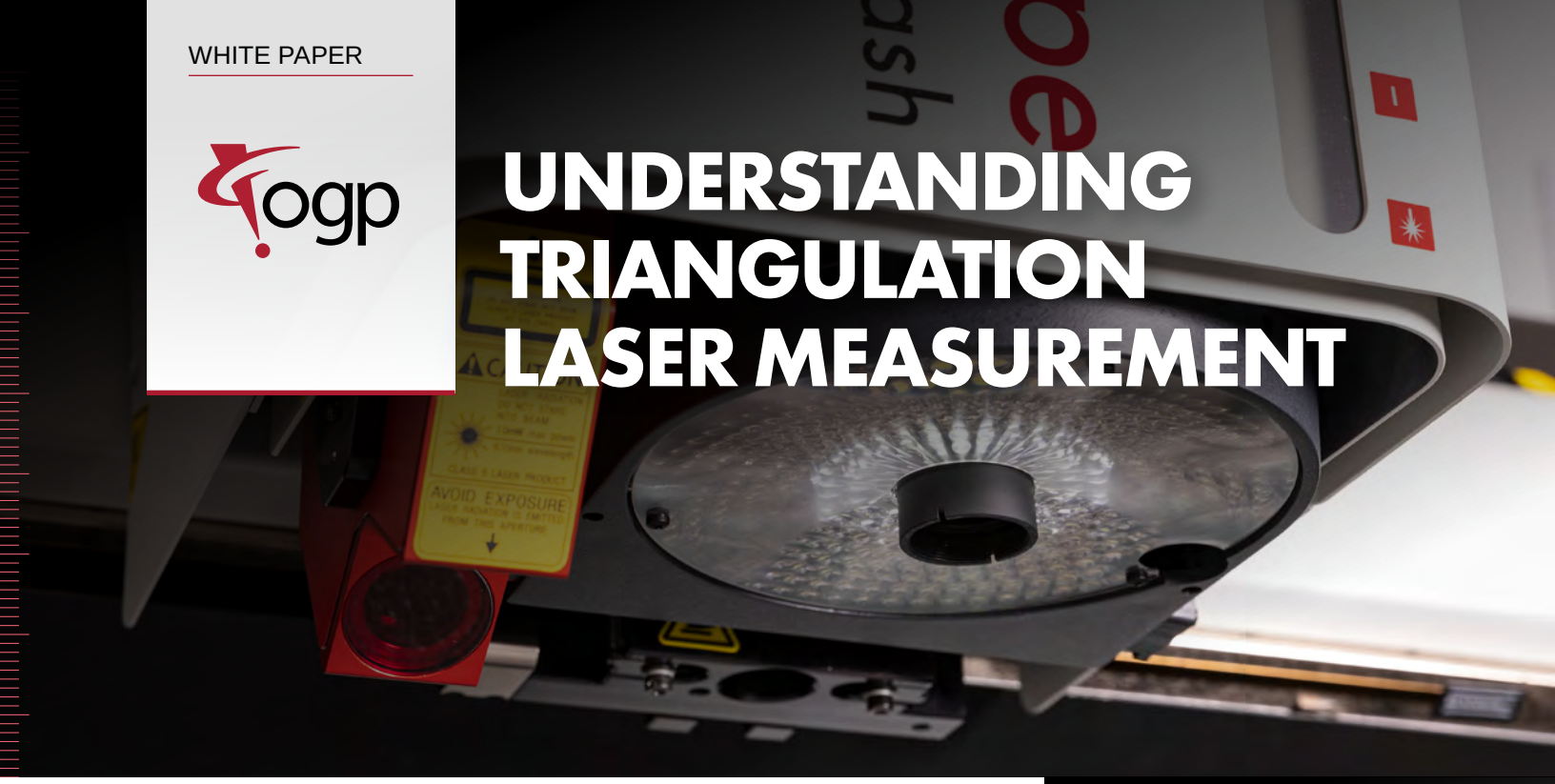
WHITE PAPER

UNDERSTANDING TRIANGULATION LASER MEASUREMENT



WHAT IS A LASER?

The word laser is an acronym that stands for: Light Amplification by Stimulated Emission of Radiation. A laser is defined as any of several devices that emit highly amplified and coherent radiation of one or more discrete frequencies.

HOW CAN LASERS BE USED?

Lasers are used in hundreds of different applications:

- **Commercial:** holograms, barcodes, light show
- **Communications:** fiber optics
- **Health and Medical:** eye surgery, dentistry, skin treatment
- **Home Electronics**: DVD, CD, CD-ROM
- **Industrial:** cutting, welding, heating, alignment
- **Measurement and Metrology:** range sensing, surveying
- **Military Weaponry**: targeting, designating

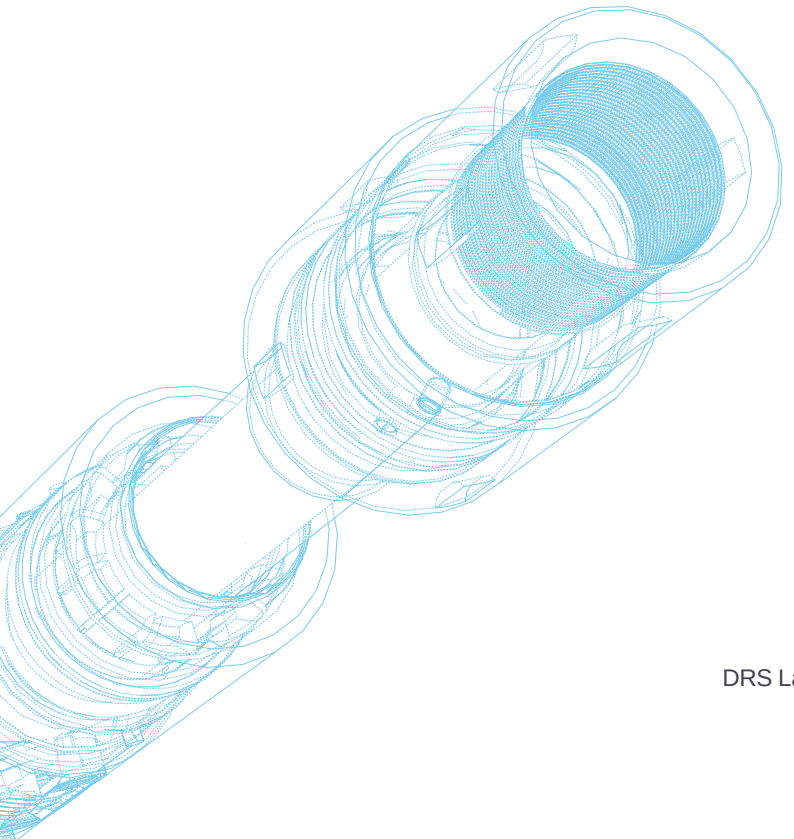
TTL Laser

WHAT MAKES ONE LASER DIFFERENT FROM ANOTHER?

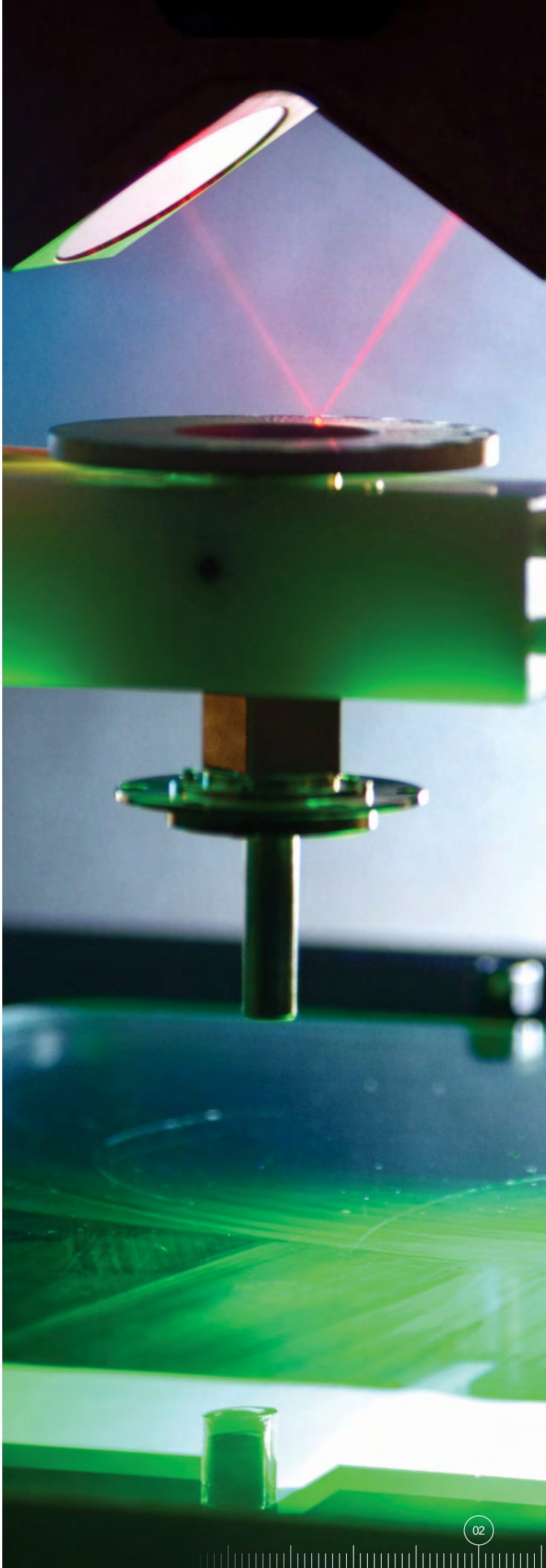
Laser radiation can be created using different methods

Lasers come in different strengths; this power rating is stated in megawatts (mW). They also come in a variety of different wavelengths, which is stated in nanometers (nm). The Center for Devices and Radiological Health (CDRH) has assigned all commercial lasers to a class-based on strength. Here are the different classes and some examples of their use:

- **Class I** – DVD player
- **Class IIa** – barcode scanner
- **Class II** – OGP triangulation laser range sensors
- **Class IIIa** – laser pointers
- **Class IIIb** – laser light show
- **Class IV** – surgery



DRS Laser



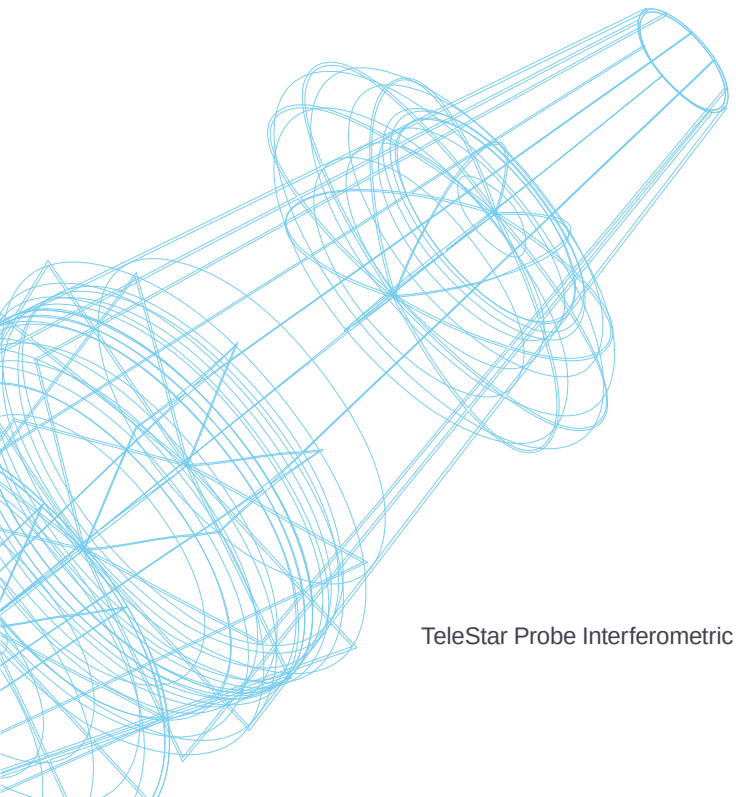
HOW CAN A LASER BE USED TO MEASURE?

There are many different types of laser range sensors:

- Confocal
- Interferometric
- Null (Foucault, knife-edge, pinhole)
- Triangulation

All laser range sensors work by sending out laser light from an emitter to something directly ahead and analyzing the light reflected back to the sensor. The method used to analyze the reflected light distinguishes one sensor type from another. This analysis can be performed in a number of different ways:

- Displacement
- Interferometry
- Time of flight (TOF)



TeleStar Probe Interferometric Laser

WHICH TYPE OF LASERS DOES OGP® USE?

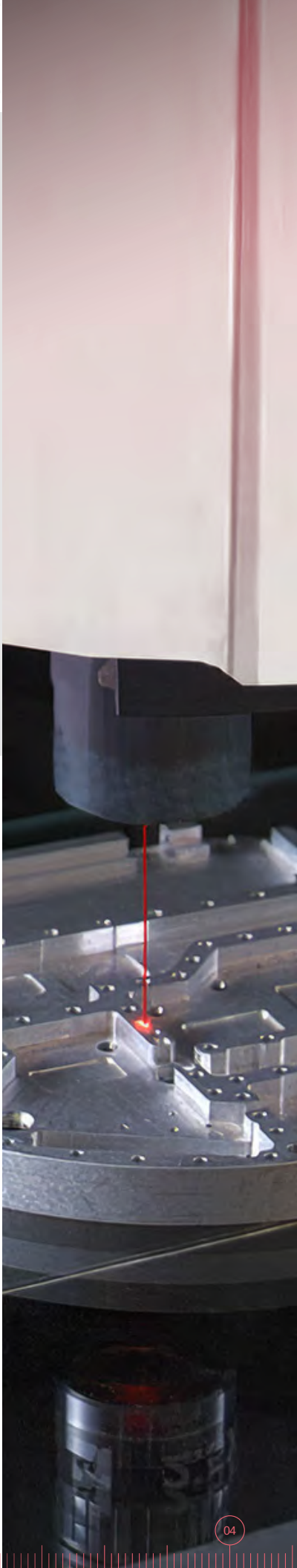
OGP offers many types of lasers including triangulation, chromatic confocal (Rainbow Probe), and interferometric (TeleStar Plus TTL and TeleStar Probe). All triangulation laser sensors from OGP have the following attributes in common:

- **Source:** Gallium Aluminum Arsenide (GaAlAs) Diode
- **Detector:** CCD
- **Type:** Laser Range Sensor
- **Configuration:** Triangulation
- **CDRH rating:** Class II
- **Power:** 1.0 mW max
- **Wavelength:** 670 nm

HOW DOES LASER TRIANGULATION WORK?

Laser triangulation sensors determine height by analyzing reflected light using the principle of displacement. The sensor's laser diode projects a beam of light onto the target object. Some of the light is reflected off the object onto a light-sensitive detector built into the sensor. The detector records the position of the reflected beam and reports a height measurement. If the target or the sensor moves, the position of the reflection on the detector changes.

The CCD detector consists of a row of discrete photodetectors, referred to as pixels. When the reflected light hits the detector the sensors electronics determine the center of the imaged spot by looking at the intensity of each pixel. One of the advantages of this type of detector is the ability to set a threshold. A threshold is a moveable limit below which extraneous information, or noise, can be ignored. The detector can also be set to ignore a condition known as multiple spots. This condition arises when a surface reflection, or other light source, creates a second center on the sensor.

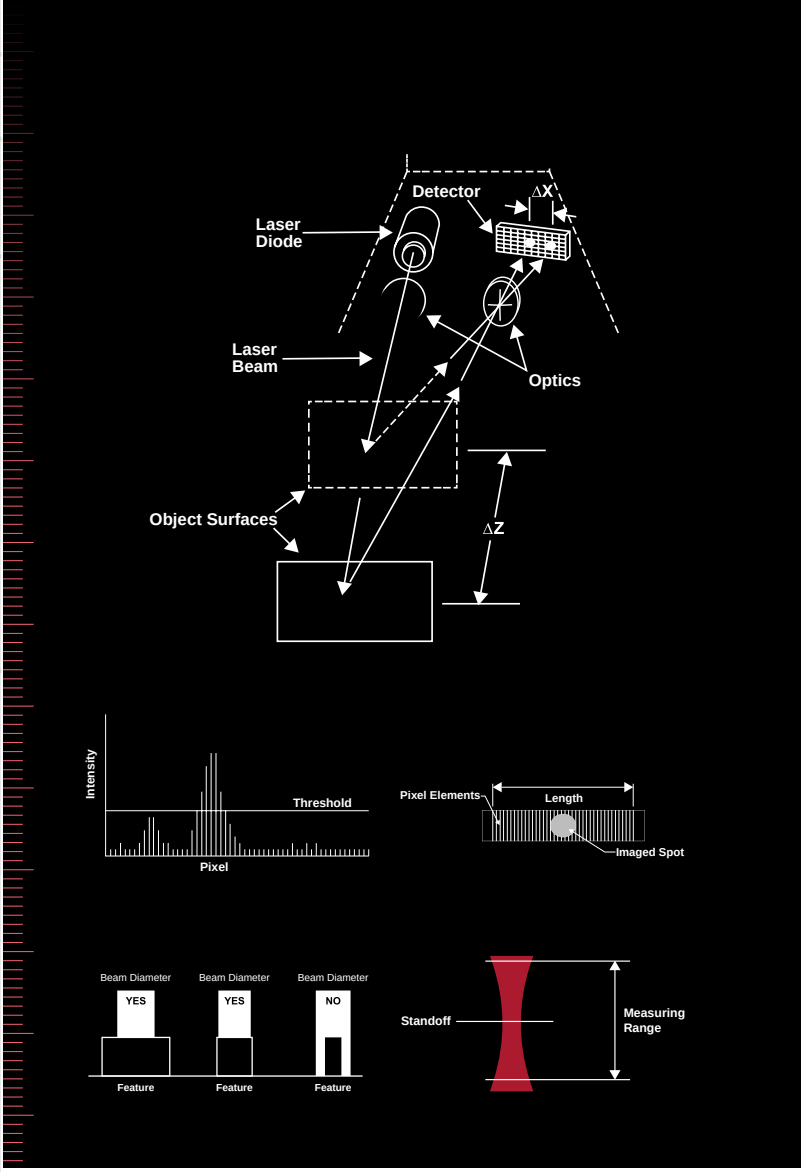


TTL Laser

DOES "SPOT SIZE" MATTER?

The diameter of the beam, or spot size does matter. The spot size can be no larger than the feature to be measured. A good rule of thumb is that the spot size must be less than one-tenth the size of the smallest feature to be measured. Triangulation sensors are designed to focus the laser beam to create the smallest spot at the sensor standoff distance.

The standoff is defined as the distance from the front of the sensor to the middle of the measuring range. This is the point where the laser spot size is specified. The size of the beam is smallest at the standoff point, but it is larger both inside and outside this point. So the sensor with the smallest spot size will also have the smallest standoff and working range.



TRIANGULATION SENSOR TERMINOLOGY

Accuracy – The combination of errors that come from both the dynamic resolution of the laser sensor and the movement of the stage. For example, if the accuracy specification of a system with a triangulation laser sensor is 2.0 + 6L/1000. This equation contains a dynamic resolution component (2.0) and the error contributed by Z-axis movement (6L/1000).

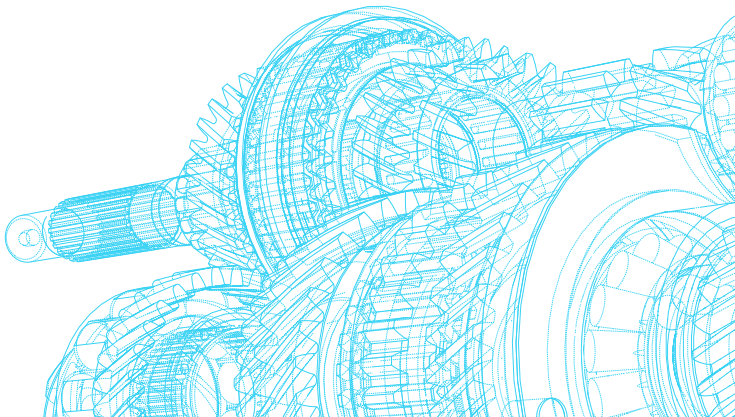
Dynamic Resolution – The smallest detectable change in height when the sensor is moved horizontally over a NIST traceable step gage of known height without moving the sensor in the Z-axis. This value is independent of the capture range but includes unintentional Z-axis movement based on temperature or other physical variations. The first number in an accuracy specification is the dynamic resolution. For example leading the 2.0 in the equation 2.0+ 6L/1000 is the dynamic resolution.

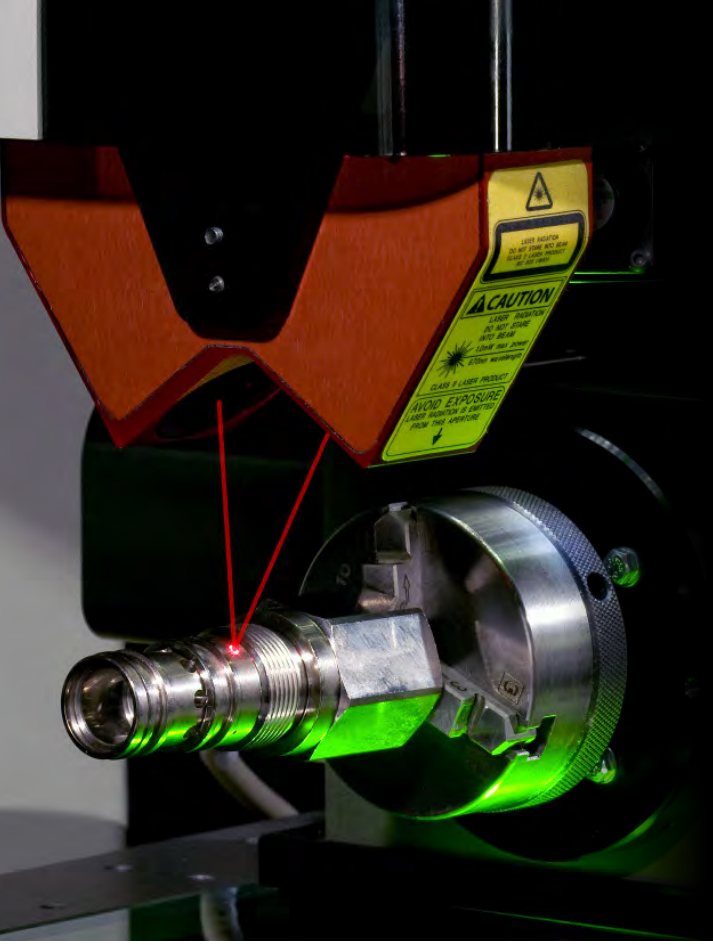
Measuring/Capture Range – The distance over which a sensor is able to gather valid measurements.

Spot Size – The diameter of the laser spot at the standoff distance.

Standoff – The distance from the sensor housing to the center of the measuring range.

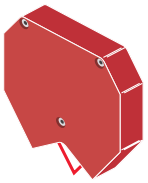
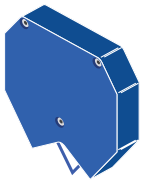
Triangulation – The angle between the laser beam and the sensor viewing axis.





DRS LASER

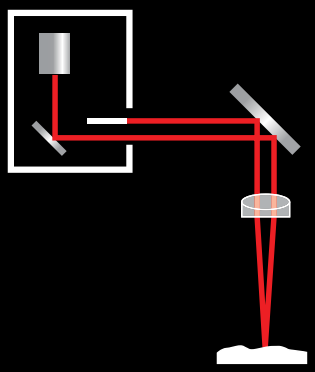
A DRS (Dynamic Range Sensor) Laser can be added to OGP SmartScope® systems to give you high-density surface profiles through sophisticated laser triangulation. The DRS laser is thoroughly integrated into, and supported by, OGP's Metrology Software. Both line and area scans may be automatically programmed to deliver high resolution Z axis profiles or high-speed Z axis single point data can be collected as part of a measurement routine. Two models are available, one with red laser and one with blue for better results on transparent or white parts. The DRS laser is deployable, and retracts conveniently out of the way when not in use. When used as part of a multisensor platform DRS lasers are mounted off the optical axis and are interchangeable.

TECHNICAL SPECIFICATIONS	 DRS-500 **DRS-500 (Red Laser)**	 DRS-500B **DRS-500B (Blue Laser)**
Available for	Most SmartScope Systems	
Required Metrology Software	ZONE3®, Measure-X®, or Scan-X	
Type of Surface	Specular or diffuse reflective surfaces	Best for translucent or white parts
Working Distance[1]	17 mm	
Measuring Range[2]	500 µm	
Spot Size[3] (nominal)	16 x 23 µm	13 x 20 µm
Resolution[4]	0.125 µm	
Accuracy[5]	1.0 µm	
Triangulation Angle	70°	

1 Distance in Z from the lowest point on the DRS laser to the middle of the capture range.
2 Measuring Range is the Z-range over which the performance of the sensor is linear and calibrated.
3 With spot size at best focus.
4 Using high quality specular (polished glass) surface, 1σ.
5 Accuracy of the laser on horizontal specular surfaces within the measuring range. System performance varies with machine type.

THROUGH-THE-LENS (TTL) LASER

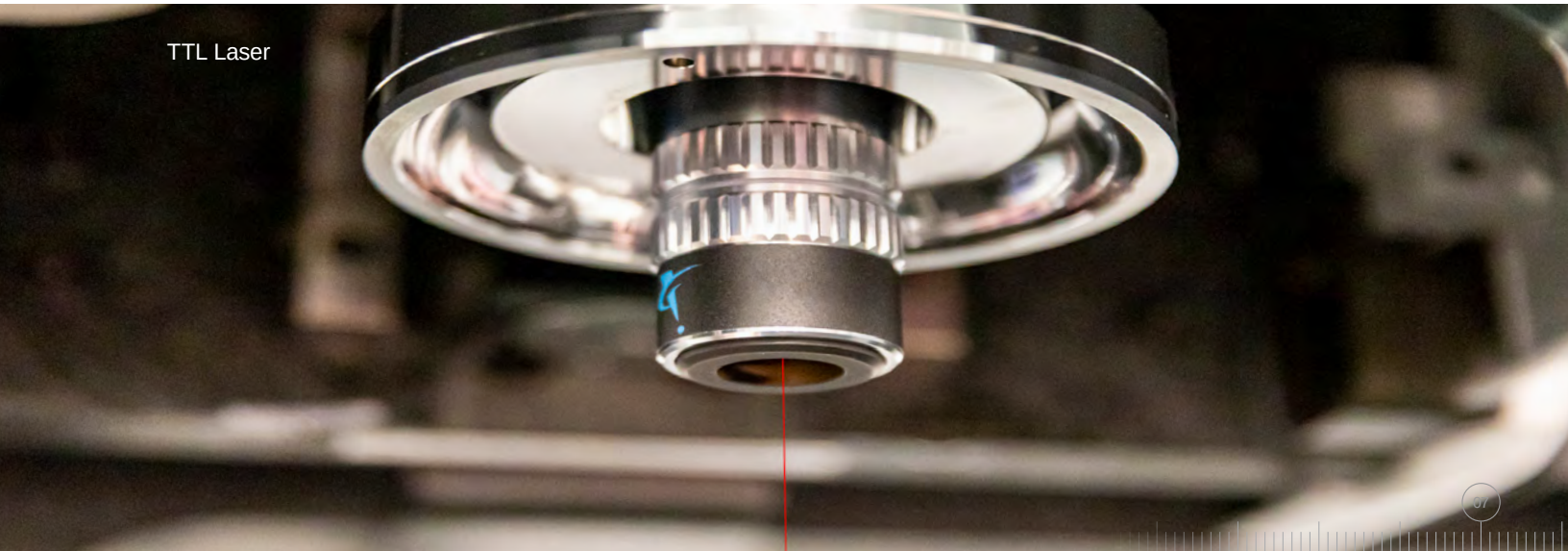
The TTL Laser is a through-the-lens option, which is completely integrated within the optical system. Its unique coaxial design provides a large standoff distance while maintaining a measuring speed twice as fast as a conventional autofocus. But unlike video autofocus, which is best performed at high magnification, Z-axis measurements with the TTL Laser deliver the same precision regardless of the zoom lens setting. So you get fast, high accuracy measurements all the time. The TTL Laser can also provide high-density surface profiles, with both line and area scans. It is thoroughly integrated into, and supported by OGP Metrology Software.



TECHNICAL SPECIFICATIONS

Required Metrology Software	ZONE3®, Measure-X®, VMS™				
Available for	Motorized Zoom Optics		Fixed Optics		
Laser Lens	2.0x (Standard)	5.0x (Optional)	2.5x (Standard)	5.0x (Optional)	10.0x (Optional)
Working Distance	38.0 mm	19.0 mm	34.0 mm	33.5 mm	20.0 mm
Measuring Range[1]	500 µm	80 µm	600 µm	280 µm	80 µm
Spot Size[2] (nominal)	8 x 6 µm	3 x 1.2 µm	16.3 x 8 µm	8.2 x 4 µm	4.5 x 1.3 µm
Resolution[3]	0.4 µm	0.2 µm	0.5 µm	0.2 µm	0.1 µm
Triangulation Angle	14°	35°	11°	21°	41°

1 Measuring Range is the Z-range over which the performance of the sensor is linear and calibrated.
2 With spot size at best focus.
3 Using high quality specular (polished glass) surface, 1σ.



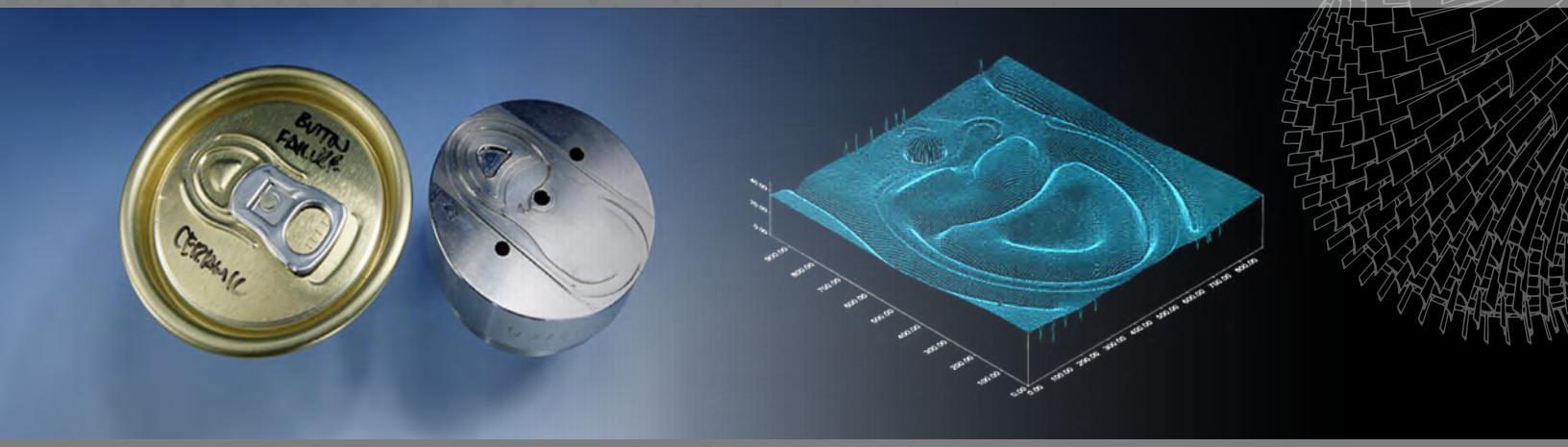
TTL Laser

APPLICATIONS

OGP offers triangulation laser range sensors in two configurations: off-axis (DRS) and through the lens (TTL). These sensors can be used to collect single points (focus) or to collect large a number of points (scanning) and are available as an integrated part of SmartScope multisensor metrology systems.

Can an OGP laser probe help you?

Complex 3D Surface Scanning:



Written by: Chris Leone, Lab Manager
Advanced Coordinate Technology

Learn more about OGP Measurement Systems at **ogpnet.com**

OGP (Optical Gaging Products) is a division of Quality Vision International Inc (QVI®), a world leading manufacturer of precision multisensor metrology systems for industrial Quality Control. Our metrology systems focus on measurement technologies that help manufacturers monitor dimensional compliance to design specifications. First introduced in 1992, the famous OGP SmartScope® product family has become one of the world's most popular and versatile dimensional measurement systems. SmartScope systems are designed and produced at QVI corporate headquarters in Rochester, NY, USA. Flash branded systems are sold in North America while Flash CNC and CNC systems are found outside North America.

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