PhotonicsViews

OPTICS • PHOTONICS • LASER TECHNOLOGY

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Spectronet Collaboration Conference 2025
International Conference for Photonics and Machine Vision

FOCUS TOPIC: Beam Shaping

The Rise of Photonic and Neuromorphic Computing

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A new beginning and continuity

Sometimes the only way is to be pathetic: Today, you are witnessing a new beginning. The first digital PhotonicsViews, after the print edition, led by Dr. Oliver Dreissigacker, will unfortunately no longer be published. This magazine, always brimming with photonics knowledge, will no longer exist in its current form. That is the bad news. But that does not mean the end of photonics at Wiley, of course not. In addition to Physik Journal, photonics has always been and continues to be part of inspect, which is very user-focused and, in addition to the German edition, also has two international spin-offs focusing on industrial machine vision and optical measurement technology. But photonics will also continue to exist in its pure form: in this digital edition, which will henceforth be published twice a year; on the industry portal www.wileyindustrynews.com; in the bilingual newsletters; in digital events, and so on and so forth.

So you can rest assured that we will continue to provide you, dear reader, with all the essential and up-to-date information you need for your business success.

Other advantages of a digital edition include: an engaging reading experience with many links to further information, exciting products, and image galleries; videos are also possible.

For my part, I am delighted with this first edition, which was produced under my direction—with the active support of Oliver, but also of partners such as Epic and Spectronet, and of course the companies that contributed to this edition.

Finally, a request: if you like, please write me a few lines about what you particularly liked and what you didn‘t. I would also be happy to hear which topics you would like to see in one of the next issues. I promise to take a close look at these suggestions and – who knows – maybe you will have inspired a topic or a change in the next issue of the digital PhotonicsViews.

Enjoy reading!

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Contents

EPIC
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Qioptiq Photonics becomes Excelitas Germany

Image: Excelitas

Dr. Robert Vollmers.

Qioptiq Photonics GmbH & Co. KG has changed its name and legal form to Excelitas Deutschland GmbH, effective August 27, 2025. This renaming is part of the global consolidation of the Excelitas Group, a US-based provider of innovative technologies.

The German locations in Göttingen, Feldkirchen, and Regen will remain unchanged. Göttingen focuses on the semiconductor industry, Feldkirchen on medical technology and life sciences, while Regen manufactures round and micro optics. The transition to "One Excelitas" is intended to standardize the international market presence and strengthen internal processes and cooperation between the German locations. Dr. Robert Vollmers, Managing Director of Excelitas Germany, emphasizes the strategic importance and potential for growth and innovative solutions. Reinhold Zeiner adds that the new structure offers opportunities for the global market.

Optics and photonics industry gathering at Optatec 2026

Optatec, the international trade fair for optical technologies will take place in Frankfurt am Main from May 5 to 7, 2026. This specialized event brings together experts, manufacturers, and users from the fields of optical engineering, precision optics, photonics, and image processing, promoting exchange between research and industry. The trade fair offers a platform for communication and knowledge transfer and is complemented by an attractive supporting program.

Image: Schall

Fabian Krüger, Projektleiter Optatec, P. E.Schall GmbH & Co.KG, Matthew Peach, Managing Director at Original Content Ltd., Robert Fisher, Head of Sales and Marketing for Optics.Org, John Yoon, Ph.D, Director of Technology Outreach, SPIE – the international society for optics and photonics.

Optical technologies, considered key technologies of the 21st century, are crucial for industries such as medical technology and automotive engineering.

Optatec presents applications that address ecological, economic, and technical challenges. With around 1,000 companies and 190,000 employees, the German photonics industry is an important economic sector. The trade fair showcases cross-sectional technologies that drive innovation across industries in areas such as mechanical engineering and automotive engineering.

Evosys Laser Celebrates 10th Anniversary

Image: Evosys

left to right: Managing Directors Holger Aldebert and Frank Brunnecker, Dr. Elfriede Eberl (Chamber of Industry and Commerce), Chair of the Chamber of Industry and Commerce Committee Manuela Achhammer, Head of the Chamber of Industry and Commerce Office in Erlangen Knut Harmsen, and Head of the Chamber of Industry and Commerce's Innovation and Environment Division Dr.-Ing. Robert Schmidt

Evosys Laser, a company that develops and manufactures customized systems for laser welding of plastics, celebrates its 10th anniversary. Since its founding in 2015 under the name „Evosys" – a combination of „evolution" and „systems" – the company has established itself in Erlangen. Despite global crises, Evosys has expanded its technical expertise and written a success story. A significant milestone occurred in 2018, when Evosys expanded internationally through a joint venture, leading to the creation of locations in China and the USA, boosting exports to 70%. The move to Felix-Klein-Straße in Erlangen-Bruck provided modern facilities for further growth. Holger Aldebert, managing director, attributes Evosys's success to innovative technology and a dedicated team. Despite current market challenges, the company remains optimistic about future achievements. The Evosys Group now includes four companies, with operations in Germany, China, and the USA.

Fujitsu plans superconducting quantum computer with 10,000 qubits by 2030

The computer will use 250 logical qubits and be based on the Star architecture developed for fault-tolerant quantum computing. Fujitsu has announced the launch of a project to develop a superconducting quantum computer with over 10,000 qubits, supported by Japan's National Institute for Research and Development. Completion is scheduled for fiscal year 2030. The computer will use 250 logical qubits and be based on the innovative STAR architecture developed for fault-tolerant quantum computing. Fujitsu aims to use quantum computing in areas such as materials science to enable complex simulations.
The company will serve as an implementation partner for a NEDO project to improve information and communication infrastructure after 5G. This project will be carried out in collaboration with AIST and RIKEN until 2027. In the long term, Fujitsu plans to develop a machine with 1,000 logical qubits by 2035 that will connect multiple quantum chips.

Opto Opens Branch Office in California

Image: Excelitas

Thomas Spieker

In July 2025, Opto opened a new branch office in the United States. Thomas Spieker is the Managing Director of Opto Microscopy Solutions. Thomas has a PhD in biology and 25 years of experience in the US microscopy market. In addition to supporting the sales partners and major customers, the company also plan to strategically expand it core business of imaging modules (an intelligent combination of camera, lighting and optics).

Lasers Are Gaining Momentum

A Wrap-Up from LWP and a Preview of the EPIC Meeting at Optoprim Italy

The latest Laser World of Photonics in Munich was the largest edition to date in terms of both exhibitors and visitors. EPIC took the opportunity to engage with the photonics community from multiple perspectives.

From a business perspective, discussions ranged from the impact of U.S. tax policy to the growing opportunities for photonics in security and defense, as well as our traditional CEO Exhibitor Breakfast.

From a technology perspective, EPIC hosted several panel discussions on topics such as innovative optics and the application of integrated photonic circuits.

In addition, EPIC co-organized a session on laser micromachining with AMS Technologies. This session focused on practical advancements in laser-based microfabrication, featuring presentations from companies and research institutions working on beam shaping, polarization control, and integrated laser systems.

Below is a summary of the presentations:
Multi-Seed MOPA Lasers - Maik Frede, CEO at Neolase: Neolase, a part of AMS Technologies, showcased its multi-seed Master Oscillator Power Amplifier (MOPA) technology, offering a versatile laser solution that merges nanosecond (ns) and ultrashort pulse (USP) regimes in one chassis. This integration allows users to switch seamlessly between high-throughput bulk material removal with ns pulses and fine, low-thermal-impact processing with femtosecond or picosecond pulses.

all images: Epic Photonics

Dr. Reinhard Pfeiffer, CEO of Messe Munich is giving a welcome speech to the attendees of EPIC CEO Breakfast at Laser World of Photonics.

Jan Meise, Anke Odouli and Antonio Castelo welcome the participants to the Laser Workshop

From Micro-Processing to Macroscale Applications Challenges of full power use for femtosecond lasers – Vincent Rouffiange, VP, Strategic Business Development Director at Amplitude Laser: Beam splitting offers effective industrial solutions for high-power processing by enhancing speed and reducing costs. By combining the increased energy of a multispot strategy with high-speed scanning systems, it maximizes the use of ultrafast laser average power. In his presentation, Rouffiange demonstrated that high-power ultrafast lasers are ready to unlock new fields of application.

Planar Light Valve & Displacement Phase Modulator for Laser Processing Applications - Lars Eng CEO at Silicon Light Machines: The company has introduced two game-changing spatial light modulation technologies for next-generation laser processing. Planar Light Valve and Displacement Phase Modulator that positions them as precision-driven laser microfabrication with fine control over spot geometry and energy delivery.

Random-to-Radial Polarization Conversion for Laser-Based Manufacturing Industry - Mariam AlKhateri, Researcher at Technology Innovation Institute (TII): TII's Directed Energy Research Center introduced a compact and passive Random-to-Radial (R2R) polarization converter designed to enhance the consistency of high-power fiber laser machining. The core motivation lies in addressing the issue of random polarization from fiber lasers due to birefringence, which affects absorption stability during laser-material interaction.

Technology Meeting on Industrial Laser Processes

In September 2025, EPIC will organise a Technology Meeting on Industrial Laser Processes at Optoprim Italy in Milan. Advances in higher-power lasers and new wavelengths have enabled novel processing techniques. During this two-day meeting, we will explore emerging laser applications in e-mobility, jewellery, glass materials, aerospace, the energy sector, semiconductors, and consumer electronics

https://epic-photonics.com

Spectronet Collaboration Conference 2025

International Conference for Photonics and Machine Vision

The future of photonics and machine vision begins now – and Spectronet invites you to be part of it! From September 17 to 18, 2025, the Spectronet Collaboration Conference 2025 (SCC 2025) will take place in Zoetermeer (Netherlands) – an international platform for innovation, exchange, and collaboration in industrial and biomedical applications of photonics and machine vision.

About Spectronet

Since 2008, Spectronet has been a leading cooperation network for connecting developers, researchers, and companies in the field of optical measurement technology. With over 45 successful international conferences, Spectronet stands for targeted innovation promotion and application-oriented knowledge transfer.

Spectronet Collaboration Conference (SCC) 2025 is more than just a conference—it is an interactive meeting place for thought leaders and practitioners. This time, the host is TKH Vision Group, a company in the field of industrial machine vision. Participants can expect an extensive program with 38 technical presentations in 7 thematic sessions, two forward-looking keynotes, an exhibition with live demonstrations, and a conference dinner night for informal networking.

The conference concept: Share knowledge, develop ideas, implement them together

Seven sessions will cover topics such as lighting & optics, spectral & multimodal sensor systems, smart vision, AI & software, industrial & bioanalytical applications, system characterization, and new developments in imaging & sensing.

A special highlight is the accompanying exhibition, where companies will present their innovations to an international audience of experts from science and industry—directly on site and with personal contact. Stand space is limited, so early registration is recommended. The TKH Experience Center will be available exclusively to the participants.

Whether as a participant, exhibitor, or speaker, SCC 2025 offers a unique opportunity to network internationally, learn about the latest developments, and gain inspiration for future projects. All presentations will also be made available online—ideal for sustainable knowledge management. ■

Topics covered at SCC 2025 in Zoetermeer:

- Lighting, filters & optics
- Spectral & multimodal sensor/camera systems
- Embedded & smart vision systems
- Artificial intelligence & smart software
- Imaging & sensing for industrial and biomedical applications
- System characterization
- Future technologies in photonics & machine vision

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Useful info and links

- Event page
- When: September 17-18, 2025
- Where: TKH Security B.V., Werner von Siemensstraat 7, 2712 PN Zoetermeer, Netherlands
- Special: Exclusive Conference Dinner & boat trip in oldtown Delft; Conference Dinner Night (to be booked separately)

The participants of the SCC 2024 in Iseo Lago, Italy

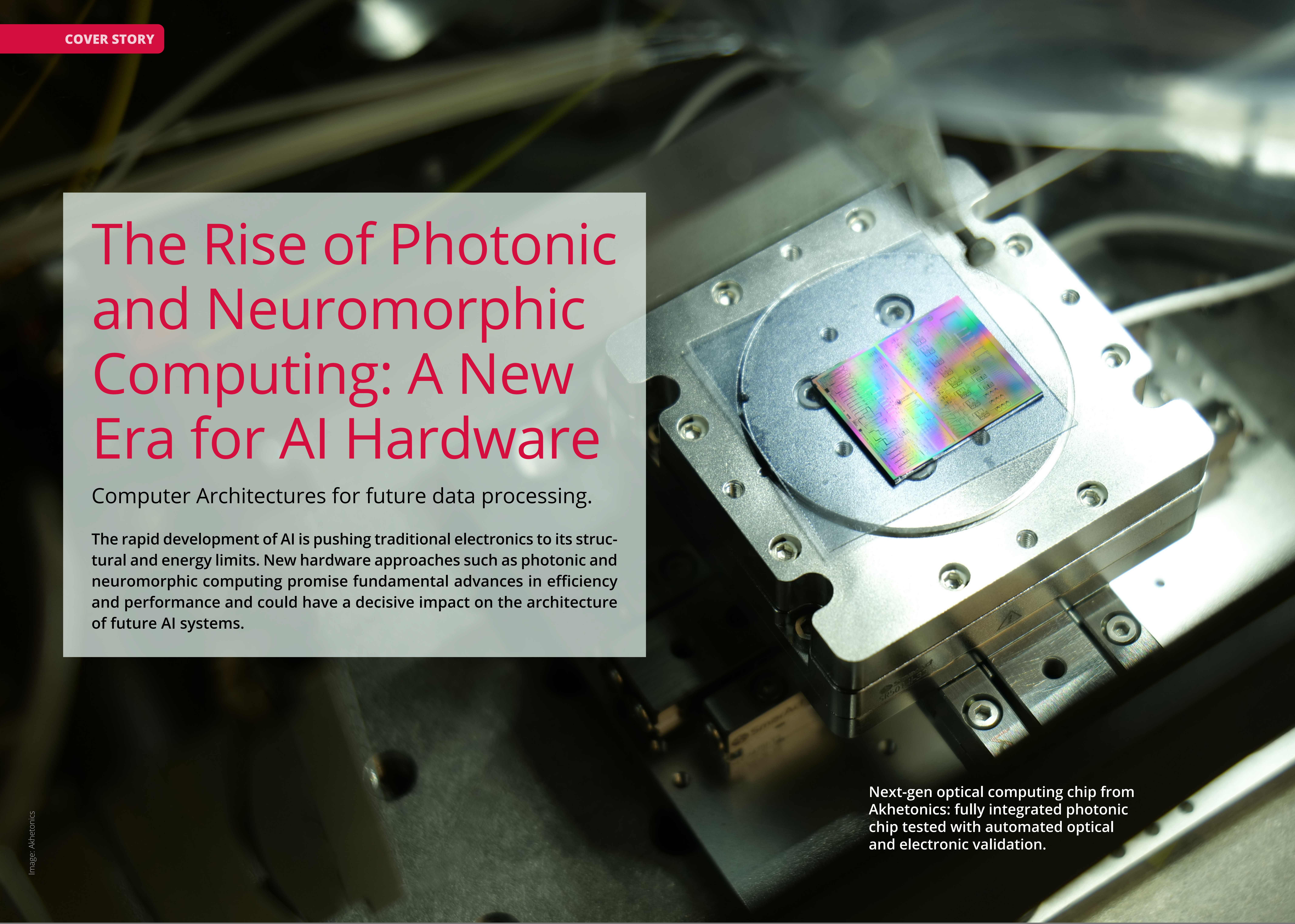

The SCC focuses not only on personal exchange, but also on technical input in the form of presentations and exhibitions.

COVER STORY

The Rise of Photonic and Neuromorphic Computing: A New Era for AI Hardware

Computer Architectures for future data processing.

The rapid development of AI is pushing traditional electronics to its structural and energy limits. New hardware approaches such as photonic and neuromorphic computing promise fundamental advances in efficiency and performance and could have a decisive impact on the architecture of future AI systems.



Next-gen optical computing chip from Akhetonics: fully integrated photonic chip tested with automated optical and electronic validation.

Image: Akhetonics

The explosive growth of artificial intelligence has starkly exposed the limitations of traditional silicon-based electronics, creating an urgent need for more efficient computing paradigms. As neural networks grow larger, the energy costs have become unsustainable, primarily due to critical bottlenecks in data movement. This has spurred a hardware revolution, shifting research toward two revolutionary and complementary approaches: energy-efficient photonic computing and brain-inspired neuromorphic architectures. These technologies promise not just incremental gains, but orders-of-magnitude improvements in speed, efficiency, and latency, fundamentally redefining the future of AI infrastructure.

IBM Research illustrates the immense scale of this computational challenge, noting that training a modern AI model requires the equivalent of 10,000 days of the world's first petaflop supercomputer. With compute power having improved 60,000-fold over memory bandwidth's mere 100-fold gain, the solution lies in new architectures. IBM is pioneering analog in-memory computing using grids of programmable resistors like resistive RAM. Optical versions of this approach use beams of light manipulated by interferometers to achieve results at light speed, with systems achieving remarkable efficiency and nearing viability for the entire AI training process.

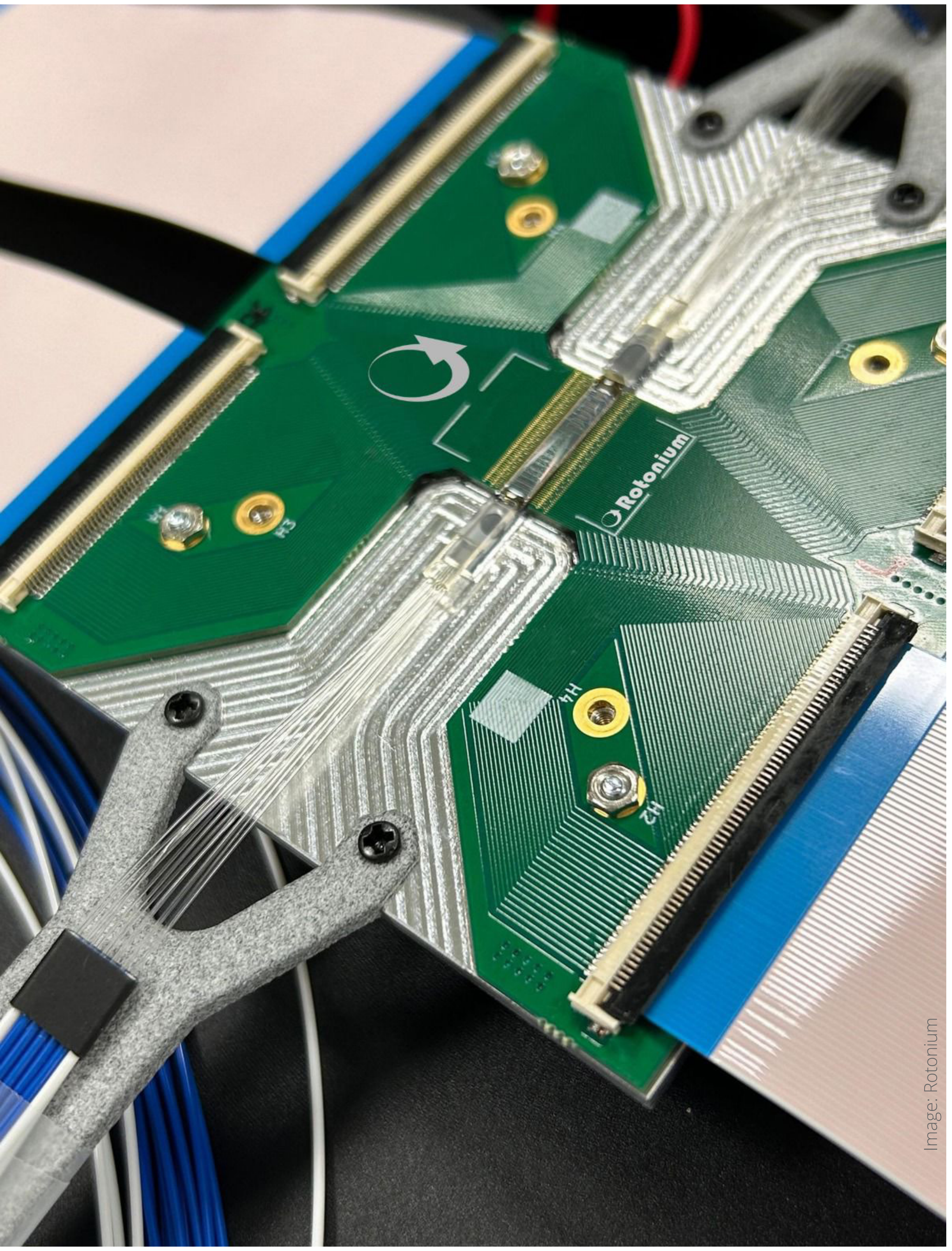
This hardware evolution is complemented by the neuromorphic computing research highlighted by Zurich University of Applied Sciences. Their work emphasizes that neuromorphic systems are defined by brain-inspired algorithmic principles, not just hardware. This approach embraces biological computation through parallel architecture with integrated memory and processing that operates asynchronously, consuming power only when responding to meaningful events. This makes it supremely efficient for real-time applications, extending beyond deep learning to optimization solvers and bio-inspired models for robotics.

Optical Computing without Conversion Inefficiency

The revolution extends beyond specific accelerators to reimagining entire computing architectures. Akhetonics company is challenging the assumption that optical computing is only suitable for matrix math by developing a general-purpose, high-performance optical processor. Their approach replaces both electronic transistors and memory with

Image: Ipronics

Programmable silicon photonics optical circuit switch from iPronics for data centers and AI infrastructure.



Single-photon quantum processor from Rotonium: a 4-qubit processor designed for oracle algorithms and hybrid quantum–classical generative models.

optical components, keeping data in the optical domain from input to output to eliminate conversion inefficiency. By simplifying designs to need thousands instead of billions of transistors, they achieve remarkable energy efficiency and low latency with a design built on European supply chains.

Simultaneously, the field of quantum computing is seeing photonic innovations that could make quantum processing more accessible. The startup Rotonium is pioneering a unique approach using a photon's orbital angular momentum to encode multiple qubits within a single photon. This creates „multidimensional qubits" that enable deterministic quantum gates without needing extra ancillary photons, significantly reducing error correction overhead and allowing for compact, room-temperature operation suitable for edge applications.

Photonics Industry Supports Advances in Computing

Supporting these advances in computing units are crucial innovations in photonic networking. The company Ipronics focuses on this critical area, developing high-speed, lossless optical circuit switches that create a reconfigurable photonic layer for AI data centers. Their technology can reroute connections within microseconds upon failure and dynamically reconfigure network topology to adapt to live traffic patterns, enhancing both resilience and training efficiency for clusters of GPUs or future photonic chips.

Finally, addressing the persistent challenge of coupling light efficiently between chips and fibers requires the precision micro-optics developed by Nanoscribe. Using advanced 3D micro-printing, they create custom micro-lenses that reshape light beams to perfectly match the different mode sizes of nanoscale waveguides and optical fibers. This technology drastically reduces coupling losses and relaxes alignment tolerances, making the packaging of photonic systems more robust and scalable—a vital step for practical integration from AI accelerators to quantum computers.

Conclusion

Together, the developments from these innovators represent a tectonic shift in computing architecture. The convergence of photonics, neuromorphic inspiration, and quantum principles is creating a new class of machines tailored for modern AI: faster, more energy-efficient, and adaptive. The race is no longer about transistor density but about unlocking new dimensions of computation. This foundational shift promises to finally decouple computational progress from unsustainable energy demands, enabling a future where AI can grow both smarter and greener. As these technologies mature and converge, they will redefine what is possible, pushing the boundaries of intelligence from the data center to the very edge of our world. This new era of intelligent, efficient computing has already begun. ■

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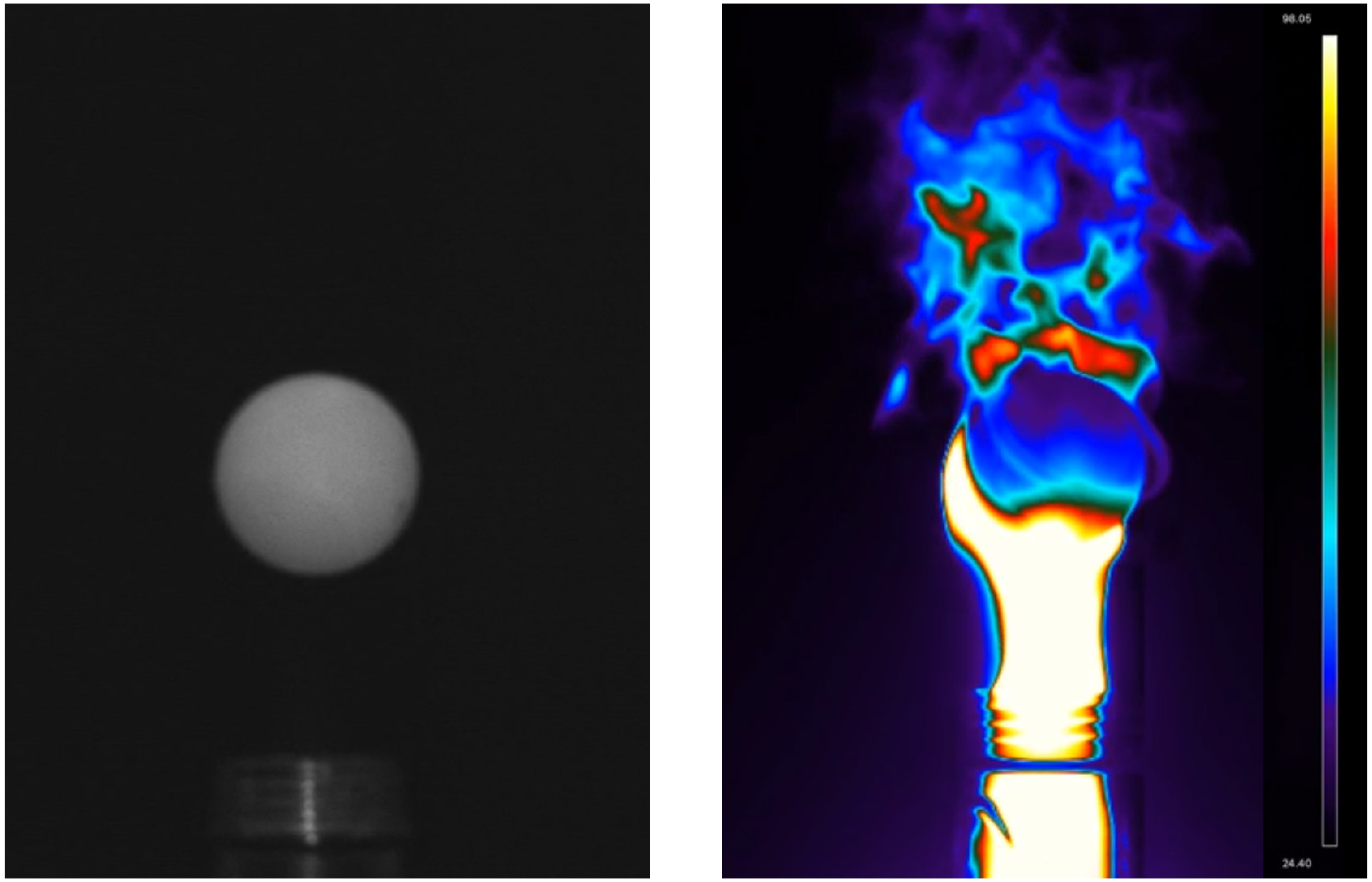
Thermal and Visual Image Synchronized

Efficient Analysis Through Combined Image Data

The parallel use of visible light and thermal imaging technology has traditionally been associated with high technical effort of organizing. A new system enables the synchronous capture of both image types in a single data set—without manual post-processing. This simplifies the analysis of dynamic processes in research and industry.

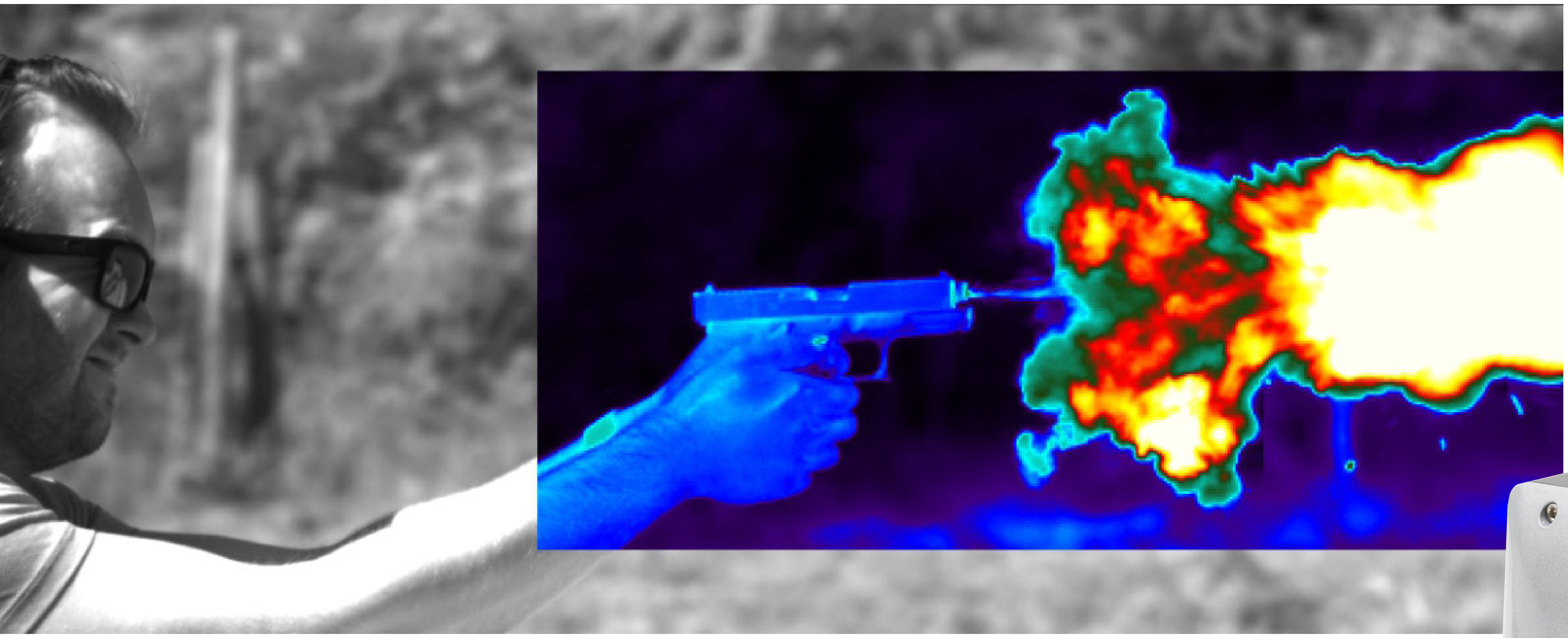


The Flir Multispectral Imaging Xperience (MIX) is effortlessly fusing high-quality thermal and visual imagery into a single, synchronized dataset.

For decades, researchers and engineers have faced a frustrating dilemma: choosing between visible-light or thermal imaging during testing. Each brings unique value; visible light captures structural detail and context, while thermal imaging reveals heat signatures and dynamic thermal patterns. But using both simultaneously? That's where things have traditionally fallen apart.

The challenge lies in the technical dance of precise spatial alignment and time synchronization of the two data streams. Historically, this has meant painstaking manual processes that often result in inconsistencies, delays, and more questions than answers. The promise of combining the strengths of both imaging types has remained just out of reach—until now.

The Flir Multispectral Imaging Xperience (MIX) is effortlessly fusing high-quality thermal and visual imagery into a single, synchronized dataset. This eliminates the historical trade-off between capturing heat signatures and revealing structural details by integrating dual-sensor technology into one seamless package. The result is a streamlined, real-time solution that removes the burden of manual alignment and post-processing, ensuring that every captured frame reflects both precise thermal nuances and vivid visible context. In doing so, effortless fusing of high quality thermal and visual imagery not only raises the standard for data interpretation but also paves the way



By converging high-speed thermal capture with high-resolution visible imaging, Flir MIX provides a complete picture of fast-moving thermal phenomena, and elevates the quality and reliability of multispectral data.

for accelerated discoveries across a multitude of research and industrial domains.

At the heart of Flir MIX is an integrated imaging architecture capable of recording events at speeds up to 1,004 frames per second. This high-speed performance is critical for capturing transient thermal events—from dynamic material stress testing and rapid chemical reactions to high-speed ballistics and airbag deployment analysis—without sacrificing spatial accuracy. The simultaneous capture of thermal and visible data allows researchers to unlock deeper insights into processes that evolve quickly over time, thereby reducing analysis time and enhancing the precision of quantitative measurements.

Tailored for High-speed Research Environments

The system is designed to address a broad spectrum of advanced applications through differentiated kit configurations. The X-Series Starter Kit, for example, is tailored for high-speed research environments, combining Flir X69xx thermal cameras with high-speed visible cameras, precision optics, and custom mounting hardware to support demanding applications such as aerospace testing and industrial diagnostics. Meanwhile, the A-Series Starter Kit offers a versatile solution for sectors like electronics design, renewable energy, and battery testing, where integration with Flir A67xx thermal cameras ensures

The X-Series Starter Kit, for example, is tailored for high-speed research environments, combining Flir X69xx thermal cameras with high-speed visible cameras, precision optics, and custom mounting hardware to support demanding applications such as aerospace testing and industrial diagnostics.

the capture of both robust thermal data and fine visual detail. For researchers seeking post-processing flexibility, the Flir MIX Toolkit provides an add-on option that seamlessly synchronizes thermal and visual footage in real time, consolidating every frame into one comprehensive dataset.

Coupled with Flir Research Studio software, Flir MIX delivers an end-to-end solution that enhances user workflows from capture through analysis. This unified control platform automates the synchronization process, offering intuitive data management and real-time analysis capabilities that dramatically reduce the time between data acquisition and actionable insights. With its pixel-accurate overlays and time-matched imagery, the system enables researchers to focus on interpreting results and accelerating discovery without being hindered by the complexities of traditional imaging systems.

By converging high-speed thermal capture with high-resolution visible imaging, Flir MIX provides a complete picture of fast-moving thermal phenomena, and elevates the quality and reliability of multispectral data. This technology empowers scientists, engineers, and innovators to interrogate and understand intricate thermal environments with unprecedented clarity and speed. The comprehensive, real-time merged datasets facilitate a more nuanced understanding of dynamic processes, driving forward breakthroughs in fields as diverse as defense, materials science, and renewable energy research.

Conclusion

Flir MIX accelerates discovery by simplifying data integration and enhancing analytical precision, thereby enabling researchers to concentrate on scientific inquiry and innovation rather than on time-consuming post-capture data reconciliation. The system enables to understand complex phenomena and accelerates progress in scientific and industrial applications. ■

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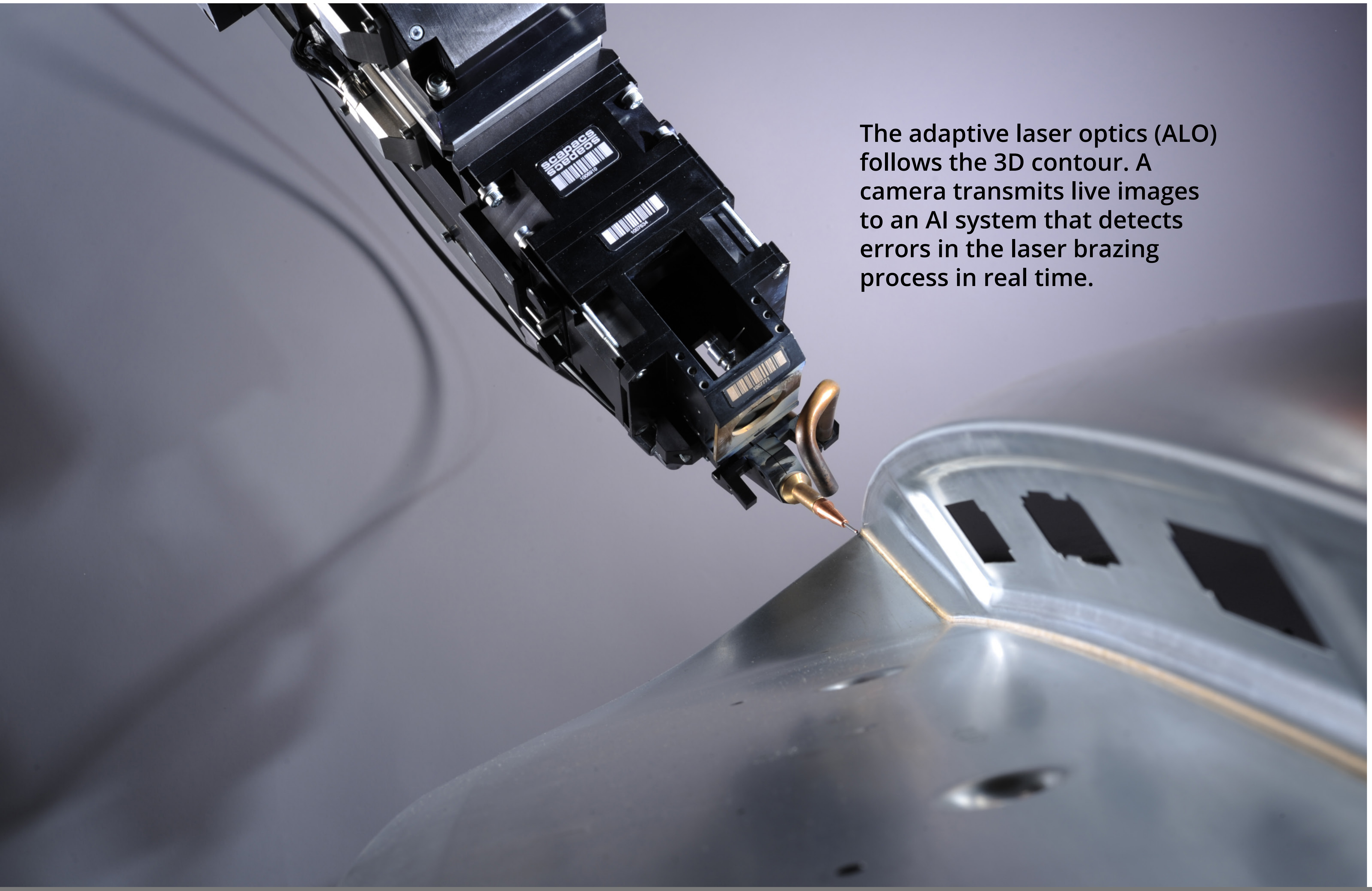
Automatic Defect Detection in Laser Welding and Brazing with AI

Process Monitoring in Automotive Production

Smart sensor technologies are key for Industry 4.0. But data alone is not enough. It must also be interpreted effectively. Artificial intelligence makes it possible to automatically detect defects in laser-joined seams with high detection rates. This marks another significant milestone in the digital transformation of automotive manufacturing.



The adaptive laser optics (ALO) follows the 3D contour. A camera transmits live images to an AI system that detects errors in the laser brazing process in real time.

It all started with a request from the German plant of a U.S. car manufacturer preparing for a model update. In the previous mid-size car version, roof and side panels were joined using spot welding and concealed behind decorative strips. The new model would forgo these strips. But exposing the seams to the customer's eye leads to increased requirements on the weld quality. At the same time, the production team aimed to digitize more of its processes.

The search began for a different joining method. The project team identified laser brazing as the optimal solution and reached out to Scansonic. The ALO4 laser processing optics – featuring tactile seam tracking and additional filler wire – has proven itself globally in this application. The integration of a camera enables online monitoring. Artificial intelligence (AI) can be used to analyze the images provided by the camera to assess the seam quality – a capability the customer wanted to explore further.

AI-Enhanced Process Monitoring

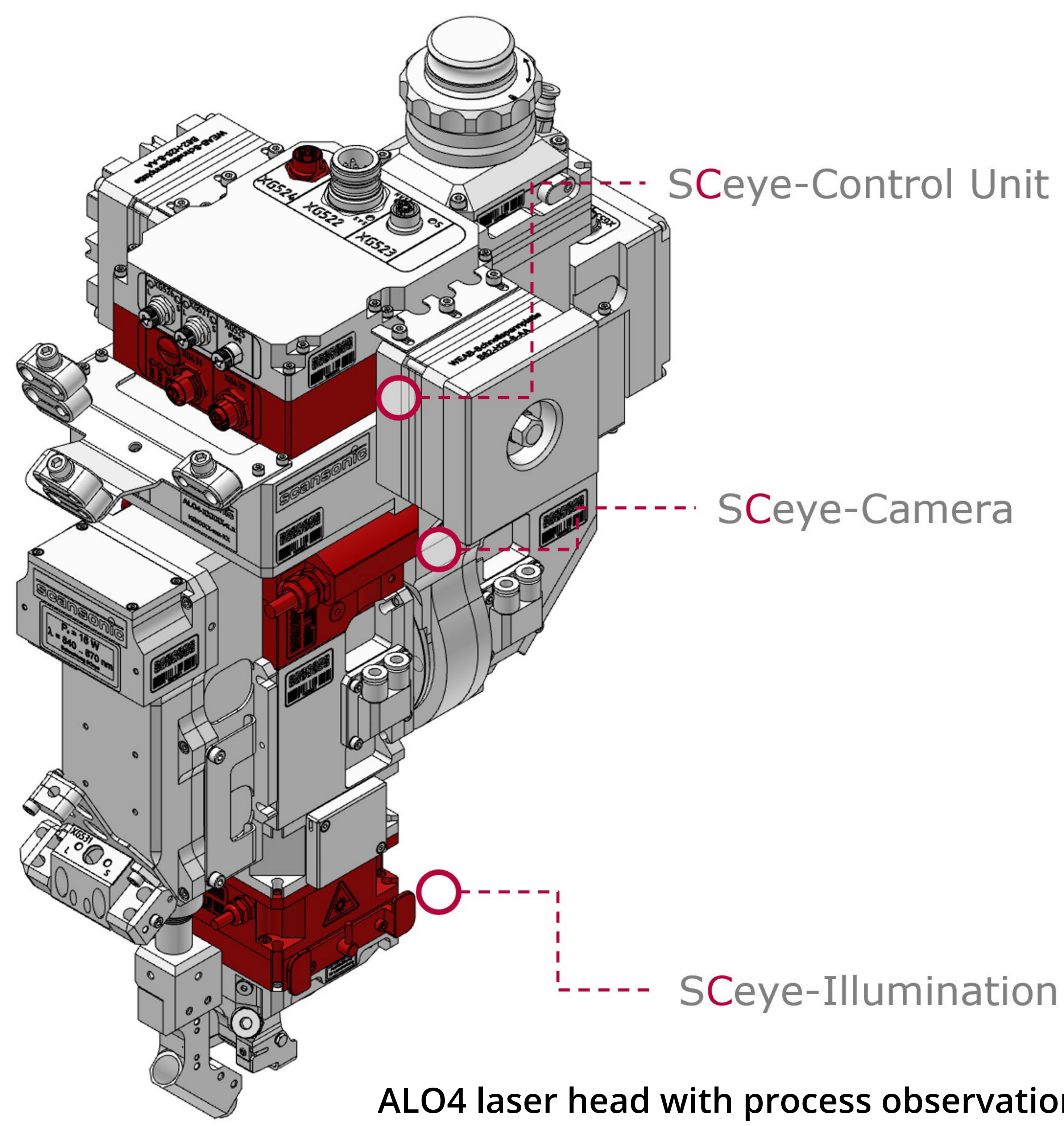
The ALO4 represents the fourth generation of tactilely guided laser processing optics in automotive manufacturing. Since 2017, the ALO has been equipped with the SC Eye monitoring system, consisting of an integrated illumination-module, a camera, and a control module. Automated image processing was a decisive factor in the customer's choice. But for three years now, the system does more than visualizing the process: The AI identifies defects such as spatter or pores in real-time. AI essentially takes over visual inspection, as operators are shown images of detected failures and can decide on rework, accordingly.

Customer Learning Curve

The integration of the laser brazing technology into the customer's production processes took several months in total. The ALO4 with the integrated SC Eye system generated large volumes of image data during the production process. These data have been essential to train an AI model and made efficient data management essential. To enable this, standards for data processing had to be established to ensure efficient handling both on the factory floor and at Scansonic.

In the meantime, the new technology has been fully integrated into the production system. Detected defects are automatically assigned to a specific vehicle and displayed to the operator. Based on the classification by the AI, the defective part is directed to a repair station.

Following the initial successful implementation phase, even the smallest defects were identified. Customer evaluations showed that the system reliably detected failures as small as 0.2 mm. This is particularly important, as pores of this size can no longer be sealed by paint or may reappear during subsequent processing steps.



ALO4 laser head with process observation system SC Eye from Scansonic MI

Processes are Fully Traceable, even across Factories

In the production line, a robot places the roof onto the body, and two more robots guide ALO4 optics along the seam to join roof and side panels. All defect-related videos are stored with metadata such as vehicle ID, materials, and tool settings. This makes processes fully traceable and optimizable, even across factories or plants. AI-based quality monitoring is becoming a key component on the road to fully digital workflows.

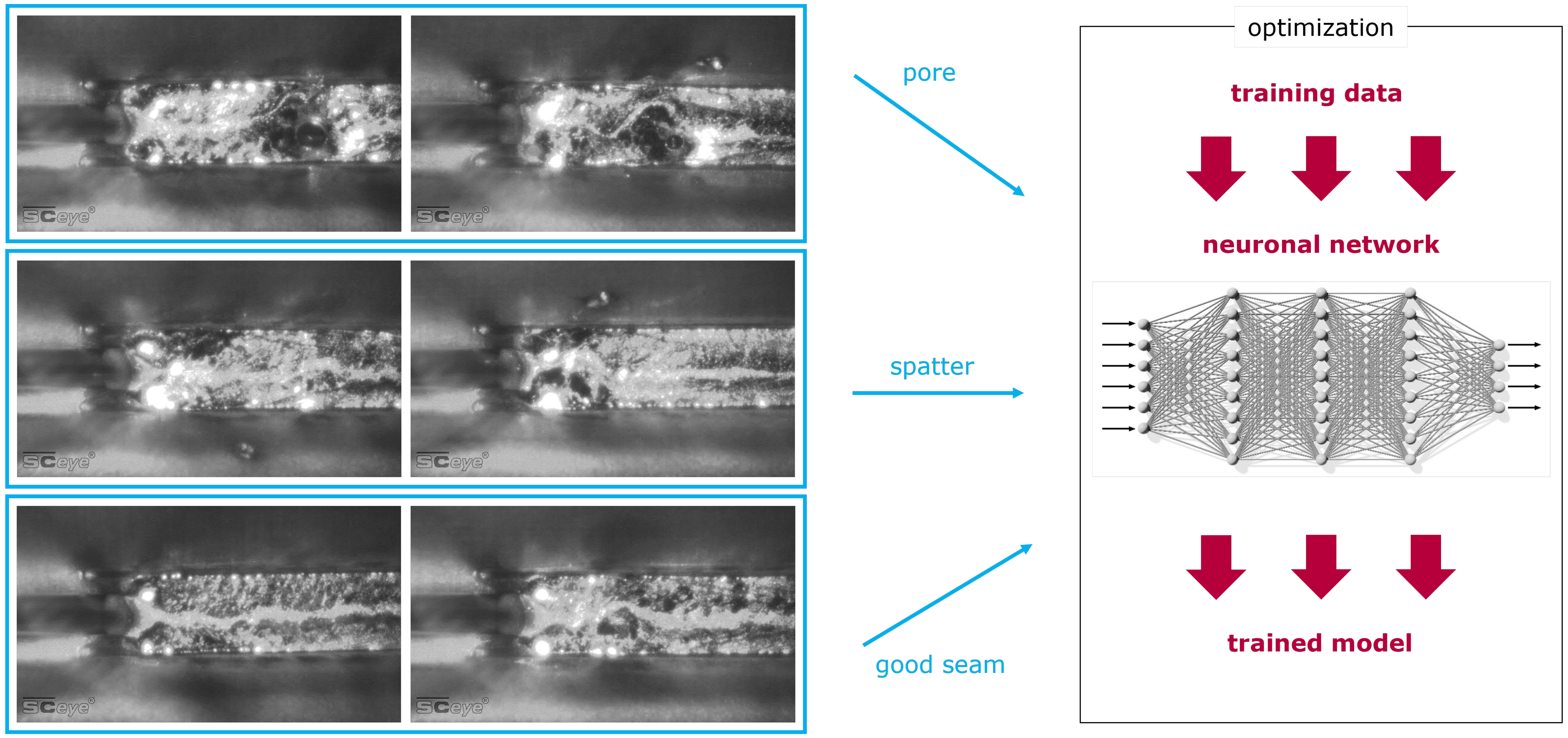
Further advantages are expected in the future – for example, setup times are anticipated to become shorter. Because of AI, fewer tests are needed when adapting processes.

What the AI Actually Does

Essentially, the AI mimics human learning. A convolutional neural network (CNN) is trained on images of good and defective seams – in this case, two defect types: "pores" and "spatter". The CNN detects these in real time and can be trained for other defect types as well. Scansonic is actively collaborating with universities and industrial partners to further enhance the detection rate of the AI model.

Machine Learning and New Processes

For the initial training of the system, the customer provided approximately 5,500 images of good brazed seams and around 2,000 images showing pores. Scansonic was able to demonstrate in its laser laboratory that only a small number of additional images were required to transfer the good detection results to similar processes. With just a few hundred images, detection rates of over 95 percent were achieved for brazing processes that differed only slightly from the automo-



Training data for the neural network includes pores (top left row), spatter (mid left row), and good seams (lower left row).

tive manufacturer's series production; primarily in terms of the materials used and the process parameters applied. Even when transferring the AI-based detection approach to entirely different laser processes, such as aluminum laser welding, retraining with only a few images still delivered excellent results for the new process.

Towards Zero Training?

Today, the system is installed at more than five different customers. Currently, each application is still trained individually. In the future, the AI could become significantly more powerful if training data from various applications were combined. This would allow the AI to be trained on a wide range of use cases, resulting in a highly advanced model that delivers optimal performance across all applications.

With this future approach, any customer willing to contribute their training data would benefit from the best-trained AI available. In the long term, this could lead to the creation of a database that eliminates the need for individual training altogether.

Looking ahead, data from other detectors (e.g., spectral analysis of process emissions) or from process parameters could also be incorporated. This would pave the way towards another strategic goal: complete process optimization through AI. A separate AI could suggest optimized process settings to the operator or even configure the entire process automatically. Although this visionary goal is still on the distant development horizon, Scansonic's development team is already laying the foundation today. ■

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Systematic Characterization of Ring-Shaped Laser Beams

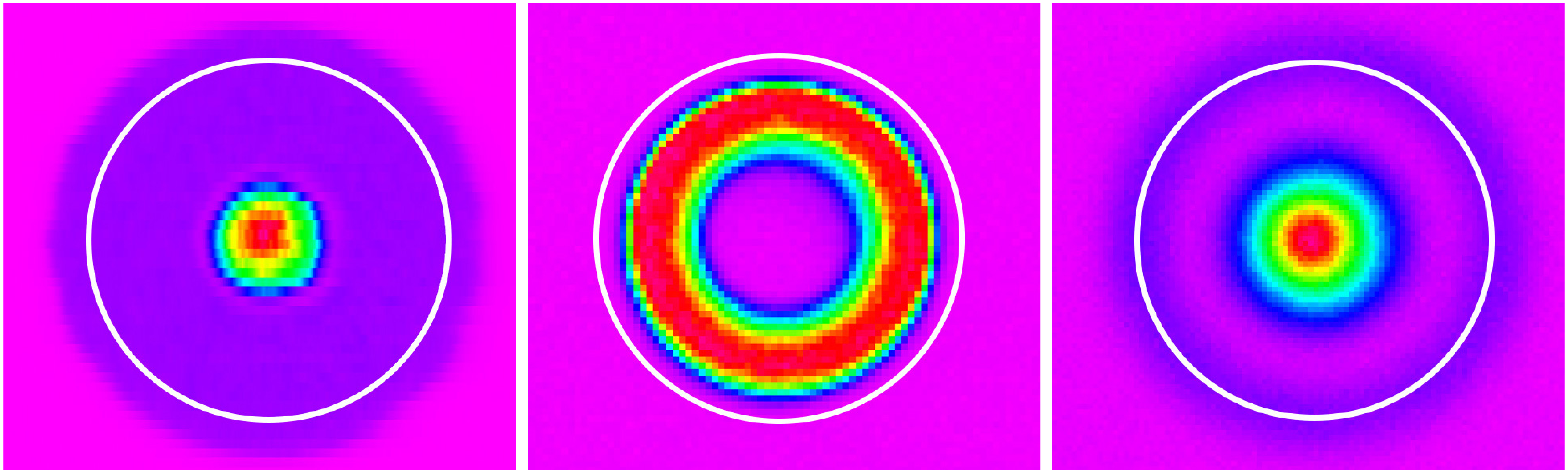
New metrics for meaningful analysis beyond ISO 11146

Ring-shaped laser beams are gaining traction in material processing due to their efficiency benefits. Yet, conventional beam analysis methods fall short in describing their unique structure. This work introduces tailored parameters for plateau and single-mode ring beams, enabling reproducible and meaningful characterization—both in the focal plane and along the beam axis. It lays the foundation for future standardization beyond ISO 11146.

The introduction of new parameters for ring-shaped beams enables an accurate and comparable characterization of these beams

Ring-shaped laser beams offer the potential for significant improvements in efficiency across various laser material processing applications, including welding, surface treatment, and additive manufacturing. Advances in laser fabrication, fiber production, and optical technologies have facilitated the widespread availability of ring beams. However, during this early phase of adoption, it is essential to establish meaningful and comparable descriptions of their properties. Conventional methods for analyzing laser beams, such as the second-moment method or the 86-percent-method, are based on the ISO 11146. These methods are optimized for Gaussian beam shapes and do not account for the substructure of ring beams, resulting in limited informational value. Furthermore, there is currently no standardized framework or a unified set of parameters for the characterization of ring beams. It is crucial that the evaluation of ring beam parameters yields reproducible, comparable, and relevant key metrics.

We distinguish between two types of ring beams: “plateau beams” and “single-mode ring beams”, which are employed in different laser processing domains and exhibit markedly different beam characteristics. To meet the specific requirements of both beam types and their respective applications, we analyze each with tailored algorithms.



Three examples of single-plane analysis of ring beams according to ISO 11146: a plateau beam, a donut beam, and a single-mode ring beam. The white circles indicate the beam dimensions derived from second-moment analysis (d4σ), while the lines mark the principal axes. These dimensions do not correspond to any specific characteristic of the beam.

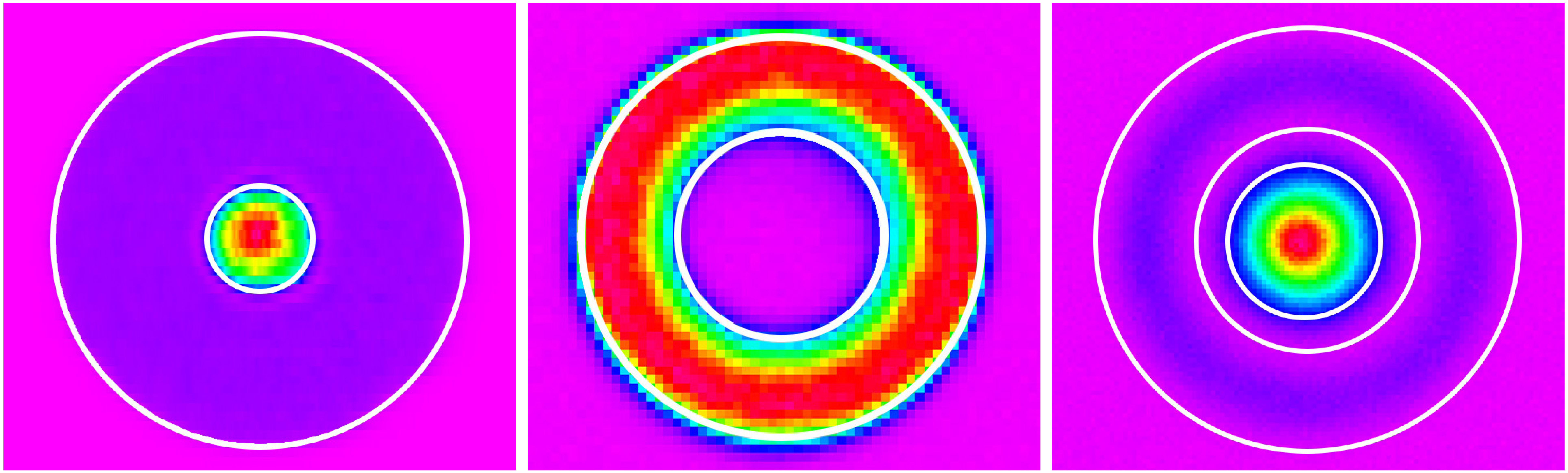
Plateau beams are predominantly utilized in welding and surface treatment processes. They are typically generated using a two-zone fiber with a core diameter of 50–100 µm and a cladding diameter of 180–400 µm. The resulting beam is a superposition of multi-mode radiation, exhibiting a stepped intensity distribution in the processing plane, depending on the power contributions from the two fiber sections.

Single-mode ring beams are mainly employed in additive manufacturing and micro machining. Their defining characteristic is that both the core and the ring follow a Gaussian distribution in the cross-section of their intensity distribution, approaching the diffraction limit, with a defined gap between the two.

Relevant Parameters in a Single Measuring Plane

Since conventional beam definitions are inadequate for ring beams, a new set of parameters is required to accurately describe their properties. We describe the geometric features of the ring and core separately. Utilizing ISO 13694, which specifies parameters for flat-top beams, we define the following parameters for plateau beams:

- **Diameter of Ring:** Full width at half maximum (FWHM) of the ring structure
- **Diameter of Core:** FWHM of the core region, assumed to be situated on the plateau
- **Decentering:** Distance between the geometric centers of the core and ring structures
- **Edge Steepness:** Ratio of the area within the edge of the ring to the total beam area
- **Homogeneity:** Intensity variation within the plateau region
- **Inclination:** Slope of an inclined plane fitted to the plateau structure
- **Modulation:** Ratio of the maximum power density in the core to that in the plateau
- **Power Share Ring:** Relative power contribution of the ring section
- **Power Share Core:** Relative power contribution of the core section
- **Power Loss:** Missing power, calculated as the difference between the total power of the beam and the sum of core and ring contributions.



Plateau beam, Donut beam and single mode ring beam evaluated according to the new set of ring beam parameters. The white circles show the diameter of ring and core. These new parameters reflect the characteristics of the beam.

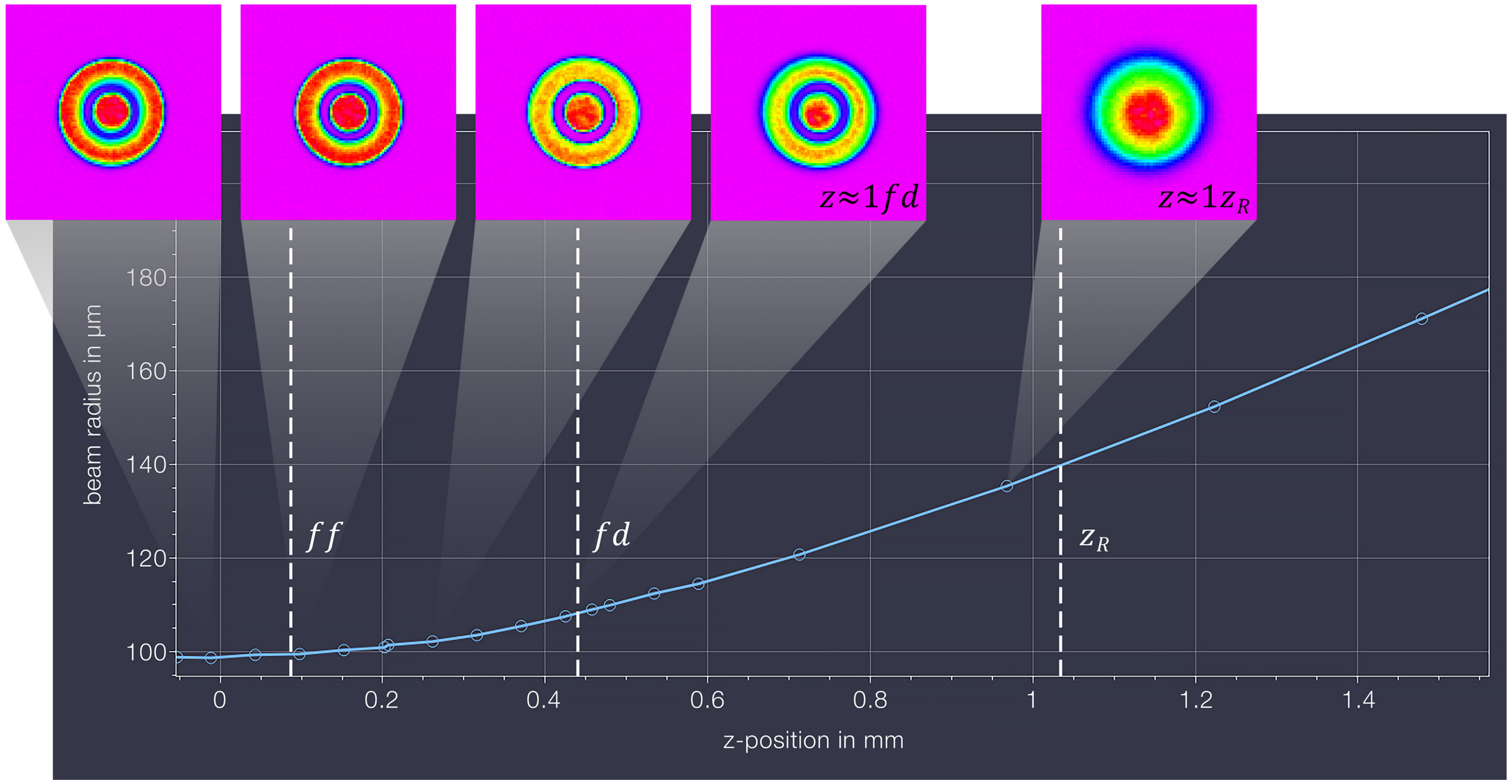
These parameters provide a comprehensive geometric description of the beam. Set laser parameters can be verified using power share and modulation, while the location of the sharpest imaging of the laser beam can be inferred from the edge steepness. It should be noted, that the location of the sharpest image may differ from the location of the beam waist, as discussed later. Misalignments within the optical system manifest as inclination or decentering between the core and ring structures. It is noteworthy that a donut-shaped beam (a ring with a central hole) is equivalent to a ring beam with negligible core amplitude.

For single-mode ring beams, the calculation of these parameters requires a slightly different approach. Such beams consist of a separate core and ring, each with single-mode character in radial direction. To account for this, Gaussian fits are applied to cross-sectional intensity distributions passing through the center of gravity, yielding the width and center position for both the ring and core distributions along the cross-sectional axis. This process provides the ring diameter, ring width, and core diameter. Rotated fits at various azimuthal angles enable the extraction of combined parameters, such as decentering between core and ring, power shares of each component, as well as statistical measures like the variation of the ring width, of the ring diameter, and of the ring amplitude.

Caustic Parameters for Ring Beams

In caustic measurements, it is evident that traditional beam parameters—such as beam quality, Rayleigh length, or waist diameter—are either not meaningful or potentially misleading when applied to ring beams. Most importantly, the ring and core feature disintegrates within a fraction of a Rayleigh length. Consequently, there is a need for new parameters that accurately characterize the process-relevant caustic properties of these beams.

Starting from the beam waist, we analyze the propagation of the power density distribution along the beam axis. As previously described, the ring beam parameters are examined in individual measurement planes around the beam waist.



Measurement of a ring beam caustic following the measurement strategy with increased axial resolution. The z-positions of the feature focus (ff = 0.09 mm) and of the feature depth (fd = ff ± 0.35 mm) are indicated, much shorter than zR = 1.06 mm. The displayed intensity distributions at various axial positions illustrate the evolution of the beam shape along the propagation axis.

The evolution of these parameters along the axis is then analyzed, resulting in the definition of two new caustic parameters: feature focus location and feature depth.

The feature focus location indicates the axial location where the respective dominant feature of the beam attains its minimum size (see “feature depth”). Due to optical misalignments or inhomogeneous fiber emission angles, the sharpest image of the ring feature may differ from the beam waist according to ISO 11146. The diameters of the core and ring at their respective feature focus location are referred to as the feature focus diameters.

The feature depth is analogous to the Rayleigh length for ring beams. It describes the axial distance over which the ring feature of the beam is maintained to a certain extent. According to ISO 11146, the Rayleigh length is defined as the distance at which the beam diameter increases by a factor of √2 relative to the waist. For ring beams, this concept is adapted to define the feature depth. While Gaussian beams are characterized by their beam diameter, we need to find another descriptive feature for ring beams. Plateau beams exhibit differing beam quality in the ring and the core: the core tends to lose its shape more rapidly than the ring. Conversely, in single-mode ring beams, this behavior is inverted, with the ring losing its shape more quickly than the core. The feature depth is thus defined as the shortest axial distance after which the width of either the ring or the core increases by √2, measured symmetrically around the feature focus location. Typically, the feature depth is significantly shorter than the Rayleigh length and provides a useful metric for process window optimization.

Given that the feature depth is considerably shorter than the Rayleigh length, a higher resolution in z is required—more than prescribed by ISO 11146. Specifically, at least five axial positions within one feature depth on either side of the feature focus should be measured. This allows for a clear separation of the ring and core regions, enabling a ring-beam-specific analysis.

Conclusion

This work demonstrates that conventional evaluation techniques are insufficient for a meaningful description of ring beams. The introduction of these new parameters provides an accurate, comparable and relevant characterization of ring beams both in the focal plane and across the full caustic. This framework lays the groundwork for discussions on establishing an ISO standard for ring beams. ■

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Additive Manufacturing of Metal becomes more Efficient, and Sustainable

Beam Shaping and Multispectral Imaging combined

The EU project "Inshape" developed a new method for optimizing laser-based powder bed fusion of metals (PBF-LB/M), combining beam shaping with multispectral imaging. Over three years, the consortium tested the approach on five industrial demonstrators from aerospace, energy, and mechanical engineering. Results included increased production rates, reduced costs, and lower energy and material usage.

Inshape demonstrator in an early stage of development (material: IN718)

Although laser-based powder bed fusion of metals, an additive manufacturing process, is now a key technology for the production of complex metal components, rigid laser beam profiles and inadequate process monitoring methods often cause problems in the melting process and can lead to defects and production stoppages. This causes scrap, increases energy consumption and production costs, and slows down the production process. The consortium of the EU project Inshape has taken up these challenges and developed a manufacturing approach in its research work that combines beam shaping and multispectral imaging.

Productivity increased sixfold

The Inshape project partners have succeeded in significantly increasing the productivity of the PBF-LB/M process. In various industrial applications, they achieved productivity increases of over 600 percent (6.2x), including production rates of up to 93.3 cm³/h for Inconel 718 components. The original production rate was 15 cm³/h. At the same time, the consortium managed to reduce costs by 50 percent, the needed energy by 60 percent and the waste by 70 percent thereby achieving an important project goal.

Parts of a space combustion chamber (material: CuCrNb)

The project partners demonstrated the innovation of beam shaping and multispectral imaging in five industrial applications: an impeller for aerospace (Inconel 718), an industrial gas turbine component (Inconel 718), a component of a space combustion chamber (CuCrNb), a cylinder head for a chainsaw engine (AlSi10Mg), and components of satellite antennas for space communications.

Beam Shaping and Multispectral Imaging

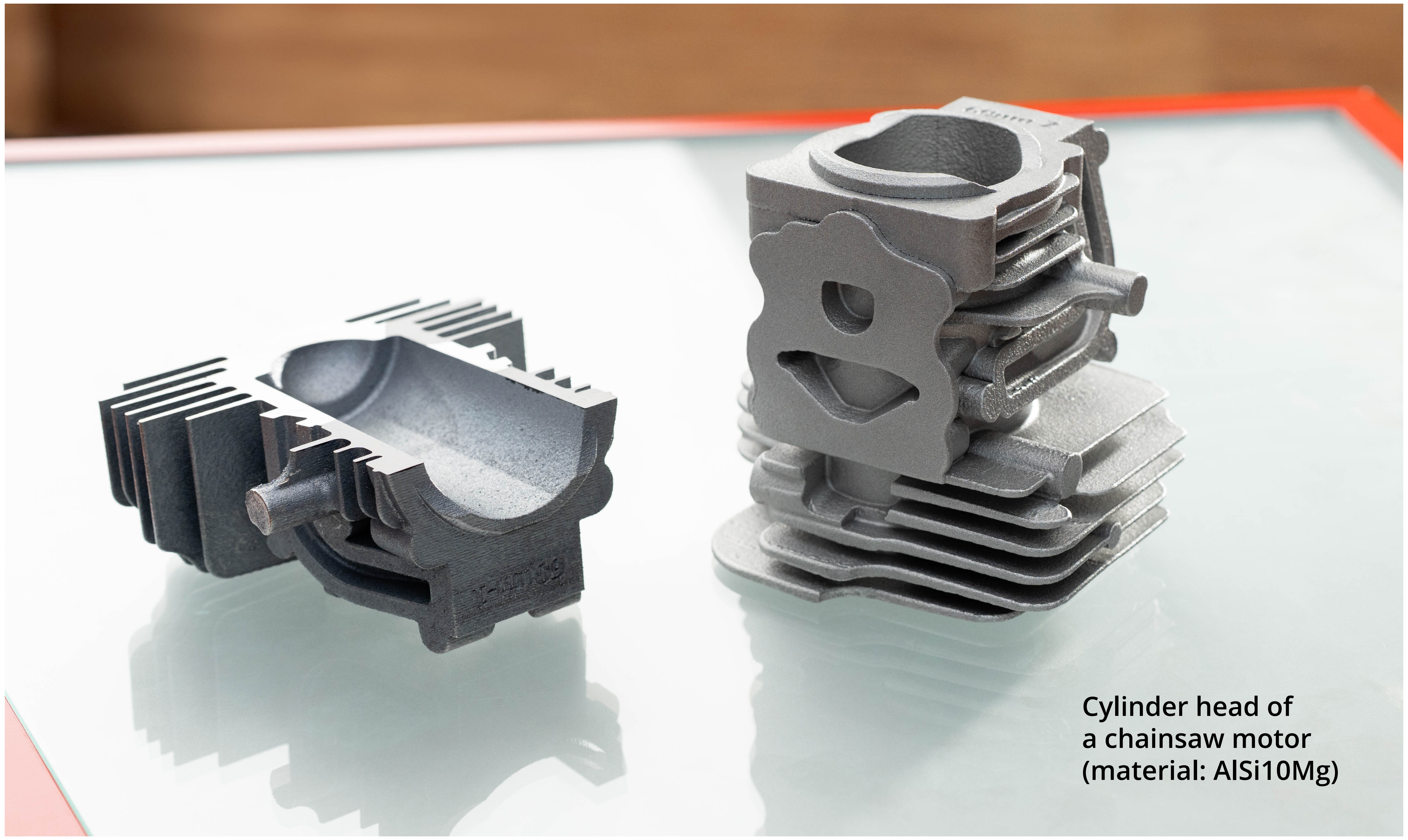
Intelligent beam shaping and multispectral imaging work closely together to improve the additive manufacturing process. The laser beam profile is adapted to the specific component, taking into account its geometry and material. This improves the quality of the component and enables faster processing by reducing defects such as spatter, and condensation, which would otherwise cause rework and/or scrap. Inshape's research has shown that a ring-shaped beam profile—in combination with optimized scanning strategies—is particularly advantageous for a wide range of applications. The laser energy is deliberately applied not by means of a Gaussian profile, but via a ring-shaped intensity distribution in order to create the melt pool. This results in a more stable melting zone and more uniform material processing.

EU project Inshape

The EU-funded Inshape project was launched in June 2022. By the end of May 2025, it had received 7.2 million Euros in funding from Horizon Europe, the EU's framework program for research and innovation. The aim of the project was to improve the efficiency, cost-effectiveness, and sustainability of laser-based powder bed fusion of metals of metals and to transform it into a commercially viable manufacturing technology. The Technical University of Munich carried out the project with ten other partners from Germany, France, Israel, Italy, the Netherlands, Sweden, Slovenia, and Spain. The project was led by Prof. Dr Katrin Wudy, Head of the Professorship of Laser-based Additive Manufacturing at the Technical University of Munich.

About the Technical University of Munich (TUM)

Technical University of Munich (TUM, Germany): As one of Europe's top technical universities, TUM hosts the InShaPe coordinator Prof. Katrin Wudy, head of the Professorship of Laser-based Additive Manufacturing at the TUM School of Engineering and Design. TUM is active across AM with diverse materials and processes, contributes leading expertise in metal AM, beam shaping, and monitoring, and supports startups and innovation transfer.



Cylinder head of a chainsaw motor (material: AlSi10Mg)

For this, the new multispectral imaging system records signals in different wavelength ranges and monitors the PBF-LB/M process. This enables thermal changes in the melt pool to be detected at an early stage. The recorded data flows directly into the process control system. Errors that previously led to production interruptions or rework can now be corrected, allowing the process to continue without significant delays.

Paving the way for industrial introduction of series production

Overall, this approach marks an important step forward on the road to industrial series production with PBF-LB/M: The interaction of intelligent beam shaping and multi spectral imaging-based process control leads to a more stable melting process, reduces sources of error, and enables targeted, resource-saving use of energy. This enables complex metal components to be produced faster, more cost-effectively, and more sustainably—while delivering higher quality and significantly increased productivity. Inshape is thus paving the way for the accelerated industrial introduction of beam shaping and multi spectral imaging-based process control and strengthening technological progress in additive manufacturing – especially for the aerospace, energy, and other industries.

„There is a great deal of interest in our work from both academia and industry. We look forward to seeing this technology incorporated into industrial systems in the near future, leading to advances in process monitoring, quality assurance, and application performance in various sectors," said Inshape coordinator Prof. Dr. Katrin Wudy from the School of Engineering and Design at the Technical University of Munich. ■

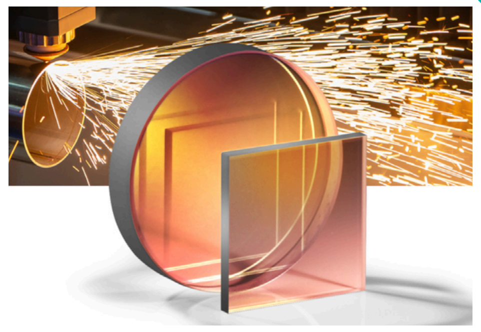
About the Bavarian Research Alliance (Bayfor)

During the application phase, the Bavarian Research Alliance supported the coordinator and the consortium in the technical and content-related design of the EU application and in clarifying financial and administrative issues. During the project period, Bayfor, as a project partner in Inshape, was responsible for financial and administrative project management as well as communication with the public and interested experts.

The Bavarian Research Alliance, which is supported by the Bavarian State Ministry of Science and the Arts, provides comprehensive advice and support to Bavarian stakeholders from science and industry (especially SMEs) on acquiring European funding for research, development, and innovation. The focus is on the EU's framework program for research and innovation, Horizon Europe. Bayfor is a partner in the Enterprise Europe Network and in the Bavarian Research and Innovation Agency.

Products

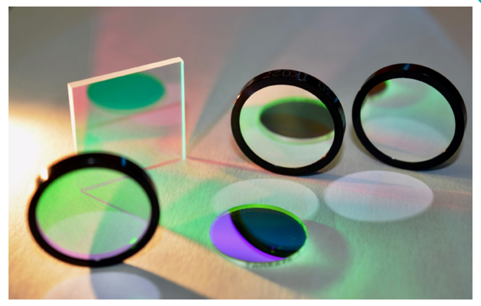
S. 27



High-Performance Beam Shaping Optics

Edmund Optics

S. 27



Next Generation Multiband Fluorescence Filters

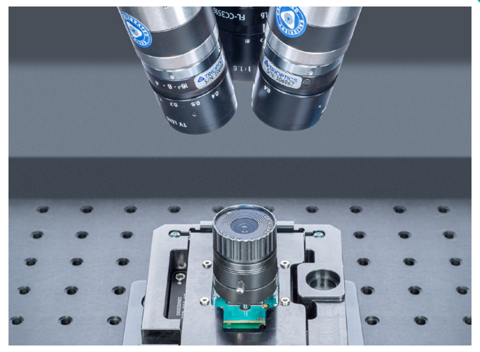
MKS

S. 28

Range of high-tech solutions

Physik Instrumente (PI)

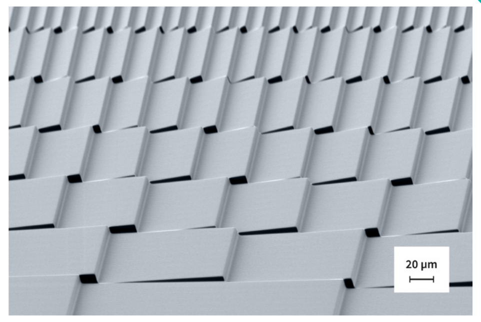
S. 28



Solution for Camera Focus Measurement

Trioptics

S. 29



Lithography System upgraded

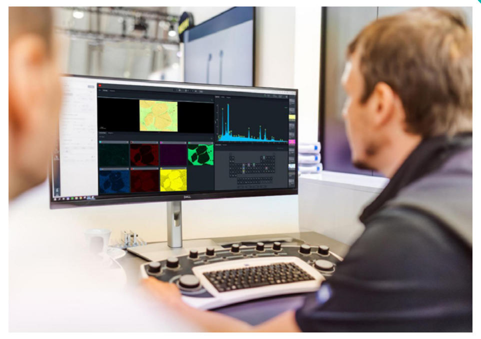
Heidelberg Instruments

S. 29

Position-Sensitive IR Beam Detection in Four Quadrants

Laser Components

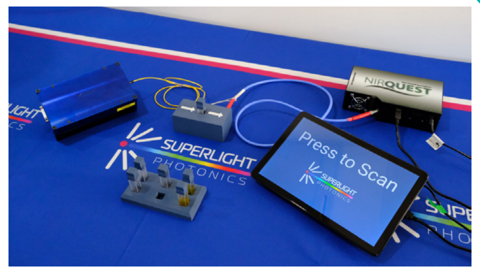
S. 30



Software Suite for SEMs

Zeiss

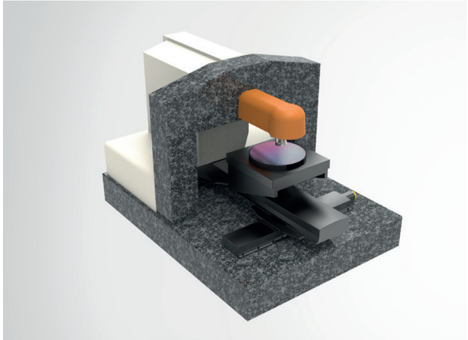
S. 30



Advanced Light Source for Spectroscopy

Superlight Photonics

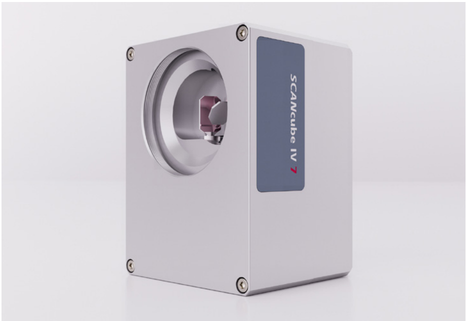
S. 31



Positioning System for Raman Spectroscopy up to 12”

Steinmeyer Mechatronik

S. 31

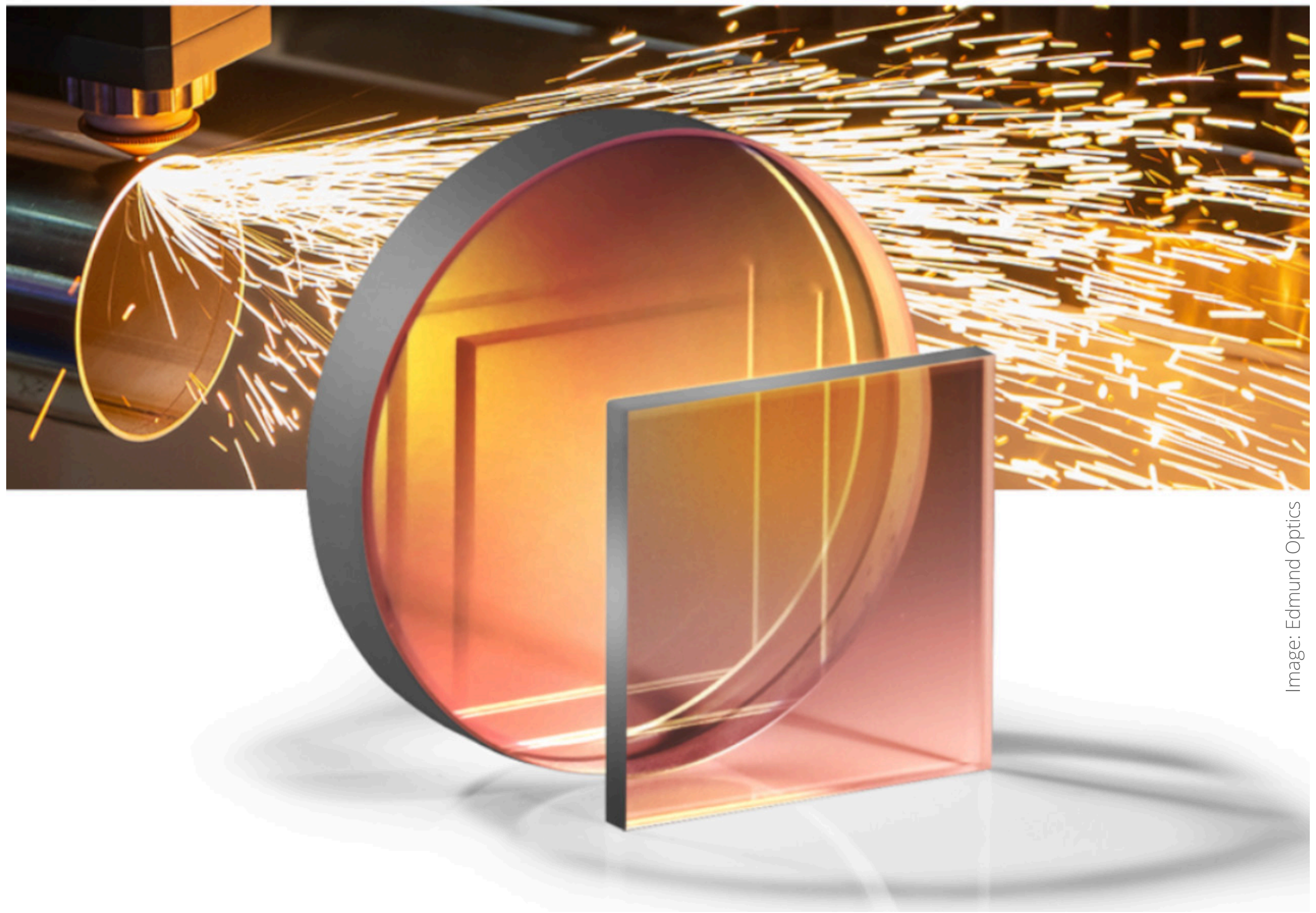


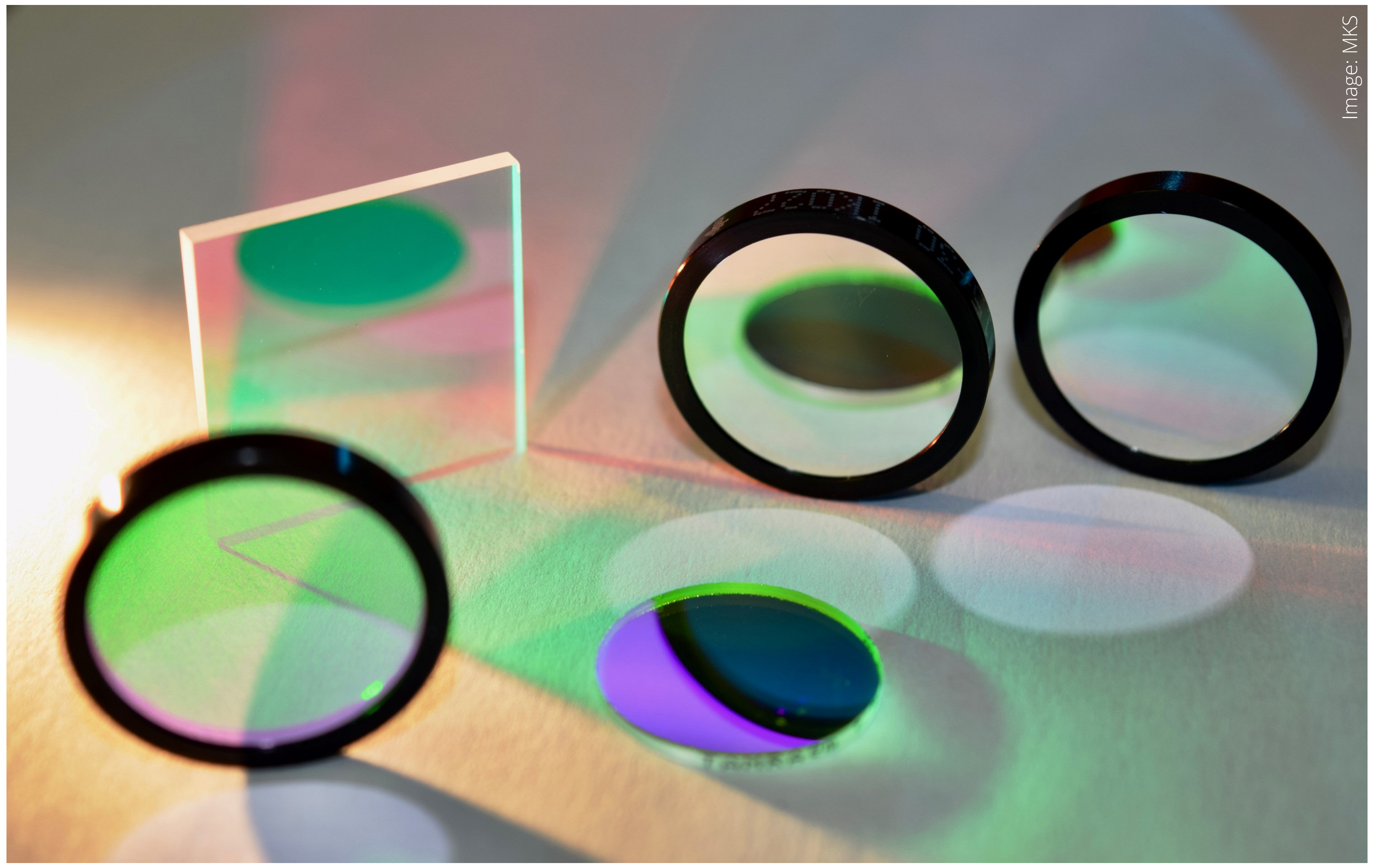
Laser-Scan Systems Boost Productivity

Scanlab

High-Performance Beam Shaping Optics

Edmund Optics now offers off-the-shelf HOLO/OR Diffractive Diffusers and Beamsplitters, providing premium beam shaping solutions for high-power laser systems without custom order delays. The HOLO/OR Diffractive Diffusers convert collimated beams into square or circular profiles with exceptional homogeneity and minimal zero-order output, essential for applications like laser welding, ablation, and medical treatment. Unlike polymer-based or micro-lens diffusers, these are designed for high damage thresholds and consistent intensity distribution, enhancing process quality at higher laser powers. The HOLO/OR Diffractive Beamsplitters create uniform spot arrays, ideal for laser scribing, 3D sensing, and fractional treatments. Optimized for Nd:YAG and CO_2 wavelengths (355 nm, 532 nm, 1064 nm, and 10.6 µm), they enable faster throughput, improved repeatability, and reliable operation under high energy loads. Both product lines are passively designed, alignment-free, and available off-the-shelf through Edmund Optics with transparent pricing, addressing a need for fast-access, high-performance diffractive optics in demanding laser applications.





Next Generation Multiband Fluorescence Filters

MKS introduces the Newport Odiate fluorescence filter sets at Laser World of Photonics 2025, featuring single-band and multiband filters for fluorescence imaging. The dual-band filters combine DAPI/TRITC and FITC/Cy5 without affecting signal strength, allowing simultaneous detection of multiple fluorescence tags in a sample. Pairing alternating fluorophores results in high-throughput passbands for enhanced signal strength. Combining DAPI/TRITC and FITC/Cy5 sets achieves 4-channel multiplex imaging, comparable to single-band filter sets. These new filters accelerate fluorescence microscopy and flow cytometry imaging and can be used in PCR-based diagnostic instruments. Dr. Glenn Mitchell highlights their ability to deliver cost-effective, high-contrast images. Based on fluorescence principles, these filters offer high transmission, steep spectral edges, and optical density, ensuring superior image quality and low noise. Manufactured using a proprietary thin-film process, they are compatible with major filter cubes and tailored to popular fluorophores. MKS collaborates with customers for custom optical systems, accommodating fluorophore trends and innovations.

Range of high-tech solutions

Physik Instrumente (PI) showcased a range of high-tech solutions at Laser World of Photonics 2025. Highlights included an industry hexapod for 24/7 precision positioning and a miniature linear stage for nanometer-accurate movements. The PILine cross table for microscopy offered exceptional stability with minimal drift. Future-oriented solutions like the MagLev platform with picometer resolution and a compact lever hexapod for fast, dynamic movements demonstrated PI's ability to push technical boundaries while reducing production costs. The new industry hexapod H-815, designed for robust 24/7 use, integrates seamlessly into photonics and automation applications. The B-421 miniature linear stage provides precise movements, ideal for demanding applications in semiconductor technology, microscopy, and photonics. PI's FMPA solution reduces fiber alignment time by 99%, significantly cutting costs in SiPh and PIC technology. The PILine XY table U-781 offers exceptional stability and precision, perfect for super-resolution microscopy. PI's Future Zone showcased the MagLev platform and lever hexapod, ideal for cleanroom and vacuum environments.

Image: Physik Instrumente

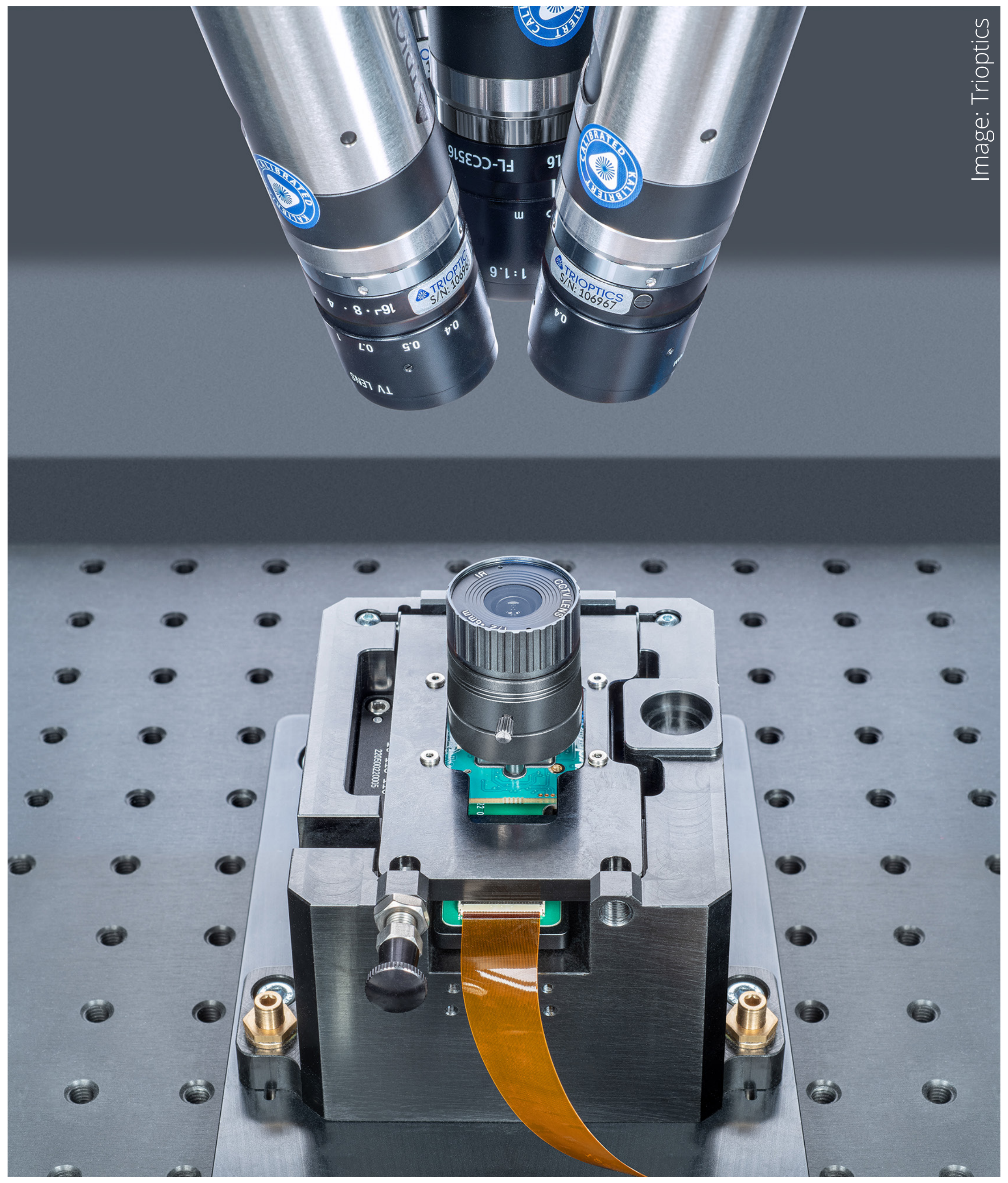


Image: Trioptics

Solution for Camera Focus Measurement

Trioptics has introduced the CamTest Focus OEM, a camera test module that simplifies and enhances the focus measurement of electronic camera modules. Designed for easy integration into production lines, this user-friendly device is suitable for both manufacturing and research environments. It can function as a standalone unit or be incorporated into existing processes, including robotic sample handling. Dr. Dirk Seebaum, Product Manager at Trioptics, emphasizes the module's ability to meet high measurement accuracy while boosting productivity in optical sensor system production. The CamTest Focus OEM boasts rapid cycle times of two seconds, utilizing motorized collimators for precise measurements. It employs Trioptics' ProCam Focus software for real-time image quality analysis and offers adaptability to various camera systems. With increasing demands in automated recognition systems, this module addresses the evolving requirements in industries like security, surveillance, and automotive, ensuring comprehensive testing capabilities.

Lithography System upgraded

Heidelberg Instruments has enhanced its DWL 66+ direct-write lithography system, achieving a market-leading 200 nm resolution and 65,536 grayscale levels. These upgrades position the system as a premier research tool for microfabrication, allowing researchers to explore new dimensions of innovation. The High-Resolution Mode, Write Mode XR, combines resolution, quality, and speed, enabling the creation of complex micro- and nanostructures for applications in quantum devices, optics, and photonics, reducing reliance on time-consuming e-beam lithography. The system's grayscale lithography capabilities allow for the creation of intricate 2.5D microstructures with exceptional surface smoothness in photoresists up to 150 µm thick. With 30 years of continuous development and over 400 units installed, the DWL 66+ is a proven and flexible platform for R&D and rapid prototyping. These enhancements offer users a powerful combination of extreme resolution and operational flexibility.

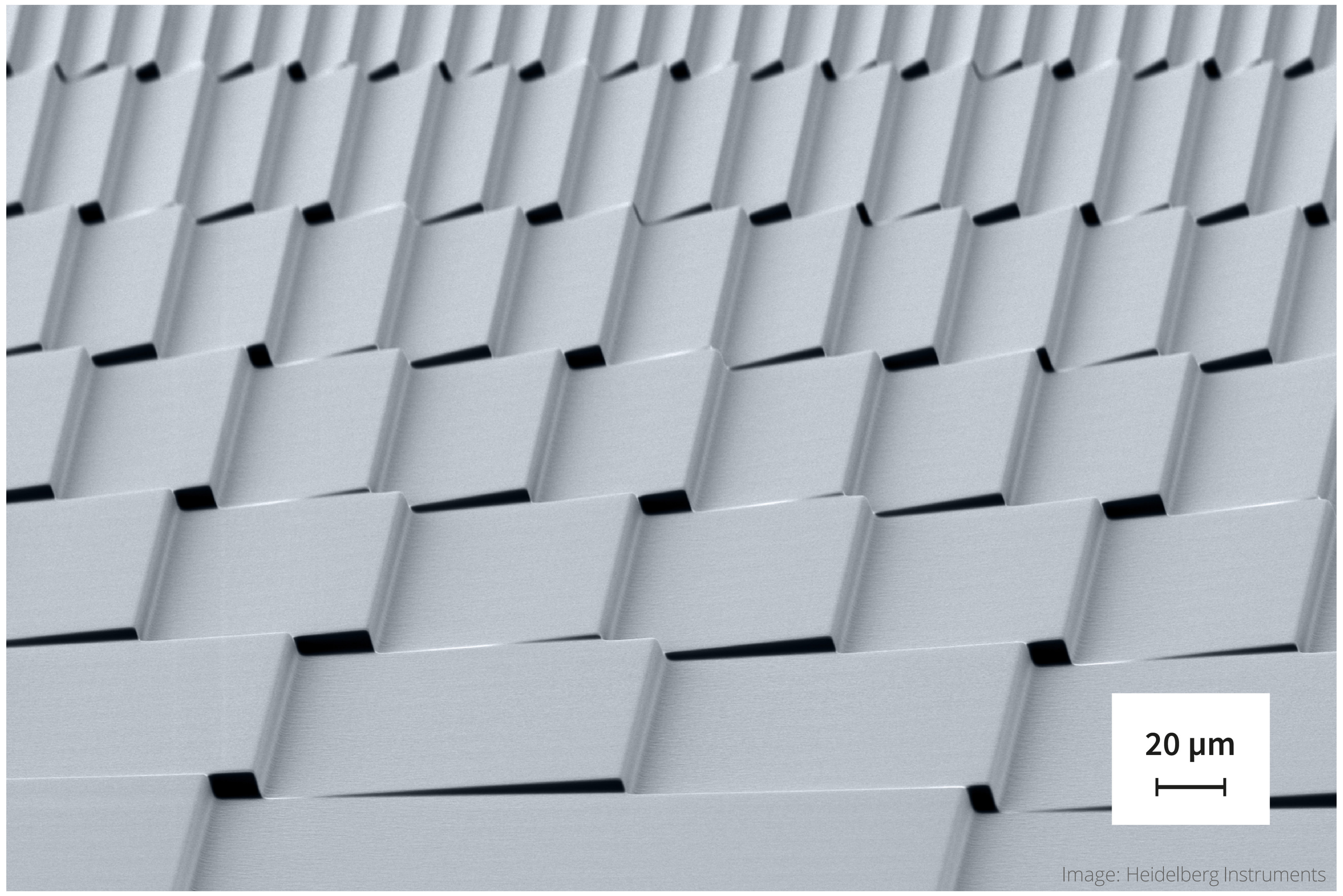


Image: Heidelberg Instruments

Image: Laser Components

Position-Sensitive IR Beam Detection in Four Quadrants

Laser Components introduces the third edition of the PR series with the PR No3, an IR-THz receiver that enables real-time beam displacement measurements. This uncooled pyroelectric 4-quadrant receiver features an active area with a 2 mm diameter, divided into four sectors with side lengths of 980 µm, separated by narrow inactive strips. The PR No3 delivers consistent performance across a wide spectrum from ultraviolet (UV) to far infrared (FIR). The quadrants are precisely aligned relative to the housing and equipped with four separate analog outputs with excellent channel-to-channel uniformity. It can determine beam position at 50 kHz -3 dB (typical for the IR version), making it ideal for long beam path experiments, fast pulse-to-pulse fluctuation calculations, and hysteresis correction in scanning systems. Available in two configurations, the PR No3 IR supports wavelengths up to 30 µm, while the PR No3 THz is optimized for frequencies up to 40 GHz, offering ten times higher sensitivity at a bandwidth of 8 kHz. Both versions provide plug-and-play solutions for challenging IR systems, with sensitivity and noise calibrated across frequencies.

Software Suite for SEMs

Zeiss has launched its ZEN core software suite for all its scanning electron microscopes (SEMs), including focused ion beam SEMs (FIB-SEMs). ZEN, which stands for "Zeiss Efficient Navigation," enhances the efficiency of capturing and analyzing data, benefiting users in material research, electronics, and life sciences. The software streamlines image acquisition, analysis, and management, optimizing both novice and expert workflows with AI-driven enhancements. It facilitates seamless integration of Zeiss light and electron microscopes, enabling unified operation and multimodal experiments. The central navigation workspace simplifies SEM processes, allowing users to manage samples and images effectively. Customizable workbenches support task-specific workflows, enhancing data security and efficiency. ZEN core also promotes connected microscopy, enabling correlative and multimodal analyses. Tim Schubert from Aalen University praises its intuitive design and comprehensive integration of Zeiss imaging systems, marking a significant advancement in microscopy efficiency and flexibility.

Advanced Light Source for Spectroscopy

Superlight Photonics has launched the SLP-1050, a light source designed for next-generation spectroscopy applications. This compact and high-performance device combines high brightness with exceptional spectral stability, enabling high sensitivity and short integration times. Traditional spectroscopy systems often rely on halogen light sources that poorly couple with optical fibers, leading to power loss and requiring long integration times, unsuitable for fast-paced industrial or medical applications. While wideband lasers offer better fiber coupling and brightness, they often suffer from spectral instability, necessitating pulse averaging. Superlight Photonics' new solution addresses these issues, offering unprecedented spectral stability and brightness compared to traditional sources. Its high sensitivity and short integration times make it ideal for rapid inline spectroscopy analysis, transforming production environment capabilities with its miniaturized and portable design.

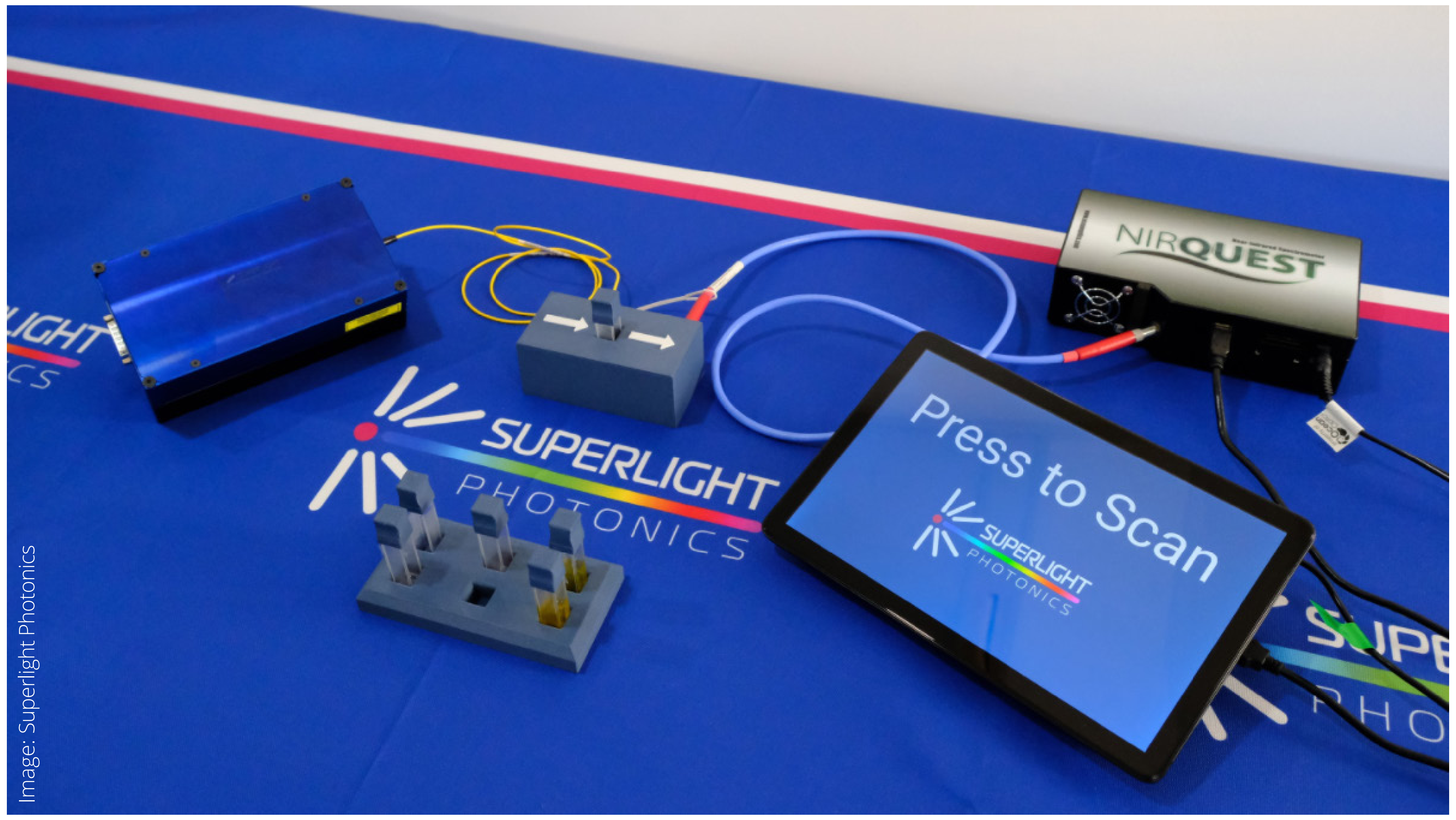


Image: Superlight Photonics

Positioning System for Raman Spectroscopy up to 12”

Steinmeyer Mechatronik’s 2X-Y-Ys(Z) positioning system is designed for precise positioning of large and heavy samples in Raman spectroscopy. The cleanroom-compatible gantry-style microscopy table offers additional loading stroke, a large scanning area, high load capacity, and minimal space requirement. Customizations are possible. Raman spectroscopy is a non-destructive method for material analysis in industry and research, relying on the positioning system’s performance. Steinmeyer Mechatronik, part of the Steinmeyer Group, specializes in high-precision positioning solutions, tailored to meet specific application demands. The system supports high-resolution XYZ movements for samples up to 400 x 400 mm and weights up to 40 kg, ideal for Raman measurement of heavy wafer chucks and large wafers up to 12”. Developed for continuous use in semiconductor production, it integrates seamlessly into existing setups, featuring ball screws and stepper motors for drive, and offers a wide range of customization options for specific needs.

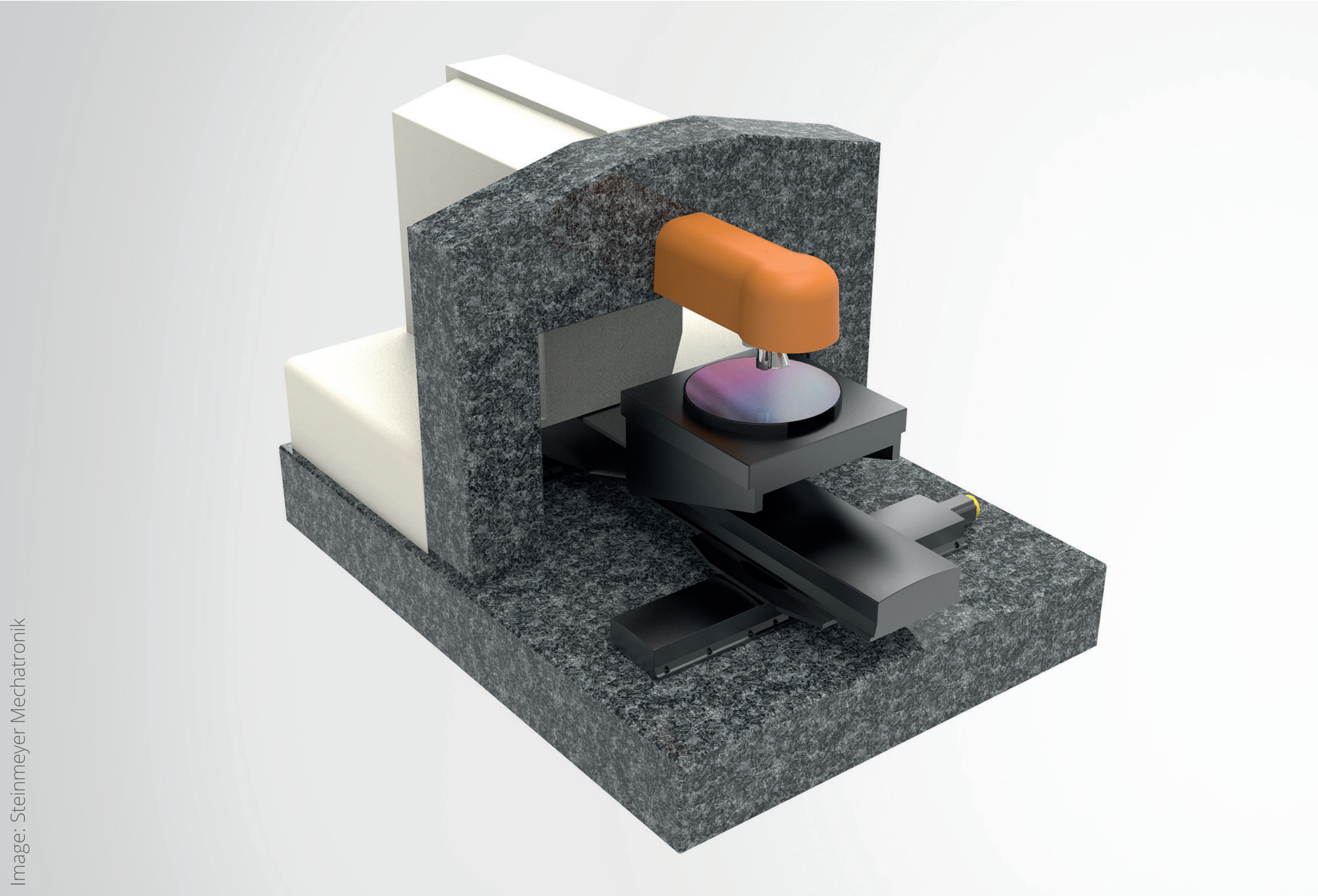


Image: Steinmeyer Mechatronik

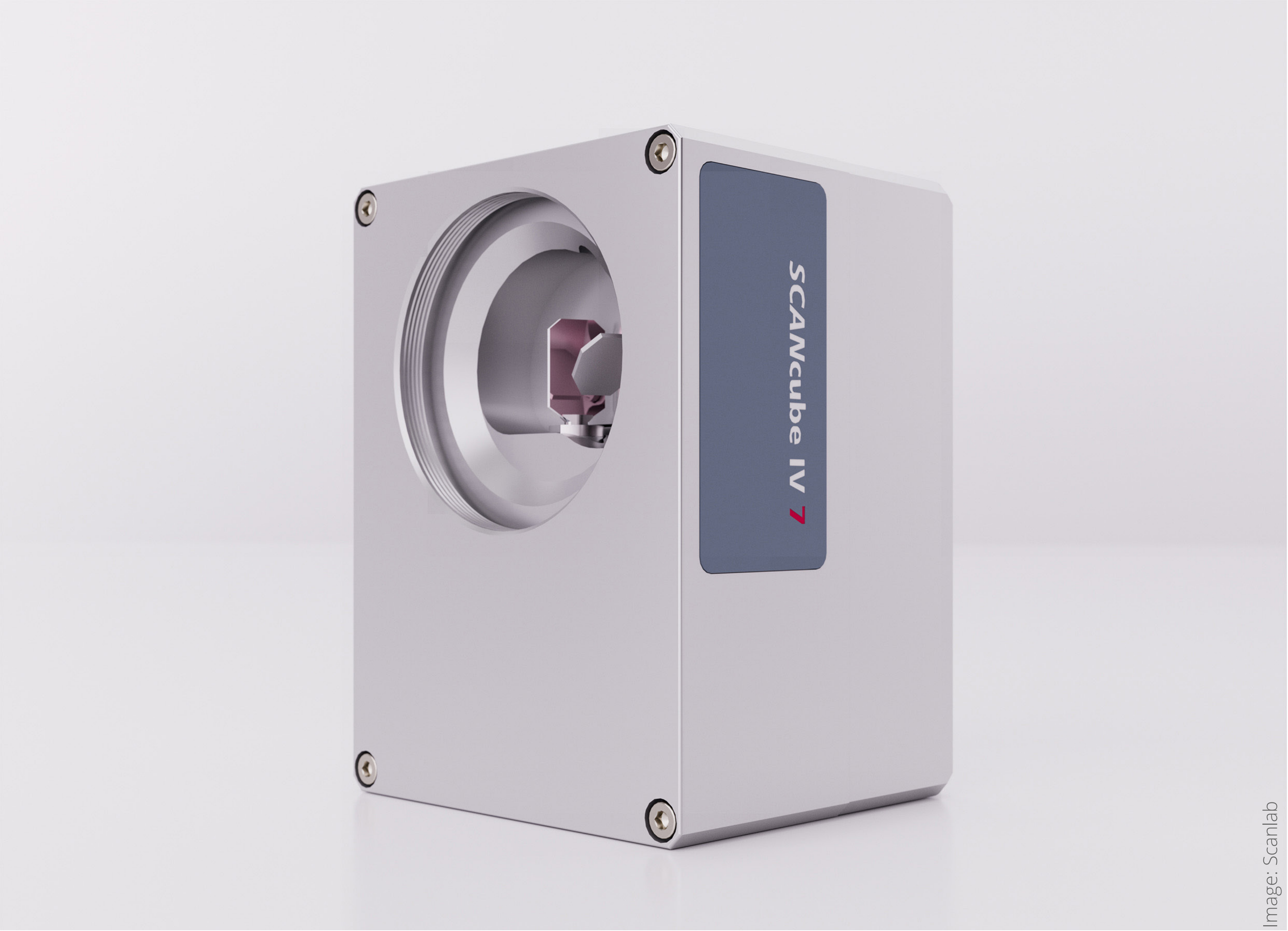


Image: Scanlab

Laser-Scan Systems Boost Productivity

Scanlab unveiled several product innovations at the Laser World of Photonics in Munich. Visitors experienced the Scancube IV 7 in action, with six synchronized scan heads showcasing impressive speed. The Intelliscan IV product family was expanded with the Intelliscan IV 10 scanner, featuring a 10-millimeter aperture ideal for micro-material processing. It achieves writing speeds of 1,310 cps and a maximum speed of 57.6 meters per second with Scanahead control. The Intelliscan SE IV 30, equipped with digital encoders, offers enhanced long-term stability and precision, perfect for additive manufacturing. Compact and robust, these scan heads boast IP66 protection, integrated cooling, and are ready for Scanmotioncontrol. Scancube IV 7 demonstrated synchronized scanning with RTC6 boards, achieving up to 1,840 cps for laser marking. Scanlabs interactive ‘Innovations Board’ introduced new solutions in beam shaping, modular welding scanners, and software frameworks for additive manufacturing, inviting visitors to discuss their needs with product experts.

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