Hamar Laser manufactures the most accurate and portable bore alignment laser systems on the market today. In most cases, our bore alignment systems can fit into a case that is not much larger than a briefcase. These alignment systems are available with a variety of options, including self-centering, see-through, 2-axis and 4-axis targets, hand-held readouts, and Windows-based software to display and analyze alignment data. Since data is live, a bore that is out of alignment can be quickly brought into tolerance using these laser alignment systems. For example, a 10-foot (3 meter) bore can be measured for straightness every three inches in 15 minutes or less, including setup.

Applications for the bore alignment system include bore straightness checks on individual parts, boring bar alignment, crankshaft bore alignment, stern tube alignment, tail rotor bearing alignment for helicopters, bar turning machines, aluminum can-making machinery and hinge line alignment for commercial aircraft. If your specific application isn’t listed, we will work with you to solve your unique alignment problems.

The L-706 Bore Laser System

L-706 Bore Laser
The L-706 Bore Laser is a battery-operated, visible light laser that mounts magnetically in a bore fixture or mounting. It is suitable for almost all bore applications. The laser has two mounting surfaces: 0.7498" (19.04 mm) and 2.2498" (57.14 mm). The laser beam is centered to both mounting ODs to within .0004" (0.010 mm). The L-706 Laser is equipped with fine angular adjustments necessary to set the laser beam to the center of the far reference target. It is used for applications from 50 feet (15 meters) to 110 feet (33 meters).

Superior Design Reduces Fixturing Costs
The L-706 Laser has been designed with a standard aerospace tooling diameter of 2.25" (57.15 mm). Since the laser beam is concentric to the OD to within .0005" (.0127 mm), a simple flat face and .750" (19.05 mm) hole on center is all that is needed to hold the laser (powerful magnets hold the laser flush to the face). In fact, the laser replaces the first reference target that a typical borescope would need. Hamar Laser’s NORMIN procedure eliminates mounting and centering errors of the fixtures.

Long Range and High Accuracy
Under good environmental conditions, the L-706 Laser is accurate to .001" (.0254 mm) over the whole range. By carefully following the NORMIN procedure, accuracies of .0001" (.00254 mm) in 10 feet (3.1 meters) can be achieved. With simplified fixturing and self-centering targets, the system can be set up in as little as 5 minutes. And in most cases, bore straightness data can be taken and analyzed in 15 minutes or less using Read9 software.
A-512 Patented Self-Centering Target Vastly Simplifies Setup
The A-512 2-Axis Bore Target is designed specifically for our A-514 line of self-centering bore adapters. The target is concentric to its housing to within .0003" (0.0075 mm). When used with the A-514 adapters, the sensor is centered to the bore within .0006" (0.015 mm). The self-centering feature eliminates the need to rotate the target 180 degrees to determine mounting errors. This means a bore measurement can be taken in about 20 seconds. The target provides live alignment data via our R-1307 readouts.

A-512 Features:
• When used with the A-514 Adapters, the A-512 provides self-centering bore alignments, significantly reducing bore alignment measurement times.
• Accurate to .0003" (0.0075 mm)
• 2-axis PSD with 10x10 mm measuring area, giving ± .100" (± 2.5 mm) measuring range
• Use with R-1307 Readouts to display data with a resolution of .00002" (0.0005 mm)
• Use wireless version of R-1307 (R-1307-2.4ZB) to transmit data to PC for data recording.

A-512 Target Measures Bore Diameters
In Measurement Mode, the A-512 will measure changes in a bore’s diameter. It works like this: First, a reference diameter is measured with an inside micrometer. The target is placed in the reference bore and the reading is noted. The target is then inverted and the readings averaged to calculate the target centering error. The corrected reading becomes the benchmark diameter. Subsequent measurement points in the bore are compared to the benchmark and the difference in target readings is the increase or decrease in bore diameter.

System Handles Large Range of Bores
Any bore, from 1.5" (38.1 mm) on up to 36" (914.4 mm) or more, can easily be measured with our L-706 Bore Laser System. For smaller bores up to 12" (30 mm), the A-512 2-Axis Self-Centering Target is used to measure bore straightness. For larger bores, the T-218 Two-Axis Universal Target and the T-225L Large Bore Flange are used instead of the A-510. The T-218 has prism that can be flipped out of its center, allowing the laser beam to pass through. This is especially useful for aligning multiple bores over long distances, such as steam or gas turbine alignment.

Alignment System Features
• Fast and simple setup
• Built-in horizontal and vertical angular adjustments for quick referencing
• Simple fixturing to mount the laser into the reference bore
• Visible laser beam straight to .0001" in 10' (0.0025 mm in 3 meters) or .001" in 100' (0.025 mm in 30 meters)
• R-1307-2.4ZB Readout supports both wireless and cabled targets
• Self-centering target, accurate to .0002" (0.005 mm), vastly simplifies measurement process
• Windows-based software with large color graphics.
• Large digital display eliminates long cables
• Dynamic or live display of component misalignment
• Portable enough to fit into small carrying case. Complete system weighs less than 15 lbs (6.804 kg).
• Laser runs for up to 8 hours on a standard, replaceable 9-volt battery
• Compact and rugged (4" L x 2.9" H x 1.75" W)
  (101.6 mm x 73.66 mm x 44.45 mm)
• Easily accommodates bores as small as 1.5" (38.1 mm)
Other Bore Applications

**Cam/Crankshaft Bore Alignment**
The L-706 Bore Alignment Laser System has provided several automotive and diesel-engine manufacturers with a fast, reliable method of measuring the crankshaft bore for both straightness and size. The laser system has proven to decrease inspection times significantly and virtually eliminated dedicated, expensive gauging. The laser and target are adaptable to most crankshaft bore applications. A simple holding fixture is all that is needed for mounting the laser. The A-512 Self-Centering Target and the A-514A, B and C adapters quickly position the target in the bore for ultra fast and accurate alignment checks.

The L-706 has also been used for measuring the straightness of engine block cylinder bores in both conventional automotive engine blocks, as well as the larger block designs used in trucks, farm implements and diesel locomotives.

**Stern Tube Alignment**
The L-706 is also ideal for measuring the straightness of stern tubes in marine applications. Combined with our T-261A 4-Axis Target and an adjustable fixture, the L-706 can project the axis of rotation of the engine or gearbox down into the tube for alignment, minimizing the number of moves during the final engine alignment.

**Bar Feeder Alignment**
The need for rapid job changeover brought about the need to have a better method of aligning turning center-bar feeders. The existing methods, such as tight wire or knocking the feeder around until it looked like it was “close to being aligned” are no longer sufficient. Misalignment can lead to poor part centering and part loading failure.

The L-706 laser can easily be adapted to the through-hole of the turning machine and made co-incidental to the axis of rotation of the headstock. A target is then mounted to the bar feeder. The system lets the operator know exactly how far to move the bar feeder and provides him with a dynamic display of the moves as he makes them. This alignment can be done at both the front end and the back end of the feed tube.
How the Alignment System Works

The L-706 Bore Laser System was designed to reduce the number of targets necessary when performing bore alignment. Traditionally, bore alignment was accomplished with a reference system (like optics) that uses two reference targets mounted in two reference bores. The L-706’s laser beam is concentric to its housing to within .0005” and thus can be used as one of the reference targets. As a result the L-706 usually needs only one reference target to perform alignments.

General Setup

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

The entire assembly is then mounted near the first reference bore. The A-512/A-514 target/adapter 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 bores and the target can be moved to (or a 2nd target can be placed in) the inner bores for alignment checks. Since the laser provides live data, any alignment errors can be adjusted and the user can watch the readings update live in the readout.

Target fixturing can consist of a 3-legged, spider-type fixture with a flange adapter (T-225) or a 4-legged, self-centering adapter (A-514).

Bore Alignment with the A-512 Target

The A-512 Target is designed so that the PSD is centered axially between the 4 feet of the 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. The A-512 takes advantage of this property by making the adapter slightly larger than the bore. To insert the target into the barrel, attach the spring-loaded handle to the target and pull the target cord. 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 handle keeps the target centered in the bore.

Adjusting the Laser Angle

Once the laser has been inserted and centered into the first reference bore, its angle must be adjusted so that it is on center at the second reference bore. This is accomplished by adjusting the laser's vertical and horizontal angles using built-in micrometers so the target in the far reference bore reads zero, both horizontally and vertically to the centerline as defined by the two reference bores.

Measuring Bore Alignment

The T-218 or A-512 target is then placed in the desired bore for measurement, and once it is properly centered, the readout displays the bore misalignment. To truly align a bore to a centerline, two sets of readings are needed: one set in the section of the bore closest to the laser and one set in the section farthest away from the laser. The average of these two sets of reading indicates how far off center the bore is relative to the reference bores. The difference between the readings is how much angle the bore has to the reference bore centerline. To align a bore, both bore sections must be adjusted to zero, an easy task given that the readings from the target are live.
High-Tolerance Bore Alignment

For high-tolerance bore alignment applications, the target sensor concentricity error (TSCE) must be calculated using the NORMIN method. TSCE is calculated by taking two readings, one at the 12 o'clock position and a second at 6 o'clock (horizontal and vertical calculations are done separately). The second reading is subtracted from the first and the result is divided by 2. This is the TCE and shows how far off the center of the target is from the center of the bore. This calculation creates an offset that can then be subtracted from all subsequent bore measurements to get the true misalignment number. Our Bore9 software can easily calculate TSCE and even automatically remove it from the displayed reading.

Using Bore9 Software

Hamar Laser’s new Bore9 software supports all of 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 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.

- **In 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.
- **In Step 2 - Target Mounting Error**, an easy procedure is followed to remove mounting errors. Mounting errors must be compensated for in order to achieve accurate results in bore and spindle work. Bore9 uses the NORMIN method (see Page 5) developed by Hamar Laser to quickly and precisely cancel out these errors and eliminate the need for complicated, expensive fixtures. The word NORMIN is a contraction of NORMal-INverted, which briefly describes the method.
- **In Step 3 – Laser Setup**, on-screen instructions guide the user through setting up the laser and making it parallel to reference points.
- **In Step 4 – Record Data**, bore straightness data is recorded. There are several different sets of data that can be taken in this step.
- **In 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.
Step 1: Setup

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

2. Enter the number of bores, the distance between the bores, the bore diameters, and select the alignment tolerances.

3. Insert the target into the near bore, then adjust the L-102 to zero the display and center the laser into the first reference bore. Press Record to record data for the target in the NORMAL position.

Step 2: Target Mounting Error

4. 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. A Mounting Error Offset will be calculated and applied to each target reading. This will remove any remaining centering errors in the target and adapter. This step may be skipped unless you are working on a high-accuracy application (0.015 mm and below).
Step 3: Laser Buckin

5. 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). 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.

6. Move the target to the far bore and press **Record**. A calculation of the laser setpoint will be made to aid the laser setup and offsets will be applied to on-screen live data.
7. With bucking offsets applied in Bore9, steer the laser using the Pitch and Yaw knobs (angular adjustment) on the L-706 until the H and V displays are zero.

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

Step 4: Record Data

9. 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.

Step 5: Results

10. Step 5: Results displays a graph of the results and a summary of the alignment.