Press Release

AKL'26 – International Laser Technology Congress in Aachen

Ubiquitous Lasers

For three decades now, the AKL – International Laser Technology Congress has been established as a key platform for exchange within the laser community. From April 22–24, 544 experts from 21 countries, around 90 speakers, and 57 exhibiting companies and institutions flocked to AKL'26 in Aachen. There, during the Gerd Herziger Session, a panel of high-caliber experts reviewed the developments of the past 30 years and looked ahead to the future of increasingly ubiquitous laser technology.

Lasers are ubiquitous. They have become indispensable across all industries: from data centers and telecommunications, clinical diagnostics and therapy, the increasing production of electric vehicles, smartphone factories, semiconductor manufacturing, to the marking, labeling, structuring, and functionalization of surfaces, and material processing—from cutting and drilling to welding and soldering. New growth markets with, in some cases, enormous economic potential are emerging thanks to fusion, quantum technologies, and the use of lasers in agriculture, mining, offshore and underwater applications, or in the field of humanoid robotics and for the lightning-fast defense against entire swarms of drones.

Added to this is the rapid expansion of data centers, nearly two-thirds of which is driven by the exponential rise in the use of artificial intelligence (AI). In his presentation during the Gerd Herziger Session, Dr. Hagen Zimer, CEO of Laser Technology and member of the Executive Board of TRUMPF SE + Co. KG, outlined why this expansion is giving the industry a boost: "A wide variety of laser processes are required for AI chips, cooling, connections such as CPU parallel connections, hole drilling, and the cutting of the sheet metal from which such data centers are largely constructed." The growth potential in this field extends far beyond EUV technology for structuring wafers with feature sizes soon to reach 2 nanometers (nm)—technology that TRUMPF also supplies to the Dutch system integrator ASML for the next generation of AI chips—and whose development required tremendous perseverance. Indeed, TRUMPF, ZEISS, the Fraunhofer IOF in Jena, ASML and other partners spent 15 years researching and developing this key technology for microchip manufacturing.

Finding an ant in Manhattan

Extreme ultraviolet (EUV) radiation generated by CO_2 lasers is indispensable for producing nanometer-scale chip structures. According to Dr. Christopher Dorman OBE, Executive Vice President Industrial at the Coherent Group in Europe, short-wavelength lasers are also needed for quality control in the microelectronics and semiconductor industries. "Twenty years ago, wafers were inspected using wavelengths in the green spectral range," he reported. Instead of these wavelengths around 500 nm, 266 nm is used today, and even shorter wavelengths will be employed in the future for even faster and more precise inspection. This is urgently needed, because in-process defect inspection for today's nm-structured wafers with a 300 mm diameter is akin to scanning Manhattan in twenty seconds and not only detecting a single ant, but also identifying its individual species.

Dorman provided further examples illustrating the progress of the past 30 years. For instance, the switch from CO_2 to fiber lasers has increased laser cutting speeds from 15 cm to 9 m per minute. The laser has gained market share and is now an indispensable driver of progress thanks to a three-step progression of increasing power, shorter pulse durations, and more flexible wavelengths. To meet growth and rising technological demands, industry, with the support of research, is driving increasingly complex solutions. This is also the case in flow cytometry for counting and analyzing cells. Using two lasers, the process can handle 10,000 cells per second. "With nine different wavelengths, up to 150,000 cells per second can be counted and analyzed," explained Dorman. For the diagnosis of diseases such as leukemia, it is sufficient to identify individual cells.

Photonics remains an industry with momentum

Laser technology is also a key enabler of the rapidly expanding production of OLED screens, which, according to market forecasts, is expected to double in total area from 10 million to 20 million square meters over the next few years. According to Dorman, excimer lasers are the technology of choice here. "We still need different approaches across the wavelength spectrum, from UV with excimer lasers to the far-infrared range with CO_2 lasers, as well as a wide variety of technologies in between," he emphasized. Despite the current macroeconomic headwinds, he sees the ever-broader and more complex use of lasers as a solid foundation for further growth, especially since photonics develops a new technology with huge market potential every 10 years. Currently, with fusion and quantum computing, there are even two. "The laser will become ubiquitous," explained Dorman—and he concurred with the other experts on stage.

Among them was Trevor Ness, Senior Vice President and Chief Revenue Officer at IPG Photonics. Ness painted a picture of the future in which lasers will be integrated across the board into infrastructures, systems, and processes and will operate so reliably that they will hardly be talked about anymore. "I believe that the most successful laser applications will be the ones we don't even notice. They will be ubiquitous in everyday life," he said. Just as technological advances in recent decades have enabled an enormous increase in the quality and scalability of lasers, they will continue to open up new fields in the future through ever-higher power, energy, flexibility, and reliability. The increasingly widespread industrial use of fiber lasers is closely linked to their increased performance and reliability, which can be attributed to the rapid development of semiconductor lasers.

Moore's Law also applies to diode lasers

"Advances in diode lasers are keeping pace with Moore's Law," Ness reported. The result: strong growth in the laser industry and enormous productivity gains for users, who today employ fiber lasers for marking, cutting, and welding, as well as increasingly for cleaning, drying, and heat treatment. Ever-improving process understanding, digital solutions for beam shaping and control, and inline process monitoring are continuously expanding the range of applications. "Today, we routinely manufacture lasers that have a power output of over 60 kW, complete with associated optics. They open up new horizons in laser cutting, where they are replacing established technologies such as plasma cutting," he explained. Cutting heads equipped with optimized functions, combined with new sensor technology, would make possible what was long considered impossible: fiber lasers routinely cut highly reflective metals such as aluminum, copper, or brass. Lasers, including in handheld welding devices, are being used so widely because high power levels are becoming easily available and costs per watt are dropping sharply. New applications such as spectrometric breath analysis in medical diagnostics, precision machining with spot sizes less than 10 µm, quantum technology, or laser applications in defense represent new opportunities for the laser industry, opportunities that, however, come with ethical responsibilities requiring a carefully considered use of directed energy.

Think in terms of applications rather than technologies—and leverage AI

According to Ness, laser technology itself is taking a back seat. "We need to focus on its intuitive application and on precisely tailored, highly integrated solutions for our customers," Ness cautioned. He sees a new era dawning of ubiquitous, intelligently embedded laser functions that will revolutionize industry and the very nature of work. "The laser of the future is intelligent, AI-capable, mobile on robot platforms, scalable, cost-effective, and available in large quantities," he predicted. As an example, he cited integration into humanoid robots. These could work in dangerous, confined, and previously inaccessible environments. The laser will become the robot's tool, enabling it to work where humans currently risk their lives: in nuclear facilities, in the deep sea, in space, or even in toxic environments. Together, humanoid robots and lasers promise the automation of skilled labor. Furthermore, exoskeletons and robots would transform the lives of people with disabilities. All of this is transformative and potentially disruptive. For Ness, this raises new questions: "What happens when lasers are no longer the limiting factor? When power is available, cost is no longer a barrier, and integration is child's play," he asked.

These questions also concern Hagen Zimer. The actual differentiation of the laser system no longer lies in the laser itself, but in how applications are implemented in each case. The foundation consists of lasers with the right components for beam guidance, increasingly sophisticated sensor technology, digitalization, AI, and stored databases. "We must use AI to control laser processes for our customers. We are expanding our hardware platform accordingly," he reported. After all, the goal is to quickly tap into new business areas and develop innovations much faster than before to survive in the face of increasing international competition. In his presentation, Zimer highlighted the strategically astute rise of the Chinese laser industry. These companies are gaining ever-higher market shares both in their home market and worldwide. Western companies must work faster, be more networked, and have a clearer focus on customer value to defend their strong position. "For customers, it is not the laser itself that matters, but its function, its price, its reliability, and seamless service," he said.

Growth areas: humanoid robots, data centers, defense

Zimer reported that major automakers are currently converting entire factories into robotic production facilities to manufacture humanoid robots. There are many laser applications here: whether in the production of structural components, batteries, drives, sensors, actuators, or even microchips. In addition to the expansion of data centers, the expert sees these applications as fields that promise growth. And after many internal discussions, TRUMPF decided to become active in the field of drone defense. In addition to the ethical issues, the technical challenges are also complex. To reliably hit a drone at a distance of 1 km within milliseconds despite atmospheric turbulence requires the highest precision. Together with Rhode & Schwarz, TRUMPF is focusing on mobile, ground-based drone defense. For this purpose, 30- to 50-kW lasers are mounted on vehicles.

All the experts on the panel agreed that defense will become an important market with significant growth potential for photonics. The same applies to fusion power plants—though Zimer sounded significantly more skeptical here than his colleagues. "If we want to pursue this business in Germany and Europe, we need to coordinate better," he cautioned. The 15-year development phase of EUV technology—often painful for all involved—has shown that a proper push-pull relationship is needed to bring such projects to a successful conclusion. "We were only able to get through this period thanks to the very strong bond between the partners and the clear demand," Zimer reported. If no one in the fusion sector steps forward to build a fusion power plant, issue concrete orders for it, and establish a supply chain for lasers, optics, glass, and diodes, then it will be very difficult to realize this technology. For example, at least 100 to 200 million euros are needed to develop the 2-kJ lasers required for fusion power plants. Such investments require a solid business model.

Supply chains and innovation ecosystems for fusion

Damian Buet, CEO of the Amplitude Laser Group, is far more optimistic about this issue. Nearly a quarter of the company's 400 employees work in research and development—developing not only femtosecond lasers for medical and industrial applications but also high-energy large-scale lasers with peak powers of up to 3 petawatts. However, these are not designed with efficiency or high repetition rates in mind. So far, high-energy lasers have relied on amplification using flash lamps. "Cutting-edge research is only just beginning to address the issue of efficiency and continuous 10- to 20-Hz operation for power plants," he said. But he is confident that the technological challenges can be overcome if there is sufficient market demand. Looking at other markets such as batteries or photovoltaics, where module costs have fallen by 99.6 percent since 1976, shows that this often happens faster than expected. "I am 100 percent convinced that fusion technology will prevail," he said, adding, "Europe has an incredible number of complementary strengths. We can win this race. Let's get to work."

Dorman agreed. He sees great opportunities for the laser industry in both magnetic fusion (MFE) and inertial fusion (IFE). "The high-temperature superconducting magnetic tapes for MFE reactors are manufactured using lasers, and IFE power plants will certainly require a huge number of lasers," he said. And the acting director of Fraunhofer ILT, Dr. Jochen Stollenwerk, also outlined a scenario in his opening lecture, "Scaling Photons, Scaling Impact: High average power, high pulse energy, and intelligent control." He discussed how research on CW and ultrashort pulse (USP) lasers with increasing average powers and beam intensities, as well as on digital, increasingly AI-supported solutions for ever more precise control and regulation of laser processes, is paving the way for commercial energy production via fusion. "Future fusion drives must deliver pulses in the multi-megajoule range at high repetition rates, with an efficiency in the range of 10 to 20 percent and a lifespan of many billions of shots. This is an enormous challenge that requires innovations in gain media, cooling, optics, and system architecture," he explained. Fraunhofer ILT is contributing its expertise in the areas of high-average-power lasers, scalable optics manufacturing, and system modeling to work with partners to develop concepts that can be scaled up to commercial fusion power plants.

Driving solutions forward quickly and in parallel

According to Stollenwerk, it will be crucial to rapidly increase the maturity of all key technologies in parallel. This is because in laser-driven fusion power plants, a wide variety of subsystems must interact seamlessly: target design and fabrication, high-power target injection, laser drivers with several hundred beams, optics, the tritium fuel cycle, blanket and chamber systems, as well as the entire plant engineering and operation. There are promising approaches for each of these areas, ranging from advanced target fabrication and the generation of high-energy pulses to radiation-resistant materials and modular plant concepts. "The key lies in continuing to develop these approaches in a coordinated manner, guided by our comprehensive physical and engineering models, while capturing the complex interactions within the facility," he emphasized. AI and digital photonics could provide very important support along the way.

During his tenure as director of the ILT, Prof. Constantin Häfner played a decisive role in ensuring that not only the Aachen-based institute, but also the German federal government set the course toward fusion at an early stage. Today, he is responsible for research and technology transfer on the Executive Board of the Fraunhofer Society. At AKL'26, he emphasized the great importance of this field of technology for photonics and outlined the pace at which the German government has made fusion a central research topic. Just two weeks before the congress, the Federal Ministry of Research, Technology, and Space (BMFTR) announced that the research budget would be increased to 3 billion euros before the end of this legislative term. Extrapolated over the next eight to ten years, a budget of 8 billion euros is conceivable. "With this massive push, Germany is taking the lead in underpinning the vision of fusion with a concrete mission," Häfner explained in Aachen.

Fusion research based on three pillars with hubs at former nuclear power plant sites

According to Häfner, research funding will flow into three pillars of knowledge. In magnetic fusion, there is a clear decision in favor of a scaled stellarator—and thus against the tokamak design. In laser fusion, Germany will build on its leading role in optics and photonics. And the third pillar concerns materials, including the challenge of breeding tritium from lithium in power plants. The timeline is tight. Interested parties have four weeks to apply for the tenders. In this case, the federal government is setting the pace demanded by industry, Häfner explained, and sent his thanks to Berlin.

"We are now working on establishing consortia to operate the fusion hubs in Germany. They will be responsible for translating a fusion roadmap into concrete, detailed roadmaps to drive the industrialization of all necessary technological components with the goal of a fusion power plant in the 2040s," Häfner explained. The fusion hubs are intended to bring together supply chains from industry and research—ranging from fusion startups and technology integrators to large-scale industry, energy suppliers, and VC firms, as well as international partners. They are seedbeds that are now expected to give rise to important photonic innovation ecosystems. The goal is to create markets, steer the mission, and establish infrastructural anchors at locations that already have power grids, cooling water, and experts capable of handling radiation.

The key to new markets for photonics

The focus is on building supply chains. “This is the key to reducing costs. We need to scale up, commercialize, and, along the way, create demand for key components so that the markets will finance their further development,” Häfner emphasized. Business markets are needed for new lasers, materials, optics, and other components to quickly drive down costs through economies of scale. If this succeeds, the laser will become a commodity for the rest of the world. “It will become ubiquitous in production. In this scenario, fusion serves as a vehicle to gain access to new markets, which we will lead if we achieve the technology and cost targets we have set ourselves,” he explained. That is what makes the technology so interesting for Germany.

He also sees potential spillover markets in directed laser energy for drone defense, in the use of high-energy lasers as drivers for secondary sources to generate EUV, X-ray, or neutron radiation—or even in the proverbial laser toaster. After all, within the target range for fusion, laser diodes could become so inexpensive that they could replace the heating elements in toasters. “We can achieve a great deal. Fusion is a field of innovation where photonics can tap into growth potential in markets that it creates out of thin air,” he argued. This requires courage, speed, and a spirit of cooperation.

Fraunhofer Fusion Industry Day 2.0 in Aachen

The build-up of viable **process and supply chains for fusion power plants** is underway. The Fraunhofer Society’s **Fusion Industry Day 2.0** will bring together stakeholders from industry, research and science, politics, consulting, as well as the energy sector and the venture capital industry for professional exchange and networking in Aachen on **October 15–16, 2026.**

Strong **innovation ecosystems** can turn the vision of fusion as a round-the-clock, climate-neutral, and safe energy source into a mission with a very concrete division of tasks. Speed is of the essence to reach the top position in the global race toward fusion.

Image 1:
The second day of AKL'26 began with the Gerd Herziger session. Leading representatives from industry and academia gathered to discuss the future technological direction of high-power and high-energy lasers.
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Image 2:
Dr. Jochen Stollenwerk, acting and deputy director of Fraunhofer ILT, opened the Gerd Herziger Session of the AKL'26 – International Laser Technology Congress on April 23, 2026, in Aachen.
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Image 3:
Damien Buet, CEO of the Amplitude Laser Group, spoke about the challenges of high-energy lasers and their potential for fusion.
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Image 4:
In his presentation, Trevor D. Ness, Senior Vice President and Chief Revenue Officer of IPG Photonics Corporation, envisioned a future in which lasers are ubiquitous.
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Image 5:
Dr. Christopher Dorman OBE, Executive Vice President of Industrial Coherent Europe, sees great growth potential for photonics because lasers are solving highly complex tasks in an increasing number of application areas.
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Image 6:
In his presentation "High Power and High Energy Lasers – Quo Vadis?", Dr. Hagen Zimer, CEO of Laser Technology and a member of the Executive Board of TRUMPF SE + Co. KG, called for a faster pace of innovation.
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Image 7:
Prof. Constantin Häfner, Executive Vice President for Research and Transfer at the Fraunhofer-Gesellschaft e.V., advocated for a rapid, decisive build-up of industrial ecosystems to facilitate the transition to fusion energy.
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Image 8:
Panelists at the panel discussion “High Power and High Energy Lasers – Quo Vadis?”.
From left to right: Damien Buet, Christopher Dorman, Trevor D. Ness, Constantin Häfner, Hagen Zimer, Jochen Stollenwerk.
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Image 9:
During the Gerd Herziger session at AKL'26, (from left to right) Jochen Stollenwerk, Christopher Dorman, Constantin Häfner, Hagen Zimer, Damien Buet, and Trevor D. Ness discussed the potential of high-power and high-energy lasers.
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The Fraunhofer-Gesellschaft, headquartered in Germany, is a leading organization for applied research. It plays a pivotal role in innovation by focusing on cutting-edge technologies and transferring research results to industry in order to strengthen Germany as a business location and benefit society. Since its founding as a nonprofit in 1949, Fraunhofer has held a unique position in the German research and innovation ecosystem.
With more than 30,000 employees at 74 institutes and independent research units in Germany, Fraunhofer operates with an annual budget of 3.6 billion euros. Contract research, Fraunhofer's mainstay, generates 3.2 billion of this budget.

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