RAYDIME METER

DISTANCE MEASUREMENT – TOPOLOGY SCANS – PROCESS AUTOMATION

OCT-DISTANCE MEASUREMENT IN LARGE WORKING FIELDS

The RAYDIME METER is an OCT-based distance measurement sensor that enables precise metrology of workpieces. Unlike existing OCT-sensors, the RAYDIME METER is designed for use with pre-focusing beam deflection units. This capability enables the RAYDIME METER to operate on large working fields of up to 500 x 500 mm^2 while achieving an excellent measurement accuracy of < 10 micrometers. The RAYDIME METER is particularly useful in scenarios where work has to be carried out within a small process window. Furthermore, it helps where precise z-distance measurement is required before laser processing, such as when welding thin sheets, welding bipolar plates or welding busbars in battery production.

In combination with a beam deflection unit, the RAYDIME METER can also measure the topography before and after laser processing. This enables precise quality control, which is required in many modern manufacturing processes. It not only improves the efficiency and results of these processes, but also reduces the risk of errors and represents a significant advance in precision manufacturing and quality control.

Automated distance measurement

Large measurement area

Easy system integration

COAXIAL OCT FOR PREFOCUSING DEFLECTION UNITS

The RAYDIME METER is a high-precision distance measurement sensor designed specifically for use with pre-focusing beam deflection units. This allows the advantages of such beam deflection systems, such as high laser power and large working fields, to be utilized, even in demanding processes with small process windows.

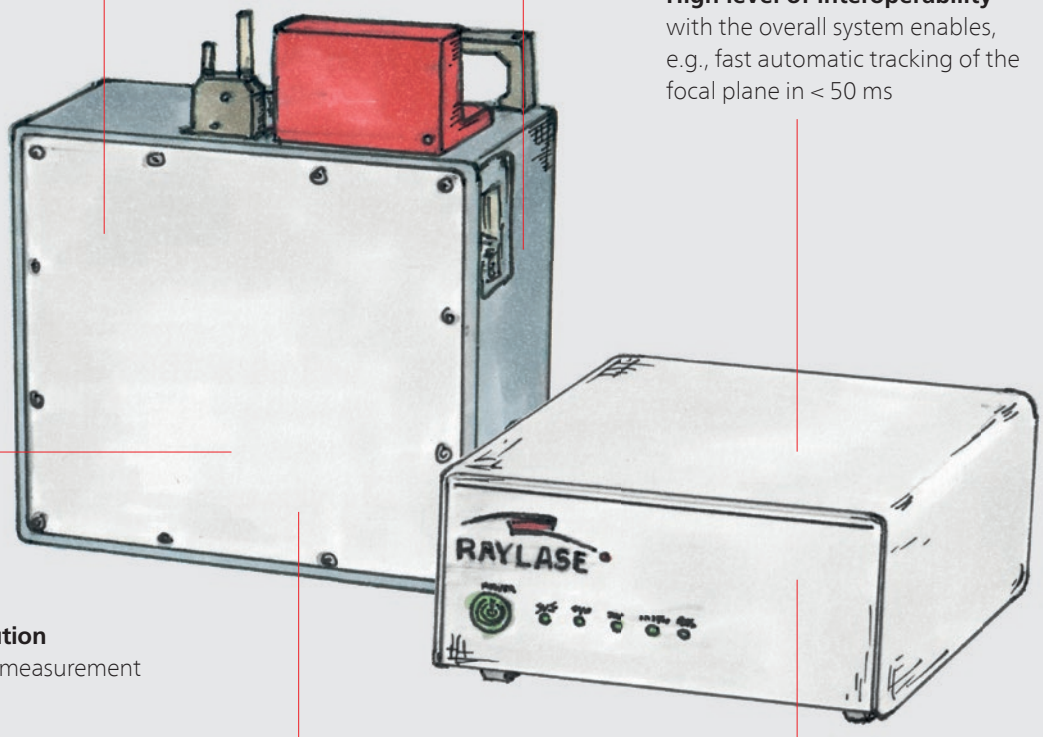
The RAYDIME METER is designed for seamless integration with our beam deflection units of the AXIALSCAN series or the AM-MODULE. By linking the devices via the SP-ICE-3 control card, the system offers a high level of interoperability and enables, for example, fast autofocusing of the scan system in less than 50 ms. This is particularly important for laser processes that require precise control of the focal plane in the z-direction or a narrow process window.

Consequently, the RAYDIME METER is the ideal tool for automating complex and demanding laser welding or laser processing. See for yourself:

Optimized for distance measurement
with high z-measurement accuracy < 10 µm
and short measurement times < 10 ms

Designed for **use with pre-focusing beam deflection units**

High level of interoperability
with the overall system enables,
e.g., fast automatic tracking of the
focal plane in < 50 ms



Cost-effective solution
for precise distance measurement
in laser production

Large working areas
of 500 x 500 m^2 in combination with
an AXIALSCAN FIBER RD-20/30/50

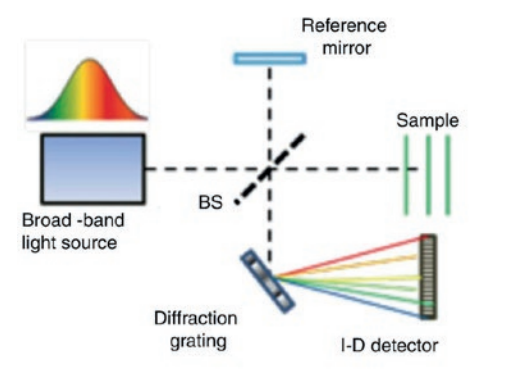
High OCT imaging depth
of 26 mm enables distance
measurements in a wide range of
laser applications

THE UNDERLYING TECHNOLOGY OF THE RAYDIME SERIES

The RAYDIME sensor platform is based on optical coherence tomography (OCT), a nondestructive imaging technique that uses interferometry of coherent light to capture topographies with micrometer resolution.

RAYDIME sensors use a spectral domain OCT (SD-OCT), in which the interference of light of different wavelengths is analyzed to obtain distance information. To do this, a light source with a high spectral bandwidth is split into two paths: a reference arm and a measurement arm. The light reflected from the sample and the reference mirror is combined, resulting in interference patterns known as interferograms. A diffraction grating is used to break down the combined light into its spectral components. This makes it possible to analyze the interference in a wavelength-dependent manner and to precisely determine the distance to the sample.

If the measuring point of the probe arm is moved over a workpiece with an additional scanner, topographical features such as distances and material thicknesses can be determined. Furthermore, process parameters, such as the keyhole depth during the welding, can be precisely measured with an OCT.

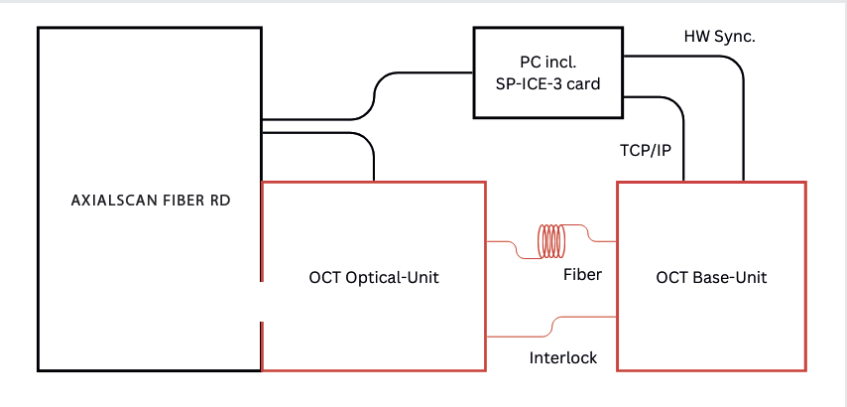


Principle of operation of a spectral domain OCT. This technology is used as the basis for the RAYDIME process sensors. (Source: High Resolution Imaging in Microscopy and Ophthalmology: New Frontiers in Biomedical Optics, 2019)

THE RAYDIME OPERATING PRINCIPLE

RAYDIME process sensors combine an OCT sensor (OCT base unit) with an OCT optical unit to correct deviations when using pre-focusing deflection units. The OCT optical unit is connected to the process light output of the beam deflection unit and the OCT base unit via fiber and interlock.

The SP-ICE-3 control card ensures synchronous control of the deflection unit and optical unit, while at the same time enabling precise assignment of OCT measurement data to positions in the processing field. This makes the RAYDIME series a highly efficient tool for detailed inspections and quality control in research and production.



Schematic structure of a RAYDIME sensor with an AXIALSCAN FIBER RD

THE RAYDIME KEY COMPONENTS

The RAYDIME process sensors consist of three main components. These allow for precise distance measurement using an SD-OCT while benefiting from the advantages of pre-focusing beam deflection units.

RAYLASE OCT-Base-Unit

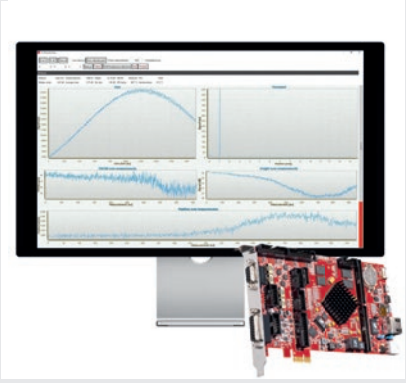
The base unit of the RAYDIME products contains the OCT's basic components:

- Superluminescent diode for coherent illumination
- High-resolution light spectrometer with high-sensitivity CMOS camera for recording interferograms
- MiniPC for autonomous and real-time operation of the distance sensor

For distance measurement applications, the base unit is optimized for high z-resolution and high imaging depth. For keyhole measurements, the OCT base unit is designed for a high sampling rate due to the dynamics of the welding process.

RAYLASE OCT-Optical-Unit

The optical unit extends the base unit and enables the use of RAYDIME products together with pre-focusing scan systems. Since the focal length of a pre-focusing system changes depending on the deflection angle, the RAYLASE OCT optical unit compensates this path length difference synchronously with the scanning movement.



RAYLASE SP-ICE-3 control card with RAYDIME software plug-in

The RAYLASE SP-ICE-3 is used to control RAYDIME sensor. It enables the optical and base units to be controlled and read out synchronously with the mirror position of the scanning system. In addition, corresponding plug-ins are available for the RAYLASE RAYGUIDE laser processing software. This also allows the RAYDIME METER to be conveniently combined with different tools, such as RAYGUIDE MATCH for automatic position and distance detection in our BUSBAR WELDING MODULE.

BUSBARS WELDING IN BATTERY PRODUCTION

The welding of busbars plays a crucial role in battery production, as the quality of the weld has a direct influence on the battery's efficiency, performance, and safety. High-quality welds ensure low resistance and thus enable effective energy distribution. Low-quality welds lead to increased resistance, energy losses, overheating, or even battery failure.

The challenges of busbar welding

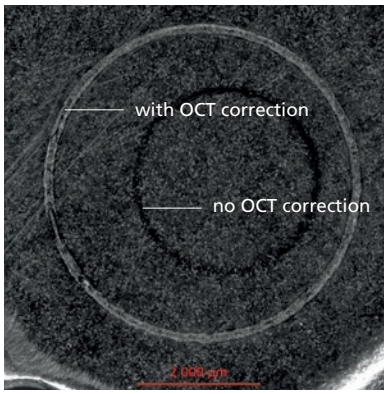
A particular challenge in battery production is the welding of busbars. Battery cells can have height differences of up to one millimeter, and the housing of the battery packs also often leads to mechanical tolerances. In addition, further positioning inaccuracies arise from the feeding of the components. Due to the low thickness of the battery housing, the welding must take place in a very narrow process window. This requires precise control of the welding process and is a challenging task for the system integrator.

BUSBAR WELDING MODULE offers application-specific integrated solution

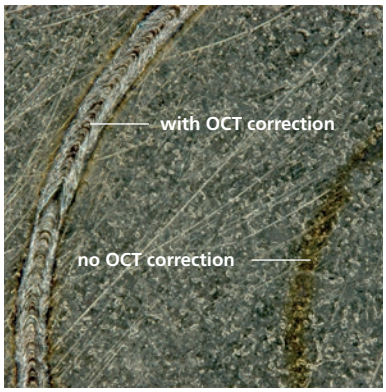
In order to develop an efficient and automated solution for this complex welding application, it is necessary to combine various components into a tailored overall solution.

Therefore, the AXIALSCAN FIBER RD-30 was combined with the RAYSPECTOR, the RAYDIME METER and the RAYGUIDE MATCH software to form the BUSBAR WELDING MODULE. It enables the processing of entire battery packs on a large processing area of up to 500 x 500 mm^2 without the need to move the battery or the laser system. This significantly reduces system complexity. The RAYDIME METER can detect height differences between the battery cells quickly and accurately, and the highly dynamic RAYVOLUTION DRIVE z-axis can compensate for them. This ensures that the focal plane remains within the process window even at high scanning speeds. In addition, the position-tracking camera port in combination with the RAYGUIDE MATCH position recognition system enables precise monitoring and automation of the welding process.

Battery pack with +/- 4 mm height difference



Automated OCT focus correction



Details of the resulting weld seams

Due to RAYDIME METER, the height of the individual battery cells can be measured exactly and the z-position of the laser processing can be adjusted automatically.

MEASURING THE PART CONTOUR AS A QUALITY CONTROL

In critical industries such as aerospace and automotive, the quality of welds is of paramount importance. However, standard quality control technologies are often inadequate. Visual inspections can miss defects that are below the surface. Other non-destructive testing methods such as ultrasound are typically time-consuming and often require production to be interrupted for evaluation.

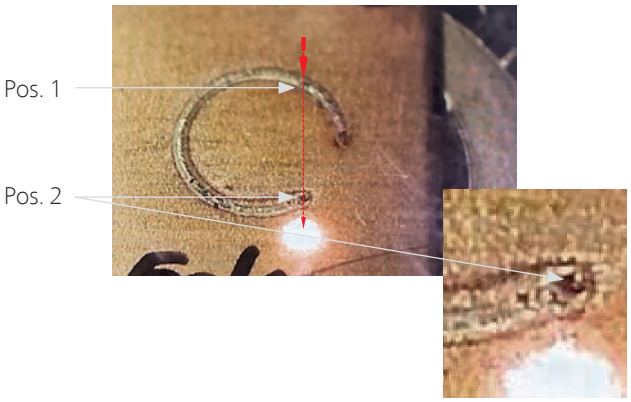
In-line topography measurement for quallity control

The RAYDIME METER revolutionizes this process step by simplifying the quality control process in several ways. First, it eliminates the need for additional post-weld quality control tools by providing a comprehensive view of weld quality immediately after the welding process. This not only saves time, but also significantly reduces the costs associated with using multiple inspection methods. Secondly, the immediate availability of detailed quality data in the event of defects enables direct reworking of the parts. These immediate corrective measures minimize production delays, increase overall efficiency and ensure that the end product meets the industry's strict quality standards.

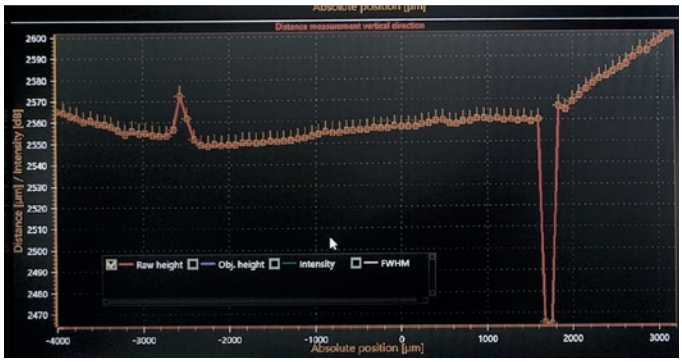
Optimized laser production with RAYDIME METER

The ability of the RAYDIME METER to integrate seamlessly into existing production lines not only overcomes the limitations of standard technologies, but also offers a cost-effective solution for ensuring the highest quality of welds. Particularly in sectors where welding defects can have significant safety or financial implications, the RAYDIME METER is an invaluable tool in modern manufacturing and quality control processes.

Visual inspection of the welding result using a camera on the RAYSPECTOR



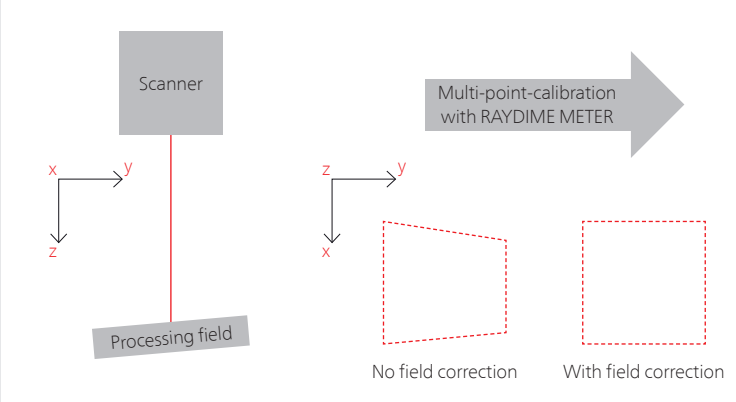
Topography measurement with the RAYDIME METER



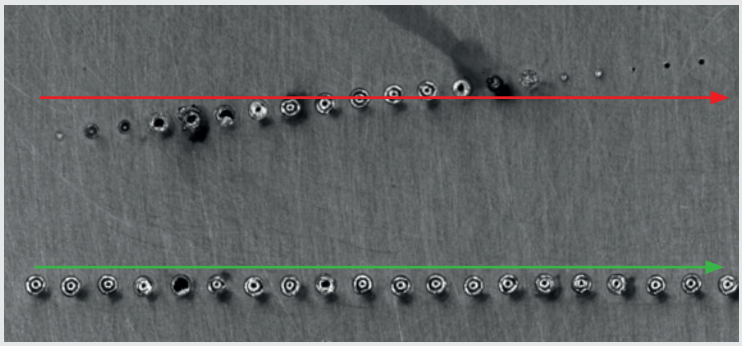
Use of the RAYDIME METER for inspecting weld seams for quality control.

3D-FIELD-CALIBRATION DURING THE PRODUCTION PROCESS

Precision in laser processing is important in many industries. That is why most laser machines are calibrated when they are put into operation to ensure the accuracy required for production. However, this calibration only corrects initial tolerances. Due to aging and other long-term effects, the machine properties change and regular inspections and recalibrations are required to maintain precision.



For this purpose, highly accurate calibration solutions such as the RAYLASE SCAN-FIELD-CALIBRATOR are available. However, even though these methods calibrate the system very reliably, they are usually only carried out during production breaks due to the time involved. In addition, they cannot compensate for short-term drifts or inaccuracies that are due to inaccurate alignment of the workpiece or manufacturing tolerances.



3D field calibration using the RAYDIME METER. Top: Tilting the process field leads to distortions in the processing field and a defocusing of the laser focus. The tilt can be detected quickly and easily from the distance measurements with the RAYDIME METER, and an individually adapted calibration file can be created to ensure precise laser processing. Bottom: The defocusing of the laser focus resulting from the tilting leads to incomplete welds (see red scan path). With an adapted correction file, the changing working distance is automatically compensated for by the z-axis of the scanning system, ensuring a uniform welding result (see green scan path).

Fast and individual field calibration with the RAYDIME METER

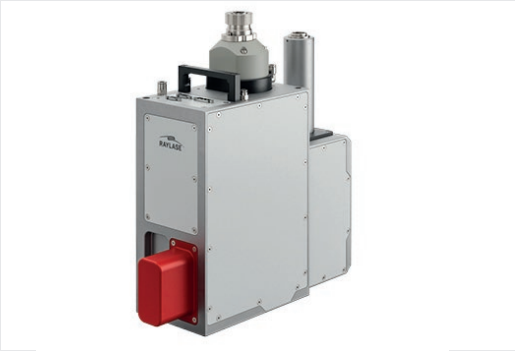
The RAYDIME METER is a precise distance sensor that offers an excellent option here: a series of measurements are taken in the processing field. Depending on the deflection angle, different distances result. The measured values are compared with the theoretical distances and a correction file is calculated. This allows to detect changes in working distances as well as tilting of the component.

Reliable series production through calibration before each processing step

Since a single distance measurement with the RAYDIME METER takes < 50 ms, the measurement of an 11x11-point calibration grid can be carried out in about 60 seconds. This can usually be easily included between two production batches and enables a regular check of a precise but more complex calibration using a laser-etched calibration plate. This allows to compensate for many short-term effects. Depending on the production cycle, each component can also be measured individually with a reduced number of calibration points and an individual calibration can be generated for each component. For optimal calibration results, the RAYDIME METER can also be combined with camera solutions such as RAYGUIDE MATCH, thus enabling even more complex manufacturing processes to be transferred to automated series production.

AXIALSCAN FIBER RD-30

INTEGRATED SCAN SOLUTION FOR LARGE WORKING FIELDS



Thanks to its dust-proof housing, the AXIALSCAN FIBER RD is ideal for use in production environments.

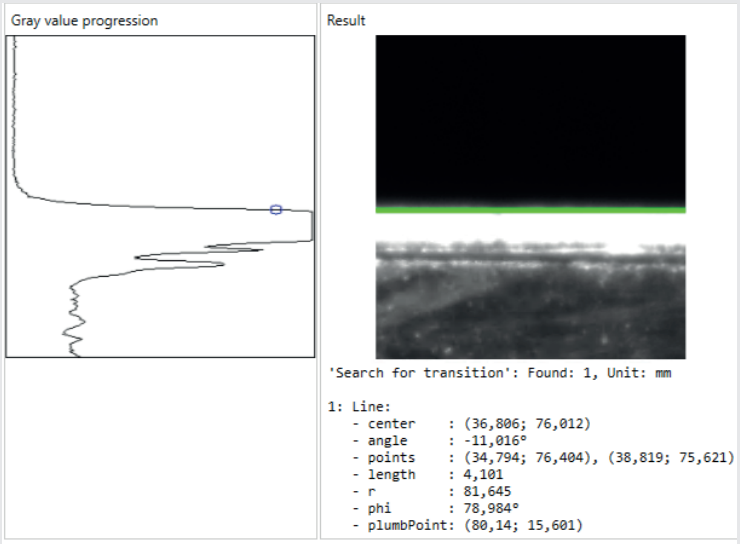
The AXIALSCAN FIBER RD-30 is a highly integrated, pre-focusing beam deflection unit that has been specially developed for industrial production. It is ideally suited for applications such as laser welding, cutting or cleaning. With its dust-proof housing and built-in collimation optics, the AXIALSCAN FIBER RD-30 is equipped for use with high laser powers of up to 6 kW and for special beam profiles such as ring modes or tophats. The RAYVOLUTION DRIVE technology, our highly dynamic optical z-axis, enables the AXIALSCAN FIBER RD-30 to utilize the full dynamics of its XY scanners without losing the focus plane. In addition, the large processing areas of up to 500 x 500 mm^2 allow large battery packs to be processed efficiently in a single pass without the need for complex movement of the workpiece or the beam deflection system.

RAYGUIDE CLICK & TEACH UND RAYGUIDE MATCH

CAMERA-BASED POSITION DETECTION FOR PROCESS AUTOMATION

In demanding manufacturing processes, precise alignment of the workpiece is a crucial aspect. While manual adjustment may be acceptable for prototypes, it is problematic even for the production of small series. RAYGUIDE CLICK&TEACH was developed to simplify this process preparation.

For this purpose, a camera on the AXIALSCAN FIBER RD-30 is used to create images of the processing area, which are then used as a background in the RAYGUIDE software. The RAYSPECTOR ensures a consistently sharp image of the image field thanks to its dynamic focus tracking. The RAYGUIDE CLICK&TEACH plug-in then allows the laser processing to be adapted to the actual positions and dimensions of the workpiece.



Automatic edge detection with RAYGUIDE MATCH for adjusting the position of the workpiece.

For the transition to series production, where manual steps would make the process uneconomical, RAYGUIDE MATCH is the ideal solution. This software plug-in expands the camera-based position detection to include automatic detection of features such as position marks or structures of the workpiece and automatically corrects the laser processing. This permits a higher tolerance in the feeding and alignment of the components, so that even precise laser processes can be carried out fully automatically and without manual intervention.

OTHER SUITABLE ACCESSORIES

RAYGUIDE

INTUITIVE PROCESS SOFTWARE

Our software solution for a quick and easy programming of your scanning solution. User-friendly set-up and calibration of the deflection unit and effortless automation through the built-in API.

SP-ICE 3

CONTROL CARD WITH FEEDBACK FUNCTION

The control center for runtime-critical process steps. Allows synchronous control of deflection unit, laser and peripherals and a combined readback of scanner and of scanner and sensor signals.

THIS MAKES RAYLASE SPECIAL

Technical specifications are important and often decisive. But at RAYLASE, we believe that there is more to it than pure technology that matters. For this reason, we are your partner for reliable and successful laser processes and offer more than just technical components.

Systems view instead of components

Modern production systems for laser processing are usually designed specifically for one process step and are highly optimized. It is therefore important to consider the interplay with the other machine components when selecting suitable beam deflection units. At RAYLASE, we therefore always have the entire solution in mind and offer our customers assistance in putting together suitable components.

Broad application knowledge

For many processes, the beam deflection unit is a decisive component. Often it determines whether the desired spot parameters and processing speeds can be implemented on the component. To identify the optimal solution here, we support our customers in selecting the right beam delivery components and sensor technology. and perform simulations of the laser processes developed by our customers. In addition, we provide support in the parameterization of the laser and deflection unit or software functionality through the experts at our Technical Competence Center TCC.

On-site support for implementation and service

Our customers are the experts for their application – we are the experts for our beam deflection units. That's why we support our customers during the commissioning of our products – if necessary also directly on site. In this way, we at RAYLASE ensure that our system is optimally adjusted and permanently delivers what it is capable of.

Education & training on the system

Modern laser deflection units are complex systems. Therefore, it is important to have a good knowledge of their characteristics. Because only when users know how the various parameters interact the optimum process becomes possible. For this reason, we at RAYLASE put a high priority on training for our products. In addition, we also offer our customers on-site training directly on the system, if required, to enable users to operate the system independently.

The POWER OF WE

Together you achieve more. At RAYLASE, we are convinced about this. That's why we place great value on cooperation in a spirit of partnership and open communication at equal level – from expert to expert. Because only when we jointly find the best solution and successful integrate it into the machine, everyone involved benefits in the end – our customers, us and also the end users.

GENERAL SPECIFICATIONS

Power supply	**Voltage [V_{DC}]**	24
	Power consumption [A]	1
Dimensions (L X W x H) [mm³]	**OCT Base Unit**	250 x 300 x 140
	OCT Optical Unit	225 x 117 x 269
IP Code	**OCT Optical Unit**	64
Ambient temperature [°C]		+15 to +35
Storage temperature [°C]		-10 to +60
Relative humidity non condensing [%]		≤ 80
Processing field sizes adjustable [mm²]		250 x 250 to 500 x 500
Interface signals		TCP/IP
Light source		SLD [1]
Laser class		3R [2]
Available cables [3] [m]	**Standard**	5
	Option	10

[1] Superluminescent diode
[2] According to EN 60825-1:2015-07
[3] Between OCT Base Unit and OCT Optical Unit

OCT MEASUREMENT SPECIFICATIONS

Wavelength [nm]		800 - 900
Bean diameter [µm]		120 - 180
Measuring range [1] [mm]	**axial**	up to 26
Resolution [µm]	**axial [2]**	< 10
	lateral	< 80
Sensor sampling rate [3] [kHz]		up to 1,3
Duration of distance measurement at a point [ms]		< 10
Total time including z-correction [ms]		< 50

[1] Measuring depth
[2] Typical resolution. Actual values may vary depending on material, surface condition of the test object, and field position.
[3] Continuous mode without sync.

Headquarters:
RAYLASE GmbH
Wessling, Deutschland
+49 8153 9999 699
info@raylase.de

Subsidary China:
RAYLASE Laser Technology (Shenzhen) Co.
Shenzhen, China
+86 199 25 48 3946
info@raylase.cn

Subsidary USA:
RAYLASE Laser Technology Inc.
Newburyport,MA, USA
+1 (313) 552-7122
info@raylase.com