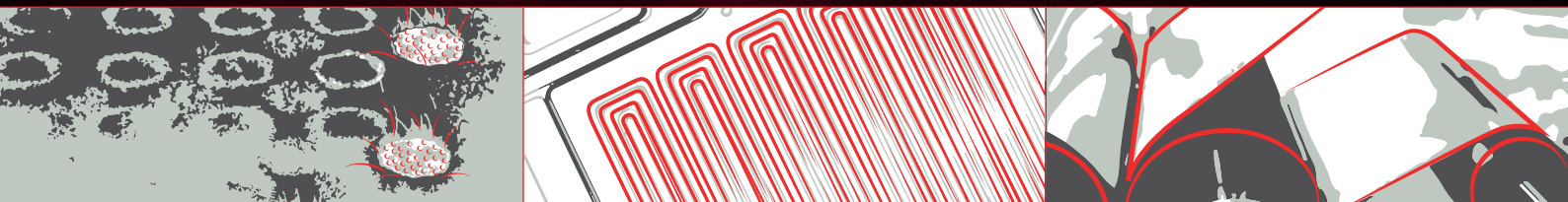


SCAN FIELD CALIBRATOR SFC 600



ADDITIVE MANUFACTURING – LASER PRECISION WELDING – PRECISION

DIGITAL
CONTROL



PRECISION AND PRODUCTIVITY BY AUTOMATED CALIBRATION

In industries such as additive manufacturing, battery production, and electronics, precision and efficiency are vital to success. Here, laser processing requires exact calibration to maintain high-quality standards across large, complex fields. Yet, traditional calibration methods are time-consuming and prone to human error, impacting both productivity and consistency.

The **SCAN FIELD CALIBRATOR SFC 600** addresses these needs by automating the entire calibration process, **reducing calibration time by up to 96%**. Supporting both **single-field calibration up to 600 x 600 mm²** and **multi-field setups with overlapping fields**, the SCAN FIELD CALIBRATOR SFC 600 provides precision alignment and consistency, even across extensive processing areas. Its multi-field capability is particularly beneficial for applications requiring multiple scan fields to seamlessly align without disruptions, ensuring continuous laser performance across large parts.

Operators benefit from a calibration process that maintains high precision, with a **correction accuracy of $\pm 15 \mu\text{m}$** , across each overlapping area, achieving greater uniformity and minimizing errors between fields. The SCAN FIELD CALIBRATOR SFC 600 **transforms calibration into a seamless and automated process** that directly enhances both product quality and profitability, even in the most complex, large-scale laser applications.



Versatile
use



Large
processing fields



Optimized for
industrial production

www.raylase.com

SEAMLESS CALIBRATION FOR SINGLE AND MULTI-FIELD SETUPS

The SCAN FIELD CALIBRATOR SFC 600 is an **advanced, automated calibration system** designed to deliver precision and reliability for laser process fields. With this capability, it directly addresses the needs of high-demand industries like additive manufacturing, battery production, and electronics. The SFC replaces labor-intensive manual calibration with a streamlined, automated process, **significantly reducing both downtime and calibration errors.**

For customers, this means a major increase in productivity and consistency. The **shorter duration of a calibration step** results in less downtime of the machine and, thus, higher utilization. The easy and automated calibration workflow also allows additional calibration steps, which can **improve part quality and reproducibility.**

With these features, the SCAN FIELD CALIBRATOR SFC 600 empowers users to achieve their quality and efficiency goals with minimal setup time and maximum reliability, making it an essential tool for maintaining high standards in large-scale laser applications.

See for yourself:

Fully Automated Calibration process

reduces time and labor costs, allowing users to focus on production and minimize downtime.

Automated Focus Level Calibration

adjusts the focal plane of pre-focusing deflection units automatically, homogeneously and precisely across the entire process field.

High Precision with $\pm 15 \mu\text{m}$ Accuracy

improves product uniformity, reducing defects and enhancing overall quality standards.

Single-Field Calibration up to $600 \times 600 \text{ mm}^2$

allows easy and convenient calibration of typical field sizes in one single step

Intuitive SFM-software SCAN FIELD MANAGER

streamlines the calibration process, making machine setup quick and accessible for operators of all experience levels.

Large Field Calibration with Multi-Field Software

allows to calibrate field sizes larger than $600 \times 600 \text{ mm}^2$ without sacrificing accuracy.

Multi-Field Calibration

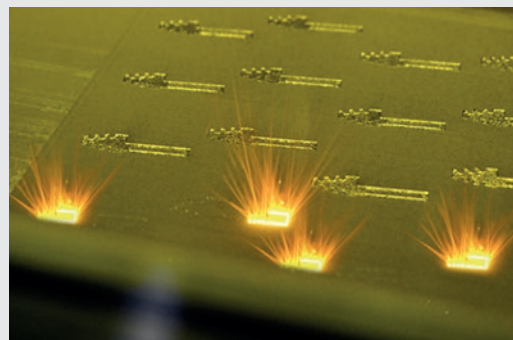
aligns overlapping fields of more than one beam deflection unit seamlessly in one calibration step and ensures consistent quality across large parts.



MULTI-LASER CALIBRATION FOR ADDITIVE PRODUCTION

Additive manufacturing (AM) has become essential for producing complex or customized parts at scale. Hence, more and more machine park operators are asking for multi-laser systems to drastically increase productivity. These powder bed machines are currently equipped with up to 12 lasers and deflection units to either work with several lasers on a large component or to produce multiple components simultaneously.

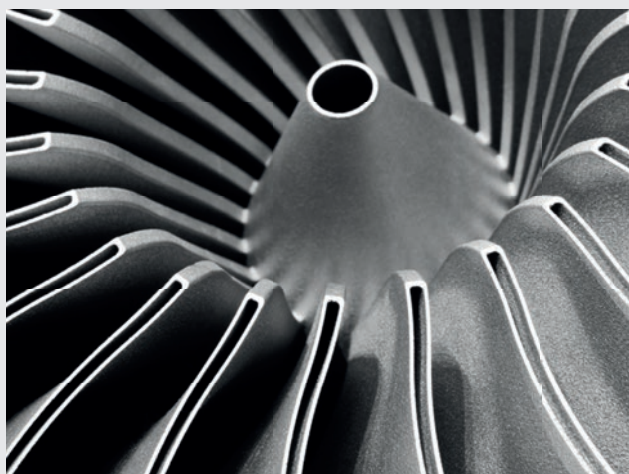
However, these multi-laser machines require meticulous calibration. Misalignment between lasers can lead to quality issues, weak points in the parts, and high rates of defective products. Additionally, the processing fields are usually arranged overlapping to achieve high flexibility. The overlap can range from a small field overlap to 100% field overlap of neighboring processing fields. This places high demands on the calibration of both the individual processing fields and the fields in relation to each other.



AM machines with multiple lasers and beam deflection units require a very precise calibration of the scan field and their overlap region.

Manual Calibration is time-consuming and often a bottleneck for part quality

Although calibration is crucial for productivity, most machine park operators still rely on very time-consuming manual calibration of their AM machines. During the calibration, it is necessary to correct the deflection units' focus z-level, adjust the individual processing fields and align neighboring fields to each other. For a LPBF machine with 8 units (4 next to each other "side by side" plus another 4 in front "face to face") and an overlap of neighboring processing fields of 50%, the manual calibration can easily take 60 hours of working time of 2 engineers each. And the manual process is also error-prone. Quite often, the required quality for the products can no longer be achieved through manual calibration.



A frequent and precise calibration of the overlap region in multi-laser AM machines allows to produce large parts with complex structures even in demanding industries like aerospace.

Automated Calibration Aligns Multiple Laser systems in one seamless workflow

The SCAN FIELD CALIBRATOR SFC 600 allows to transform the manual calibration process to a fully automated workflow. Automatic calibration with the SFC 600 achieves a high correction accuracy of $\pm 15 \mu\text{m}$ and takes a single engineer only 2 hours to complete all steps to calibrate a machine with 8 processing fields. The time saving is therefore over 96%. The automated process ensures that each laser field precisely aligns with the others, effectively eliminating the common issues of overlap errors and inconsistent layer quality. With its short and automated process, additional calibration steps can be introduced, which significantly increases the longterm stability of the machine.

Improved Production due to Higher Machine Uptime and more reliable Part Quality

With the SCAN FIELD CALIBRATOR SFC 600 a production facility can achieve a faster, more efficient calibration which will greatly improve the part quality and consistency. With 58 hours saved in downtime per cycle, the

production company can see a significant boost in productivity and machine availability. The high accuracy of the calibration minimizes defects and rework, resulting in lower scrap rates and cost savings on materials. In addition, the calibration system opens up new possibilities for machine operators, who can check the calibration of their machine in the shortest possible time after a long production run and in this way provide their customers with proof of consistent production quality.

SEAMLESS PRECISION FOR WELDING APPLICATIONS

Laser applications are increasingly reliant on highly accurate calibration. For example, in manufacturing large bipolar plates for hydrogen fuel cells, multiple lasers and deflection units are necessary to cover the extensive surface areas of these plates. A critical challenge, as the junctions between welding seams must align perfectly. Misalignment can easily create gaps or uneven welds, compromising fuel cells' gas-tightness. Similar high requirements are found in battery production. Here, laser welding must join thin electrode layers with extreme precision to ensure durability and efficiency of the battery. Hence, achieving high precision is essential, as reliability directly impacts product performance and safety.

Precise Calibration and Field Alignment

The SCAN FIELD CALIBRATOR SFC 600 addresses this need by calibrating the working field with an accuracy of $\pm 15 \mu\text{m}$. The SFC 600 also performs z-calibration, ensuring precise focus and beam positioning across the entire working field. This is particularly critical in applications requiring uniform welding quality over large surfaces. Additionally, the SFC 600 aligns multiple deflection units with high precision, which is essential for seamless stitching of welding seams in applications such as fuel cell bipolar plates.

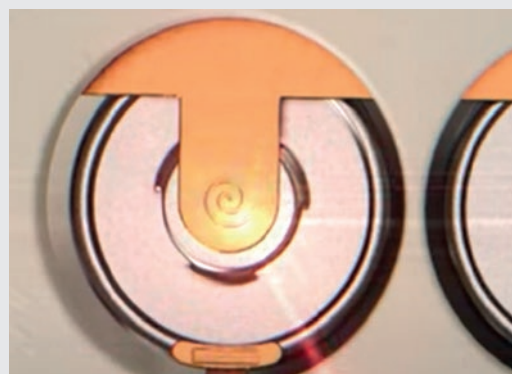
With its user-friendly software, the SFC 600 automates the calibration process, significantly reducing downtime and operational errors associated with manual adjustments by the user. The SFC 600 integrates easily into existing workflows, simplifying calibration and improving process reliability. These capabilities support higher throughput and consistent quality.

Rapid Return on Investment with improved process quality

With its capacity to handle large fields, multiple deflection units, and z-axis calibration, the SFC 600 ensures uniform performance across large areas, even in complex manufacturing setups. However, the benefits of precise calibration extend beyond quality improvements. By reducing downtime, eliminating waste, and ensuring consistent reliability, the SFC 600 provides a rapid return on investment. For example, a fuel cell manufacturing line can quickly offset calibration costs by minimizing defects and avoiding rework. Similarly, in battery production, consistently high-quality welds reduce warranty claims and enhance customer satisfaction. These advantages drive operational excellence and enable manufacturers to confidently meet industry demands.



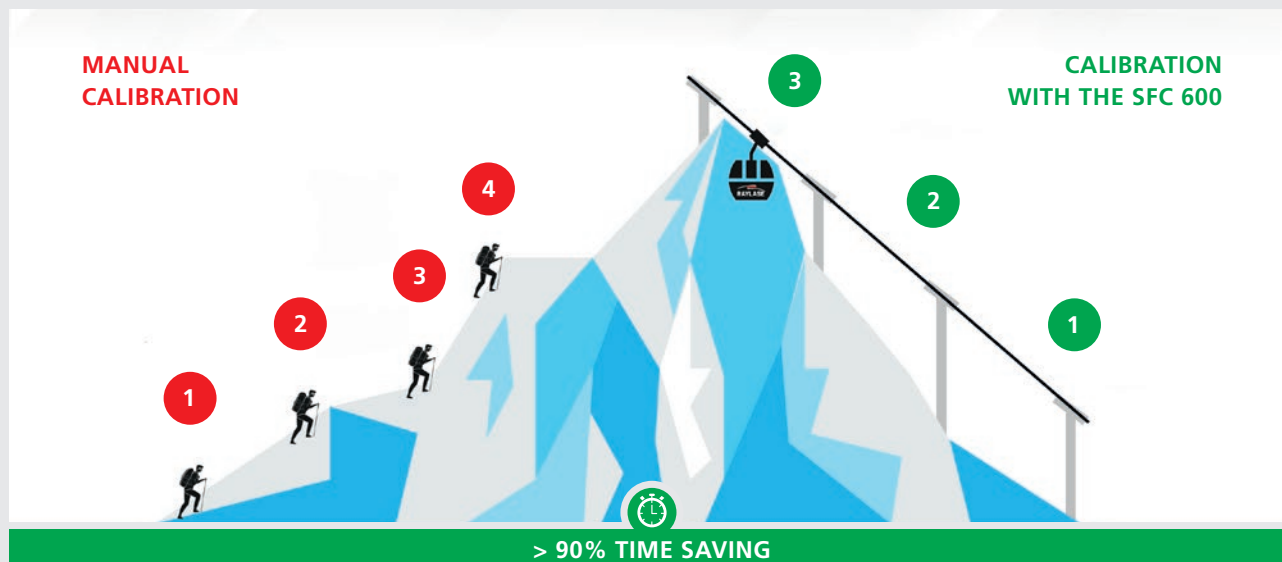
The production of fuel cell stacks often includes the processing of large bipolar plate. Here, laser machines frequently combine multiple beam deflection units to cover the large working field.



During busbar welding, the electrodes are connected to the battery housing. This requires extremely precise z-calibration to ensure a stable welding seam and to avoid punching through.

MANUAL VS. AUTOMATIC CALIBRATION – A COMPARISON

Calibration can either be a detailed, time-consuming manual process or a streamlined, automated workflow. This comparison shows how the SCAN FIELD CALIBRATOR SFC 600 transforms each step into a seamless process, eliminating repetitive tasks, reducing human error, and drastically shortening calibration time. By switching to automated calibration, manufacturers achieve consistent, high-precision results with minimal downtime.



1 Manual focus calibration (Z)

- Only mechanical with spirit level
- Requires additional lasering with manual measurement
- Low accuracy

2 Define & laser XY calibration pattern

- Working in any laser software
- Freely create a laser job
- Typically max. 11 x 11 support points
- Low homogeneity and resolution

3 Measure the XY calibration plate

- Observe the orientation of the calibration plate in the machine
- Risk of error due to twisting
- Measure the support points with a magnifying ruler
- Media breakage
- High risk of error due to reading and transmission errors in an editor
- Typical resolution $\pm 50 \mu\text{m}$

4 Optimizing the correction file

- Manual generation of correction file
- Overwriting the correction file in the laser software
- Risk of error during manual selection of the control card
- Media break

1 Define & laser XYZ calibration pattern

- Menu-guided creation of all necessary parameters in SCAN FIELD MANAGER (SFM) software
- Automated z-calibration with predefined pattern
- Up to 256 x 256 support points, mostly 48 x 48 used
- High homogeneity and resolution
- No media break

2 Measure the XYZ calibration plate

- Orientation is recognized via QR code, regardless of how the calibration plate is positioned on the SFC
- Automatic measurement on the SFC 600
- No media break
- No risk of error

3 Optimizing the correction file

- Correction file directly from SFM software
- Assigned control card is stored in the QR code and is automatically distributed via the network
- No risk of error
- No media break

RETURN ON INVEST – FASTER THAN EXPECTED

With significant reductions in calibration time, improved part quality, and minimized downtime, investing in the SCAN FIELD CALIBRATOR SFC 600 quickly proves its value. The following examples showcase how various production setups benefit from faster, more efficient operations, delivering rapid ROI through time and cost savings.

Example 1:

MACHINE BUILDER OF SINGLE-FIELD MACHINES

SITUATION

- Production of **40 machines per year**
- **1 beam deflection** unit per machine
- 2 calibrations per machine incl. FAT
- **XYZ calibration of a single field**

MANUAL CALIBRATION

- Manual calibration requires 2 engineers
- **8 h per machine and calibration**
(4 h / calibration x 2 engineers)
- 640 h per year overall working time for calibration
(8 h / machine & calibration x 40 machines x 2 calibrations)

SFC 600

- Automated calibration with SFC 600 requires only 1 engineer
- **20 min per machine and calibration**
(20 Min x 1 engineer)
- 27 h per year overall working time for calibration
(20 min / machine & calibration x 40 machines x 2 calibrations)
- **Yearly cost savings: approx. 25,000 EUR**
- **ROI Single-Field machines: approx. 4.5 years**

Example 2:

MACHINE BUILDER OF MULTI-FIELD MACHINES

SITUATION

- Production of **10 machines per year**
- **4 beam deflection units** per machine
- 2 calibrations per machine incl. FAT
- **XYZ calibration of a multi-field incl. alignment in the overlap region**

MANUAL CALIBRATION

- Manual calibration requires 2 engineers
- **48 h per machine and calibration**
(24 h / calibration x 2 engineers)
- 960 h per year overall working time for calibration
(48 h / machine & calibration x 10 machines x 2 calibrations)

MORE THAN 0.5 EMPLOYEES (FTE) ONLY FOR CALIBRATION!

SFC 600

- Automated calibration with SFC 600 requires only 1 engineer
- **50 min per machine and calibration**
(50 Min x 1 engineer)
- 17 h per year overall working time for calibration
(50 min / machine & calibration x 10 machines x 2 calibrations)
- **Yearly cost savings: approx. 50,000 EUR**
- **ROI Multi-field machines: approx. 2.5 years**

RETURN ON INVEST – FASTER THAN EXPECTED

Example 3:

MACHINE BUILDER OF LARGE MULTI-FIELD MACHINES

SITUATION

- Production of **10 machines per year**
- **8 beam deflection units** per machine
- 2 calibrations per machine incl. FAT
- **XYZ calibration of a multi-field incl. alignment in the overlap region**

MANUAL CALIBRATION

- Manual calibration requires 2 engineers
- **120 h per machine and calibration**
(60 h/calibration x 2 engineers)
- 2,400 h per year overall working time for calibration
(48 h/machine & calibration x 10 machines x 2 calibrations)

MORE THAN 1 EMPLOYEE (FTE) ONLY FOR CALIBRATION!

SFC 600

- Automated calibration with SFC 600 requires only 1 engineer
- **2 h per machine and calibration**
(2 h x 1 engineer)
- 40 h per year overall working time for calibration
(2 h / machine & calibration x 10 machines x 2 calibrations)
- **Yearly cost savings: approx. 120,000 EUR**
- **ROI Large Multi-field machines: approx. 1 year**

Example 4:

OPERATOR OF A MACHINE PARK

SITUATION

- Machine Park with **10 multi-field machines**
- **8 beam deflection units** per machine
- **Weekly verification** of all machine calibrations
- **XY verification of a multi-field incl. all overlap regions**

MANUAL CALIBRATION

- Manual verification requires 2 engineers
- **48 h per machine and verification**
(24 h / verification x 2 engineers)
- 25,000 h per year overall working time for verification
(48 h/machine & verification x 10 machines x 52 verifications)

WEEKLY VERIFICATION BARELY POSSIBLE!

SFC 600

- Automated verification with SFC 600 requires only 1 engineer
- **30 min per machine and verification**
(30 min x 1 engineer)
- 260 h per year overall working time for verification
(30 min/machine & verification x 10 machines x 52 verifications)

100x LESS TIME CONSUMPTION!

QUALITY CONTROL WITH REGULAR VERIFICATIONS NOW BECOME POSSIBLE!

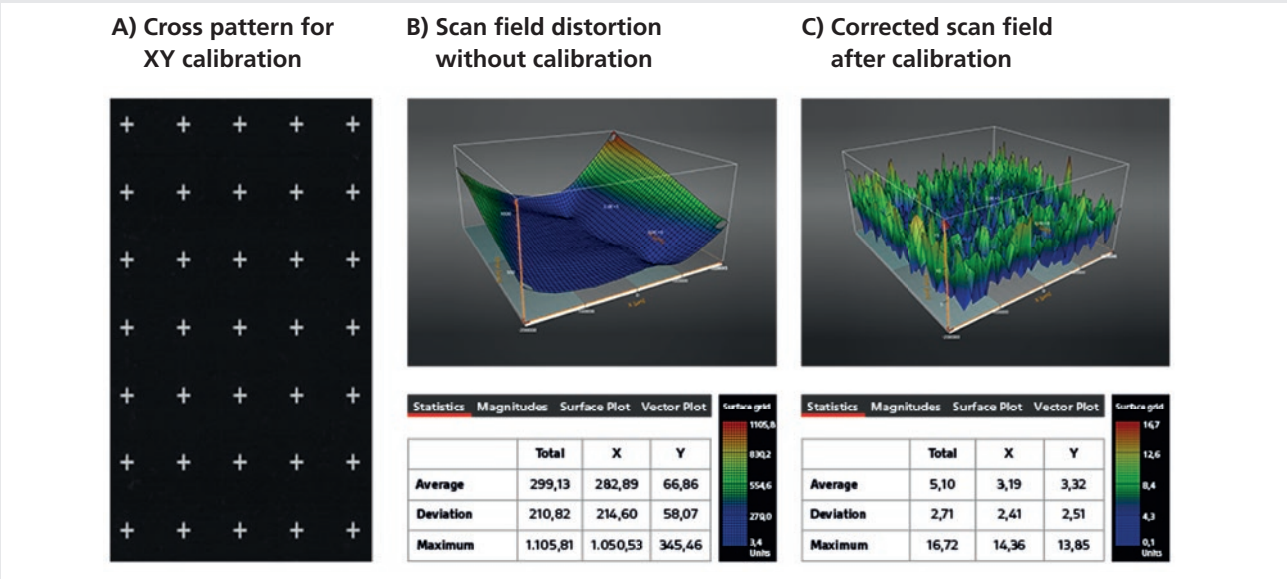


PRECISE CALIBRATION AND MULTI-FIELD ALIGNMENT

The SCAN FIELD CALIBRATOR SFC 600 provides advanced capabilities in xy calibration, correction of tilted workplanes, and the alignment of multiple fields, addressing key challenges in laser-based manufacturing processes. These features ensure precise laser positioning, consistent beam focus, and seamless integration across overlapping fields, directly enhancing the quality and efficiency of production.

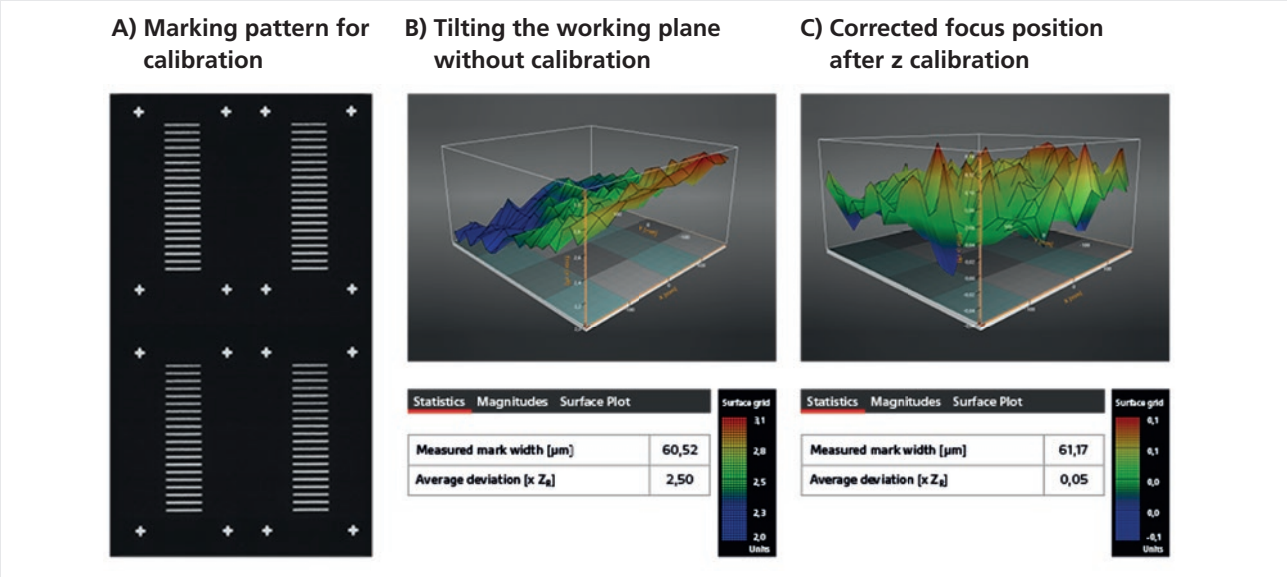
IMPROVED ACCURACY WITH XY CALIBRATION

Calibration in the xy-plane eliminates distortions and ensures precise positioning across the entire scan field. This is critical for achieving uniformity and reducing errors in processes requiring high positional accuracy, such as additive manufacturing or high-precision laser welding and structuring. With the SFC 600, the average error can be reduced by almost two orders of magnitude. Using this optimized xy-calibration, manufacturers benefit from improved process stability, reduced waste, and higher product quality.



RELIABLE Z-AXIS CALIBRATION FOR TILTED WORKPLANES

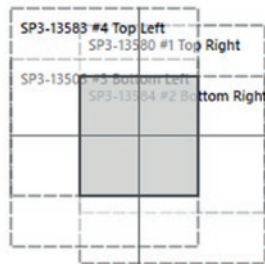
Z-axis calibration compensates for tilted or uneven work planes, ensuring that the laser maintains a consistent focus across the entire surface. By adjusting for angular deviations, the z- calibration guarantees uniform energy distribution and optimal beam positioning. This capability is essential for maintaining weld consistency and preventing defects caused by variations in focal precision, particularly on larger or irregularly positioned parts.



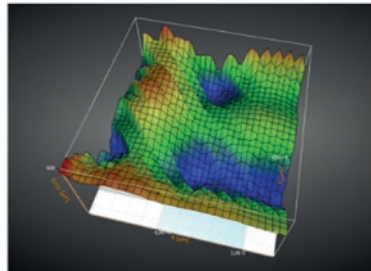
SEAMLESS INTEGRATION OF MULTI-FIELD SYSTEMS

When multiple deflection units operate in parallel, alignment becomes critical to avoid errors between neighboring processing fields. The **multi-field calibration** capability ensures perfect alignment across overlapping fields. To do so, it marks a combined pattern with all deflection units on a single calibration plate. This enables seamless transitions and eliminating stitching defects. This is particularly valuable in large-field applications like fuel cell manufacturing, where precise welding is crucial for maintaining gas-tightness and functionality.

A) Quadruple system in a multi-field layout

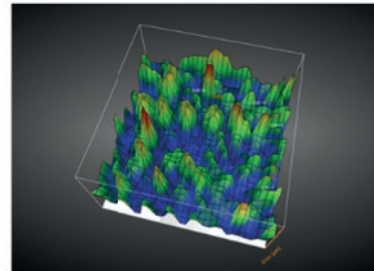


B) Alignment error without multi-field calibration



	Total	X	Y
Offset [μm]		-3674.8	-1990.8
Rotation [μrad]	1125.3		

C) Corrected Alignment with multi-field calibration



	Total	X	Y
Offset [μm]		-1.5	-1.5
Rotation [μrad]	0.8		

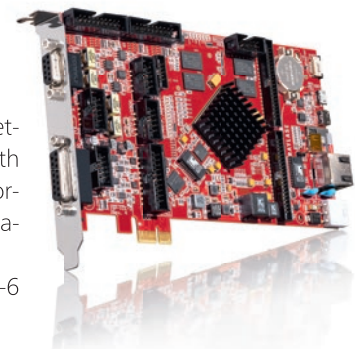
ACCESSORIES FOR CALIBRATION VIA NETWORK

SP-ICE 3

CONTROL CARD FOR AUTOMATED HANDLING OF CORRECTION FILES

The RAYLASE control card SP-ICE-3 is a central element for operating the SFC 600 via a network. All control boards in a shared network domain are automatically recognized with their ID. After selecting the control boards of a system, it is ensured that the optimized correction files are assigned exactly to the relevant control boards and laser systems. This reliably prevents operating errors.

For compatibility reasons the SFC 600 can also be used together with the RTC-5 and RTC-6 scan controllers.



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 successfully integrate it into the machine, everyone involved benefits in the end – our customers, us and also the end users.

SCOPE OF DELIVERY

Image provider	SFC 600
Software	SCAN FIELD MANAGER (SFM) With activation or dongle license including correction values for the specific flatbed scanner

ADDITIONAL REQUIREMENTS (ON THE CUSTOMER SIDE)

Windows PC or laptop with network connection	Windows 10 or higher, 64 bit Microsoft .NET Framework Version 4.8 or higher 16 GB RAM 10 GB of free disk space
Control card for laser and deflection unit	SP-ICE-3 ¹ Alternatives: RTC5 / RTC6 ²

¹ Manufacturer RAYLASE GmbH² Manufacturer SCANLAB GmbH

GENERAL TECHNICAL DATA

Weight and dimensions

Weight [kg]	110
Dimensions length x width x height [mm³]	1121 x 813 x 295
Max. weight of a calibration plate [kg]	18
Max. detectable scan area [mm²]	600 x 600

Ambient conditions

Use only indoors, in closed rooms and in a dry environment.

Ambient operation temperature range [°C]	5 ... 35
Ambient operation temperature [°C] (T: Temperature of the basic calibration, see device calibration file)	T ± 1
Storage temperature [°C]	-10 ... +60
Relative humidity [%] (not condensing)	≤ 80
Altitude acc. to EN 61010-1 [m]	≤ 2000
Degree of contamination acc. to EN 61010-1	2

Power supply

Power consumption (standby / active image capture) [W]	80 / 150
Power [V]	100 / 240
Fluctuation of the mains voltage [%]	± 10
Überspannungskategorie gem. EN 60664-4	II
Inrush current [A]	< 40

PERFORMANCE DATA

The orientation of the X-Y coordinate system of the laser system is detected automatically.

Control of the complete calibration process	via SFM GUI
Average measuring accuracy [μm]	± 4
Standard deviation [μm]	2
Average Scan field correction accuracy [μm]	$< \pm 15$

Clear assignment of laser system / calibration plate with a marked QR code

Who calibrated?	Name
When was calibration done?	Date
Which calibration routine was used?	Z Calibration / Single Field XY / Multi Field XY
Which parameters were calibrated?	X / Y / Z
Which laser system / control card was calibrated?	Customer-specific

SCAN FIELD MANAGER software

Software licenses	„Single Field“ (SF)	For single process fields Calibration routines: Z Calibration / Single Field XY (incl. Large Single Field XY)
	„Multi Field“ (MF)	For multiple, overlapping process fields Calibration routines: Z Calibration / Single Field XY (incl. Large Single Field XY) / Multi Field XY
Features of the calibration routines	Workflow 1	Parameterization and marking of the calibration pattern
	Workflow 2	Analysis of the measurement results with specification of statistical characteristic values Tabular and graphical display of all measured values (Magnitudes / Surface Plot / Vector Plot ¹) At the request of the user: Automatic adjustment of the active correction file including backup of the previous version
Software interface		Graphical software interface including configuration interface for setting the laser power etc. (as with RAYGUIDE)
Database		with all data on all calibrations performed and their metadata
History		The history of calibration results can be viewed at any time and calibrations can be restored. Results from separately saved images recordings can be checked again at a later date.
Automatically calibratable technical parameters		Scan field size (XY calibration) Scan field homogeneity (linearity) Rotation Focal plane for the entire laser process field (Z calibration) ²

¹ Only for XY calibration routines.

² A pre-focusing deflection unit is required to track the laser beam focus in the scan field.

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