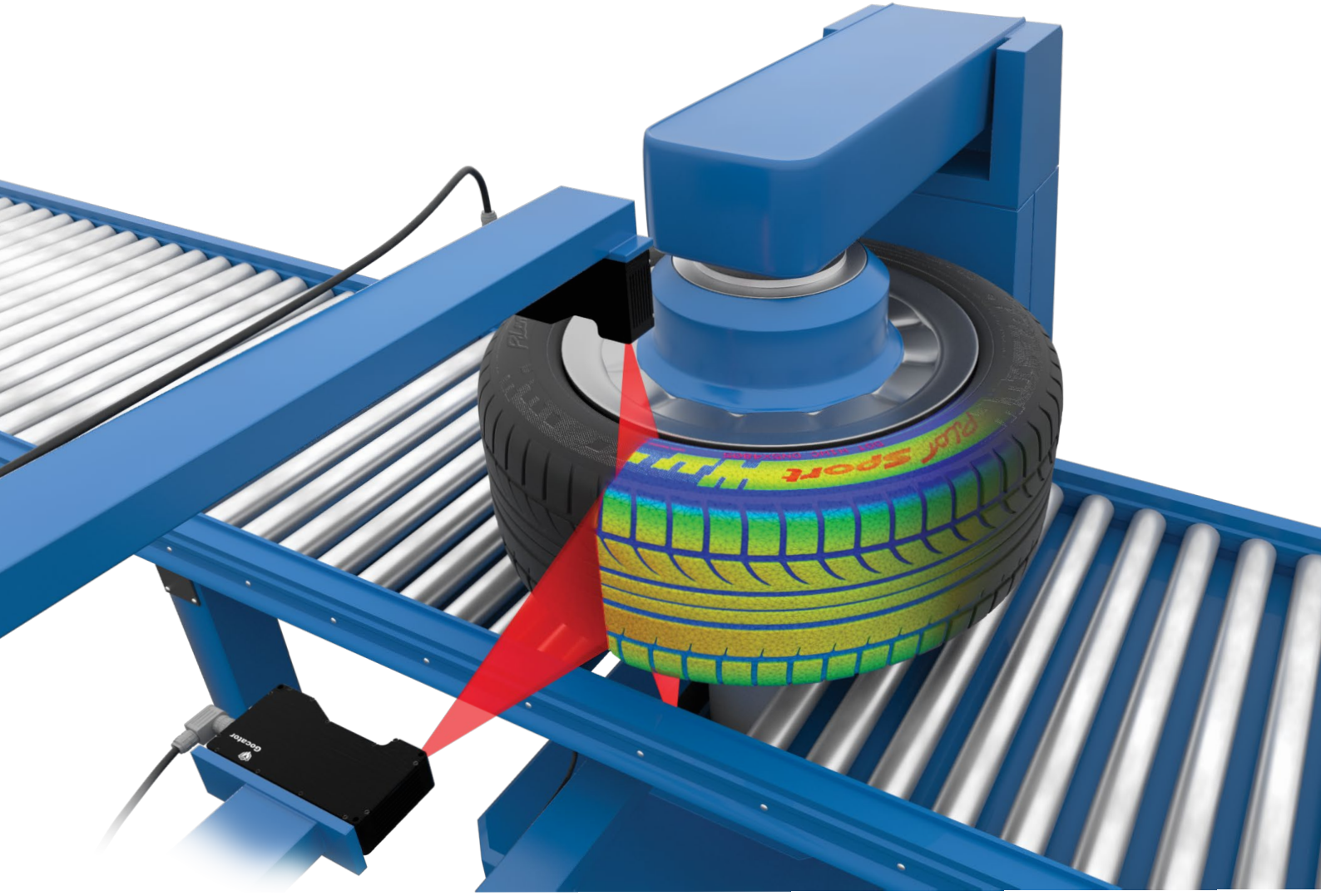
LMI TECHNOLOGIES

FactorySmart® Inspection



A PROVEN LEADER IN 3D SCANNING AND INSPECTION

FOR THE RUBBER AND TIRE INDUSTRIES

Gocator®

CONTENTS

WELCOME TO FACTORYSMART®

Advanced 3D Quality Control for Rubber & Tire

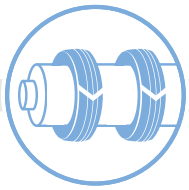
LMI Technologies designs and supplies high-performance, non-contact, all-in-one 3D scanning solutions for critical rubber and tire inspection applications such as rubber extrusion profiling, strip guidance, splice and layer control, bulge and dent inspection, radial and lateral runout, tire markings and DOT-code identification.

TIRE BUILDING INSPECTION

RUBBER EXTRUSION PROFILING

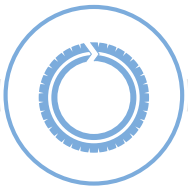
Gocator provides a complete set of built-in extrusion measurement tools that include functions such as length, width, height, depth, angle, vertex location, and groove dimension.

STRIP GUIDANCE



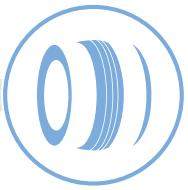
As tire strips (or plies) are wound around the drum of the tire, Gocator scans the strip edges to ensure they are fed to the correct position.

SPLICE CONTROL



During tire assembly, Gocator is used to detect problems with joins in splicing and stitching such as gaps, overlaps, dog ears, and folded material.

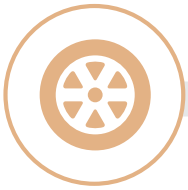
LAYER CONTROL



Gocator scans for the presence, width, and overlap position of key components, looking for gaps between layered gum rubber strips and flat rubber sheets that make up the body of the tire.

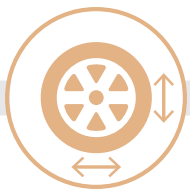
FINISHED TIRE INSPECTION

BULGE AND DENT



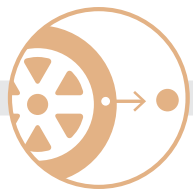
Gocator sensors provide full 3D surface data to detect small bulges and dents on tire sidewall surfaces.

RADIAL AND LATERAL RUNOUT



Gocator inspects for radial runout (RRO) and lateral runout (LRO) by taking profile measurements at the tire's centerline and shoulders. These measurements indicate the deviation of the tire's roundness from a perfect circle and identify potential spin problems such as "hop" and "wobble".

TIRE MARKINGS



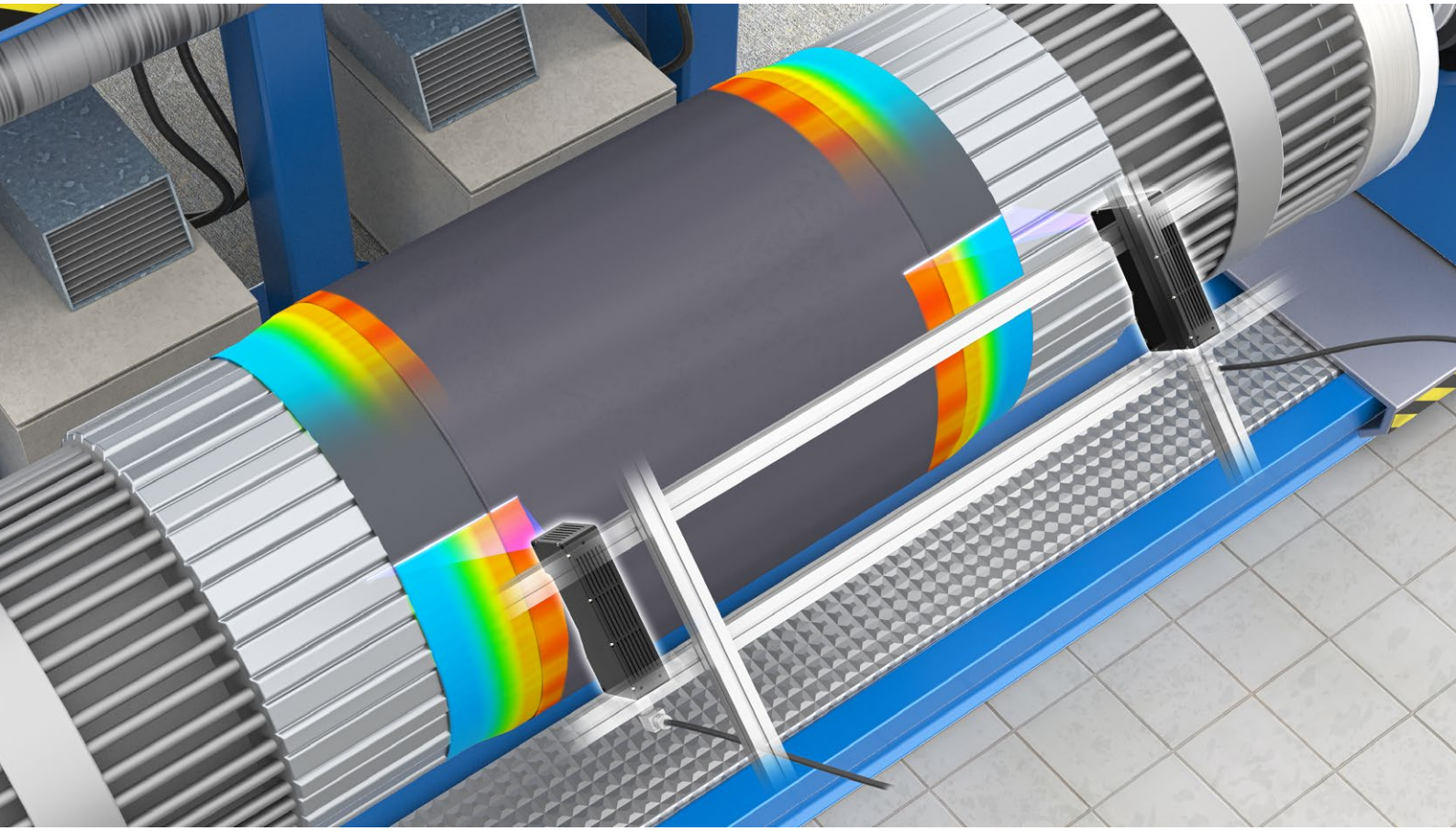
Gocator scans painted or laser tire markings on the sidewall of the tire, including values such as tire size and maximum inflation pressure. Gocator generates an intensity image of the marking that is then processed using HexSight or Gocator SDK.

DOT-CODE IDENTIFICATION

Gocator produces a height-map image of embossed, black-on-black sidewall characters for analysis and conversion to alphanumeric data.

CHALLENGES OF RUBBER & TIRE INSPECTION

Rubber and tire production presents a unique set of challenges due to the nature of the materials involved.



High-Speed Inspection of Dark Materials

R&T applications involve scanning low-contrast, dark materials with complex geometry at very high speed. From shiny green rubber surfaces to hard-to-scan black-on-black DOT-codes, ensuring 100% quality control requires a 3D scanning solution.

The Limitations of 2D

2D machine vision relies on contrast to detect features. 3D relies on shape. Scanning black features on a black tire is a natural application for 3D. With shape, 3D can measure critical features such as object flatness and surface geometry.

ACHIEVE YOUR MANUFACTURING GOALS

These are the goals you need to reach to improve your factory production.

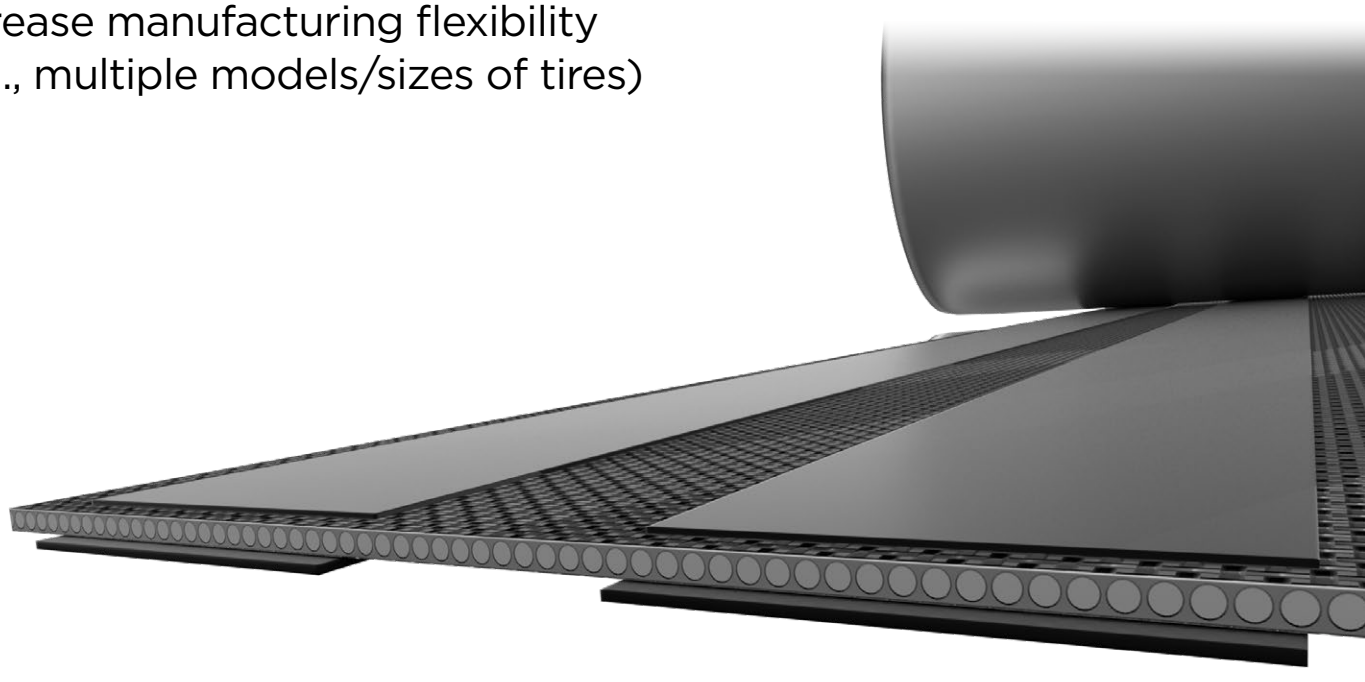
» Speed up inspection cycle times

» Ensure quality tire production

» Generate less waste/rework of material

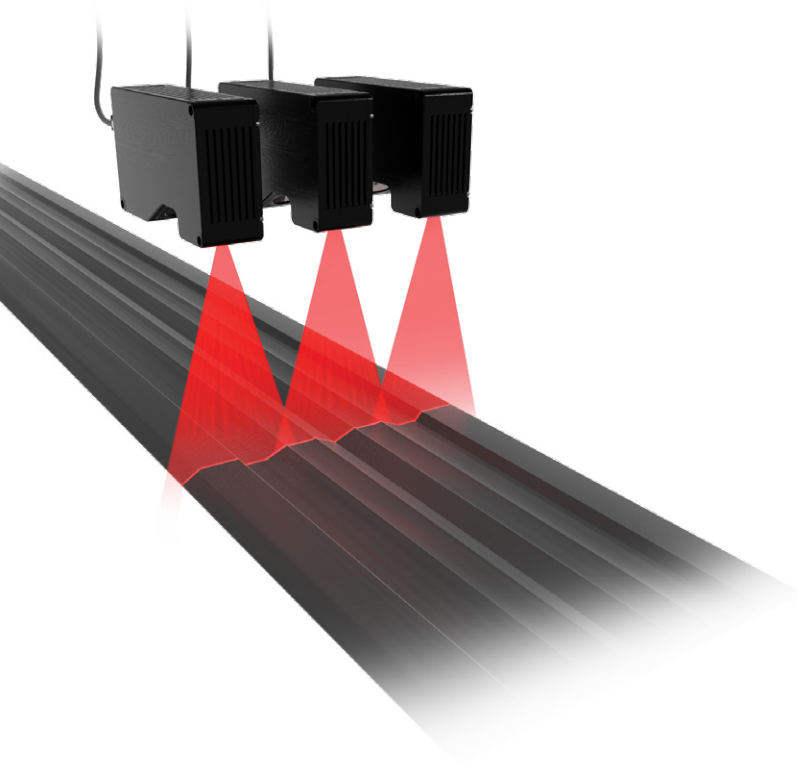
» Reduce exposure to product recalls

» Increase manufacturing flexibility (e.g., multiple models/sizes of tires)



GOCATOR® FOR SMART R&T INSPECTION

Gocator 3D smart sensors improve factory production by providing a complete solution for 3D scanning, measurement, and control in high-speed, low-contrast R&T applications.



Complete 3D Inspection. Built-In.

Inspection is a multi-step process. First, the target is digitized in 3D. Then it's measured to verify critical tolerances are met. Finally a control decision is communicated—either to a robot, PLC, or factory process control monitoring systems. What makes Gocator smart is that all of these capabilities are onboard, minimizing system cost and complexity and helping manufacturers achieve 100% quality control.

Quality Control Decision-Making

Gocator makes critical pass/fail decisions and communicates these directly to factory networks and equipment—all within a single package, and all at production speed.

Designed for High-Speed R&T Applications

Gocator line profilers have a 2-megapixel imager that delivers high-resolution profiles at 10 kHz—making them ideal for any high-speed scanning task, including tread/sidewall, rubber extrusion, and more. Faster scanning allows users to speed up their inline process and achieve the highest resolutions.

Gocator Firmware and HexSight

Every Gocator comes with proprietary built-in measurement tools. You can also extend your Gocator packaging inspection system with HexSight's integrated, robust 2D machine vision library for Optical Character Recognition (OCR).

REALIZE THE BENEFITS OF SMART 3D

Gocator makes production FactorySmart®.

Web-Based User Interface

Gocator offers an easy-to-use web-based user interface that requires no special training. Simply open your favorite web browser to access and control the Gocator. Leverage a point-and-click design with effective 3D visualization using responsive pan, zoom, and rotate navigation.

Flexible Design for Multi-Model Production

Gocator 3D smart sensors can be "reprogrammed" on-the-fly by loading different "job" files that correspond to each model in a multi-model production line. A job file contains the specific settings for measurements, exposures, and pass/fail criteria.

Network Connected

Gocator can adapt to changing inspection requirements because it is connected to the factory network, and can easily be updated with new firmware. New firmware can introduce custom measurement tools developed by the process engineering group overseeing the factory environment so that a new process or part receives proper inspection.

Scalable

Gocator laser profilers support seamless multi-sensor networking for scanning large or complex objects (i.e., with irregular surface geometry and multiple occlusions). These sensor networks are connected by LMI Master controllers.

WHY YOU NEED SMART 3D:

- Volumetric measurement (X, Y, and Z axis) provides shape and position related parameters
- Contrast invariant, ideal for inspecting low contrast objects
- Immune to lighting variation and ambient light
- Higher repeatability due to integrated optics, lighting, and factory pre-calibration
- Simpler to build multi-sensor setups for large object inspection

GOCATOR LASER PROFILERS
for Rubber Extrusion Profiling

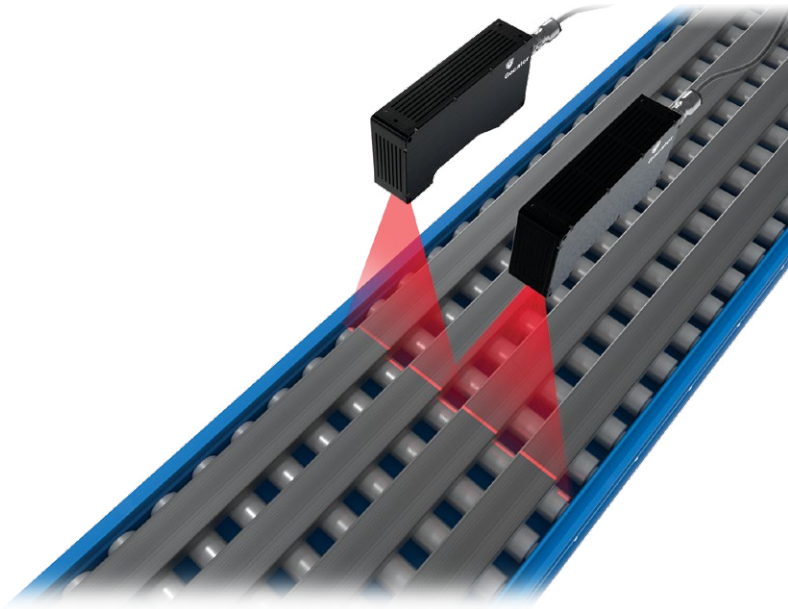
Fast, High-Density Contour Measurement Profiles

Rubber Extrusion Profiling

Measurement of a tire's extrusion groove pattern, geometry, and location is very challenging to achieve at production speed. The task of gauging extrusions is made even more complex by frequent product changeover. This means an effective inline scanning and inspection solution must deliver the high scan speed and measurement flexibility required to achieve maximum finished tire quality and minimize material scrap.

The Smart 3D Solution

Gocator 3D smart sensors deliver high-speed, high-density contour measurement, even from the highly reflective shiny black surfaces of "green" tires. What's more, Gocator offers a powerful dedicated Groove measurement tool designed expressly for extrusion measurement applications. This built-in, user-configurable tool includes measurement functions such as length, width, height, depth, angle, vertex location, groove dimension, and many other tire metrology requirements.



GOCATOR® IS FLEXIBLE:

- Supports inspection of multiple grooves in a single setup
- Groove measurements unaffected by changes in surface angle relative to the sensor
- For wider extrusions, multiple sensors can be networked for larger field of view
- Measurement values can be communicated over factory networks using Gigabit Ethernet

GOCATOR LASER PROFILERS
for Strip Guidance and Splice Control

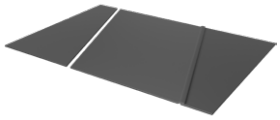
3D Tread Length, Width, Depth, Profile, and Splice

Strip Guidance

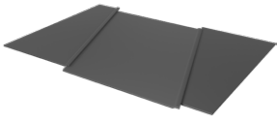
As different types of tire strips (e.g., body plies, gum strips, band bead filler strips) are wound around the drum of the tire, Gocator scans the strip edges to ensure they are in the correct position. Its built-in measurement tools for strip positions—including multiple groove location, depth measurement monitoring, and automated alignment—enable users to configure setup parameters without requiring any additional measurement software development.

Splice Control

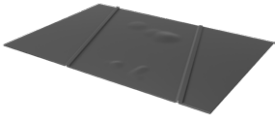
During tire assembly, Gocator 3D smart sensors are used to detect splicing and stitching issues such as gaps, faulty overlaps, dog ears, and material that's folded back on itself.



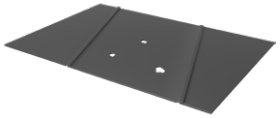
Gaps



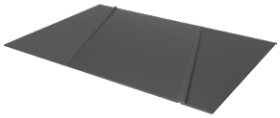
Dog ears



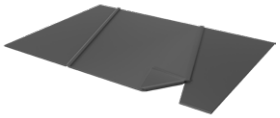
Blisters



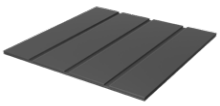
Holes



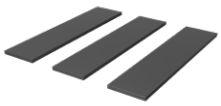
Faulty overlaps



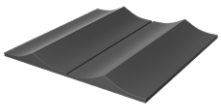
Folds



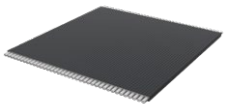
Grooves



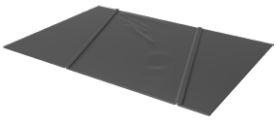
Strips



Peaks and valleys



Belt plies



Wrinkles

GOCATOR® IS SPECIALIZED:

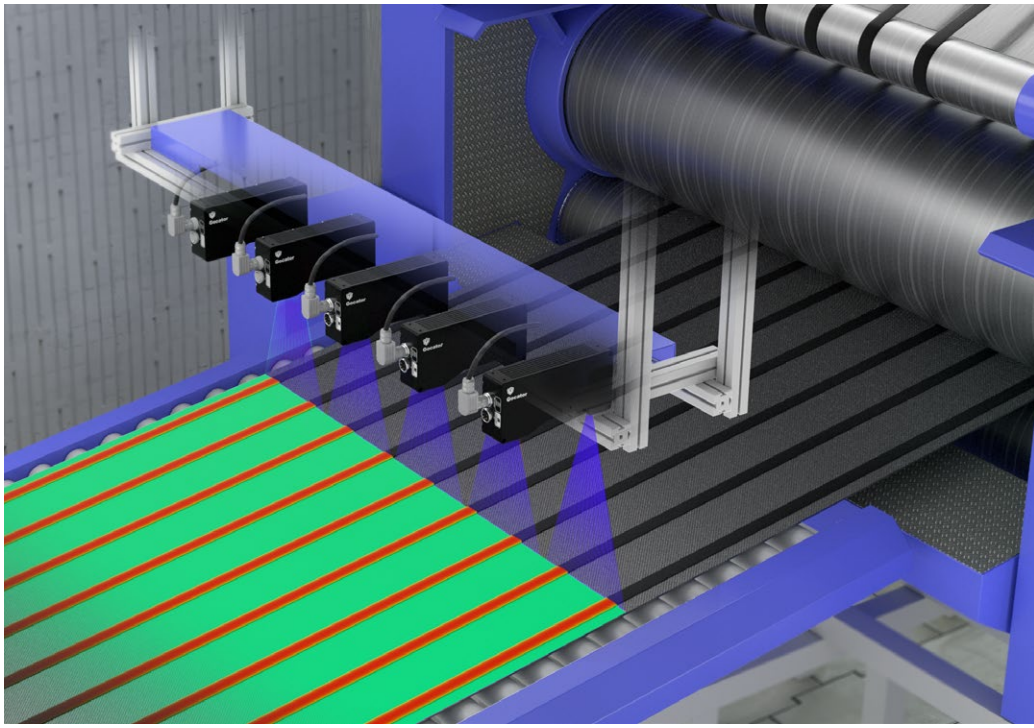
- Built-in tools for strip and groove measurement
- Ability to store multiple geometry configurations
- No additional software development required

GOCATOR LASER PROFILERS
for Layer Control

Fast, High-Density Profile Measurement

Layer Control

Gocator 3D smart sensors scan for the presence, width, and overlap position of key components such as gum rubber strips and layered flat rubber sheets that make up the body of the tire. In order to take layer measurements, Gocator scans a raised line extruded into the rubber that serves as a reference point for guiding and positioning additional layers of rubber material. Scanning this extruded edge requires Gocator's 3D depth measurement.



USE GOCATOR FOR:

- Bank and stop gap calender roll inspection
- Feed bandwidth and thickness inspection
- Groove/embossing depth measurement
- Cap and steel ply inspection
- Rib and shoulder inspection

SDK for Smarter Tire Inspection

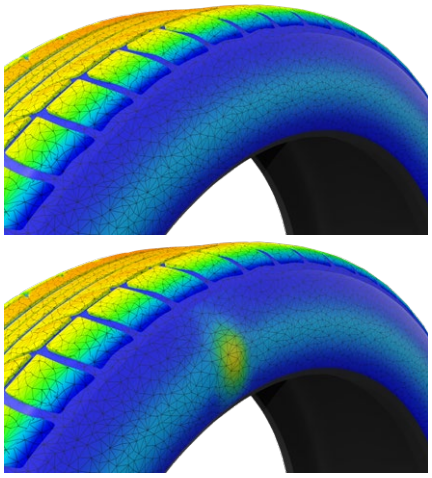
The SDK (Software Development Kit) provides complete control and management of your Gocator sensor in order to fit your specific application needs. You can use the Gocator SDK to create network TCP/IP connections, stream data into circular buffers, parse XML settings, and manage multiple threads. With open source C-based code provided, it's easy to program exactly how Gocator acquires and processes data on any computer or mobile device of your choice.

GOCATOR LASER PROFILERS
for Finished Tire Inspection

Complete 3D Surface Data

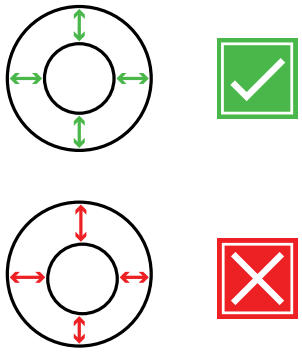
Bulge and Dent

Final tire geometry systems need to detect bulges and dents as small as 25 µm, which indicate critical internal defects that may lead to tire failure. These imperfections can occur anywhere on the tire sidewall or tread. To increase quality and improve product safety, small areas of dimensional variation or defects must be detected with submillimeter accuracy and reliability. Cycle time is also critical for final inspection, requiring full surface inspection in one revolution to meet strict throughput requirements.



Radial and Lateral Runout

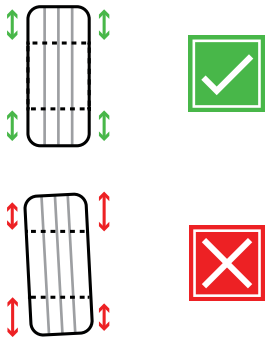
Radial runout occurs when the radius of the tire is not consistent from the wheel midpoint to any point on the rim. Too much radial runout can cause up and down vibrations, or "hopping", when the tire spins. Lateral runout is the amount of sideways motion, or "wobble", in a tire as it rotates.



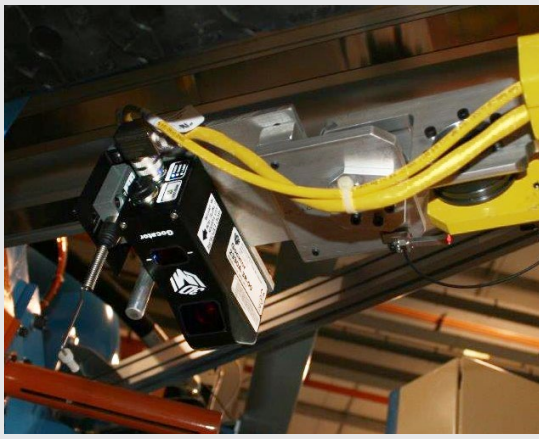
Radial runout

The Smart 3D Solution

With rapid scan speed and real-time data acquisition, Gocator provides full 3D surface data to detect small defects anywhere on the sidewall surface and tire tread, meeting demanding cycle time requirements. A typical Gocator tire inspection system includes three profile sensors: one for profiling each sidewall, and a third for monitoring radial and lateral runout of the tread.



Lateral runout



CASE STUDY:

CTI Uses Gocator in Its Tire Uniformity Optimization Systems

Faced with the challenge of upgrading their old capacitive sensors, CTI introduced Gocator into select TUO systems. Gocator gives CTI's system a greater volume of tire data and its unique all-in-one 3D scanning and inspection functionality minimizes component and system complexity, improves reliability, maximizes robustness and repeatability, and makes system integration faster, easier and more cost-effective than any other 3D scanning and inspection solution on the market.

GOCATOR LASER PROFILERS

for Tire Markings and DOT-Code Identification

Height Map Imaging for Automated Code Recognition

Tire Markings

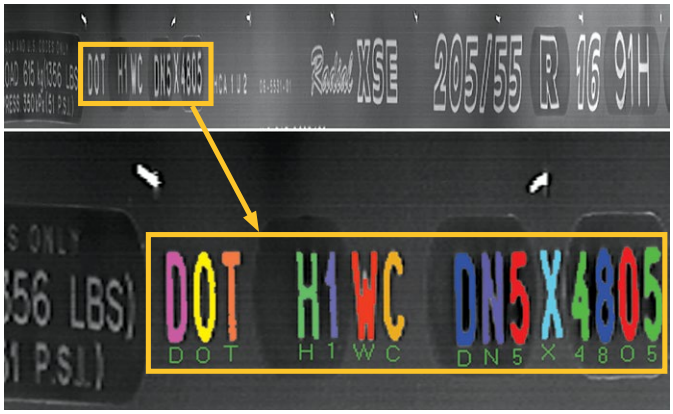
Gocator scans painted or lasered tire markings on the sidewall of the tire, including tire size and maximum inflation pressure. It achieves this measurement by generating an intensity image of the marking that is then processed using HexSight or Gocator SDK.

DOT-Code Identification

Tire sidewalls contain extensive alphanumeric information in the form of raised or embossed characters. These include tire identification codes for sorting and DOT-codes for tracking the vehicle identification number at the time of assembly. The common industry solution of reading alphanumeric characters with 2D imaging and optical character recognition software is insufficient for tire sidewalls because the raised or embossed characters are “black-on-black”, with effectively zero contrast.

The Smart 3D Solution

Gocator solves this challenge by generating an image of embossed characters as a height map. Its native GenTL driver sends the height-map data to compliant third-party software for automated character recognition. When tires are rotating, such as in uniformity inspection systems, Gocator supports triggering by a quadrature encoder, stamping each profile with a Z position index value. This allows seamless scan alignment across multiple sensors.

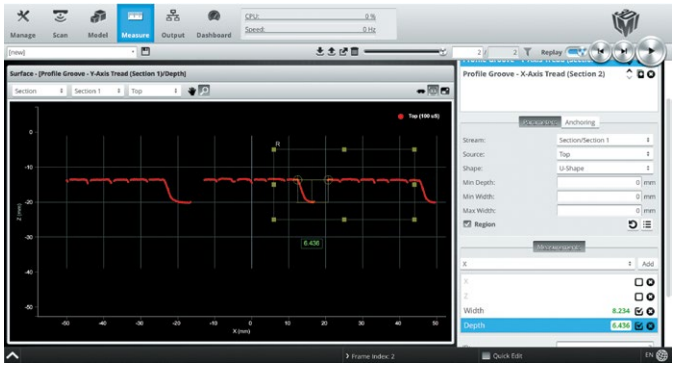


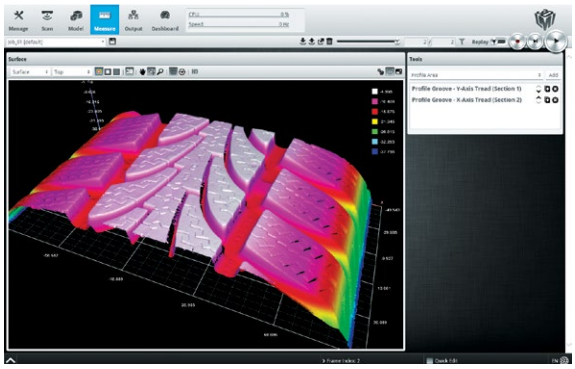
An example of automatic reading of DOT codes is shown above. The upper image is a scan of the tire sidewall (flattened), and the lower image shows the 3D height map of the DOT-code, with the alphanumeric code as read superimposed below the characters.

GOCATOR FIRMWARE

Built-In Measurement Tools for Efficient Tire Inspection

Application-Specific Tools Make Measurement Fast and Easy





Built-In Profile Measurement Tools

Gocator provides a full selection of built-in rubber and tire inspection measurement tools for key features such as width, length, distance between points, positions, angles, profile C/S area, grooves, multiple strips, and more.

Built-In Surface Measurement Tools

Gocator has volumetric measurement tools for evaluating 3D geometry such as area, volume, and centroids.

GOCATOR® IS SMART:

- Rapid scan speeds of 10 kHz
- Buffered, real-time processing ensures no lost data
- Pre-calibrated to measure out-of-the-box for a selected measurement volume
- Provides optimized exposure setting
- Ability to easily set decision thresholds
- Ease-of-integration results in faster setup and lower system costs

Gocator® LINE PROFILERS

Gocator 2100 Series — Laser Line Profile

MODELS	2120	2130	2140	2150	2170	2180
Data Points / Profile	640	640	640	640	640	640
Linearity Z (+/- % of MR)	0.01	0.01	0.01	0.01	0.04	0.04
Resolution Z (mm)	0.0018-0.0030	0.006 - 0.014	0.013 - 0.037	0.019 - 0.060	0.055 - 0.200	0.092 - 0.488
Resolution X (mm) (Profile Data Interval)	0.028-0.042	0.088 - 0.150	0.19 - 0.34	0.3 - 0.6	0.55 - 1.10	0.75 - 2.20
Repeatability Z (µm)	0.4	0.8	1.2	2	8	12
Clearance Distance (CD) (mm)	40	90	190	300	4 00	350
Measurement Range (MR) (mm)	25	80	210	400	500	800
Field of View (FOV) (mm)	18 - 26	47 - 85	96 - 194	158 - 365	308 - 687	390 - 1260
Dimensions (mm)	Side Mount 35x120x149.5	Top Mount 49x75x142	Top Mount 49x75x197	Top Mount 49x75x272	Top Mount 49x75x272	Top Mount 49x75x272
Weight (kg)	0.8	0.74	0.94	1.3	1.3	1.3

Optical models, laser classes, and packages can be customized. Contact LMI for more details. Specifications stated are based on standard laser classes. Linearity Z, Resolution Z, and Repeatability Z may vary for other laser classes. Refer to specifications in the Gocator Line Profile Sensor user manual for more details.

ALL 2100 SERIES MODELS	
Scan Rate	Approximately 170 Hz to 5000 Hz
Interface	Gigabit Ethernet
Inputs	Differential Encoder, Laser Safety Enable, Trigger
Outputs	2x Digital output, RS-485 Serial (115 kBaud)
Input Voltage (Power)	+24 to +48 VDC (13 Watts); Ripple +/- 10%
Housing	Gasketed aluminum enclosure, IP67
Operating Temperature	0 to 50°C
Storage Temperature	-30 to 70°C
Vibration Resistance	10 to 55 Hz, 1.5 mm double amplitude in X, Y, and Z directions, 2 hours per direction
Shock Resistance	15 g, half sine wave, 11 ms, positive and negative for X, Y, and Z directions
Scanning Software	Browser-based GUI and open source SDK for configuration and real-time 3D visualization. Open source SDK, native drivers, and industrial protocols for integration with user applications, third-party image processing applications, and PLCs.

Gocator 2300 Series — Laser Line Profile

MODELS	2320	2330	2340	2350	2370	2380
Data Points / Profile	1280	1280	1280	1280	1280	1280
Linearity Z (+/- % of MR)	0.01	0.01	0.01	0.01	0.04	0.04
Resolution Z (mm)	0.0018 - 0.0030	0.006 - 0.014	0.013 - 0.037	0.019 - 0.060	0.055 - 0.200	0.092 - 0.488
Resolution X (mm) (Profile Data Interval)	0.014 - 0.021	0.044 - 0.075	0.095 - 0.170	0.150 - 0.300	0.275 - 0.550	0.375 - 1.100
Repeatability Z (µm)	0.4	0.8	1.2	2	8	12
Clearance Distance (CD) (mm)	40	90	190	300	400	350
Measurement Range (MR) (mm)	25	80	210	400	500	800
Field of View (FOV) (mm)	18 - 26	47 - 85	96 - 194	158 - 365	308 - 687	390 - 1260
Dimensions (mm)	Side Mount 35x120x149.5	Top Mount 49x75x142	Top Mount 49x75x197	Top Mount 49x75x272	Top Mount 49x75x272	Top Mount 49x75x272
Weight (kg)	0.8	0.74	0.94	1.3	1.3	1.3

Optical models, laser classes, and packages can be customized. Contact LMI for more details. Specifications stated are based on standard laser classes. Linearity Z, Resolution Z, and Repeatability Z may vary for other laser classes. Refer to specifications in the Gocator Line Profile Sensor user manual for more details.

ALL 2300 SERIES MODELS	
Scan Rate	Approximately 170 Hz to 5000 Hz
Interface	Gigabit Ethernet
Inputs	Differential Encoder, Laser Safety Enable, Trigger
Outputs	2x Digital output, RS-485 Serial (115 kBaud)
Input Voltage (Power)	+24 to +48 VDC (13 Watts); Ripple +/- 10%
Housing	Gasketed aluminum enclosure, IP67
Operating Temperature	0 to 50°C
Storage Temperature	-30 to 70°C
Vibration Resistance	10 to 55 Hz, 1.5 mm double amplitude in X, Y, and Z directions, 2 hours per direction
Shock Resistance	15 g, half sine wave, 11 ms, positive and negative for X, Y, and Z directions
Scanning Software	Browser-based GUI and open source SDK for configuration and real-time 3D visualization. Open source SDK, native drivers, and industrial protocols for integration with user applications, third-party image processing applications, and PLCs.

Gocator® LINE PROFILERS

Gocator 2400 Series — Laser Line Profile

MODELS	2410	2420	2430	2440	2450	2490
Data Points / Profile	1710	1940	1500	1500	1800	1920
Linearity Z (+/- % of MR)	0.015	0.006	0.01	0.01	0.01	0.04
Resolution X (µm) (Profile Data Interval)	5.8 - 6.2	14.0 - 16.5	37 - 57	90 - 130	100 - 255	250 - 1100
Repeatability Z (µm)	0.2	0.4	0.8	1.2	2.0	12
Clearance Distance (CD) (mm)	19	60	75	183	270	350
Measurement Range (MR) (mm)	6	25	80	210	550	1525
Field of View (FOV) (mm)	10 - 10	27 - 32	47 - 85	96 - 194	145 - 425	390 - 2000
Dimensions (mm)	44x90x145	44x90x145	44x90x155	44x90x190	44x90x240	49x85x272
Weight (kg)	0.88	0.88	1.0	1.2	1.2	1.5

Optical models, laser classes, and packages can be customized. Contact LMI for more details. Specifications stated are based on Recommended laser classes. Linearity Z, Resolution Z, and Repeatability Z may vary for other laser classes.

ALL 2400 SERIES MODELS	
Scan Rate	200 Hz, up to 5 kHz. (Note: 2400 series provides up to 2x scan rate for equivalent window size as 2300 series)
Interface	Gigabit Ethernet
Inputs	Differential Encoder, Laser Safety Enable, Trigger
Outputs	2x Digital output, RS-485 Serial (115 kBaud)
Input Voltage (Power)	+24 to +48 VDC (9 Watts); Ripple +/- 10%
Housing	Gasketed aluminum enclosure, IP67
Operating Temperature	0 to 50°C (10 to 50°C for Class 2 Blue)
Storage Temperature	-30 to 70°C
Vibration Resistance	10 to 55 Hz, 1.5 mm double amplitude in X, Y, and Z directions, 2 hours per direction
Shock Resistance	15 g, half sine wave, 11 ms, positive and negative for X, Y, and Z directions
Scanning Software	Browser-based GUI and open source SDK for configuration and real-time 3D visualization. Open source SDK, native drivers, and industrial protocols for integration with user applications, third-party image processing applications, and PLCs.

Gocator 2500 Series — Laser Line Profile

MODELS	2510	2512	2520	2522	2530	2540	2550
Data Points / Profile	1920	1920	1920	1920	1920	1920	1920
Scan Rate (kHz)	2.4	2.4	1.6	1.6	2.0	1.7	1.7
Linearity Z (+/- % of MR)	0.015	0.015	0.006	0.006	0.01	0.05	0.06
Resolution X (µm) (Profile Data Interval)	8.0	8.0	13.0 - 17.0	13.0 - 17.0	28.0 - 54.0	64.0 - 160.0	80.0 - 270.0
Repeatability Z (µm)	0.2	0.2	0.4	0.4	0.5	1.2	2.0
Clearance Distance (CD) (mm)	17.0	17.0	47.5	17.75	40.0	152	216
Measurement Range (MR) (mm)	6	6	25	25	80	295	595
Field of View (FOV) (mm)	13.0 - 14.5 (diffuse)	13.0 - 14.5 (diffuse & specular)	25.0 - 32.5 (diffuse)	25.0 - 32.5 (diffuse); 25.0 (specular)	48.0 - 100.0 (diffuse)	120.0 - 292.0 (diffuse)	154.0 - 518.0 (diffuse)
Dimensions (mm)	46x80x110	46x80x110	46x80x110	46x110x110	46x80x110	55 x 105 x 195	55 x 105 x 195
Weight (kg)	0.65	0.65	0.65	0.65	0.65	1.48	1.48

Optical models, laser classes, and packages can be customized. Contact LMI for more details. Specifications stated are based on Recommended laser classes. Linearity Z and Repeatability Z may vary for other laser classes.

ALL 2500 SERIES MODELS	
Interface	Gigabit Ethernet
Inputs	Differential Encoder, Laser Safety Enable, Trigger
Outputs	2x Digital output, RS-485 Serial (115 kBaud)
Input Voltage (Power)	+24 to +48 VDC (15 Watts); Ripple +/- 10%
Housing	Gasketed aluminum enclosure, IP67
Operating Temperature	0 to 40°C
Storage Temperature	-30 to 70°C
Vibration Resistance	10 to 55 Hz, 1.5 mm double amplitude in X, Y, and Z directions, 2 hours per direction
Shock Resistance	15 g, half sine wave, 11 ms, positive and negative for X, Y, and Z directions
Scanning Software	Browser-based GUI and open source SDK for configuration and real-time 3D visualization. Open source SDK, native drivers, and industrial protocols for integration with user applications, third-party image processing applications, and PLCs.

It’s Better to Be Smart.

contact@lmi3D.com | lmi3D.com

AMERICAS
LMI Technologies Inc.
Burnaby, BC, Canada

EMEAR
LMI Technologies GmbH
Teltow/Berlin, Germany

ASIA PACIFIC
LMI (Shanghai) Trading Co., Ltd.
Shanghai, China

LMI Technologies has offices worldwide. All contact information is listed at lmi3D.com/contact

BROCHURE_RubberTire_UK-2.2