BLISTER & PRODUCTS

SPECTRA 3D – Laser Safety

Introduction

The geometry inspection with the **SPECTRA 3D** system is carried out using a line scan camera that records the scanning result of a laser. With regard to this technology, many users ask how safe staff and products are when using the geometry inspection system.

This document describes the technology behing the geometry inspection system using technical data and exact calculations carried out by the manufacturor of the laser and compares **SPECTRA 3D** with other systems. In this manner the document not only explains why laser technology cannot be ignored for geometry inspection but also compares **SPECTRA 3D** to other laser systems in daily life.

Laser Protection Classes

The laser used in **SPECTRA 3D** has a comparatively low laser power of 35 mW. The system can thus be compared to a CD or DVD player, systems that also have lasers that cannot leave the housing at any time and is hence non-hazardous. Apart from this, Blu-Ray players use lasers with 405 nm and a laser power of 150 mW and Blu-Ray burners even attain laser powers of up to 500 mW. **SPECTRA 3D** was thus graded, like the other systems, laser protection class 1.

Due to its solid housing the system is sufficiently protected to guarantee safe working, as long as no security mechanisms (e.g. drawer contact, enable-signal) are bypassed negligently.

The laser class 3B mentioned in the technical data sheet only refers to the laser if not widened, i.e. the direct punctiform laser beam. The laser used in the **SPECTRA 3D** system however is turned into a line using a special lens and thus looses irradiance. This is one of the reasons for the laser protection class 1 grading.

The laser safety standards refer only to the direct contact to free laser radiation and shall prevent that uninvolved staff is accidentally exposed to the radiation. Due to the containment of the laser and to the cut-off mechanisms the user is never exposed to the laser. A laser safety officer is only necessary if a class 3B laser is operated freely in a working area.

The laser radiation is explained in detail in chapter Radiation Properties of the **SPECTRA 3D** Laser on page 4.

Technical Data

Ambient Conditions	
Operating temperature range	-10... +45 °C
Relative humidity	90% (non condensing)
Transport/storage temperature range	-10... +80 °C

Optical Specifications	
Laser class	3B (non-widened)
Wavelength (λ)	660 nm
Optical output power (P)	35 mW
Intensity distribution	Uniform along length, Gaussian along width
Fan Angle (φ)	30°
Line length (L)	~180 mm
Line width (W)	~200 µm

Mechanical Specifications	
Weight	44 g
Diameter	19 mm
Length	73,5 mm
Housing	Bronze anodised aluminium
Isolated Body	yes

Electrical Specifications	
Input voltage	5 V
Reverse polarity protection	yes
Internal current limiter	yes

Protection Housing Specifications	
Housing dimensions (H × B × T)	166 × 80 × 40 mm
Glass plate dimensions (H × B)	40 × 16 mm
Glass type	anti-reflex glass
Adjusting device	2 axes

Comparison of 3D recording technologies

This chapter compares the two prevalent technologies for the recording of 3D images and their performance. It also shows why the presumably dangerous laser technology has an advantage over the stereoscopic processing.

Stereovision (stereoscopic method)

Fields of application:
- Geo data acquisition
- Robot control
- Touchless interaction (e.g. Microsoft Kinect)
- Entertainment (3D films)

Stereovision is a flexible way to determine positions in space. It is mostly used in the consumer sector, e.g. for driving assistant systems and in robotics. The image is generated using standard hardware (standard cameras) but requires a complex mathematical calculation in order to create one 3D image out of two 2D images.

This method requires tie points, i.e. points that can be clearly identified in both images. This is one of the biggest problems of stereovision image acquisition. Particularly when handling weakly contrasting or homogenous objects points often cannot be assigned without using additional special tools.

The worse the points are assigned the less accurate the resulting image. This leads to a wrong combination of the image information which in turn reduces the resolution. Some structures that can be clearly recognised in 2D images are not recognisable anymore in the 3D view.

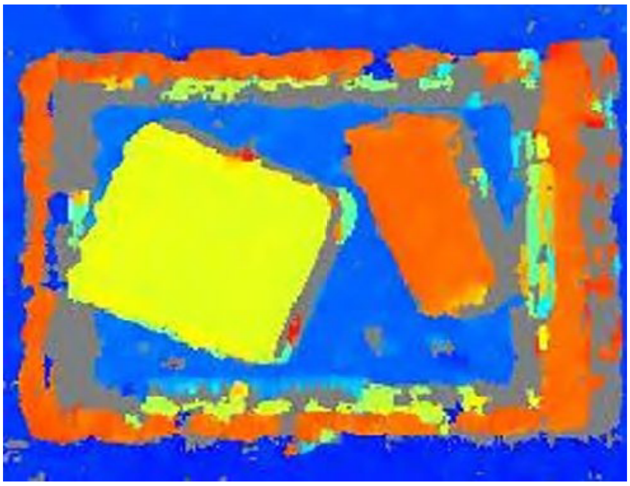


Image output of stereoscopic method
Source: wiki.zimt.uni-siegen.de

Laser Triangulation (laser light sheet method)

Fields of application:
- Weld seam testing
- Detection of surface defects
- Object measurement
- Object position recognition

The laser light sheet method used in the **SPECTRA 3D** system is an extremely exact method that provides maximum performance for the industrial usage. The measured data (i.e. the 3D image) is provided directly by the camera and can be processed immediately. There are only few restrictions for the surface to be measured, however, this method offers constant accuracy due to exact position determination using an incremental encoder. This method can only be used for moved objects, which is the case on packaging lines and thus does not affect the geometry inspection system.

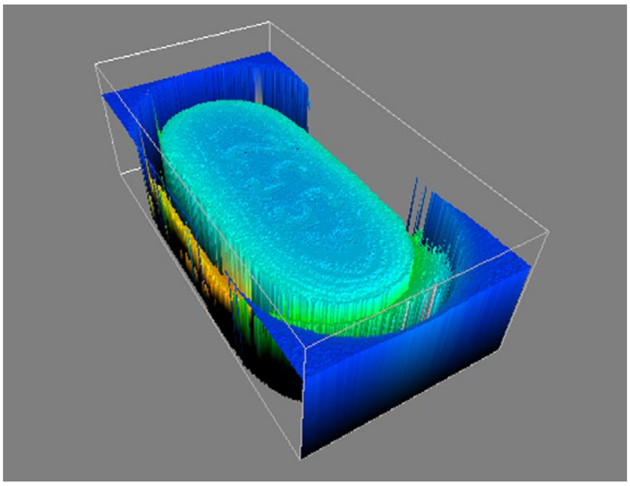


Image output of laser light sheet method

Radiation Properties of the SPECTRA 3D Laser

This chapter specifies the numeric laser radiation properties of the laser used in the **SPECTRA 3D** geometry inspection system.

Optical Specifications

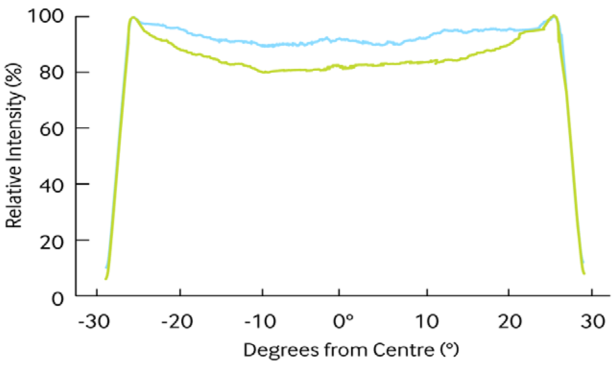
Parameter	Value
Wavelength (λ)	660 nm
Optical output power (P)	35 mW
Fan angle (φ)	30°
Line length (L)	~180 mm
Line width (W)	~200 µm

Even Power Distribution

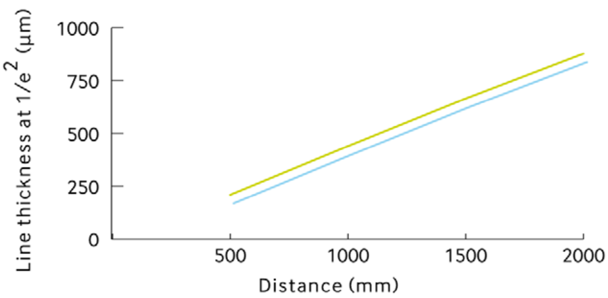
The green chart represents the relative intensity, i.e. the luminence of the laser used in **SPECTRA 3D**. The chart displays that the luminence remains nearly constant throughout the fan angle range. Thus, the laser shows only slight luminance deviations and can achieve optimal results.

Focusing

Again, the green chart represents the laser performance of the **SPECTRA 3D** laser. This chart displays that the laser line gets wider with increasing distance between laser and object. The increasing line width may cause inaccurate measuring result the larger the distance. This does, however, not affect the **SPECTRA 3D** performance, since the distance between laser and object is generally inferior than the starting point of the graph shown in the chart, namely smaller than 500 mm.



Even power distribution
Source: global-laser.co.uk



Representation of focusing values
Source: global-laser.co.uk

Calculation of the Illuminated Area

If you want to find out, which radiation the inspected products are exposed to when using the **SPECTRA 3D** geometry inspection system, you first have to calculate the size of the illuminated area (A).

This is calculated as follows:

$$A = \text{length} \times \text{width} = L \times W$$

In this specific case the size of the illuminated area is:

$$A = 180 \times 10^{-3}\text{m} \times 200 \times 10^{-6}\text{m} = 36 \times 10^{-6}\text{m}^2$$

Irradiance Calculation

Using this value you can now calculate the irradiance value (E).

This is calculated as follows:

$$E = \frac{\text{power}}{\text{area}} = \frac{P}{A}$$

In this specific case the irradiance value is:

$$E = \frac{35 \times 10^{-3}\text{W}}{36 \times 10^{-6}\text{m}^2} = 972,22\frac{\text{W}}{\text{m}^2}$$

In comparison, the sun has (in summer at noon in Central Europe) an irradiance value of 700 W/m².

Average Exposure Time

With these values an average exposure time (t) for the products can be calculated. This is done using a maximum exposure time on continuous machines. Intermitting machines are even faster and thus have an even shorter exposure time for the products.

This is calculated as follows:

$$t = \frac{\text{speed}}{\text{linewidth}} = \frac{S}{W}$$

In this specific case the exposure time is:

$$t = \frac{0,5\frac{\text{mm}}{\text{ms}}}{0,2\text{mm}} = 0,4\text{ms}$$

In the worst case the products are exposed to the laser radiance for 0,4 ms.

Conclusion

The laser used in the **SPECTRA 3D** geometry inspection system emits slightly more energy per area (W/m²) than the sun on a sunny day at noon in Central Europe. The laser radiance is visible and has a very narrow bandwidth around 660 nm (red). The sun radiation however covers the whole spectrum of wavelengths, e.g. UV and visible IR, which is more dangerous for human eyes and skin. Additionally the exposure time per area is very short since only a small part of the product is illuminated at the same time.

Laser Safety Certificate

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LASER SAFETY CERTIFICATE

The laser measurement system described hereunder has been classified regarding laser safety according to the stated norms and has been evaluated as described. Measurement techniques and test results are documented in the stated laser safety report.

Laser Safety Report	**110930 GUT scanware**	
Manufacturer / Distributor	scanware electronic GmbH	
Street	Darmstädter Straße 9	
Post code / Town	D – 64404 Bickenbach, Germany	
Product / System		
Description	Image processing system for geometric control	
Test unit S/N	LYNX-SPECTRA 3D	
Intended use	Geometric control of pharamceutical products and packaging	
Laser source(s)		
Manufacturer	Global Laser	
Model & S/N	Lyte MV	103715-28418-1
Laser type / wavelength	Diode	λ 650 nm
Op. Mode / power	CW	P_{peak} 35 mW
Norms / Regulations		
ISO IEC EN	60 825-1 / 60 825-4 / 11 553-1	
FDA ANSI	./.	
BG or national	BGV-B2 / OStrV July 2010	

Classification			
Operating mode	Normal operation	Teaching / Service	Service / Repair
Applies to	User	User	Manufacturer
Laser class	1	1	3B
Housing test class	T1 (30.000s)	./.	./.
Eye safety confirmed	YES	YES	Only with PSE
Laser safety officer	NO	NO	YES
Laser protection goggles	NO	NO	YES
Registration trade supervision / trade association	NO	NO	YES

Our expert survey confirms the classification and the safety of the laser system (product) for the user in the above mentioned intended uses according to the operating manual of the equipment manufacturer in regard to the original delivery configuration. A risk analysis was not undertaken by the surveyors.

Darmstadt, the 24th Oktober 2011

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Von der Industrie- und Handelskammer Darmstadt öffentlich bestellt und vereidigt
Dipl.-Ing. Klaus R. Goebel
Sachverständiger für Lasertechnik

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- Öffentlich bestellte und vereidigte Sachverständige für Lasertechnik
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- Zertifiziert nach EN ISO 9001 – 2000 / Reg.: 287 496 QM
- Zertifiziert nach EN ISO 13 485 / Reg.: 287 496 MP 21

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