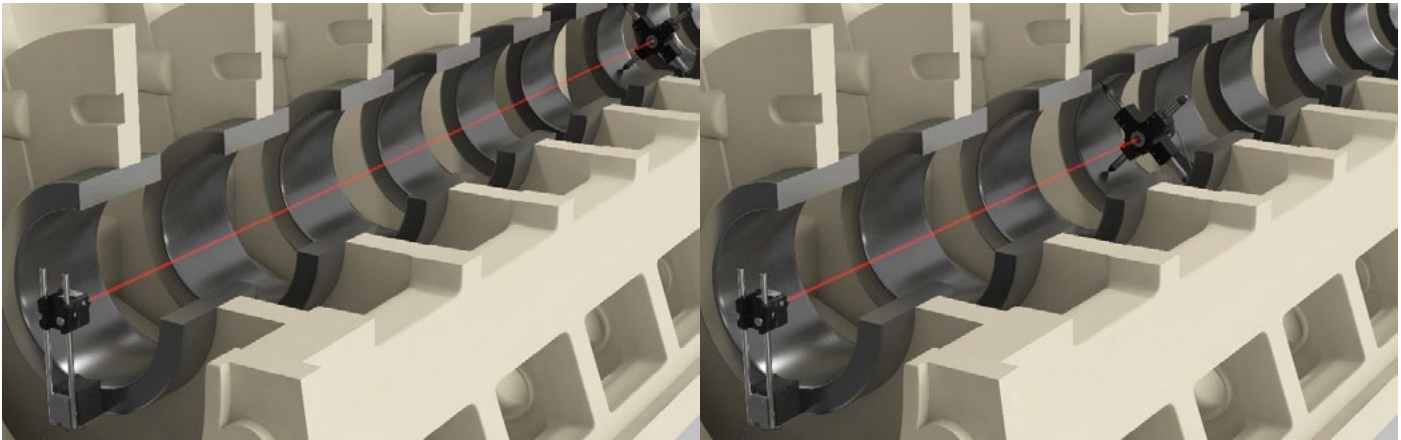# Application Note

Engine Block Bore Alignment with the L-703B Laser

L-703B 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-703B Laser is mounted in the L-112 Laser Stand and the L-103 Laser Beam Translator is attached. The L-112 has coarse *angular* adjustment capabilities and the L-103 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 A-512/A-514 target/adapter is placed in the first bore and the L-103 Beam Translator is adjusted to center the laser beam to the target. The target

L-703B Laser in L-112 Laser Stand

A-514A, B & C Self-Centering Bore Adapters

is then moved to the far reference bore and the angular adjustment 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 in 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.

Other Self-Centering Targets.

We also make several other self-centering targets (A-220, A-221 and A-510) that use customized set of tooling for each bore ID. These targets can align bores from .7 to 16 in. (18 to 400 mm) for applications such as extruder barrels, large gun barrels and compressors or for applications where there are only a few bore ID's.

Hamar Laser Instruments, Inc.
5 Ye Olde Road Danbury, CT 06810 Phone: 800.826.6185 Fax: 203.730.4611
Int'l: +1.203.730.4600 E-mail: sales@hamarlaser.com   www.hamarlaser.com
Click here for a list of our distributors.

MADE IN AMERICA

How it Works - the A-512 Target and A-514 Bore Adapters

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 45º. 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.

The A-512 Target inserts into the A-514 Adjustable Self-Centering Bore Adapters and self-center into a bore to within .0007 in. (0.01 mm). These A-514 adapters cover a range of bore ID's from 3.75 to 40 in. (95-1,000 mm) and are can be set to the nominal bore ID over this range using our A-514GS Leg-Setting Gage.
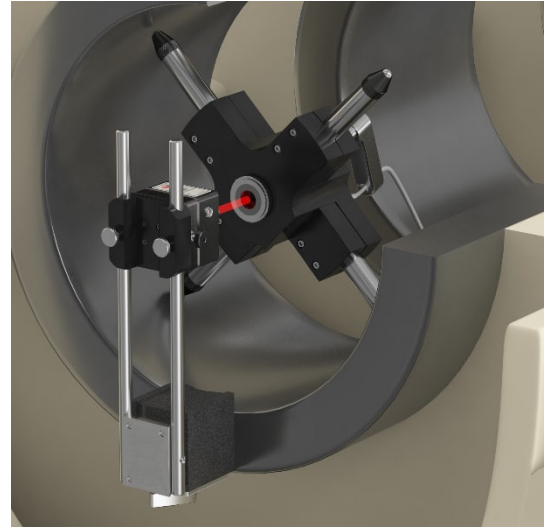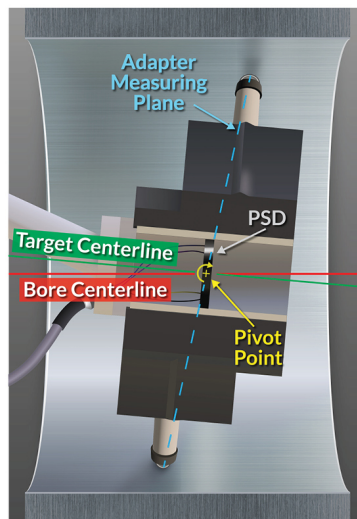

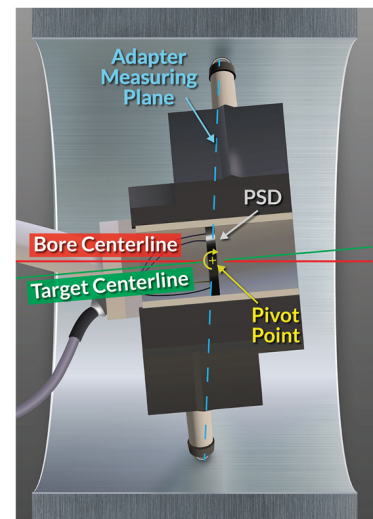*A-512 Target in A-514B Self-Centering Bore Adapter mounted in a bore*

Self-Centering Target Adapters and Bore Diameter Changes
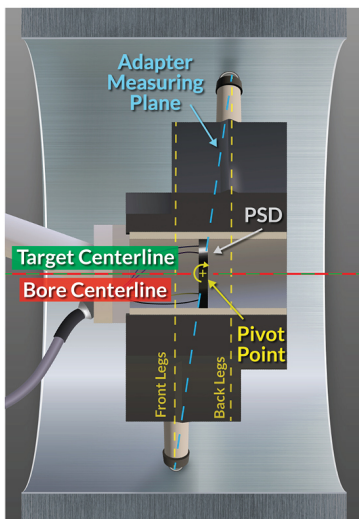
Adapter OD = Nominal Bore ID
Target is square to centerline

Bore ID > Nominal ID
Target tilts forward but PSD is still centered

**Bore ID < Nominal ID**
*Target tilts back but PSD is still centered*

How it Works – The L-103 Laser Beam Translator

The L-103 uses a parallel-sided piece of glass to redirect the laser beam to center it into a bore target. It works by the laser beam passing through the glass and reflecting off entrance surface and going up/down, or left/right, and coming out the exit surface with the beam being parallel but offset from the input beam. The angle of the beam is not affected by tilting the optic. The greater the tilt, the greater the position change of the laser beam. The resolution of the adjustment is .00005 in. (0.001 mm). It has a range of ±.040 in. (±1 mm)

The L-103 is attached to the L-703B Laser with powerful magnets. To translate the beam, there are 2 adjustment screws, one for horizontal movement and one for vertical. When the target is centered in the near bore with in ± .040 in., the L-103 is then used to finely adjust the position of the laser beam to be centered to the target. This makes the laser setup go much faster and easier than trying to move the magnetic base or the laser up/down the posts.
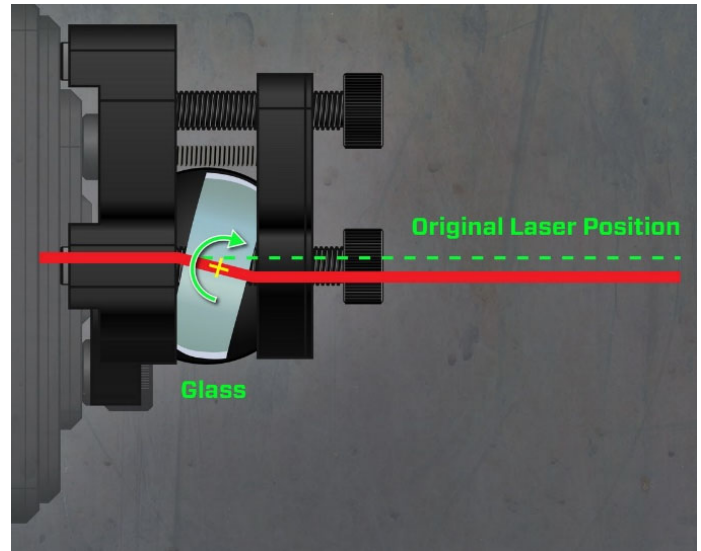
L-103 Laser Beam Translator Showing Beam Position Change with Tilted Optic
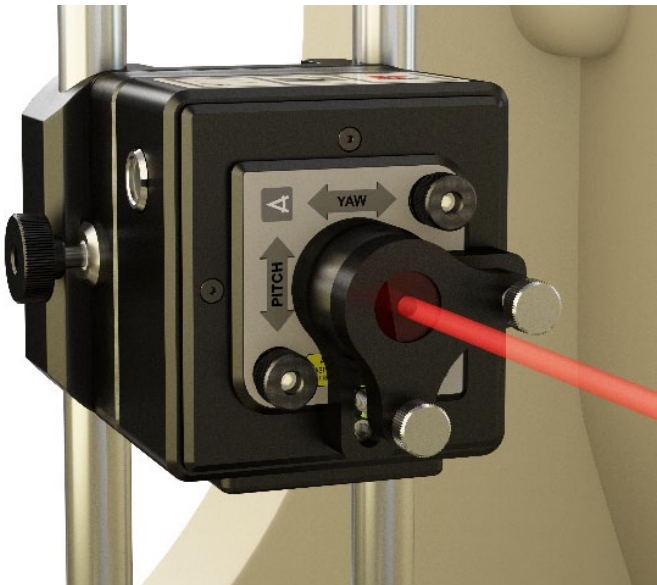
*L-703B Laser with L-103 Beam Translator*
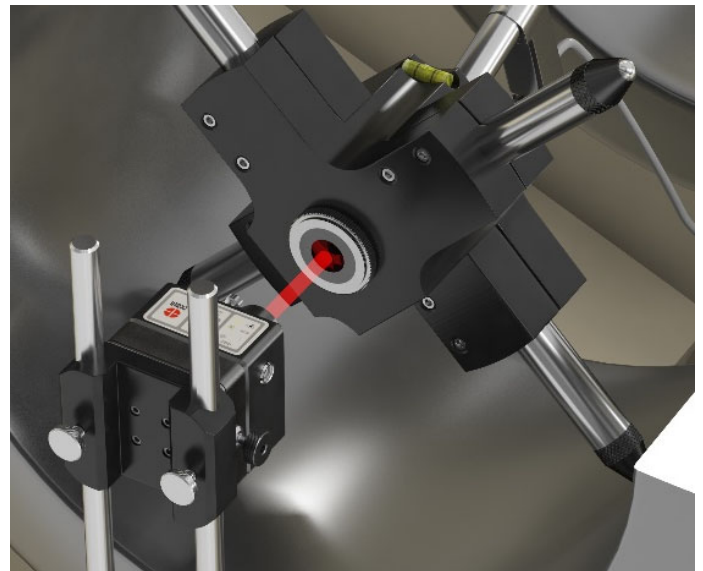
L-703B Laser with L-103 Beam Translator with Laser Beam Centered to A-512 Target

How it Works – Bore Alignment Procedure
## Using L-703B, L-112, L-103 and Bore9

Step 1: Setup

a. Open Bore9 and select the target and computer interface.

b. Enter the number of bores, the distance between the bores, the bore diameters, and select the alignment tolerances.
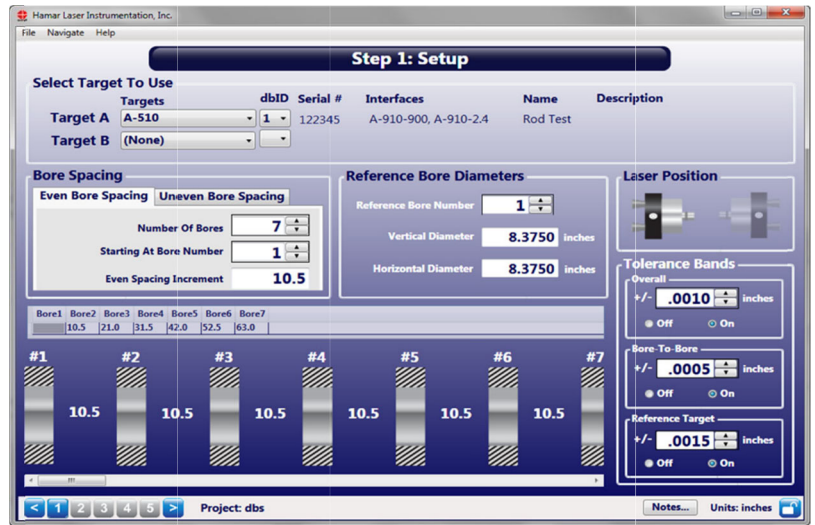
Bore9 – Step 1: Setup

c. Measure the nominal bore ID. Then use the A-514G Leg-Setting Gage to set the length of the legs to the nominal ID for the A-514 Bore Adapter.

Note: If using the A-220, A-221, A-510 Targets and Self-Centering Bore Adapters, then the matching customized set of bore adapter tooling would be assembled with the target.
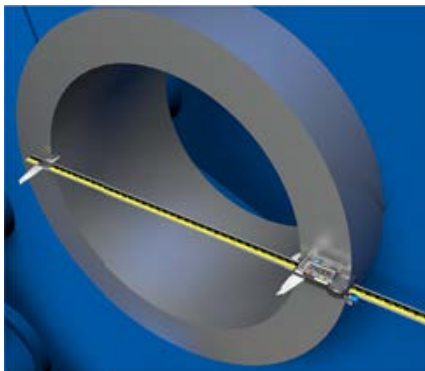
A-514GS Leg-Setting Gage for A-514 Adapters

d. Slide the A-514A, B or C onto the A-514GS gage. Insert the stop-pin and insert a leg into one of the mounting holes. Push the leg against the stop and tighten the set screw. Repeat for all four legs. This sets all 4 legs to the same length to a high degree of accuracy – usually below .0002 in. (0.005 mm).
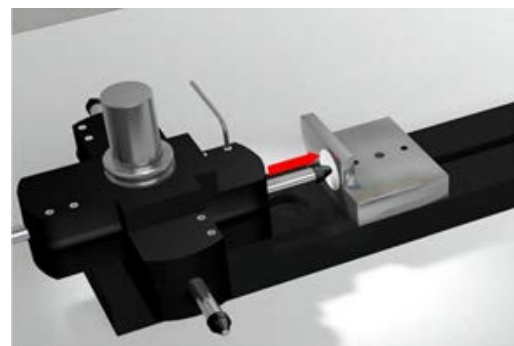
A-514GS Leg-Setting Gage - positioning the legs of A- 514B Bore Adapter

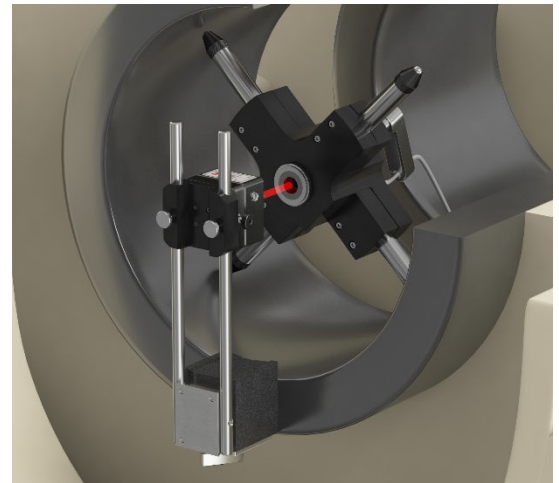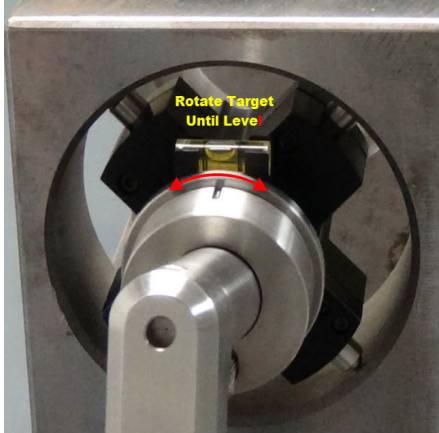e. Insert the A-512 into the A-514 Adapter and insert them both into the near bore, making sure the adapter's level vial is level, which aligns the target's V&H measurement axes with the bores V & H axes.

L- 703 Laser with A-512/A-514 Target in near bore

f. Adjust the L-103 Beam translator to zero the R-1307 Readout and center the laser into the first reference bore *(see the graphic on page 2 that shows how the L-103 moves the height of the laser beam, but not the angle)*.

g. The laser beam is now centered to the A-512 Target located in the near reference bore.

L-103 Laser Beam Translator Adjustments

Step 2: Remove Target Mounting Error (optional)

Note: Step 2: Remove Target Mounting Error of the Bore9 program is usually 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.

6

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). With the target in the *near* bore and zeroed, press **Record** to record data for the *near* bore.

Bore9 - Step 3: Data Taken Near Bore

a. Move the target to the *far* bore and press **Record**. A calculation of the laser *Set Points* will be made to aid the laser setup and offsets will be applied to on-screen live data. This allows the user to steer the laser to zero instead of the calculated offsets, making the setup process a faster and easier.
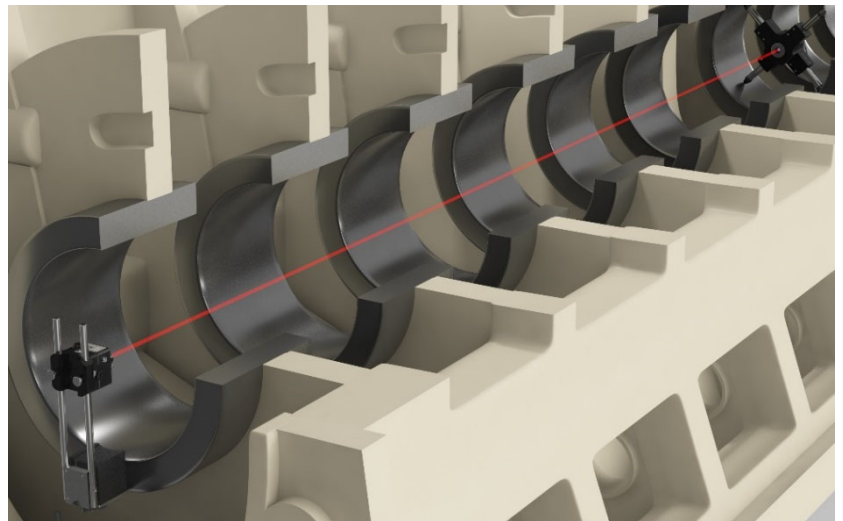
A-512/A-514 Target/Adapter Moved to Far End Bore

Bore9 - Step 3: Data Taken Far Bore and Set Points Calculated

b. With Buckin Offsets applied in the Bore9 software, tilt the laser beam using the Pitch and Yaw knobs (angular adjustment) on the L-703B until the H and V displays equal the set point or are very close.

Adjusting the H & V angles on the L-703B to center it at the far bore

Bore9 - Step 3: Laser Steered to Zero (Bucked-In)

c. Move the target back to the *near* bore to confirm the values are the same as they were at the *far* bore.
d. If needed, repeat the process to confirm the same value at both end bores. The laser is now "bucked in" (aligned or concentric) to the centerline of the near and far reference bores.

Step 4: Record Data

a. Move the target to the first bore you want to measure for alignment and press **Record**. Inserting the target and taking a measurement only takes 5-10 seconds. Continue moving the target to each bore until all data is taken.
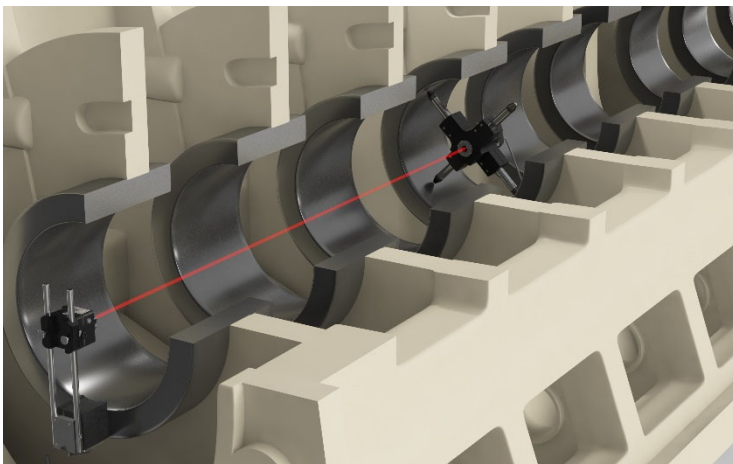
A-512/A-514B Target/Adapter Measuring an Inner Bore

Bore9 – Step 4 – Data Recorded for All Bores

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 one 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. The best fit calculation removes any remaining slope error in the data due to the laser not being perfectly bucked in to the end bores.

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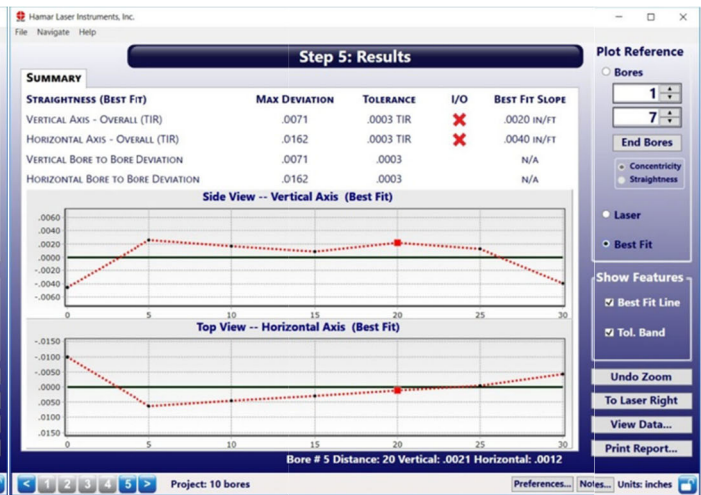
Bore9 – Step 5: Results – Straightness Plot using the Best Fit line as a reference.
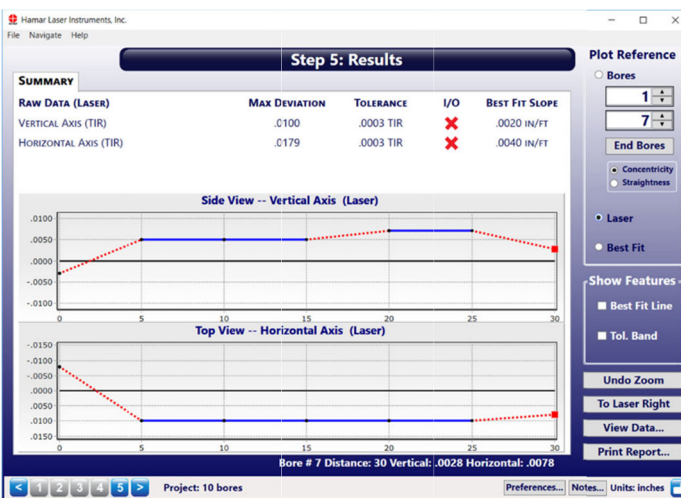
Bore9 – Step 5: Results –Concentricity Plot using the Laser as a reference.

Bore9 – Step 5: Results – Concentricity Plot using Bores 2 & 8 as a reference.

Bore9 Sample Report

Bore9 Report

HAMAR LASER

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-1307-2.4
Serial Number	
Calibration Date	1/1/0001

Result Graphs

Side View -- Vertical Center (Laser)

Top View -- Horizontal Center (Laser)
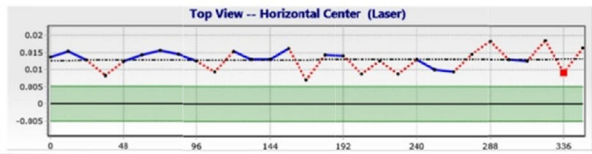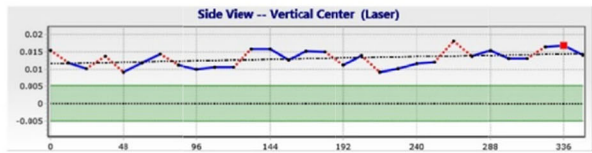
Alignment Data

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	.0153	.0184	.0153	.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