



Integrated Metrology (iM) Solutions Guide



Introduction: What Is Integrated Metrology?

Manufacturing operations are continually pushed for higher efficiency and productivity with improved quality in every process on the factory floor. These initiatives can be completed through API's Integrated Metrology (iM) portfolio of solutions to go above and beyond conventional portable metrology. iM is the integration of API's latest products and technologies for factory/process automation, with 9D LADAR serving as the culmination of our three decades of effort. In API's iM vision, Laser Trackers work with LADAR to produce a single, integrated, 6DoF precision, large volume solution, offering maximum set-up flexibility. LADAR is the final piece that allows API to completely deliver on our original vision of tracked robots delivering high precision measurements at the speed of production.

iM focuses on factory automation for machining, assembly, and inspection. With Dynamic 9D LADAR's ability to deliver robot, tripod, or rail-mounted automated non-contact measurements, API's innovative sensors are now fulfilling Manufacturing 4.0 and Quality 4.0 initiatives, bringing shop floor automation to the micron-level.

But setting up an automation cell is a complicated process, and it can be difficult to even know where to begin. So, we put together this guide to give an overview of the main pieces that you will need to consider for your automated measurement setup, or setups based on various application needs. In the following pages, we'll cover everything from the measurement range you need to consider for the equipment, how the equipment will be mounted, how the measurements will tie-in, what software to use, and how the installation will be integrated into your facility.

For each of these steps, we'll cover the complete portfolio of options API's iM can provide to create automated measurement setups for cells as small as 5m or rails as long as 100m for any manufacturing industry (including Aerospace, Automotive, Shipbuilding, Oil and Gas, and Wind Power).

These automated setups are ideal for:

- **Measurement Cells**
 - **In-line Production Measurement**
 - **Assembly Line Spurs**
 - **Final Assembly Inspection**
(including Body-in-White)
 - **Mold Verification and Leveling**
 - **Part Inspection**
 - **Tracked Robot Measurements**
 - **And More**
-

iM unites API's complete offering of high precision sensors and our Globally Local team of Real Metrologists to deliver high speed, high precision Industry 4.0 solutions to quality departments around the world.

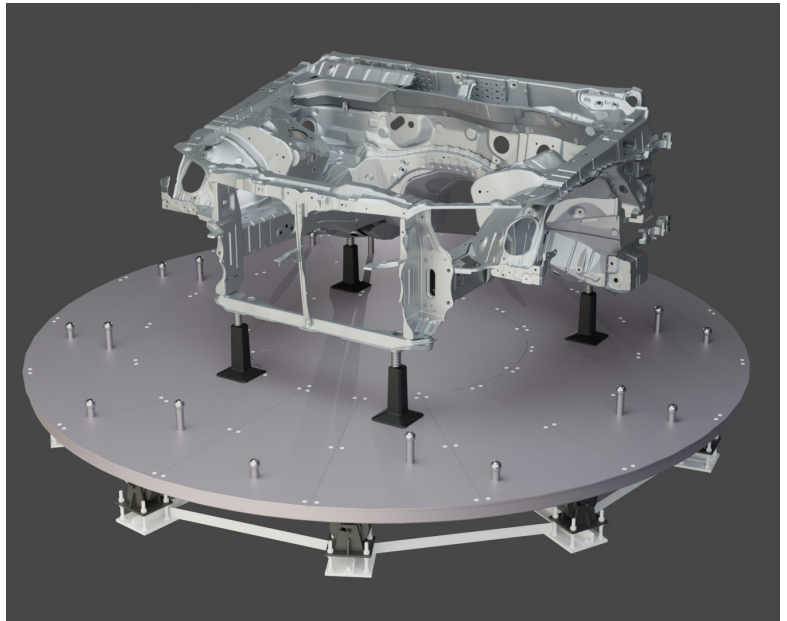


Step 1: Setup Your Integration Cell

Assembly line, Spur, Rotary table, or Fixture?

When setting up your Automated inspection cell, one of the key questions is where the cell will be located in your factory, and a main determining factor is the size of the part, mold, or tool that is being measured. Essentially, the larger the part, the more difficult it is to move, so you will need to have an inspection cell that is as close to (if not directly integrated into) the production line.

The main places that an automation cell can be located in a factory are on the assembly line, a spur attached to the line, a horizontal rail next to production, a rotary table inspection cell, or a part in a fixture on the shop floor. Knowing where the cell will be located will help determine what pieces will be needed at every other step in this guide, as the location and how the part is held will determine the measurement range, how the equipment will be mounted, and the measurement tie-in. For rails and rotary tables, API offers custom designs based on your application needs, with tables of load capacity up to 2500lbs.



Need An Integration Partner?

If you need an Integration Partner, API's Advanced Automation Integration (AAI) Team is available to help identify and coordinate all needs, purchases, and installations, and for larger, multi-location installations. API has collaborated with leading integration partners, such as: FFT, 3D Infotech, Metrologic, and VRSI.



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AUTOMATION®

Step 2: Choose Your Measurement Range

When planning an automation setup, one of the most important factors to identify is what range your measurement equipment will have to measure. This includes the standoff from the part, the size of the part, and whether the equipment will be moving or stationary. API's Dynamic 9D LADAR is available in 3 ranges: 8 meter, 15 meter, and 25 meter, with minimum measurement distances ranging from 0.5-1.5m.*

LD-8

LD-8 is the 8m measuring range 9D LADAR, with the shortest minimum measurement distance (.5m), making it ideal for measurements in tight spaces including, small automation cells, stationary mounted "car wash" style measurements, or moving mounted measurements that will bring LADAR close to the part.



LD-15

LD-15 is the 15m measuring range 9D LADAR, with a minimum measurement distance of 1m. LD-15's range and minimum distance make it the most flexible LADAR, capable of larger inspection cells and stationary mounts than LD-8, while still able to be moved close to parts if the space requires it.

LD-25

LD-25 is the 25m measuring range 9D LADAR, with the largest minimum measurement distance (1.5m) and longest maximum measurement range, covering a 50m diameter. LD-25 is ideal for large-part inspections, such as full assemblies of cars, airplanes, and windmill rotors, able to capture feature details within a handful of microns even when mounted to a large gantry or linear rail.



*For all API automation setups, mScan (range up to 50m) or RapidScan (range up to 25m) are also available.

Step 3: Chose Your Equipment Mount

Tripod/Metrology Stand

A tripod or metrology stand is the lowest cost option for an automation cell, requiring no moving parts. It offers the flexibility that most permanent fixtures allow while still being portable to move to many locations around a part or locations in your plant. A fixed location with parts being brought to and from the stand or passing by on an assembly/production line still offers a fully automated solution, but any movements needed must be manually made, reducing the overall speed of the setup. API offers multiple LADAR stands and provides mount options that are compatible with all major stand brands.



Industrial Robot

On the other side, Industrial Robots are one of the most flexible solutions offered in this guide. API's Dynamic 9D LADAR is integrated with Fanuc, Staubli, Yaskawa, and Eston, among others, offering users complete freedom in their choice of robots. This allows for automation designs that can be scaled up or down throughout the entire lineup of robots offered. On a 5m robot, the LD-25's measurement range can be expanded to 30m, as the robot moves LADAR closer to or further from the part or assembly it is measuring.

While a larger investment upfront, Industrial Robots provide one of the most automated solutions in this guide, with programmable, repeatable paths that can be used in inspection cells, production lines, spurs, assembly inspection, and more.



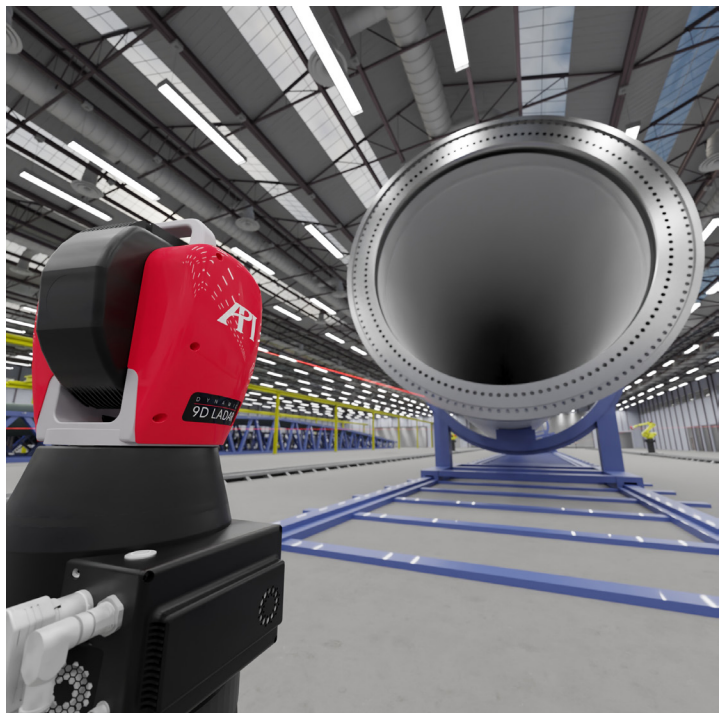
Multiple-Axis Linear Rails

Whereas Industrial Robots offer 3D movement for the measurement equipment (in X, Y, and Z planes), Multiple Axis linear rails can move measurement equipment along X and Y planes. But they can make these movements on a much greater scale than Industrial Robots and can even be used in conjunction with robots to greatly expand their measurement range. API's vertical rails range up to 5m and our horizontal rails range up to 100m, with load capacities up to 3,000lbs. These rails allow for maximum flexibility in automation cell setups for small scale rotary table inspections to mold or assembly inspections spanning entire factory lengths. Horizontal rails are essential to the largest-scale automation setups, helping robots and measurement equipment to overcome their distance limitations.



Horizontal-spindle rotating arm

Horizontal-Spindle Rotating Arms offer a smaller-scale version of the flexibility and benefits of Industrial Robots at a price point that is closer to the Tripod/ Metrology Stand option. The horizontal rotation of this arm allows it 7DoF movement, and it can reach parts in all 360° around where it is mounted. API's arm is available in ranges from X-Xm, making it ideal for inspection cells, rotary table measurements, in-line and spur inspections, and more.



Step 4: Choose Your Tie-In

For all measurement setups that feature movement of the part or the measurement equipment, you will need a method for the different measurement sections or positions to be tied together in the measurement software to create one point-cloud of data for CAD comparison or creation.

Radian & i360

A Radian Laser Tracker can be used in combination with an i360 6DoF sensor mounted to 9D LADAR to provide real-time positional data for the unit as it moves along a rail or in three dimensional space. This eliminates the need for tie-in measurements each time LADAR changes position. This reduces tact time and allows LADAR to produce measurement results more than 20x faster than traditional Laser Radar systems. Radian & i360 tie-in, while more expensive than other analog methods, is the fastest tie-in option available, dramatically improving throughput across the production process.



Tooling Ball



Tooling balls have been in use in manufacturing for decades, and with the rise of automated measurement setups in the last 20 years, they have become the industry standard tie-in method. These stainless steel balls are manufactured to have the most perfect sphericity possible, so that a measurement taken from any orientation provides a perfect reference point. Tooling Balls are not as fast as a tracked 6DoF application, but they are less expensive and are necessary for any inspection cell that requires part movement during the measurement (like one using a rotary table). API's tooling balls are concentric to within 5 microns and come in a variety of sizes to support any application.

Step 5: Choose Your Software

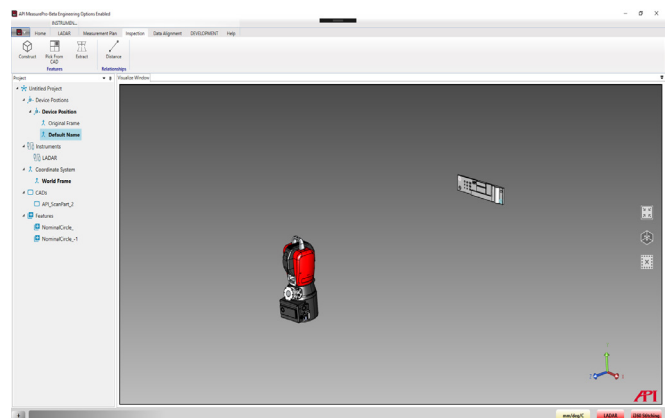
API MeasurePro

API's MeasurePro software was designed to be the complete automation software, capable of controlling 9D LADAR, Radian, i360, Industrial Robots, and other elements of the automation cell from one location to reduce manhours and increase throughput. This single simulation environment means that inspection paths are automatically generated from CAD part data with interactive robot measurement path definition based on optimum sensor angle and standoff.

MeasurePro captures the generated sensor point cloud data in real-time with dynamic on-screen representation. Physical part alignment, imported CAD part feature extraction, and measurement analysis are seamlessly generated. Geometrical analysis of features and surfaces from point cloud data can be performed directly in MeasurePro along with the creation of a digital twin of the measured part by direct comparison with nominal part CAD data. Different functional groups within the software are laid out in different sub-menus across the top of the screen to compartmentalize the various hardware components of your inspection cell. The entire automated measurement path (and each group's role within it) is listed in the side panel, along with the various layers of real-time measurement data, for easy manipulation of

the entire automation setup. Measurement selections can be made using the data plane or 9D LADAR high-definition camera for simple, streamlined feature selection. Data in the plane can also be rotated or zoomed in any orientation, with easy right-click menu options available for additional measurement features, reporting, or to repeat the measurement path.

With API's MeasurePro in a fully integrated automation cell, a single person at a computer can perform the quality inspection process for a rotary cell, in-line or assembly line spur, or large rail verification in a fraction of the time it used to take a team of people.



Already Integrated with a 3rd party software?

All of API's iM equipment is already integrated with all major 3rd part software programs, including Metrologic, Polyworks, and Spatial Analyzer.



Aircraft Scan

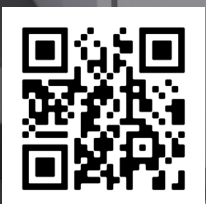


See it in
action here



LADAR Rotary Automation Cell

See it in
action here





Windmill Rotar Scan

API Equipment and Part Numbers

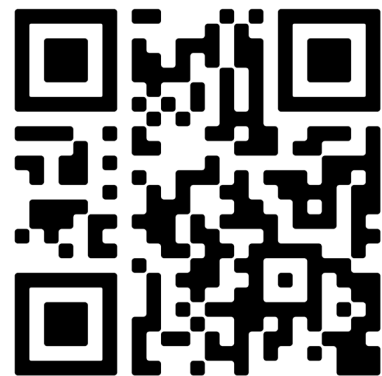
Equipment Name	Part #
Dynamic 9D LADAR 8m	193913 Whole Sale Kit, Gimbal only 193920
Dynamic 9D LADAR 15m	193914 Whole Sale Kit, Gimbal only 193921
Dynamic 9D LADAR 25m	193915 Whole Sale Kit, Gimbal only 193923
Radian Plus Laser Tracker 20m	R101594 Whole Sale Kit, Gimbal only 190091
Radian Plus Laser Tracker 50m	R190629 Whole Sale Kit, Gimbal only 190091
Radian Plus Laser Tracker 80m (IP Rated Gimbal)	R198630 Whole Sale Kit, Gimbal only 198612
Radian Pro Laser Tracker 20m	R100029 Whole Sale Kit, Gimbal only 101483
Radian Pro Laser Tracker 50m	R100032 Whole Sale Kit, Gimbal only 101483
Radian Pro Laser Tracker 80m	R100035 Whole Sale Kit, Gimbal only 101483
i360 6DoF Sensor	195102
MeasurePro Software	193852
Tooling Ball	193883 - 1.5" Sphere
API Heavy Duty Metrology Stand	194025 - Friction Link Receiver Mounting
Multiple-Axis Linear Rail	Varies by size
Horizontal Spindle Rotating Arm	Varies by size
360 Heavy-Duty Horizontal Turntable	Varies by size

About API

For more than 30 years, API has pioneered advancements in laser-based metrology equipment for industrial inspection and calibration. API is continually developing products to deliver innovation and automation to the manufacturing floor.

API's advanced 6DoF Laser Trackers, Scanners, and Dynamic 9D LADAR provide customers with tools to complete complex production tasks with next-level speed and efficiency. Our customers can perform in-line inspection, automated measurement, and precision robot verification to increase production and decrease costs.

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