111 Laser Stand showing fine and course angular adjustments.*

- d. Repeat the process to confirm zero at both end bores. The laser is now “bucked in” (aligned or concentric) to the centerline of the near and far reference bores.



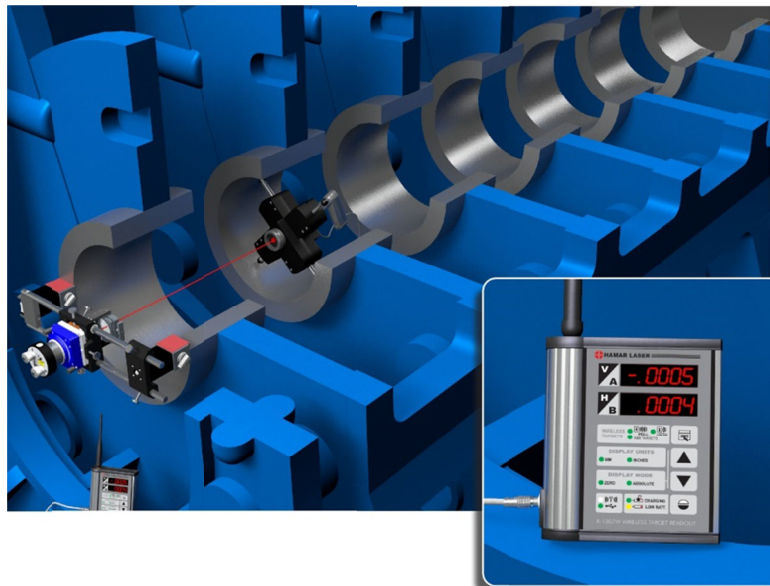
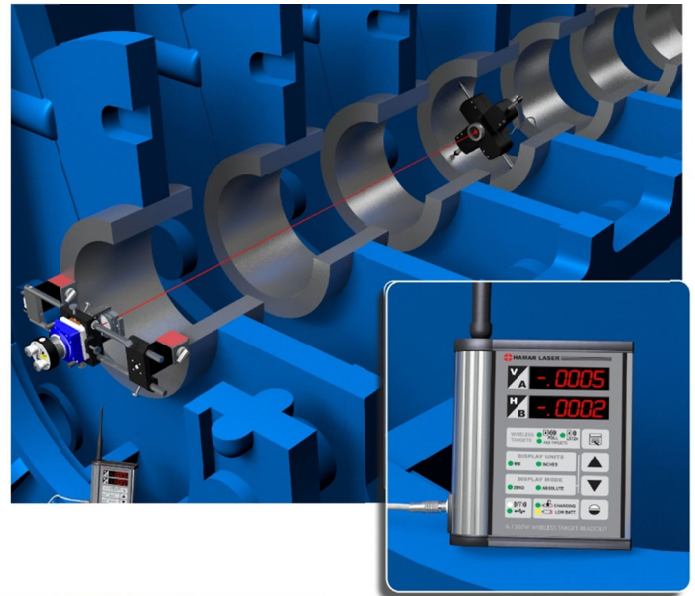
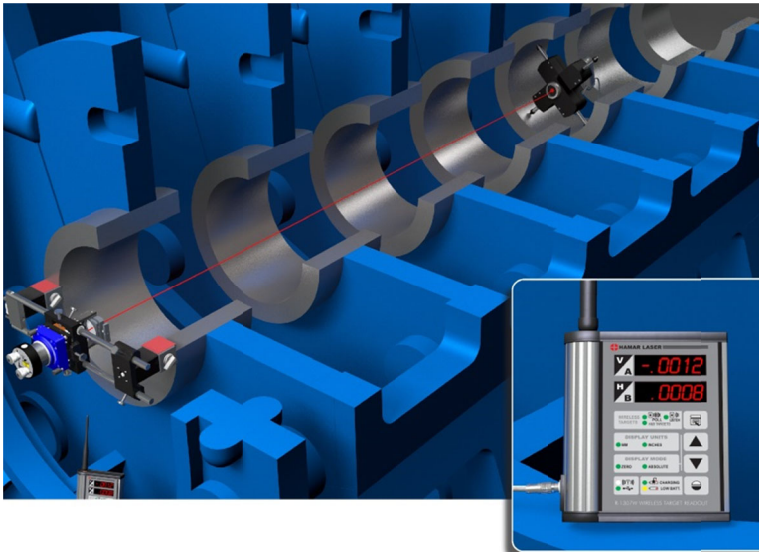
*The L-706 aligned to the center of both end bores.*

## Step 4: Record Data

- Move the target to the first bore you want to measure for alignment and press **Record**. Continue moving the target to each bore until all data is taken.



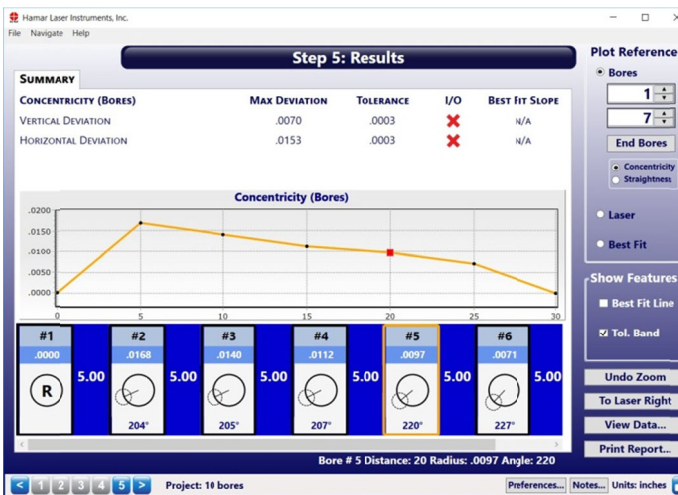
*Bore9 - Step 4: Record Data*



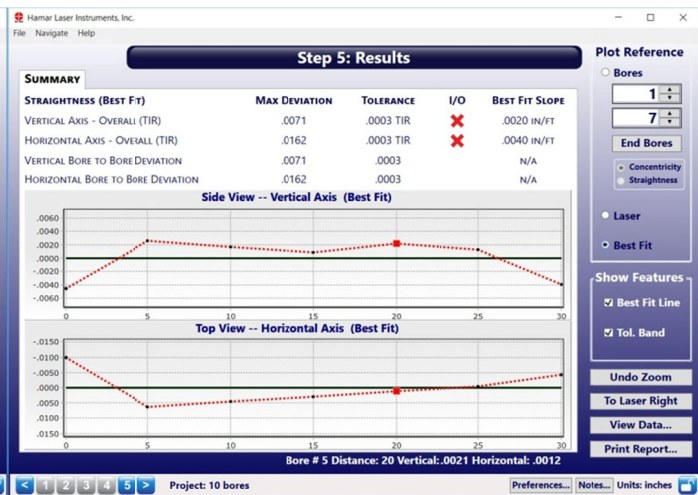


## Step 5: Results

- a. Step 5: Results displays a graph of the results and a summary of the alignment. There are several different options to view the data and whatever plot reference is chosen is printed in the report:
  - a. *Concentricity Plot – Bores:* this plot converts the Vertical & Horizontal values into 1 concentricity value and shows the angle of the radius for each bore. The user can choose any combination of bores to use as the reference and Bore9 will replot the data and alignment results.
  - b. *Straightness Plot – Bores:* this plot shows the V & H values for each bore and plots them individually. The user can choose any combination of bores to use as the reference and Bore9 will replot the data and alignment results.
  - c. *Straightness Plot – Best Fit:* this plot shows the V & H values for each bore and plots them individually. The summary data and graph are plotted relative to the least-squares, best-fit line calculated by Bore9.
  - d. *Straightness Plot – Laser:* this plot shows the V & H values for each bore and plots them individually. The summary data and graph are plotted relative to the laser beam (raw data).



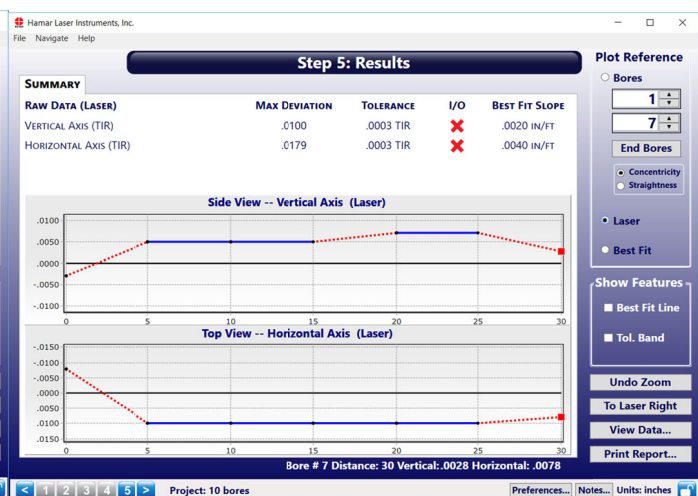
*Bore9 – Step 5: Results – Concentricity Plot using the End Bores as a reference.*



*Bore9 – Step 5: Results – Straightness Plot using the Best Fit line as a reference.*



*Bore9 – Step 5: Results – Straightness Plot using the Best Fit line as a reference.*



*Bore9 – Step 5: Results – Straightness Plot using the Laser as a reference.*

# Bore9 Sample Report

## Bore9 Report



Project: 30bores

Report Issued By

Company Name:

Address:

City, State Zip:

Phone/FAX:

Company Email:

### Machine Information

Factory Name:

Machine Information:

Notes:

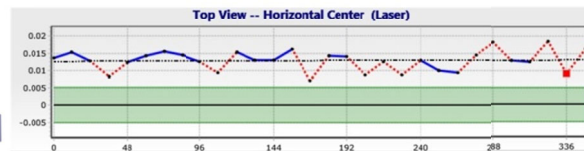
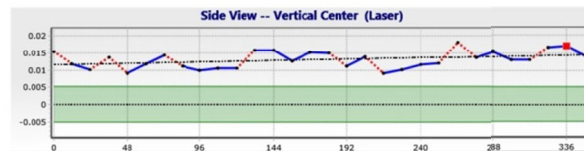
### Alignment Results

Alignment Check	Value	Tolerance (+/-)	BF Slope	Best Fit I/O	Plot I/O
Vertical Straightness (TIR)	.0085	.0051	.0001	✓	✗
Horizontal Straightness (TIR)	.0114	.0051	.0000	✗	✗
Vertical Bore To Bore (Max)	.0061	.0031		✗	N/A
Horizontal Bore To Bore (Max)	.0093	.0031		✗	N/A

### Setup Information

Number of Bores	30
Distance between bores	12.00
Units	Inches
Overall Tolerance	.0051
Bore to Bore Tolerance	.0031
Target / Interface	R-1307-900, R-1307-2.1
Serial Number	
Calibration Date	1/1/0001

### Result Graphs



### Alignment Data

Bore #	Dist	V Raw	H Raw	V Plot (Raw)	H Plot (Raw)	V Diam	H Diam	Rad	Ang Pos
1	0	.0154	.0137	.0154	.0137	0	0	.0206	228
2	12.0000	.0118	.0155	.0118	.0155	0	0	.0195	217
3	24.0000	.0101	.0129	.0101	.0129	0	0	.0164	218
4	36.0000	.0138	.0083	.0138	.0083	0	0	.0161	239
5	48.0000	.0091	.0124	.0091	.0124	0	0	.0154	216
6	60.0000	.0118	.0144	.0118	.0144	0	0	.0186	219
7	72.0000	.0144	.0156	.0144	.0156	0	0	.0212	223
8	84.0000	.0112	.0146	.0112	.0146	0	0	.0184	217
9	96.0000	.0099	.0127	.0099	.0127	0	0	.0161	218
10	108.0000	.0106	.0095	.0106	.0095	0	0	.0142	228
11	120.0000	.0106	.0153	.0106	.0153	0	0	.0186	215
12	132.0000	.0158	.0130	.0158	.0130	0	0	.0205	231
13	144.0000	.0158	.0131	.0158	.0131	0	0	.0205	230
14	156.0000	.0127	.0162	.0127	.0162	0	0	.0206	218
15	168.0000	.0152	.0070	.0152	.0070	0	0	.0167	245
16	180.0000	.0150	.0143	.0150	.0143	0	0	.0207	226
17	192.0000	.0112	.0141	.0112	.0141	0	0	.0180	218
18	204.0000	.0139	.0088	.0139	.0088	0	0	.0165	238
19	216.0000	.0092	.0126	.0092	.0126	0	0	.0156	216
20	228.0000	.0102	.0088	.0102	.0088	0	0	.0135	229
21	240.0000	.0117	.0130	.0117	.0130	0	0	.0175	222
22	252.0000	.0120	.0101	.0120	.0101	0	0	.0157	230
23	264.0000	.0181	.0094	.0181	.0094	0	0	.0204	243
24	276.0000	.0137	.0146	.0137	.0146	0	0	.0200	223
25	288.0000	.0151	.0184	.0151	.0184	0	0	.0239	220

### Alignment Data (Continued)

Bore #	Dist	V Raw	H Raw	V Plot (Raw)	H Plot (Raw)	V Diam	H Diam	Rad	Ang Pos
26	300.0000	.0130	.0130	.0130	.0130	0	0	.0184	225
27	312.0000	.0130	.0126	.0130	.0126	0	0	.0181	226
28	324.0000	.0164	.0186	.0164	.0186	0	0	.0248	221
29	336.0000	.0168	.0093	.0168	.0093	0	0	.0192	241
30	348.0000	.0141	.0165	.0141	.0165	0	0	.0217	221