BLACKBIRD

Pre-Process seam tracking

OCT edge tracking

with intelli*WELD* II PR and xHAWK

- Detection of an edge for seam position correction and tracking
- Omnidirectional measurements in the whole scan field
- Compatible with beam oscillation up to 1000 Hz
- Gap measurement and process control

Blackbird's OCT system

Process monitoring is an essential part of every laser welding system. It is crucial to position the laser beam correctly, to neither exceed nor fall below the permissible welding tolerances, and to check the weld seam for obvious defects such as pores.

The welding process must be closely monitored before, during and after welding. This poses a particular challenge for remote laser welding, since neither camera-based methods nor methods using process light-based sensors offer a holistic solution.

The OCT scanner xHAWK

The OCT scanner xHAWK was developed in order to be able to deflect the measuring beam in a highly dynamic manner and thus to be able to carry out demanding measurement tasks. The xHAWK scanner was developed in cooperation with SCANLAB, in which all mechanical, optical and electrical components used in the Blackbird OCT scanner were redesigned and adapted.

The main focus was on userfriendliness and on how to obtain the best possible signal quality with maximum utilization of the process dynamics. The result is a unique OCT scanner that has been optimized for use in laser welding applications. The system can be used independent of the welding direction and one can make use of the complete working area (2D or 3D design) of the processing scanner without any restrictions. Precise positioning of the OCT beam is guaranteed even at fast feed speeds and beam oscillation frequencies up to 1000 Hz.

Info

Optical coherence tomography (OCT)

Optical coherence tomography (OCT) is currently the only technology that can be used universally for sensing in process monitoring. This is due to its ability to measure any geometrical features in a welding process. Using the data obtained from such measurements, edges can be found and tracked, the welding depth can be determined and the resulting welding seam can be analyzed for defects.

Whereas other options for process monitoring depend on process lighting, which can have an effect on signal quality. An inherent advantage of OCT technology is that it works independently of such process lighting. A measurement of the penetration depth is non-destructive and can be performed in-situ with OCT. This technology therefore allows measured variables in all process zones to be monitored, controlled or evaluated with one measurement instrument.

Users of Blackbird's OCT system benefit from:

- The largest possible OCT scan field
- The fastest dynamics and highest accuracy of any OCT scanner on the market
- Precise synchronization of the processing scanner, OCT scanner and OCT sensors
- A software solution for configuring the entire welding process including OCT

OCT edge tracking

In laser welding applications, the laser beam must be guided and focused over the part with an accuracy of sometimes less than 100 µm, depending on the process requirements. The positioning accuracies that can be achieved, for example with robot-guided applications, are often not sufficient to carry out the process adequately or to meet the specifications. In order to achieve the required accuracies, OCT edge tracking is used. With the help of this measuring method, it is possible to place the laser beam consistently and precisely at the desired positions, even with large deviations, e.g., those caused by distortion, shape and position tolerances or deviations of the guide tool.

Blackbird's OCT system records the geometry of the part immediately before the joining process. With the help of the resulting measurement data, the real position of the edge is continuously determined and the laser beam tracks it accordingly. Disturbances in the OCT data are reliably detected and do not affect the subsequent result. If there are several edges within the measurement range, the system automatically selects the previously defined, correct edge.

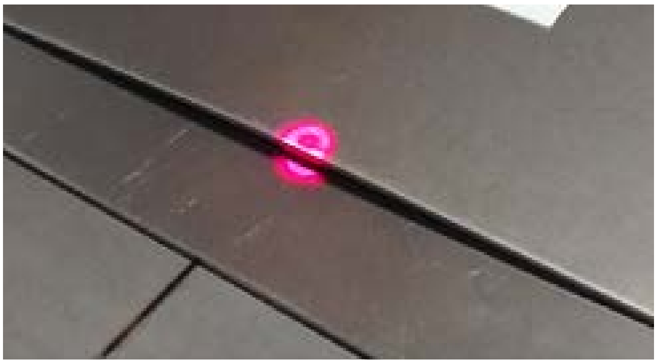
Another challenge that occurs in welding processes with thin sheets is the formation of gaps at fillet welds. The OCT measuring method is also the best solution here. By determining the distance between the upper and lower sheets, the gap size can be precisely calculated and, depending on its extent, the system can respond to it. If the gap widens, for example, the laser power can be increased or the position of the processing beam on the upper sheet can be shifted. This is also possible in combination with beam oscillation. The amplitude of the oscillation is another control variable that can be adjusted in order to increase the amount of melted material which, in turn, bridges the gap and therefore makes a connection.

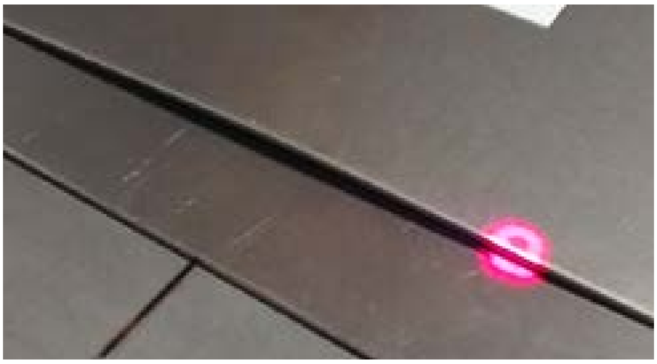
OCT edge tracking can be used in static and on-the-fly applications without any restrictions. 3D scan fields with seams on different or varying levels are also possible.

Awarded 3rd place in the **Innovation Award Laser Technology 2022** by Arbeitskreis Lasertechnik e.V. (AKL) and the European Laser Institute (ELI).

Examples of applications for remote laser welding with OCT edge tracking:

- Doors (fillet seams / overlap seams with a reference edge)
- Seat rails
- Battery boxes
- Body shells (e.g., A/B pillars, cross members)





Technical Specifications

OCT SENSOR	
Measurement Frequency	66 kHz
Measurement Area (Z)	6 mm

OCT SCAN FIELD	
Scan Field The calibrated field of the OCT scanner.	**[X=180 mm × Y=180 mm × Z=100 mm]** (Min: [20 × 20 × 0] mm, Max: Scan field of the main laser)
Measurement Field The area around the current weld position where OCT measurements can be made.	Shape: Circle, Diameter = 40 mm (Maximum distance to the welding spot = 20 mm)

OCT MEASUREMENTS	
Measurement line length	Typ. 6 mm (Minimum 0.1 mm; Maximum 40 mm)
Measurement point distance Distance between consecutive measurement points on a measurement line.	Typ. 50 µm (Minimum 10 µm; Maximum 1000 µm)
Maximum scan speed Scan speed over a measurement line.	64 m/s

OSCILLATION	
Shape	Circle
Amplitude	0.1 to 5 mm
Frequency	1 to 1000 Hz

EDGE TRACKING	
Available tasks	Edge tracking at lap joints for fillet welding • Offset regulation (dependent on the gap) • Amplitude regulation (dependent on the gap) • Laser power control (dependent on the gap, offset or amplitude)
Maximum tracking distance Safety distance for position correction: maximum deviation from the programmed seam.	10 mm
Resolution in the welding direction Distance between measurement lines.	Dependent on: • welding speed • measurement line length • measurement point distance

Welding Speed	Resolution in the welding direction (with edge tracking) Distance between measurement lines (measurement point distance = 50 µm)	
	3 mm measurement line	**6 mm measurement line**
1 m/min	89 µm	130 µm
2 m/min	179 µm	261 µm
3 m/min	269 µm	391 µm
4 m/min	359 µm	521 µm
5 m/min	450 µm	652 µm
6 m/min	540 µm	782 µm
7 m/min	631 µm	912 µm
8 m/min	722 µm	1043 µm
9 m/min	814 µm	1173 µm
10 m/min	905 µm	1303 µm

Blackbird Robotersysteme GmbH
Carl-Zeiss-Str. 5 | 85748 Garching | Germany
T: +49 89 307 484 700 | info@blackbird-robotics.de

Blackbird Robotics (Shanghai) Co., Ltd.
338, #1, #526, Fute 3rd Road East | FTZ - Shanghai, 200131 | P.R. China
T: +86 216 037 78 88 | info-CN@blackbird-robotics.com