



**FORI AUTOMATION** INC.

Privately held, U.S. Owned  
and Operated Since 1984

# FORI AUTOMATION End of Line SYSTEMS

13231 23 Mile Road  
Shelby Twp., MI USA 48315

email: [sales@foriauto.com](mailto:sales@foriauto.com)

586-247-2336

[www.foriauto.com](http://www.foriauto.com)

## GLOBAL HEADQUARTERS

## IN THIS ISSUE

# 3-D Wheel Alignment Systems with Digital Headlamp Aimers

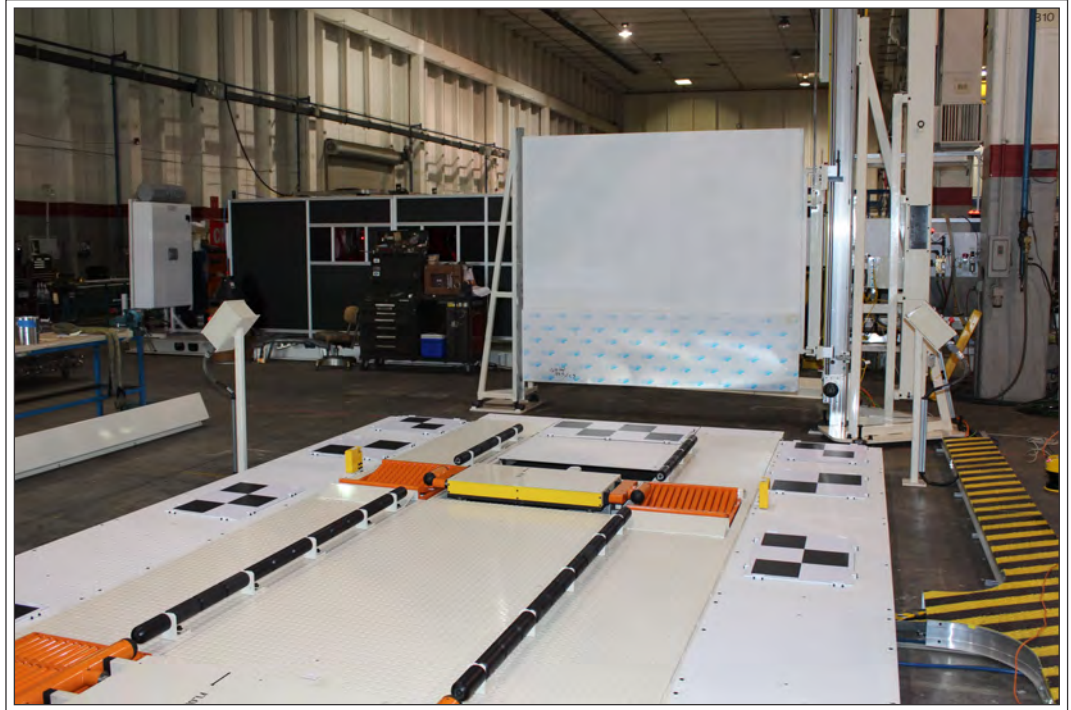
- Centering Platforms
- Headlamp Aiming
- Roll / Brake & DVT
- Side Slip Testing
- Toe Set Tooling
- Vehicle Safety
- Vehicle Exerciser
- Wheel Alignment



# Centering Platforms

Centering platforms can be used for a variety of applications including that for stand alone headlamp aiming systems, for use with Driver Assist Calibration equipment, and other vehicle measurements when centering of the vehicle is required.

The platforms contain leveling adjustment to provide a level surface for the vehicle. It also includes front and rear pneumatic centering devices, and vehicle guides.



## Headlamp Aiming Systems

- Gantry frame provides for easy add on to existing wheel alignment platform or centering platforms, In-Floor style integrated with wheel aligner.
- Single Door control panel with I/O interface is included for stand alone, or add on to Wheel Aligner
- Optional AB Compact Logics or other brand PLC can be included if required
- Options for Semi-Auto Smart Screwdrivers to control aiming capability
- Algorithms leverage increase resolution, frame rate and processor speed to improve accuracy
- Digital cameras
- No Vision Board in PC – Direct E-net PC to Camera
- Aiming Accuracy  $\leq \pm 0.2\text{CM}$
- Servo Positioning Accuracy  $\leq \pm 1\text{mm}$
- Solid state computer

# Digital Aiming

- Large size box and lens to optimize processing of lamp image
- No Auto iris:
  - Reduction of potential machine downtime
  - Reduction in aimer set-up complexity
- Improved machine to machine correlation
- Gigabit Ethernet
- Reduction of potential machine downtime
- 50% increase in camera resolution
- Improved lamp intensity measurement
- Faster data acquisition time:
  - Frame rate increased from 30 to 54 FPS
  - Lamp image data transferred directly in digital format to PC
  - Ethernet communication thus eliminating video noise
  - Improved aim point tracking throughout aiming process

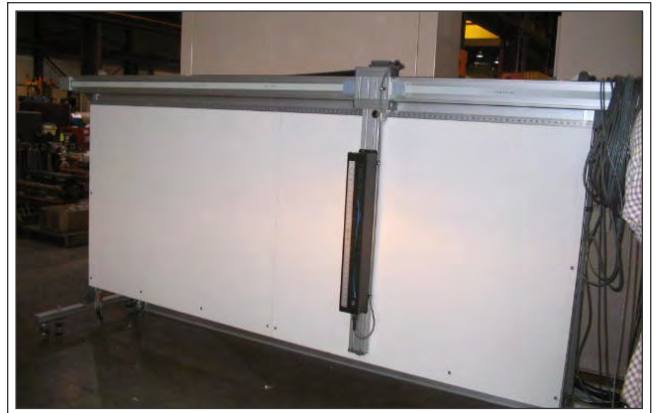


## Pre-Final Assembly



- Headlamp aim pre adjust systems are specifically design to fixture headlamps in perfect parallelism to the X, Y, Z planes
- Fixture tooling can adapt to various headlamp styles
- Headlamps are aligned prior to being installed on the vehicle
- Automatic screwdrivers are fixture to locate adjuster precisely
- Accuracy and repeatability  $\pm 0.2$  cm

## Audit Board



- Up to 5' x 12' board (Truck series size)
- Vertical scan length of 24"
- Stand alone control panel with PC
- Photo array of 128 photo diodes with 0.2" resolution

# Roll / Brake & DVT Systems



## Features

- Windows 7 Embedded based software
- Full featured SPC Package
- On-the Fly customizable software
- High speed computer and hardware
- Comprehensive diagnostics covering all I/O
- Capability for direct plug-into various vehicle ECU's via the OBDII connector, and receive/transmit commands
- Capability for dynamic brake test, free roll testing and DVT testing
- Various wheelbase adjustment ranges can be accommodated
- Various horsepower, torque and speed requirements can be accommodated
- Various styles of machine frame architectures can be considered to accommodate pet depths, width and length requirements
- Dual roller or Single roller design can be offered
- Safety retaining rollers, safety stop posts, auto lubrication, auto roller scrapers, and other devices are normally included
- Options for sound proof booths and ventilation systems can be offered

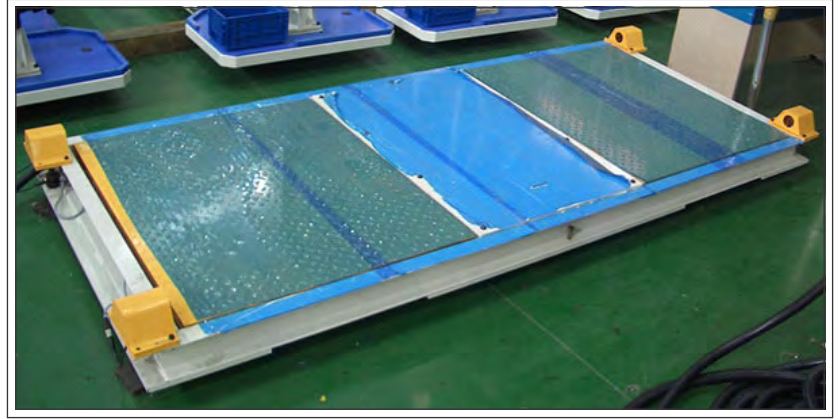
# Available Roll / Brake Tests

- Roll
- Dynamic Brake
- 4-Wheel Drive
- Speed Testing and Speed Calibration
- Noise vibration or harness testing
- Drag force tests
- Wireless dynamic vehicle testing
- Cruise control testing
- Electrical integration
- Transmission shift point
- Individual wheel testing
- Reverse testing



- The system software computes brake force and anti-lock braking system characteristics.
- Precision speed measurement is attained with the use of optical encoders.
- Preventative maintenance is simplified with the installation of automatic lubrication systems throughout the machine
- Fori's four-roller design cradles and centers the vehicle on top of the rollers providing superior safety, stability and accuracy.
- Vehicle Side Guides keep the vehicle on the rollers

## Side Slip Testing



- A system with one plate can be used to measure slip displacement on one side of the vehicle, or a dual plate design can be used in the case LH/RH displacement values are required.
- The machines are also capable of measuring the slip on the front axle, and rear axle individually.

## Toe Set Tooling Systems

- Decrease in cycle time
- Reduced work force
- Increased accuracy & repeatability
- Increases flexibility by allowing compensation for vehicle variation, X, Y & Z positioning, tie rod or cam bolt angle by vehicle type
- Allows greater head access by having programmable paths versus straight line or fixed cam paths
- Decreases cycle time by having close proximity robot pounce positions
- Robotic toe set eliminates many valves and actuators thus reducing downtime
- Vision system can be added to locate adjust points and compensate robot position
- Tie rod or cam bolt adjustment



# Toe Set Adjustment



Fori has several patents for toe set gear head advance, tie rod guide fork rollers and single guide fork gear head with a compliance locking brake

The most popular Fully Automatic Toe Set system is Fori's patented hex adjustment system. This system incorporates the adjustment and socket into one assembly. The socket is shuttled from one location to the other to perform the appropriate task. Powering the motions of the automation can be pneumatics, electric servo or robot controlled. Fori's unique compliance in tooling allows for various vehicle variation. Fori offers a full range of Semi & Fully automatic adjustment tools to fit your product. Fori's tools can be driven pneumatically or electrically, with full integration to the plants torque data verification & storage systems. The motion of the fully automatic toe set system can be air, electric servo, robotic, or a combination.



## Robotic Front & Rear Toe Set System

Specially designed front tooling is provided as the end effector of the robot. The tooling consists of a gear driven socket that engages with the tie rod adjust hex for setting the toe automatically, then shift to the outer tie rod for engaging with the jam-nut and securing to the required torque.

### Robotic Tooling Changers

The robots can be equipped with different style toe tooling and changes as each vehicle is driven onto the system

Various robot brands and styles can be used. The latest design using the compact series Robot allows the tooling to be stored under the machine frame, to maintain an open architecture. Maintenance slides are not necessary if the tooling must be placed off line.

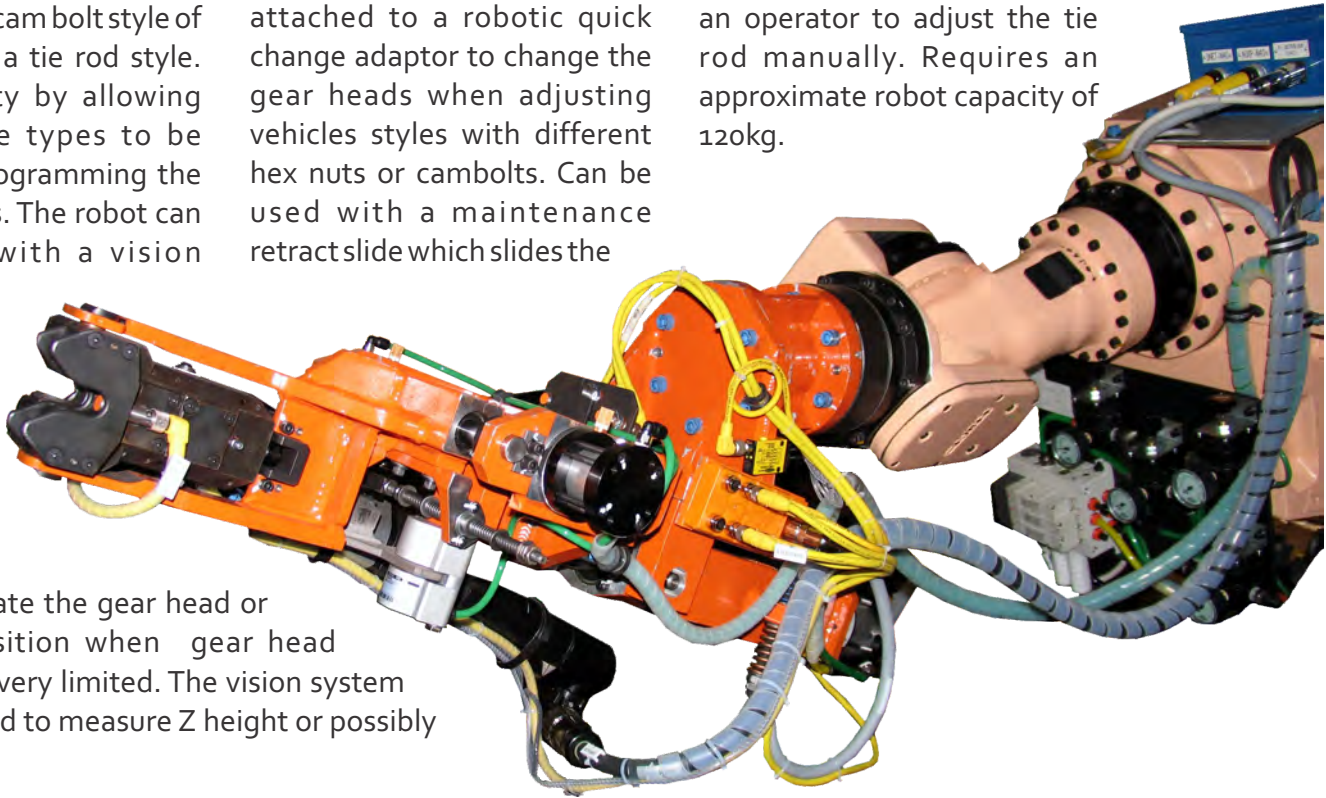


# Vision Based Robotic Placement

Front and rear robotic toe set can be either a cam bolt style of adjustment or a tie rod style. Adds flexibility by allowing future vehicle types to be added by reprogramming the robot positions. The robot can be coupled with a vision system to first find the tie rod or cam bolt position X, Y & Z and the bolt or tie rod angle then compensate the gear head or nutrunner position when gear head accessibility is very limited. The vision system can also be used to measure Z height or possibly caster.

The gear heads can be attached to a robotic quick change adaptor to change the gear heads when adjusting vehicles styles with different hex nuts or cam bolts. Can be used with a maintenance retract slide which slides the

robot out of position allowing an operator to adjust the tie rod manually. Requires an approximate robot capacity of 120kg.



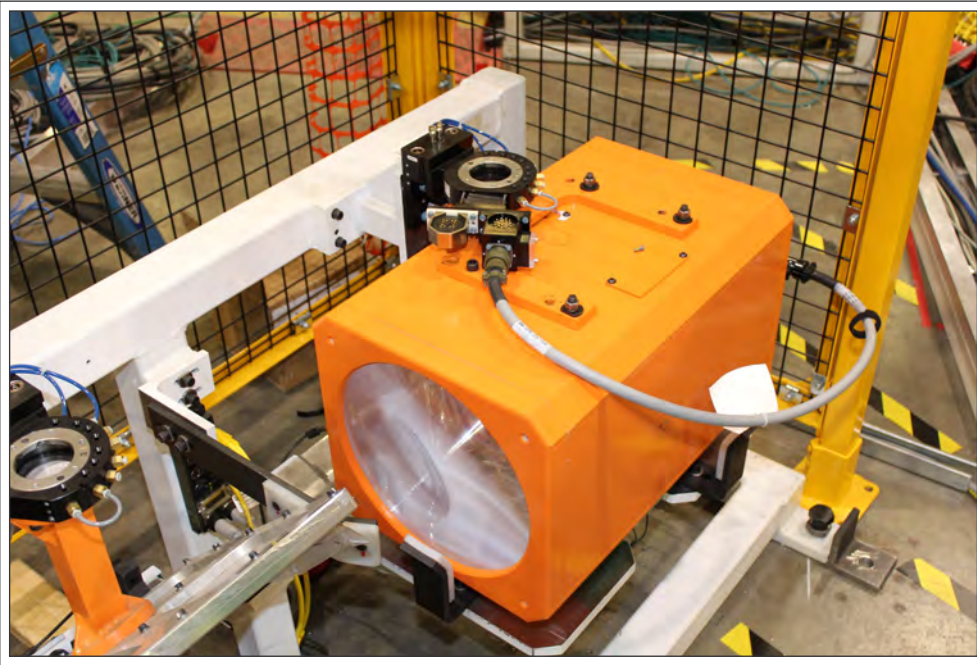
# Audit Systems

The non-contact high speed audit system is designed to give the most accurately measured toe, camber & caster values in the market to date. This system utilizes many patented Fori technologies to allow the plants

plants the fastest and most accurate audit system in the world. The whole system requires a very shallow pit or the system can use a ramp. A wide range of wheelbase lengths allows the system to run multiple vehicle styles on a single machine.



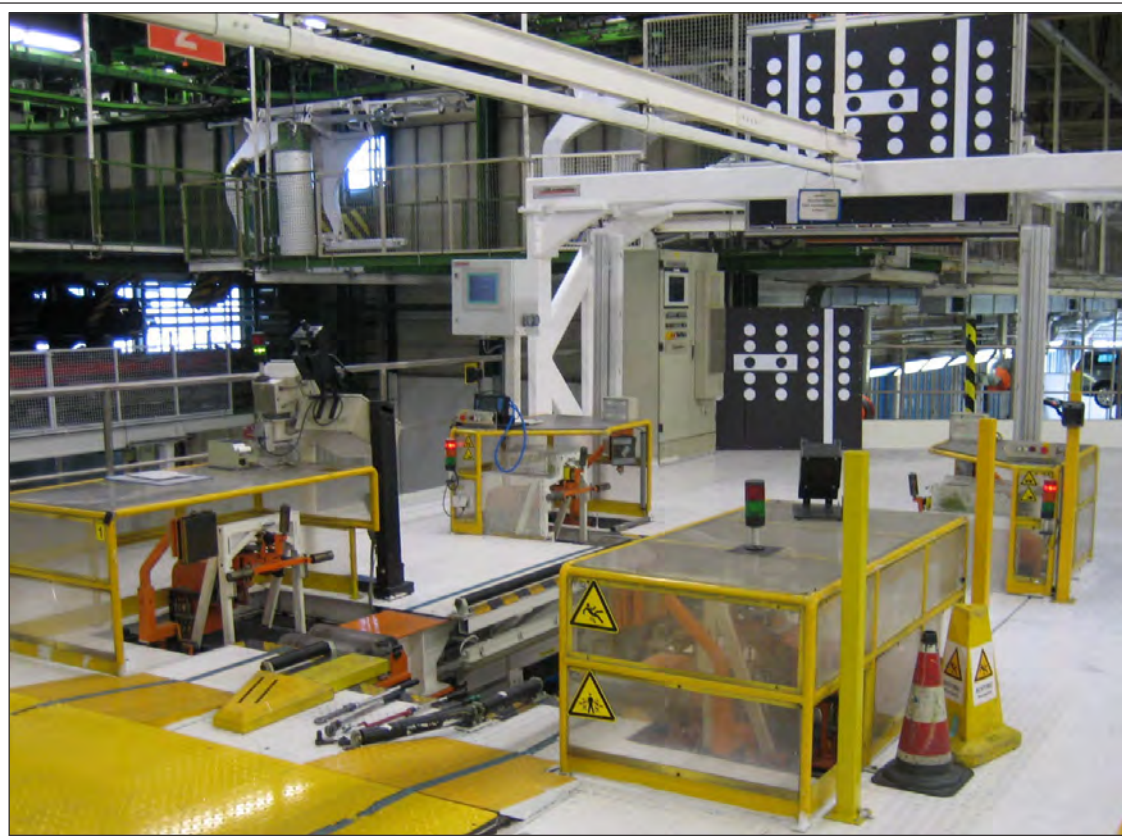
# Adaptive Cruise Calibration



- For ACC sensors containing a small reflective mirror on the vehicle's radar sensor, it is possible to aim and adjust this sensor with a modified version of the Fori HLA camera box
- The modified box contains an LED light sources for reflecting off the sensor mirror, and a pneumatic rotate device to place the box on a small angle to the sensor to avoid "Bounce-Back"
- The Fori HLA camera will then aim the reflect light similar to how it aims a headlamp.

Quick Disconnect Tooling Selection

## Rear View Camera Calibration



The driver can see on the screen a live view of the rear part of the vehicle. The system indicates in the display the approximation to an obstacle and warns acoustically by small distances between the car and the obstacle. The Fori Unit provides a reference sample (installed behind the vehicle on the hall floor). The rear view camera takes a picture of the sample, and the calibration is independently calculated in the car controller.

## Vehicle Suspension Exerciser



The spring force exerciser is used to jounce to exercise the vehicle suspension similar to affect seen from roads.

The equipment consists of 4 Motor driven exerciser mechanisms that applies a jouncing force to each wheel individually

The jouncing motion as has a viable control for the frequency of at which the wheel is exercised.

Resultant forces and displacement values are calculated and stored in the database by the Host PC

## 3-D Wheel Alignment Systems

The 3D measurement is a brand new process developed by Fori Automation, using laser measurement modules. Software and system interface improvements resulted in a more precise static / dynamic measurement with better resolution as well as making the system more reliable. This new 3-D wheel alignment machine is a fast flexible and highly accurate system running over 40 JPH.



### SYSTEMS WORLDWIDE

Fori Automation has installed over 400 Wheel Alignment Systems Worldwide

# Measuring Head Technology

- Two (2) 3-D Camera Modules per wheel: 8 total. Each module generates 36 laser lines for static aligners and dynamic aligners to provide high density measurement data.
- Each module contains (1) high speed digital camera (70 FPS).
- More than 38,000 possible measured points with more than 10,000 on any one tire equals increased measurement accuracy.
- Increased caster sweep accuracy & decreased caster sweep cycle time.
- Large field of view: 350 mm height x 250 mm width allows for extremely large range of tire variation. 250 mm Depth of measurement per side accommodates larger vehicle tread width variations and allows for stationary measurement head.
- 1 Gigabit Ethernet communication capable of long cable runs without electrical noise interference.
- Highly accurate wheel center measurement due to high density measurement.
- Optional fender measurement module provides X, Y & Z fender location for body height measurement.

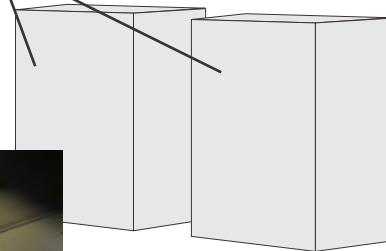


## Modular 3-D Measuring Heads

ONE-PIECE ALUMINUM CASTING CAN BE USED FOR ALL FOUR (4) CORNERS & ANY FLOATING PLATE CONFIGURATION

FIELD OF VIEW 12" HIGH  
x 10" WIDE x 10" DEEP

3-D MEASURING HEAD  
MODULE

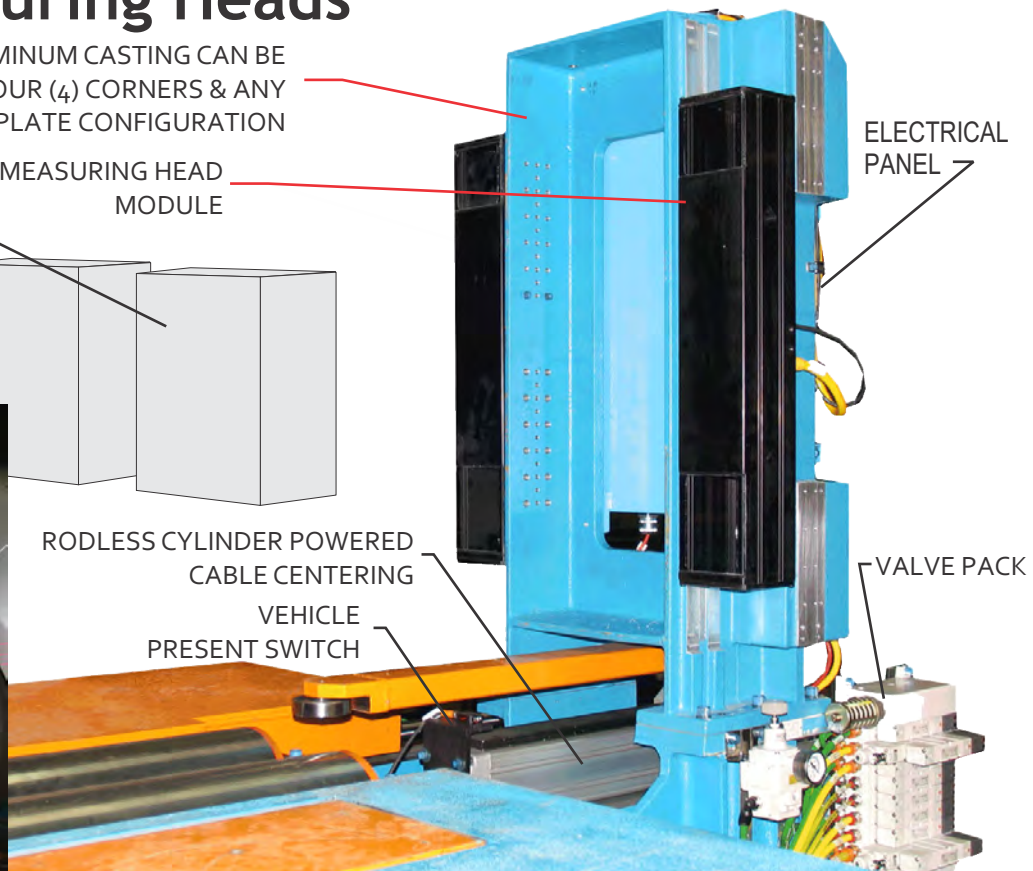


RODLESS CYLINDER POWERED  
CABLE CENTERING

VEHICLE  
PRESENT SWITCH

ELECTRICAL  
PANEL

VALVE PACK

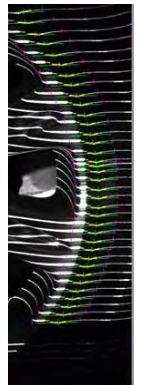
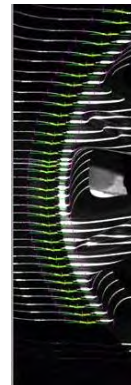


## 3-D Measuring Head Features

- Each module contains (1) high speed digital camera(100 FPS)
- Large number of measured points = increased measurement accuracy
- Measuring heads do not move, eliminates cable tray & wiring connection problems
- Large field of view: 350 mm height x 250 mm width.
- 10" Depth of measurement per side accommodates larger vehicle tread width variations and allows for stationary measurement head
- Available on all new machines and upgrades / retrofits 3-D system is incorporated with new Fori world standard modular machine design
- Static toe set process decreases machine cycle time
- Highly accurate wheel center measurement due to high density measurement.

## 3-D Measuring Head Accuracy

- Static mode updates @ 0.01 second  
+/- 100 mm tread width (200mm Total) and minimum of 12° of caster sweep (optional 400mm tread width range available)
- Variable mounting - covers the smallest low profile tire to the largest off road tire so all tire ranges can be accommodated
- Modular system is pre-wired, pre-piped and packaged for inventory
- Intel dual core quad processor in computer eliminates auxiliary image processors



## Load Simulation

After the vehicle enters the system the load is placed on the vehicle and the system reads the values, the load is lifted and the wheel alignment cycle begins. During the cycle the system uses the data from the load to calculate road conditions at 15 mph.



## Vehicle Weight Measurement

16 Weight measurement transducers are integrated into the 4 floating plates to equally measure the distributed load of the vehicle during the alignment process. This eliminates the need for a separate weight measurement station used in the past when vehicle weight measurement is mandatory prior to shipping the vehicle. Weight measurement capability is < 5% of requirement.



## Suspension Pull Down

Some vehicles requiring adjustment for variable brake systems or other simulation may need to have the suspension pre-loaded before or after wheel alignment adjustment process.



# Heavy Duty 3 Axle Systems



- The heavy duty three axle wheel alignment machine uses 3 sets of floating plates to accommodate the front, middle and trailing axles.
- The construction of the frame is designed to support truck weights of more than 10MTon
- Can use 4 sets of 3-D measuring heads if only measuring the rear toe, 6 measuring heads if adjustment of rear toe is required
- Wheelbase range is 2000mm with 300mm adjustment 2nd to 3rd Axle

## Main Line / Driverless

- The Wheel alignment system is integrated into the main conveyor line at a stop and go station
- The floating plates are raised into position by servomotor and simulate the vehicle weight
- The vision system is used to measure the true steering wheel angle when locked at center to make the system completely driver-less wheelbase



## Fender Height

Mounted on top of measuring head riser at 4 corners. Includes specially designed camera housing with brackets to adapt to all styles of Fori Wheel Alignment systems. Camera modules includes Basler ACA 1600-20GM digital camera. LED light sources embedded in camera modules and mounted to bottom of riser for illumination of the fender bottom edge. Measurement tolerance =  $\pm 1$  mm  
Camera view of 250 mm (D) x 250 mm (H) x 90 mm (fore/aft) : processor rate = 20 fps



## Predictor Mode

After each adjustment made during a cycle it takes, 3 or 4 seconds (one tire rotation) to update the run out of the tires and display the new measurement value. Predictor Mode identifies a unique feature on the wheel and determines its orientation. Virtual real time measurement updates are then performed which reduces machine cycle time by 3 or 4 seconds for every adjustment made. If several adjustments are made the cycle time decreases even more



## Steering Wheel Leveling



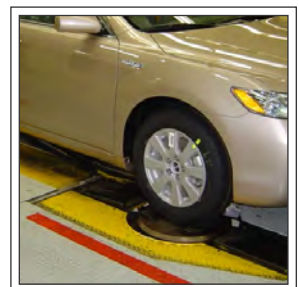
- Fori's steering wheel leveler is a mechanical device that is attached to the steering wheel. The locating rollers accurately and repeatedly locate on the wheel at points that represent the steering wheels horizontal axis. The device ensures the steering wheel is level while the alignment process is performed.
- The standard SWL tool uses an electronic inclinometer with feed back to the WA Host PC via I/O input modules.
- Other systems also available for wireless communication.

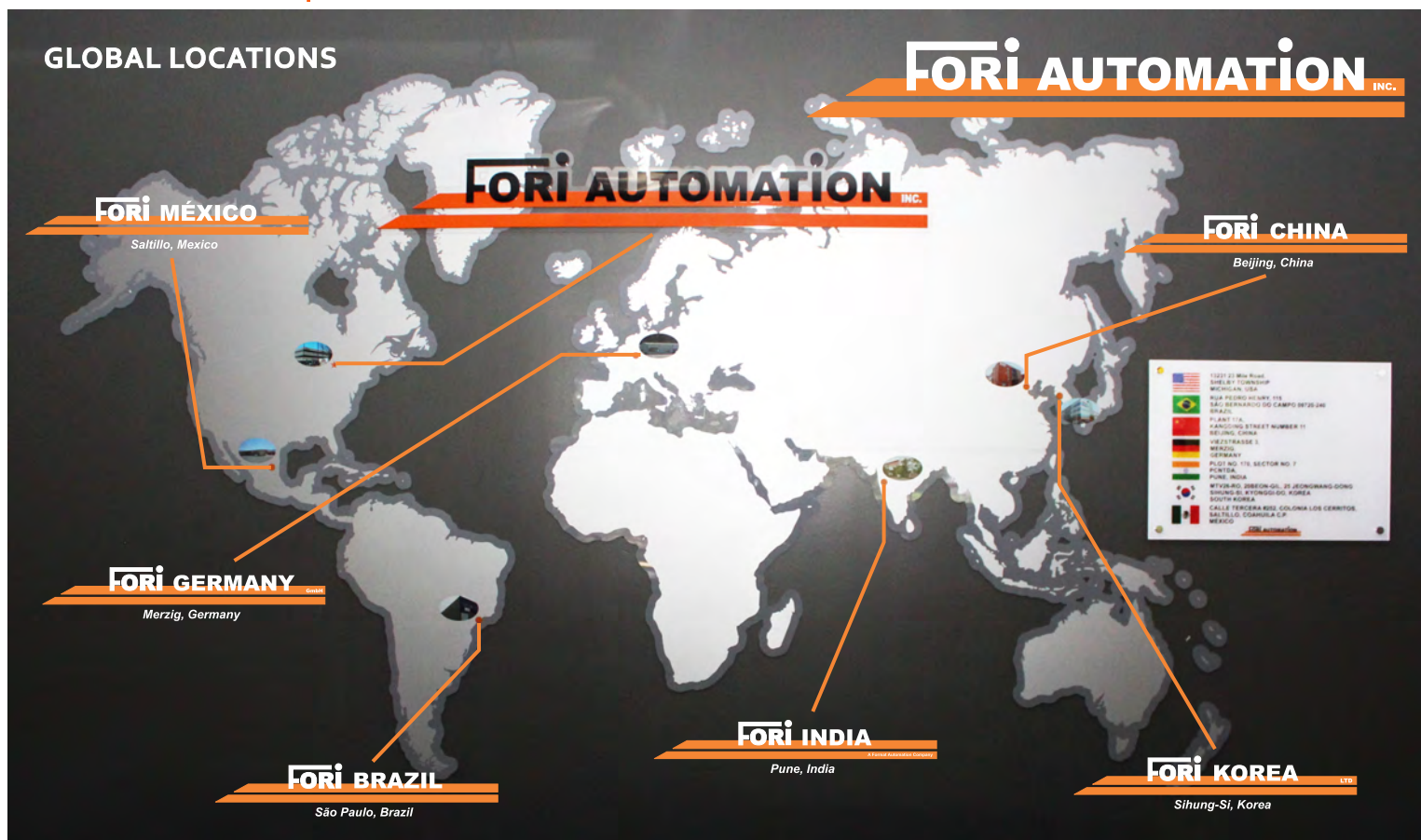
## Caster Sweep / Turn Angle Testing

Caster sweep process incorporated with Wheel Alignment  
Multiple laser data points & capability to sweep  $\pm 12^\circ$  provides for improved accuracy of  $< 0.10^\circ$  caster angle repeatability.  
Capability to measure front caster on multiple vehicles with various tire styles

Turning angle tester incorporated into wheel alignment front floating plates, or a stand alone turning angle system can be provided  
Rotary encoders read to the angle that wheel is turned while operator rotates steering wheel CW to Lock, then CCW to lock. Designs can be for  $30^\circ$  -  $50^\circ$  turning angle capability as per customer specification.

A final calculation is made in WA software program to display to final LH and RH turning angle, and to signify if set within specification.





**Fori Automation Inc.**  
Global Headquarters  
Shelby Twp., MI, USA 48315  
Phone: 586-247-2336  
Fax: 586-266-6773

**Fori Automation China**  
Beijing, BDA, 100176 China  
Phone: 86-10-6780-2940  
Fax: 86-10-6780-2945  
email: sales@foriauto.com

**Fori Korea Ltd.**  
Sihung-Si, Korea  
Phone: 82-31-496-3400  
Fax: 82-31-431-528

**Fori Automation India**  
Pune, India  
Phone: +91-20-30792679/80  
Fax: +91-20-30792681

**Fori Automation do Brasil**  
São Paulo, Brazil  
Phone: 55-11-4124-7624  
Fax: 55-11-4337-3172

**Fori Automation GmbH**  
Merzig Germany  
Phone: + 49 (0) 6861-7009-0  
Fax: + 49 (0) 6861-7009-310

**Fori Automation de México**  
Saltillo, Coahuila, Mexico  
Phone: 52-844-416-8918



Privately held, U.S. Owned  
and Operated Since 1984



[www.foriauto.com](http://www.foriauto.com)



ISO 9001:2008 ISO 14001:2008 Certified / ITAR Certified / Cage Code M20746