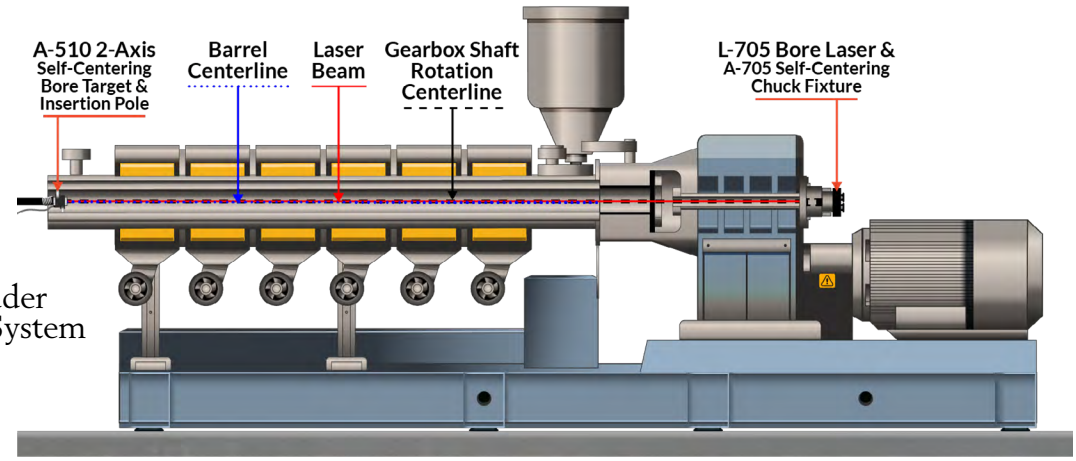
Application Note 2

System Recommendations:
L-705 Laser Boroscope for Extruders
L-700 Laser Borescope for
Twin-Barrel Extruders

Extruder Alignment

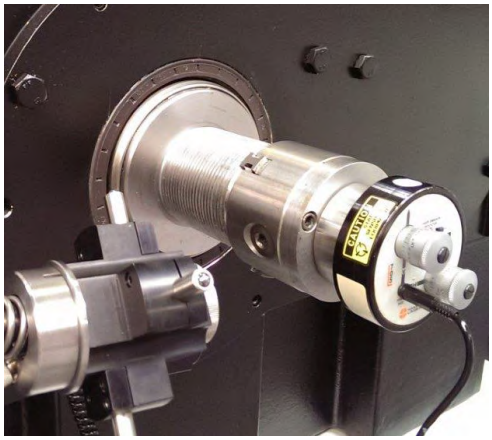
How the Alignment System Works



L-705 Extruder Alignment System Basic Setup

The L-705 Laser is mounted into the gearbox spindle through-hole (counter bore) by using our A-705 self-centering chuck, which has a specially adapted plate with a .750" (19 mm) laser-mounting hole that is centered to the feet to within .0005" (0.01 mm). The A-510 2-Axis Target and self-centering bore adapter are inserted into the barrel and self center, producing a reading within 2-3 seconds. The target and adapter are specially designed to find the center of the bore, without any moving parts, to a tolerance of .0005" or 0.01 mm (with care, tolerances of .0002" or .005 mm can be achieved). The bore adapters are customized for each barrel diameter but can handle a small range of diameter variance (~± .040" or 1 mm).

To check the alignment, the L-705 laser is aligned to the axis of rotation of the extruder gearbox spindle, using a method we call the NORMIN (NORMal and INverted) procedure. After this quick setup, the laser projects the spindle rotation axis down the barrel, where the target supplies the alignment value of the barrel. Using the A-510E Insertion Pole, the target is then inserted into the barrel, where the barrel-support is located, and it produces a nearly instantaneous measurement. The target values update in real time, so the barrel can be adjusted while watching the values update. When the readings are zero (or within a tolerance), that part of the barrel is aligned and the target can be inserted into the next barrel-support location (if there is more than one).



L-705 Bore Laser with A-705 Self- Centering Chuck in an extruder counterbore

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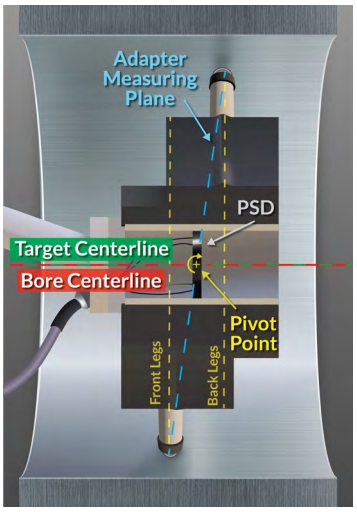
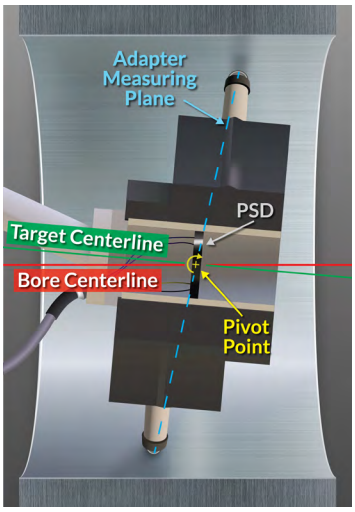
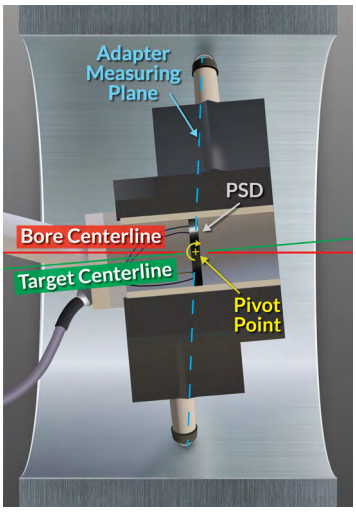
How the 2-Axis Bore Targets and Self-Centering Adapters Work



Bore Target & Adapter Adapter OD = Nominal Bore ID



Bore ID < Nominal ID
Target tilts forward. PSD is still centered

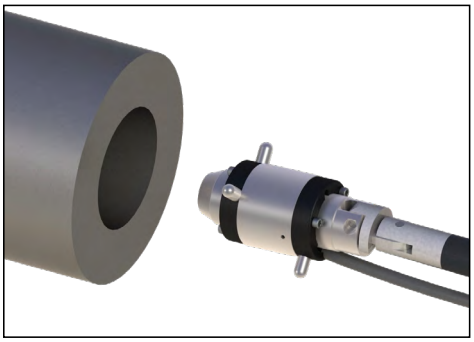


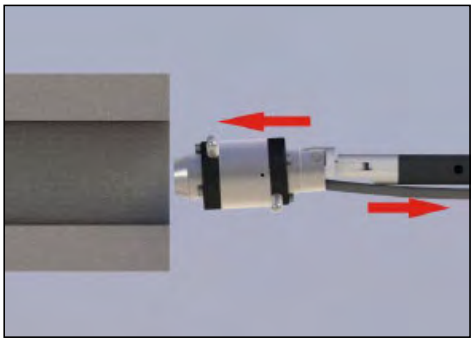
Bore ID > Nominal ID
Target tilts back. PSD is still centered

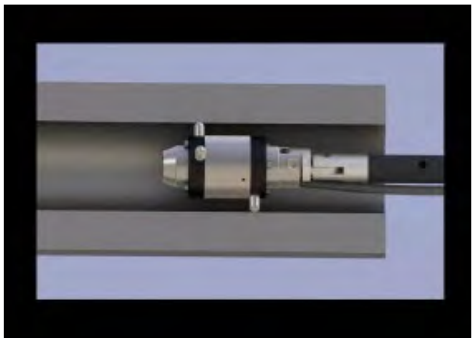
The A-220, A-221, A-510, A-512 targets and self-centering bore adapters are designed so that the PSD (Position Sensing Detector) is centered axially between the four feet of the adapter, two of which are offset axially from the other two (see graphic above). This, in effect, puts the PSD on the pivot point of the adapter and allows the angle of incidence to the laser beam to vary by up to 45°.

With "spider-type" bore measuring targets, diameter changes cause the target center to move up or down, so this requires that 2 measurements be made at each bore location: with the target at 0° and rotated 180°. Calculations are then performed on the 2 measurements to generate the actual alignment value, a time consuming process. However, with self-centering bore adapters, the diameter can change up to ~± .040 in. (1 mm) and this will not affect the measurement. All it does is either tilt the target/adapter forward or back but it always finds center!

To insert the target into the barrel, a spring-loaded pole is attached to the target and the target cord is pulled. This tips the target forward, allowing it to easily slide into the bore. When the cord is released, the target and adapter "jam" into the bore, finding the center automatically. The weight of the pole keeps the target seated in the bore.







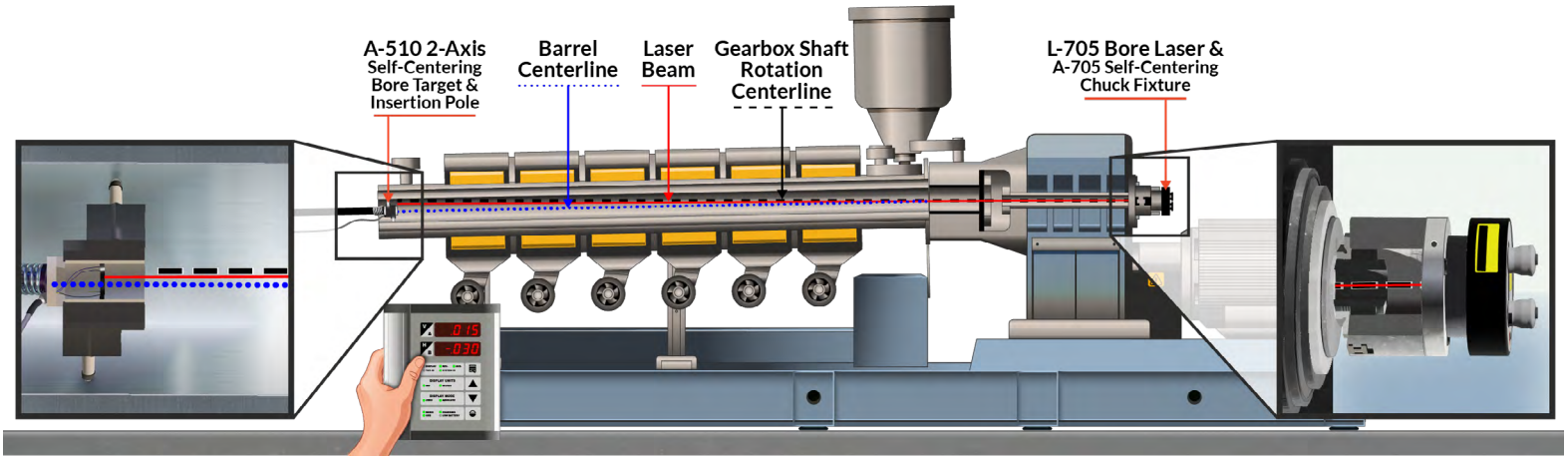
A-221 Target and A-221LTA Bore Adapter Inserted into a Extruder Barrel

The L-705 Extruder Alignment Procedure Using the A-510 Target and A-510STA Adapter

To perform an alignment, Hamar Laser's NORMIN procedure is used to put the laser beam on the axis of rotation of the gearbox, which is then projected down the barrel to the target.

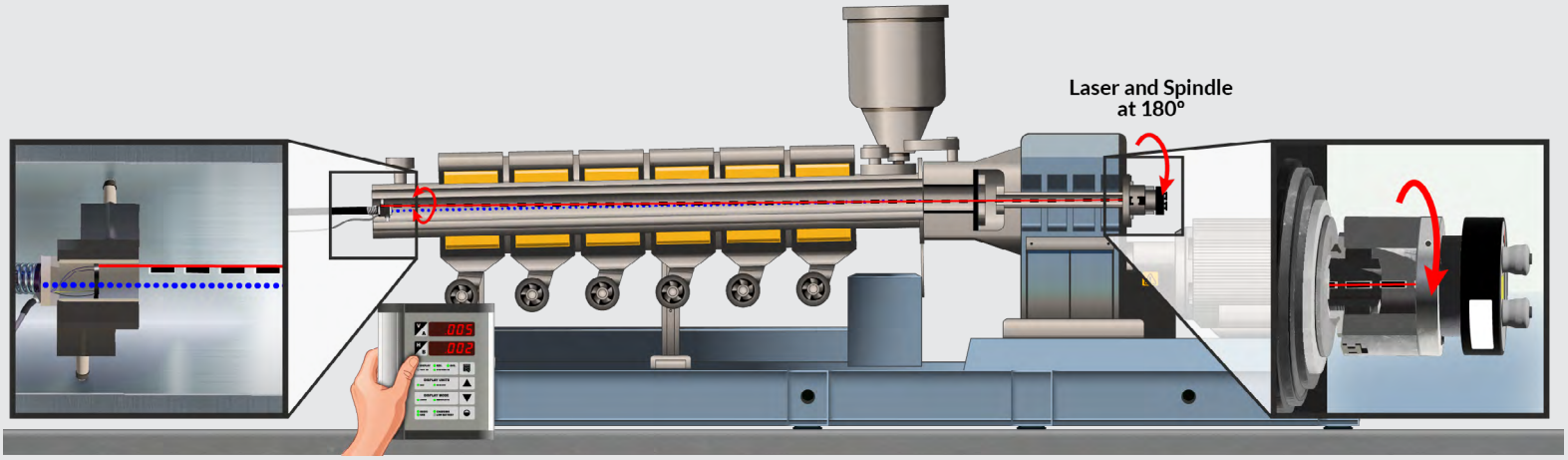
Step 1: L-705 Laser in Normal Position

Insert the laser and the self-centering laser fixture into the gearbox counter bore and the A-510 Target and A-510LST Bore Adapter into the free end of the barrel. Write down the H (horizontal) and V (vertical) readings.



Step 2: L-705 Laser in Inverted Position

Rotate the gearbox by hand until the laser is inverted, using the built-in levels to determine the inverted position. Write down the second set of readings.



Step 3: Calculate Set Points

Average the horizontal values for NORMal and INverted, and then average the vertical values. The results determine the set points for the horizontal and vertical axes (see example below). You can also use Bore9 to automatically calculate the set points.

Laser at 0 degrees (12 o'clock)

V Reading	+.015"
H Reading	-.030"

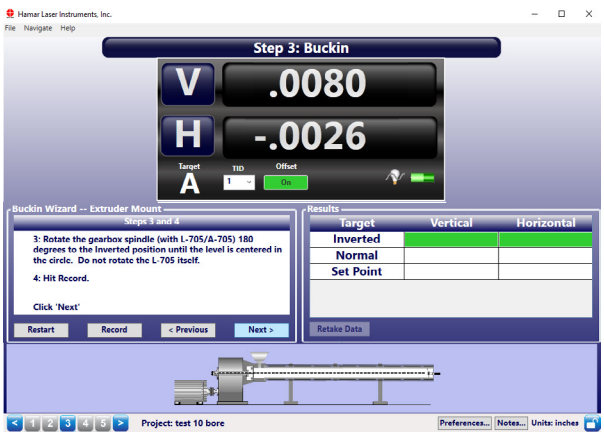
Laser at 180 degrees (6 o'clock)

V Reading	+.005"
H Reading	+.002"

Setpoint =

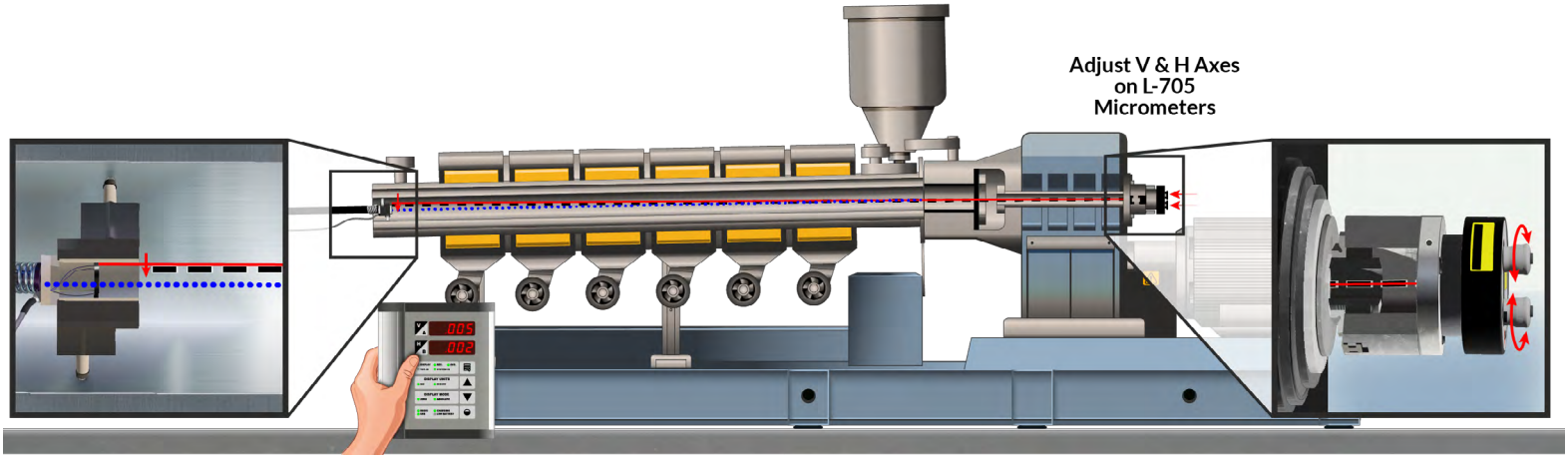
$$\frac{V_N + V_I}{2} = \frac{.015 + .005}{2} = +.010"$$

$$\frac{H_N + H_I}{2} = \frac{-.030 + .002}{2} = -.014"$$



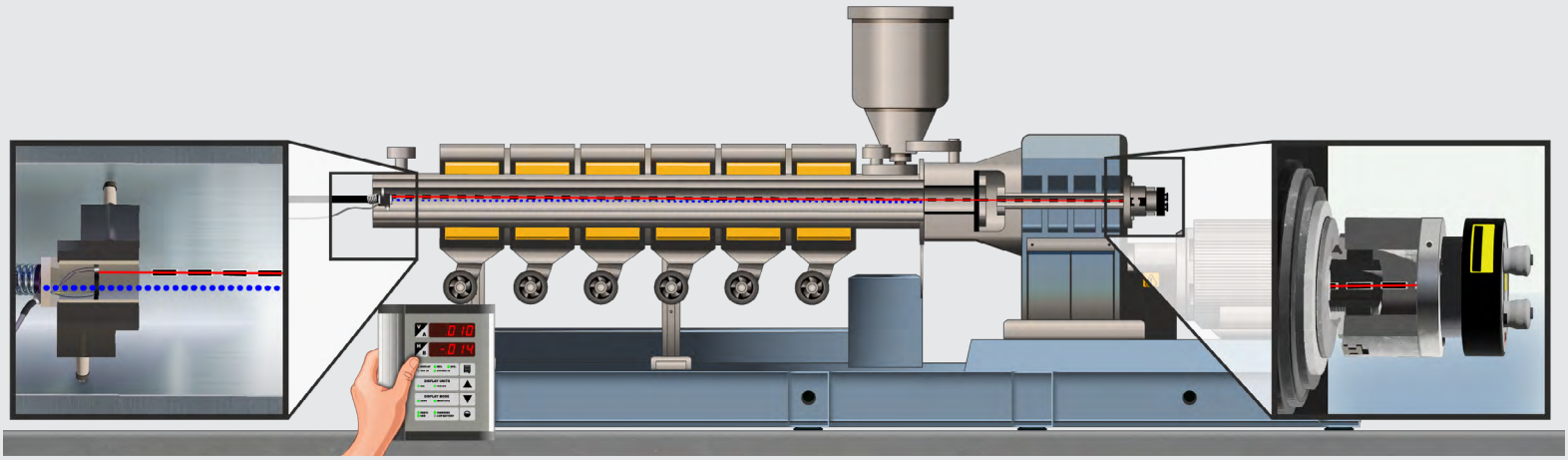
Step 4: Adjust Laser V & H Micrometers Until Readout Displays the Set Points

Turn the angular adjustment micrometers until the readout V and H display values equal the Set Points.



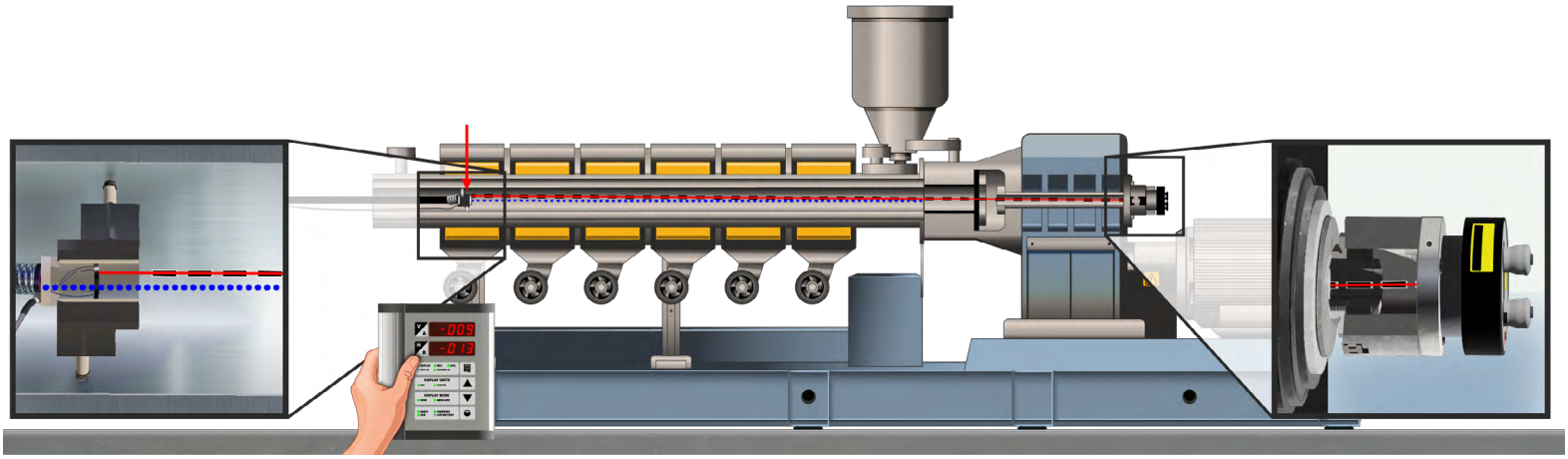
Step 5: Laser Beam Concentric to Axis of Rotation

The reading produced after completing the NORMIN procedure is then a measure of the misalignment of the free end of the barrel to the gearbox axis of rotation. To align the barrel, it is best to move the target into the barrel just above the first support. Now the barrel can then be shimmed or moved until the readout displays .000" in both axes. If there are no other supports, then the barrel is aligned!



Step 6: A-510 Target Inserted to First Adjustment Point

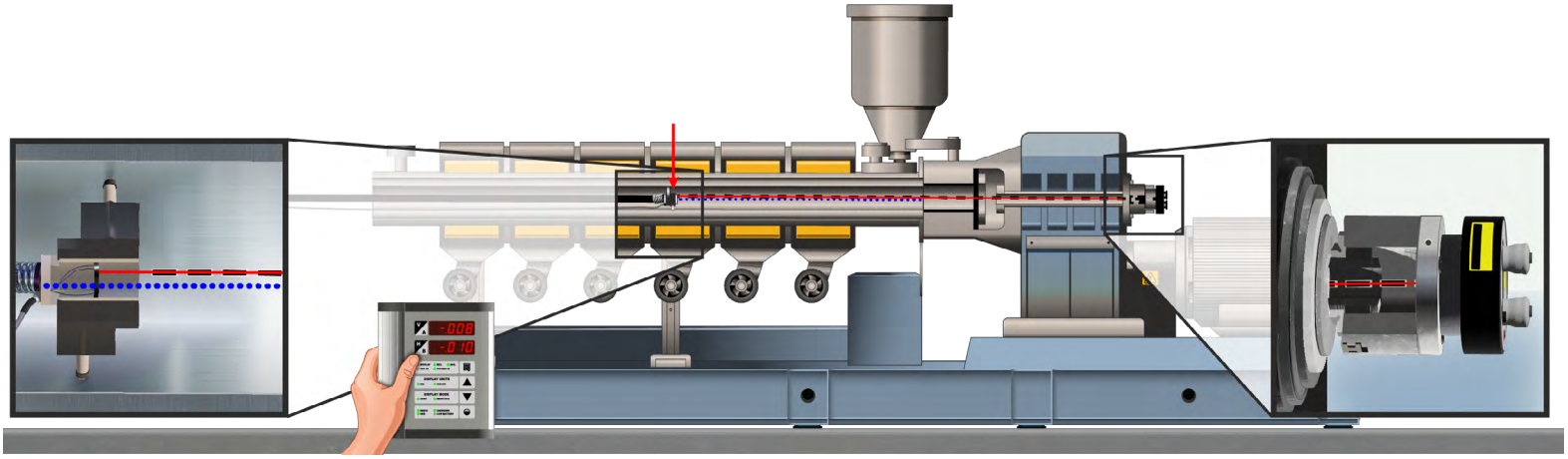
Pull on the cord to release the A-510 Target and move the target into the barrel to just above the first adjustment point. Adjust the V and H axes of the barrel until the R-1307 Readout shows zero or is within the alignment tolerance. The data is live, so the R-1307 readout will update as the barrel is adjusted.



Step 7: A-510 Target Inserted to Second Adjustment Point

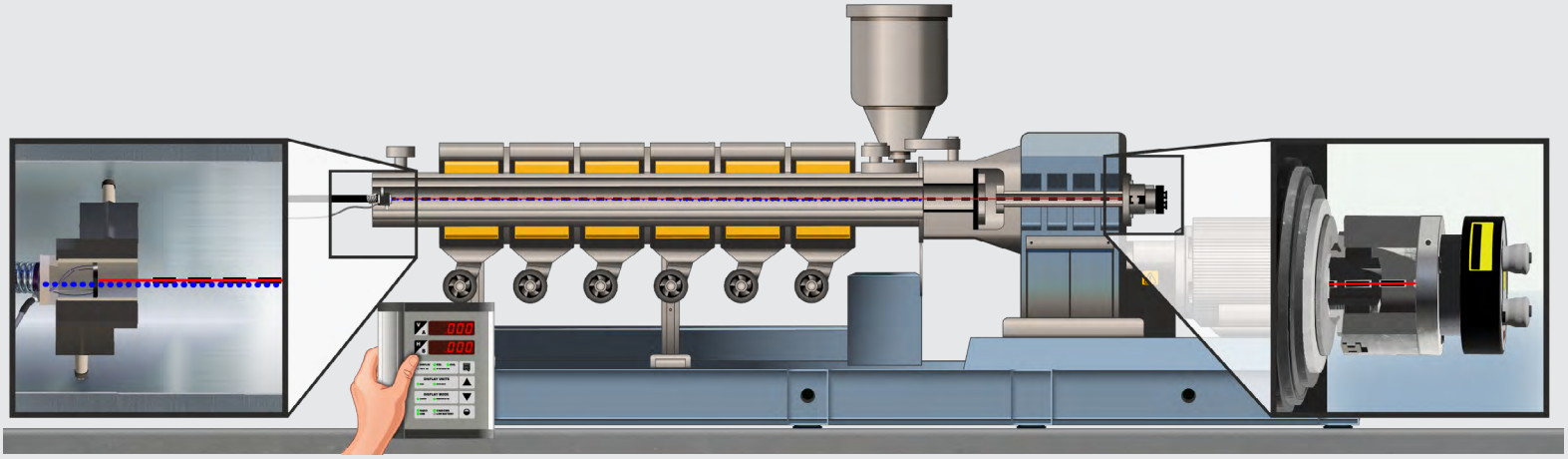
If there is more than one adjustment point for the barrel, then the target can be inserted into the barrel at the point just above the second support, and again the barrel can be shimmed or moved until the readout reads zero or is within tolerance.

Note: It is always advisable to move the target back to the first support point and check to see if adjusting the barrel at the second point caused the alignment at the first support to be slightly out of tolerance.



Step 8: L-705 Extruder Alignment System –Barrel Aligned to Gearbox

Double check to make sure the first and second adjustment points are still aligned. If so, then, the barrel is now aligned!



Using Bore9 Software

Hamar Laser's Bore9 software supports all Hamar's past and present bore alignment equipment to create a powerful tool for measuring and aligning up to 50 bores. This comprehensive and easy-to-use program measures bore straightness (axis centering) and barrel wear (diameter change) when using our targets in measuring mode. Applications include engine blocks, extruder barrels, hydraulic cylinders, large-bore gun barrels, printing press bearings, rotary compressors and turbines.

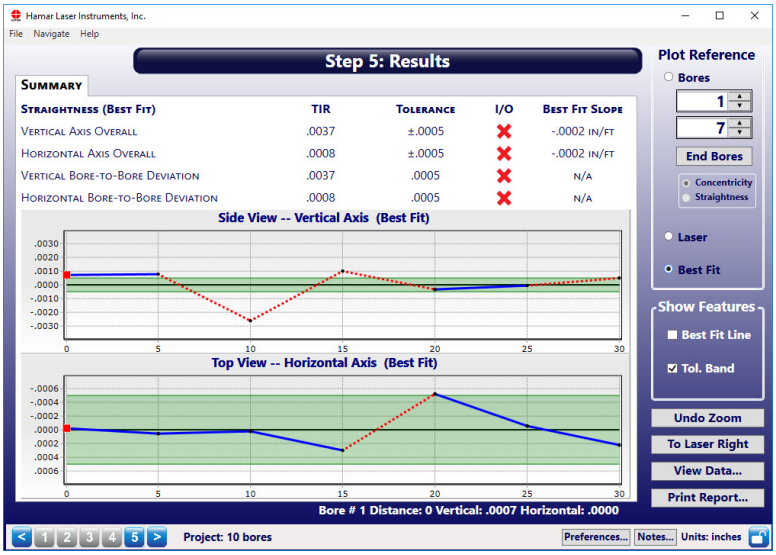
Bore9 features an easy 5-step process (described briefly below) that guides the user through the alignment process from setup to results. These results can be plotted, saved, and exported to an Excel spreadsheet.

- **Step 1 – Bore Setup.** The user enters setup information for the alignment check such as number of bores, distance between bore, bore diameters and bore straightness tolerances.
- **Step 2 – Target Mounting Error.** An optional step in the extruder alignment process for high accuracy applications to remove target adapter mounting errors, using the NORMIN method. The word NORMIN is a contraction of NORMal-INverted, which briefly describes the method.
- **Step 3 – Laser Setup.** On-screen instructions guide the user through setting up the laser and making it parallel to reference points.
- **Step 4 – Record Data.** Bore straightness data and barrel wear data is recorded here. There are several different sets of data that can be taken in this step.
- **Step 5 –Results.** Results of the recorded data are plotted on a graph and a least-squares, best-fit data algorithm is applied to generate the straightness results and to determine if they are in or out of tolerance. Plot data can be changed to reflect the position of the centerline of the bores relative to the end bores, selected bore numbers, the laser beam or a "Best Fit" line. The data for each point is recalculated automatically based upon which references are chosen.
  Reports are also generated in this step and can be customized to the four different bore references. Comments may be added and the report can be printed with a summary, a graph of the vertical and horizontal straightness, comments and a table showing the recorded data.

Bore9 Sample Report

Bore9 Step 1: Setup (Bore diameters, tolerances, etc.)

Bore9 Step 4: Record Data showing barrel wear and straightness recorded data.

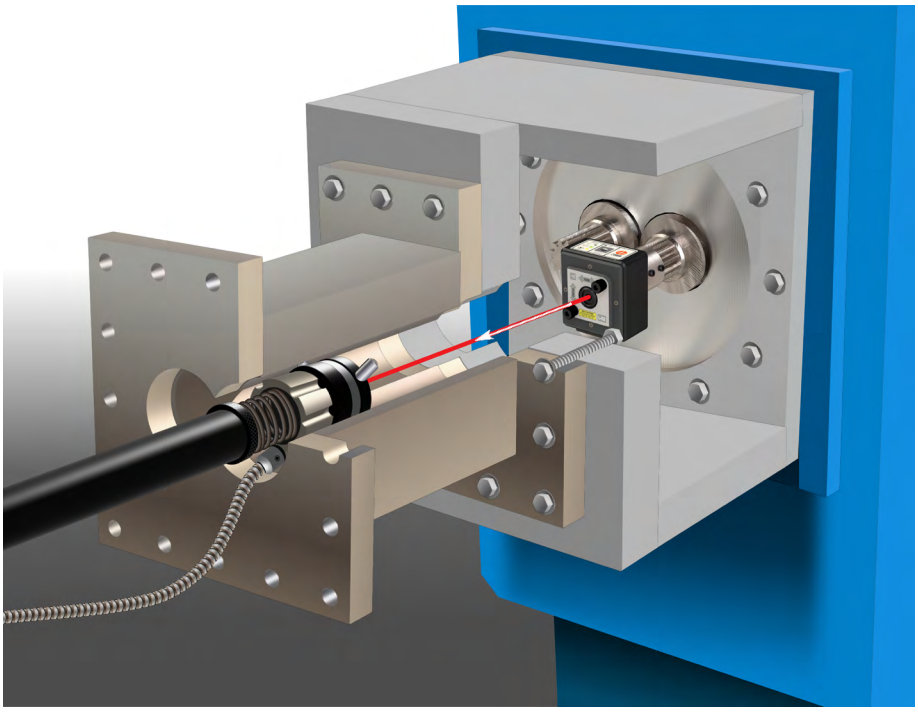


Bore9 Step 5: Results showing overall straightness of the barrel relative to the Best Fit line.

Aligning Twin Barrel Extruders with the L-703B Laser Alignment System

The L-703B Alignment System Procedure

The L-703B Laser is affixed to the gearbox output shaft using the A-703T-A-OD Customized Spline-Shaft Adapter. The A-703T has an adjustable plate that is used with a dial indicator to center the mounting hole to the rotation axis of the spline shaft. When the L-703B is installed in the A-703T, the laser then projects the gearbox shaft centerline out to 50 feet (15 m).



L-703B Bore Laser, A-703A Spline-Shaft Adapter and A-510/A-510STA Self-Centering Target and Bore Adapter

A customized bore adapter (M-220, M-221, A-221LTA, A-510STA, A-510LTA bore adapters) and pole are attached to the 2-axis bore target (A-220, A-221, A-510 or A-512) and the assembly is inserted into the free end of the barrel. The target automatically centers itself and immediately provides a horizontal and vertical measurement of alignment. Similar to the procedure for the L-705 Laser, the L-703B H & V laser beam angles are aligned to the gearbox shaft rotation axis. Once completed, the resulting values show the alignment of the barrel to the gearbox rotation axis. The target is then inserted into the barrel to be over one of the adjustment points. The R-1307 Readout displays the misalignment numbers dynamically, so you can simply adjust the barrel until the readout reads zero and the barrel is aligned.

If the twin-barrel is under construction, the system can be used to align each section of the barrel. This is a much better alignment method than using indicators on the outside of the barrel or relying on pins and manufacturing to perform the alignment, both of which are subject to significant stack up errors.