THURSDAY
EDITION

SPIE. | optics.org | THURSDAY, JANUARY 30, 2025

PHOTONICS WEST SHOW DAILY

Prism Award winners
p. 28

NIL Technology's Award winning MetaEye Ultra-Compact Camera. Credit: Joey Cobbs.

Fast car: Autonomous racing is here. Credit: Joey Cobbs.

Photonics West races ahead

SPIE welcomes more than 24,000 registrants to Moscone.

At an engaging Photonics West, the exhibit floor was a veritable hive of customer conversations, product demonstrations, and face-to-face reunions. In a week that saw the Society's global membership grow to a record 25,000 Members, SPIE registered more than 24,000 for Photonics West.

"We started out very busy right away," said Optikos Director of Operations Dennis Fantone. "It's been really exciting connecting with colleagues and friends that hadn't been to the show before, or hadn't been in a few years. It's a great place to meet up with vendors as well, to get the personal touch that you just don't have over email and phone."

"We've had an extremely busy four days so far because we were also at BiOS," said Nanoscribe Sales Manager, Americas, Arwin Shrestha. "And from our current lead-gathering services, it seems it might be a record year. It's been very fruitful, and we're looking forward to the rest of the week."

"It's been a very good week so far," confirmed NKT President and CEO Basil Garabet. "I've been going to Photonics West ever since it was a tiny, tiny show in San Jose, and we like it — for us it's the big show in the US. And because we are very much into the medical and bio area, being at BiOS is good for us as well. I really like the networking aspect — I think SPIE does a great job in terms of

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Max-IR Labs sounds pitch perfect at Startup Challenge

The annual pitch competition champions photonics innovation in healthcare and deep tech.

On Tuesday, Max-IR Labs was announced as the winner of the $10,000 top prize at the 15th annual SPIE Startup Challenge. Its AquaCarbon Monitor is set to facilitate carbon credits with precise CO_2 monitoring in water systems.

Photosynthetic B.V. and its Volumetric Micro-Lithography product which enables the rapid production of complex 3D devices with submicron features, received $5,000 for second place. OptiCardio came in third, winning $2,500 with their spectroscopy-enabled device for real-time guidance to reduce the recurrence rate of ablation procedures for atrial fibrillation.

The pitch competition, held annually at Photonics West, showcases new businesses,

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Max power: Trey Daunis, VP of Technology at winner Max-IR Labs. Credit: Joey Cobbs.

DON'T MISS THESE EVENTS.

PHOTONICS WEST EXHIBITION
10 AM – 5 PM Moscone North/South Exhibition Halls

CREATING A SUSTAINABLE PHOTONICS INDUSTRY
10:15 – 11:15 AM Moscone Center, Expo Stage, Hall DE (Exhibit Level)

FROM SURGE TO STABILITY: MACHINE VISION'S NEXT CHAPTER
11:30 AM – 12:30 PM Moscone Center, Expo Stage, Hall DE (Exhibit Level)

COMMUNICATION FOR SELF-ADVOCACY AND CONFLICT RESOLUTION
12:00 – 1:00 PM Moscone West, Community Stage (Level 2)

PRISM AWARDS WINNERS CIRCLE
1:30 – 3:00 PM Moscone Center, Expo Stage, Hall DE (Exhibit Level)

For the full schedule and most up-to-date info, download the SPIE Conferences app. Some events require a paid technical registration.

SEE YOU NEXT YEAR!
PHOTONICS WEST
17 – 22 January, 2026

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Brain waves: Quantum sensing in the Hamamatsu booth. Credit: Mike Hatcher.

Hamamatsu device targets quantum brain imaging

Hamamatsu is showing off its latest foray into quantum sensing, a compact optically pumped magnetometer aimed at an emerging application in brain imaging. The idea is to reduce the size of magnetoencephalography (MEG) scanners, which sense electrical activity in the brain, from the size of a room to something that can be worn on the head.

Under development by companies including the University of Nottingham spin-out Cerca Magnetics, the quantum technique is said to track brain activity with millimeter-scale accuracy, revealing details of critical neurological features like functional connectivity.

Shown at the Hamamatsu booth 1127 this year are the firm's new hermetically sealed alkali vapor cells that form a critical element in the quantum sensors. The Japanese company has combined those cells with a VCSEL source matched to the absorption line of the ion in the vapor cell and a photodiode, to create an extremely compact unit that can then be integrated within the MEG helmet design.

"At Hamamatsu we have a long history of developing glass fabrication, alkali control, and gas charging techniques," announced the firm. "While in the past, these have found use primarily in our many photomultiplier and lamp products, we have now extended our capabilities to include alkali vapor cell related technology."

The units are said to offer some unique features for the vapor cells used in the quantum sensors — including a proprietary coating technology that stops alkali vapor sticking to the glass cell — and also prevents helium permeation. "This technique minimizes changes to the vapor cell characteristics with time, and can therefore prevent the degradation of the quantum sensor performance," explained Hamamatsu, adding that it expects to launch the product around the middle of 2025.

MIKE HATCHER

Microscopic spectral sensor identifies materials with unprecedented accuracy

Imagine smartphones that can diagnose diseases, detect counterfeit drugs, or warn of spoiled food. Spectral sensing is a powerful technique that identifies materials by analyzing how they interact with light, revealing details far beyond what the human eye can see.

Now, researchers at Aalto University, Finland (Visit Photonics Finland's cluster at booth 4119), have combined miniaturized hardware and intelligent algorithms to create a compact tool that is "capable of solving real-world problems in healthcare, food safety, and autonomous driving."

"It's similar to how artists can train their eyes to distinguish hundreds of subtle colors," said lead researcher Zhipei Sun. "Our device is trained to recognize complex light signatures that are imperceptible to the human eye, achieving a level of precision comparable to the bulky sensors typically found in laboratories."

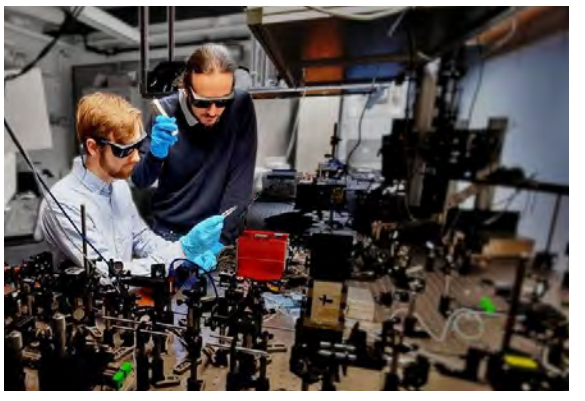
Unlike conventional spectral sensors, which typically require large optical components like prisms or gratings, the new Aalto sensor achieves spectral differentiation through its electrical responses to light, making it suitable for integration into small devices. The researchers describe in a paper published in *Science Advances* (22 January, 2025) how they have demonstrated its capability to identify materials directly from their luminescence, including organic dyes, metals, semiconductors, and dielectrics.

"Our spectral sensing approach simplifies challenges in material identification and composition analysis," said co-developer Xiaoqi Cui, who recently defended his doctoral thesis at Aalto University. The innovation combines tunable optoelectronic interfaces with advanced algorithms, unlocking new possibilities for applications in integrated photonics and beyond.

During its training, the device was exposed to a wide range of light colors, enabling it to "learn" and generate unique electrical fingerprints for each light type. These fingerprints are then decoded by an intelligent algorithm, empowering the sensor to accurately identify materials and analyze their properties based on their interaction with light.

Measuring just 5 μm x 5 μm, the device achieves an extraordinary peak wavelength identification accuracy of ~0.2 nm, enabling it to distinguish thousands of colors. With this performance, tunable design and versatility, the research team hopes that this tiny sensor will soon bring the power of advanced spectroscopy into the devices we use every day.

MATTHEW PEACH



Researchers at Aalto University hold a tiny chip, designed to accommodate hundreds of ultra-compact spectral sensors. Credit: Faisal Ahmed and Andreas Liapis/Aalto University.

Exhibition

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networking. And I'm the President of EPIC, so we work closely with SPIE; there's a lot of collaboration, and that's fantastic."

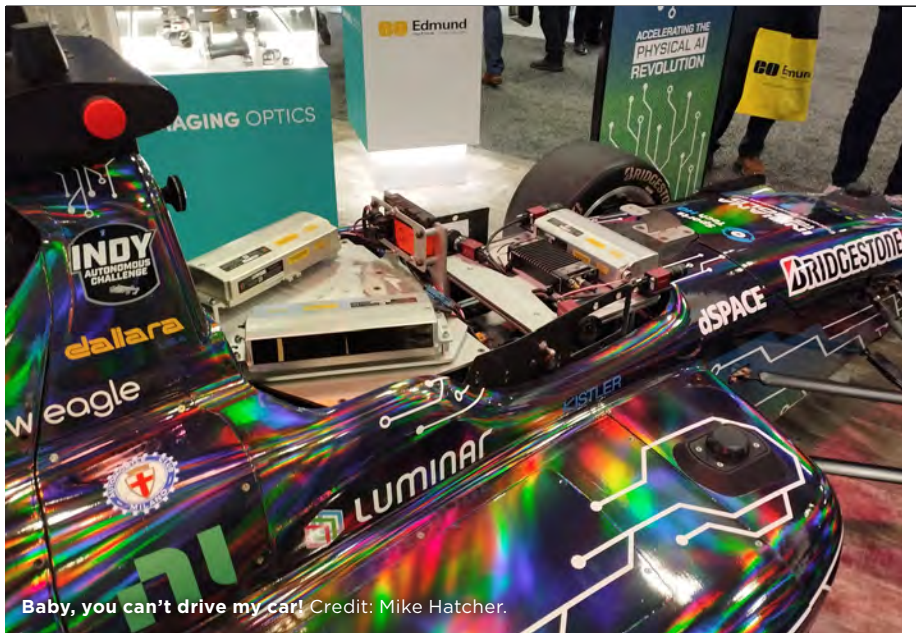
Networking aside, leave it to the exhibitors to also focus on the optics and photonics technology that draws the SPIE community to the Bay Area. "We are having an exciting week," said Nyfors CEO Erik Böttcher. "We've been doing live demonstrations of our flagship product SMARTSPLICER, and those have been very well received. It's fun to interact with customers and show them the new features in person, so that's something we're both excited about and proud of."

"It fascinates me, the diverse sets of applications that we're fielding as a company," said Chroma Technology Engineering Solutions Manager Jeff Clark. "Chroma is embracing it because we're able to respond, but there's a lot of people with a lot of diverse expectations of our products. People are coming to our booth, asking us to supply them with the products to meet the requirements for those applications. And we were at AR | VR | MR as well — lots of interest there, too."

"Photonics West 2025 has highlighted the industry's focus on precision, integration, and scalability in optical and photonic technologies," noted Stratos Kehayas, President, Photonics at G&H. "We've seen significant interest in advanced laser beam shaping, integrated photonics for compact systems, and high-reliability optical components for demanding applications in industrial, laser fusion, and life sciences. The conversations at our booth reflect a growing demand for solutions that enhance performance while addressing challenges in power efficiency, miniaturization, and system integration."

"The show's been good," adds nLight Key Account Manager Tony Enriquez. "We've had lots of meetings, mostly with people who we already know: we use this show as an opportunity to reconnect with our customers, get some face-to-face time, and also with our suppliers." He pauses, then grins. "So far, so good."

DANEET STEFFENS



Baby, you can't drive my car! Credit: Mike Hatcher.

Edmund Optics presents autonomous racecar

Parked at the Edmund Optics booth this year is one of the racecars from the Indy Autonomous Challenge. Fresh from completing the world's first multi-vehicle autonomous race — at speeds of up to 120 mph — as part of the CES 2025 event in Las Vegas, the challenge is sponsored by Edmund Optics and Luminar, among others. Edmund Optics provides the optical components for several on-board cameras from Allied Vision, while each of the 10 racers also uses four lidar systems from Luminar.

Andy Keats from the Indy Autonomous Challenge says that the vehicles have reached a top speed of 192 mph under autonomous control. The CES demonstration saw the racecars complete 20 laps of the Las Vegas Motor Speedway, each one piloted by an AI driver from university teams competing head-to-head. In a photo finish, Unimore Racing crossed the finish line less than three-tenths of a second ahead of Cavalier Autonomous Racing.

MIKE HATCHER

Waymo experiments with coherent lidar

Now a very familiar sight on the roads outside the Moscone Center, current Waymo ride-hailing autonomous vehicles use a number of conventional time-of-flight lidars to navigate around the city. But the company has been experimenting with the frequency-modulated continuous wave (FMCW), or coherent, version of the technology. Although more complex, that approach can capture velocity as well as positional data of the vehicle's surroundings via the Doppler effect, and systems can be scaled to the size of a chip.

Presenting Waymo's results on Monday, Alexander Piggott from the company said that a team there had built a coherent lidar system that matched theoretical expectations but needed some improving. Key challenges include optimizing laser transmission with very narrow beams, and deploying a laser power of at least one watt. At the moment, the kind of silicon photonics devices that are available have been optimized for optical communications, and typically produce only tens of milliwatts. "If you want to use a coherent lidar in an autonomous ride-hailing vehicle, what you probably need is a very high channel count to get the aggregate power that you need," he said, although he added that the technical challenges were "by no means insurmountable."

MIKE HATCHER

"Take me to Photonics West." Credit: Mike Hatcher.

Startup

continued from page 01

products, and technologies that address critical needs by utilizing photonics in the areas of healthcare and deep tech. This year's seven finalists included innovations in medical applications, environmental monitoring, and manufacturing.

"Our participation in the SPIE Startup Challenge has been really great for putting me into the mindset of seeking investments and talking to investors," said Max-IR Labs Vice President of Technology Trey Daunis about winning the competition. "I especially found a lot of value in the mentoring sessions that we did before the presentations, which were really helpful. Being one of the winners feels pretty good, and the money will come in handy as we move forward with our business plan."

"Being part of the SPIE Startup Challenge is a great opportunity and we really appreciate being here," noted second-place winner Photosynthetic B.V. CEO Alexander Kostenko. "I think it's a very relevant stage, and we had good sessions with the judges who listened critically to our pitch, and gave us very good, tough-love feedback."

"As a fresh graduate PhD student — I just defended last fall — I feel so encouraged to be part of the SPIE finals," added OptiCardio Co-founder and CEO Haiqiu Yang. "It's definitely surprised me, and it's super encouraging. It's also given me the motivation to continue our business. And being part of the Challenge was a really good chance to connect with others and get professional feedback from the judges. I believe that will be super helpful moving forward as well."

The 2025 SPIE Startup Challenge was supported by Founding Partner Jenoptik, Lead Sponsor Hamamatsu, and Supporting Sponsors Luminate and Thorlabs. The competition judges who vetted the applicants for their business models, financial cases, and competitive advantages included Jenoptik Vice President Marc Grahl; Hamamatsu Ventures Principal Robert Warren; Edmund Optics Senior Director of Global Strategic Marketing Agnes Hübscher; Launch Team President Michele Nichols; Advancing Photonic Technologies Director Christine Galib; and ams OSRAM Senior Director and Head of Product Line Automotive & Vital Signs Markus Arzberger.

DANEET STEFFENS

The verdict is in: Startup judges (L-R) Markus Arzberger, Robert Warren, and Christine Galib. Credit: Joey Cobbs.

(L-R) Ralf Kuschnereit of Jenoptik, Trey Daunis of Max-IR Labs, and 2025 SPIE President Peter de Groot. Credit: Joey Cobbs.

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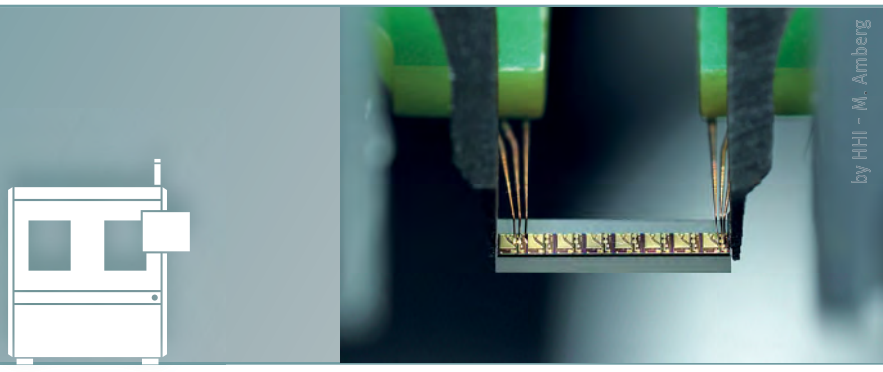

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TELOPS

Photonics upgrades push quantum computing utility

IonQ looks to fiber lasers and PICs as it scales production of its ion-trap designs — potentially aiding efforts to meet the huge challenge presented by AI data center energy requirements.

It's hardly news that the energy demands of artificial intelligence (AI) data centers are colossal, and growing fast. Indeed, Google's very own AI engine provides a succinct overview when asked. "No, the energy demands of AI data centers are not currently sustainable," it responds. "But there are ways to make them more sustainable."

IonQ's Rima Alameddine (chief revenue officer), Thomas Kramer (CFO) and Peter Chapman (president and CEO) with a display of the firm's ion trap design that is currently on show in the lobby of the New York Stock Exchange (NYSE). Credit: IonQ.

The algorithm also spews out some verifiable and well-sourced facts and figures, citing McKinsey's October 2024 report that the power demands of servers in the racks of AI-ready data centers have more than doubled in two years, and are expected to rise to 30 kilowatts per rack by 2027.

"AI-driven data center energy consumption is expected to grow at a compound annual growth rate of 44.7%," it adds, quoting a recent estimate from Goldman Sachs Research suggesting that AI will increase data center power consumption by 200 terawatt-hours (TWh) per year between 2023 and 2030, and Gartner's prediction that the requirements of AI-optimized servers will hit 500 TWh per year in 2027.

Another report, this time from IDC, outlines how electricity is by far the largest ongoing expense for data center operators, accounting for around half of their overall spending. IDC projects that the surging demand for AI workloads will lead to a significant increase in capacity, energy consumption, and carbon emissions, and that global data center electricity consumption will rise at an average of nearly 20% per year to reach 857 TWh in 2028.

"At the same time, electricity prices are rising due to supply and demand dynamics, environmental regulations, geopolitical events, and sensitivity to extreme weather events fueled in part by climate change," points out the analyst firm. "IDC believes the trends that have caused electricity prices to increase over the last five years are likely to continue. Rising consumption and increased energy costs will make data centers considerably more expensive to operate, but how much is uncertain."

One location where there has already been a notable impact is tech-heavy Ireland, where according to a BBC report nearly a fifth of the country's electricity is now consumed by data centers, at a time when Irish households are reducing their consumption.

Reflecting the scale of the anticipated challenge, both Google and Amazon are now looking to nuclear power to meet future demand, with prior commitments to reducing their energy footprints going out of the window.

Another approach

Is there another way? Perhaps. And it could come in the form of quantum computing and photonics innovation. That's where IonQ thinks it can make an impact. Originally spun out of research at Duke University and the University of Maryland, this is no fly-by-night startup. Following major venture backing from the likes of Google, Amazon Web Services, and Samsung, and commercial partnerships with Microsoft and Google Cloud Services, the College Park enterprise can boast of becoming the world's first public pure-play quantum computing company with its October 2021 listing on the New York Stock Exchange.

IonQ's ion-trap designs rely on a multitude of lasers and optical components. The company is now looking to scale its technology for rack-mountable deployments, partly thanks to new fiber laser systems provided by NKT Photonics. Credit: IonQ.

Speaking to *Forbes.com* last year, IonQ's CEO Peter Chapman suggested that quantum processors could help meet the computing challenges of AI, because the large language models on which the technology relies tend to operate on linear algebra, something that quantum computers are well suited to.

IonQ is now looking to scale its

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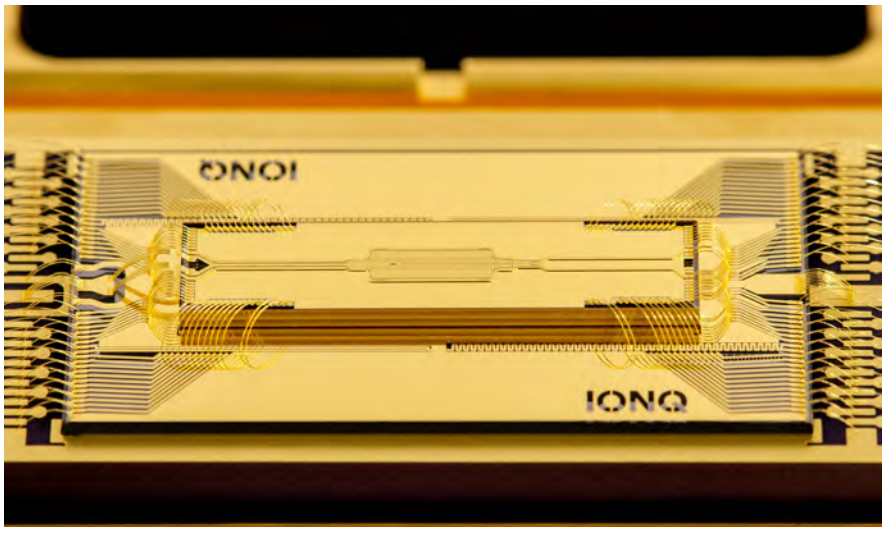
IonQ continued from page 07

trapped-ion hardware to be compatible with existing data centers, meaning no need for cryogenics, customized shock-absorbing server racks, or advanced construction requirements. And the firm's approach relies on a lot of optics and photonics, with various technologies instrumental to the full operation of the quantum computer. For example, multiple lasers are needed to manipulate the ions, including cooling, state preparation, state detection, quantum gate operations, and more.

Stephen Crain, senior staff engineer at IonQ, told *Show Daily*: "The wavelength of the lasers is dependent on the specific ion species that is used for our qubit. Each laser output is conditioned with acousto- and electro-optical modulators to control the amplitude, frequency, and phase of the light sent to the qubits, and the resulting light is delivered to our qubits via a combination of optical fibers and standard reflective and refractive optics.

"The state detection and readout system is responsible for collecting and detecting the photons emitted from each of the qubits in order to determine their quantum state. We use a custom-designed, high numerical aperture refractive optic to relay the photons onto our detector," Crain said.

So far, IonQ has chosen to work with ytterbium ion qubits — partly because of the ion's relatively simple electronic energy level structure, and partly because of the wide availability of lasers that can address many of the relevant energy levels.



Close-up of the ion-trap technology that forms the basis for IonQ's quantum computing approach. Photo: IonQ.

And although some of the wavelengths needed to operate a ytterbium qubit quantum computer are fairly difficult to achieve with fiber lasers, other sources such as direct diodes and diode-pumped alternatives can cover the required spectrum.

Now IonQ is looking to push towards scale with its new "Tempo" products, partly through a deal with Hamamatsu-owned NKT Photonics announced in November. "The Tempo product is focused on improving the quantum computer performance as well as the manufacturability, maintainability, and scalability of its various subsystems," Crain explained.

"Lasers are a part of the foundation of our quantum computers, so the reliability and uptime of the components is critical for us to deliver a useful product to our customers.

"We believe that the laser platform under development by NKT Photonics will progress all of these key metrics for our quantum computers. As our quantum computers expand in qubit count and performance, the demands of our laser systems grow as well. This new architecture will provide a modular approach to our key laser systems, which allows us to efficiently scale our laser resources."

Barium ion advantages

One new aspect will see IonQ build quantum computers around barium ions, with the company saying that this should yield several advantages — including a higher native fidelity limit, faster gate speeds, and lower state preparation and measurement errors.

"In general the photonics technology requirements are very similar between the ytterbium and barium systems, with key differences primarily relating to the laser and collection optics wavelengths," added Crain, noting that the similarities would allow it to leverage existing designs and experiences. The barium ion systems are scheduled for launch later this year, with IonQ highlighting the reliability and rack-mountable nature of the NKT fiber lasers.

Looking longer-term, IonQ also extended an existing agreement with the Belgian electronics research center imec that aims to shrink its quantum computers by using photonic integrated circuits (PICs). "By optimizing the design, production, and integration of chip-scale photonic devices and ion traps for scalable and high-performance quantum computers, the developments aim to push the boundaries of quantum computing performance," stated IonQ on signing the deal in November, 2024.

"Traditional trapped ion quantum computing approaches rely on bulk optics for laser light modulation, delivery, and photon collection. By moving traditional bulk optical components into integrated photonic devices, IonQ aims to reduce overall hardware system size and cost, increase qubit count, and improve system performance and robustness.

"Chip-scale optical technologies and IonQ's tight integration with imec's trap manufacturing and packing are expected to open up new system capabilities, increase reliability, drive down overall cost-per-qubit, and reduce time to market for new generations of quantum computers."

Whether those kinds of advances can make any serious dent in the escalating energy requirements of AI-focused data centers remains debatable, with Forbes highlighting a view from Barclays analysts that there are unlikely to be any "silver bullet" solutions.

But in tandem with modernized power grids, utility-scale storage, and hoped-for advances in low-carbon electricity generation, perhaps quantum computers and the photonics technologies that underpin many of the approaches to qubit generation and management can help square the AI energy circle.

NKT Photonics and imec can be found at the Photonics West exhibition, at booths 3401 and 5001 respectively.

MIKE HATCHER

Photonics industry remains strong

SPIE projects global annual revenues for photonics core components to reach $376 billion in 2025.

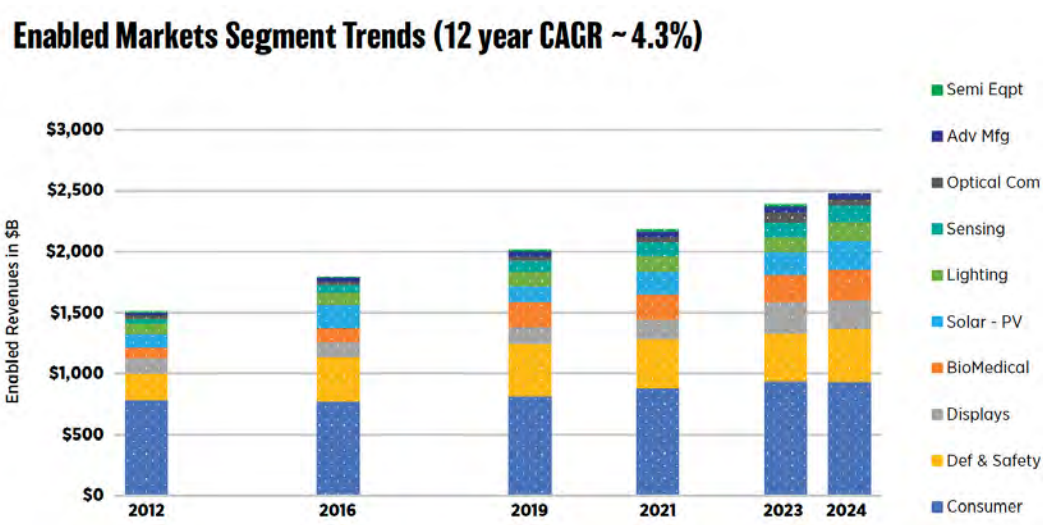
During a presentation Monday from SPIE Senior Director of Global Business Development, Andrew Brown, SPIE released its *2025 Optics and Photonics Global Industry Report* at the Society's Global Business Forum. According to the new report, global annual revenues from the production of optics and photonics core components have grown at a pace approaching 6% CAGR for the last decade, reaching $345B in 2023. These core optics and photonics components underpin a global market for photonics-enabled products that is projected to exceed $2.5 trillion for 2024, highlighting the strength and importance of the photonics industry.

According to the industry analysis, accelerating innovation coupled with an incredibly diverse range of light-enabled applications markets has pushed the growth of photonics technology revenues to consistently outpace gains in global gross domestic product (GDP). Since 2012, the photonics components industry has grown at a rate more than twice that of global GDP.

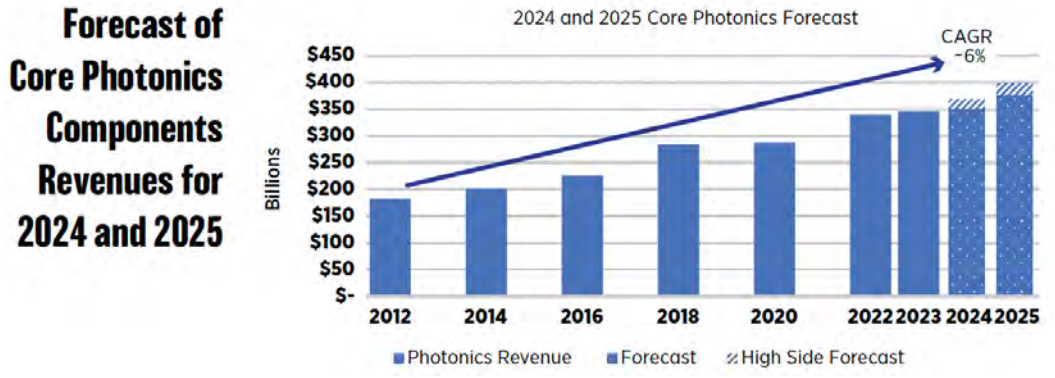
"While maybe surprising to those not in the photonics industry, the executives in the audience at the report's release have firsthand knowledge of the markets we serve and validated the continued growth of our industry the report documents," notes Brown. "All of us working in photonics understand how light-based technologies and products underpin so much of the global economy, but it is vital for us to get that message out to policymakers and investors. At SPIE, it's key to our mission to advocate for the industry, and the data found in the report is key to helping get that message out."

The report draws on the Society's industry expertise, world-class database, and global footprint, which uniquely position SPIE for its analysis and understanding of the photonics industry. For more than a decade, the report has tracked metrics like the number of companies, distribution of global revenues, jobs based on company headquarters, and more, painting a picture of solid growth in the photonics industry.

As defined in this 11th edition of the Industry Report, core photonics components underpin all light-enabled products and services like smartphones, computers, laser-based instruments for industrial and medical applications, cloud computing, streaming content services, and e-commerce.



Source: SPIE 2025 Optics and Photonics Global Industry Report.



Source: SPIE 2025 Optics and Photonics Global Industry Report.

Estimates of the total monetary value of all light-enabled products and related services exceed 19 percent (~ $20 trillion) of worldwide economic output. Core photonics components range from raw materials to image sensors and light-emitting diodes (LEDs) to lasers. By focusing on the core components and the companies that produce them, SPIE has leveraged its comprehensive understanding of the photonics ecosystem to characterize the global photonics industry. "With 13 years

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Vision for growth

SPIE announces new Vision Tech Expo to accompany Photonics West 2026.

Like the photonics industry it serves, Photonics West has steadily grown since its inception 30-plus years ago, and in 2026, that growth will spill over into Moscone West with an exhibit and industry program to serve the vision and imaging markets. The Vision Tech Expo will take place 20-22 January 2026 as part of Photonics West and the co-located AR|VR|MR.

Photonics West is already the premier event for the optics and photonics industry, bringing 20,000-plus annually to San Francisco. By incorporating vision and imaging technologies and their wide range of industries and applications, the scope and size of the audience in Moscone every January will grow to now include more from the manufacturing, automotive, life sciences, agriculture, and robotics sectors. Researchers and business professionals from different industries will be able to connect, share insights, and collaborate on innovative projects, and this cross-industry interaction will lead to the development of new technologies and solutions that benefit multiple fields.

As part of the growth and expansion into Moscone West, current Photonics West exhibitors will also be able to expand their footprint in 2026 — an opportunity many have been asking for the past couple of years.

"The growth of Photonics West has been constrained by the available space in Moscone North and South," says SPIE Director of Sales, Jeff Nichols. "Once Moscone West became available to us, we started exploring applications and markets that would complement the existing makeup of Photonics West and AR|VR|MR. The vision and imaging markets have a growing application space and combines many of the components and technology already on display at Photonics West, so bringing this community into Photonics West is natural."

Machine vision technologies are increasingly being adopted in various industries for quality control, inspection, and automation. Exhibitors will be able to showcase their products to a diverse audience, leading to new business opportunities and partnerships. This market expansion will help drive innovation and growth within both the photonics and machine vision sectors. The Vision Tech Expo will highlight cutting-edge technologies in cameras, image sensors, lighting, embedded vision, AI/deep learning, lenses, image processing, and automation. Attendees can expect to experience live demonstrations, compare products, and gain hands-on experience with the latest tools and systems, as well as listen to thought leaders and innovators who are applying machine vision in their systems and businesses.

Nichols adds, "In discussions with prospective exhibitors, it was clear that a North American show that focused on machine vision and the associated technologies was needed. At the same time, bringing new audiences and potential customers to our Photonics West exhibitors is key to our collective success as an industry. The interdisciplinary nature of technology today makes the cross-pollination of ideas from disparate fields more important than ever, and to help foster those connections, Photonics West 2026 will have more researchers, engineers, business people, and companies from across a wider spread of applications and fields to enable future innovations."

Machine vision technologies often rely on advancements in optics, lasers, and imaging systems, which are core areas of focus at Photonics West. By integrating Vision Tech and strengthening synergies between these related fields, attendees can explore how different technologies intersect and complement each other, leading to the continued growth of the photonics industry and its global footprint.

After a successful Photonics West 2025, Nichols is looking forward to 2026. "The week of Photonics West has always been the best place to see the size and scope of our industry. By becoming even more comprehensive, SPIE is turning San Francisco in January into a single stop for anyone interested in the latest advancements in photonics technologies and the numerous applications it enables. This week has been fantastic, and I am in awe of the collective smarts and inventiveness in such a small radius, it's exciting to imagine all of this growing!"

KEVIN PROBASCO

A golden opportunity in cancer therapy

A Sunday evening BioPhotonics plenary by Joanna Depciuch explained the promise and challenges of applying gold nanoparticles to fight cancer.

Joanna Depciuch. Credit: Institute of Nuclear Physics Polish Academy of Sciences, Krakow.

Globally, over $5 billion is spent per year on cancer research. Yet, for those of us unlucky enough to receive a diagnosis, most cancers doctors will offer the same standard treatment options that they have offered for well over half a century: surgery, chemotherapy, and/or radiotherapy. Despite improvements to all three options over the decades, they each still carry risks of damaging normal tissue or failing to eradicate the cancer.

Nanoparticles might provide a way to dramatically reduce these risks and improve patient outcomes due to their numerous advantageous properties. For example, their small size means that they can passively accumulate in tumors due to what is known as the enhanced permeation and retention effect. And their ample surface area can be functionalized with ligands to actively direct them to desired locations in the body.

As a result, various types of nanoparticles are being investigated for guiding surgical resection of tumors, delivering chemotherapeutic agents more effectively, and enhancing the therapeutic efficacy of radiation-based treatments. They may even open the door to the creation of new therapeutics using nanomaterial properties themselves.

However, there remain significant roadblocks to nanoparticle-based therapy. "Some magnetic nanoparticles have been used during surgery where they wanted to cut out a glioblastoma, but only directly to tumor cells," explains Joanna Depciuch of the Institute of Nuclear Physics, Polish Academy of Sciences, Poland. "They are afraid to inject these nanoparticles, because they aren't sure where these nanoparticles will accumulate and they are concerned that ions, which can interact with our blood, can cause a huge toxic effect."

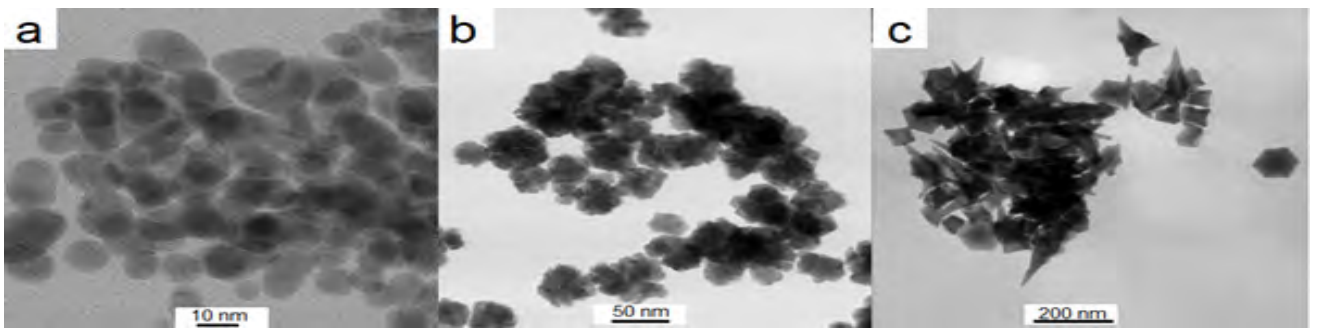
Depciuch is laser focused on solving these challenges, particularly in regard to the application of gold nanoparticles, known to be lethal to cancer cells, in anticancer therapies. Her BioPhotonics plenary, "Application of nanoparticles in anticancer combination therapies," on Sunday night presented fascinating new insights her research has uncovered.

Previous to this year, it was thought that the smaller the gold nanoparticles are that are applied to cancer cells, the better. The logic behind this was that smaller nanoparticles would find it easier to sneak into the cancer cell core, where they could cause maximum damage and ultimately cell death.

Depciuch decided to study this in more detail using a holotomographic microscope. This advanced instrument — the first to be purchased in Poland — combines tomography with an optical microscope to enable visualization of the interaction between cells and nanoparticles based on differences in refractive index.

In more detail, a beam of electromagnetic radiation is carefully calibrated to ensure its energy does not interfere with cellular metabolism. As the beam scans the cells, it generates holographic cross-sections that reveal variations in the refractive index. The differences in light refraction between the cytoplasm, cell membrane, and nucleus enable the reconstruction of a detailed 3D image, capturing both the cell's external structure and its internal composition.

Crucially, the resulting holotomographic image not only offers 3D information on nanoparticle accumulation in these cells with nanometric resolution, from all sides simultaneously and practically in real time, it does so without using fluorophores (fluorescent molecules often used to tag cells or other molecules).



TEM images of (a) spherical, (b) flower, and (c) star-shaped gold nanoparticles. TEM images acquired by Magdalena Parlinska-Wojtan.

"Normally, we know that the fluorophores cause some toxic effects," reveals Depciuch. "But all changes that we observed in the morphology of the cells were caused by the nanoparticles, not by the nanoparticles and fluorophores."

With this clarity, Depciuch and colleagues were able to paint a more nuanced picture: "We obtained information that the accumulation and the absorption of these nanoparticles depend on the shape of the nanoparticles, size of the nanoparticles, and also the type of cancer cells." For example, tiny spherical nanoparticles, 10 nanometers in size, had almost no effect on either a glioma or colon cancer cell line, whereas much larger (200 nanometers) star-shaped nanoparticles resulted in high mortality in just 20 minutes, due to their sharp tips perforating the cell membranes to the point that the cells could not cope with repairing the increasing damage, leading to programmed cell death.

Using these results, the researchers built a theoretical model of nanoparticle deposition. This model can already be used by other researchers to quickly determine the uptake of a certain size and shape of nanoparticle by cancer cells over a given period of time.

"We have created a model whose parameters are only the shape and size of the nanoparticles and the different kinds of cells, and these are just glioblastoma and colon cancer cells," confirms Depciuch. "But I want to extend these experimental results to create a model where we put all physical properties of the nanoparticles (chemical composition, zeta potential, size, shape, and, for example, concentration of these nanoparticles in different kind of cells) and use it to try to analyze which kind of nanoparticles we should use for which kind of cancer cells."

Such a model will be of huge benefit to the community, allowing researchers to immediately eliminate a huge swathe of property combinations that they would otherwise have to eliminate via time-consuming and costly experimental verification. What is more, it will enable researchers to focus on the most promising experiments in which the nanoparticles will be particularly well absorbed by selected cancer cells, while maintaining low or zero toxicity to healthy cells in the patient's other organs.

So far, with the Polish team having conducted experiments on only three cell lines — two glioma and one colon — the model's applicability is limited. Current work is aiming to design experiments to include further parameters, such as the chemical composition of the particles and further tumor types, in order to build the model Depciuch envisions.

At the same time as building a picture of what types of nanoparticles work best on which cancers, Depciuch is exploring the best ways to apply gold nanoparticles. For example, star-shaped nanoparticles appear to be ideal if applied directly to a given tumor, but more caution must be taken if directed to the cells via the blood for chemotherapy. "The stability of the nanoparticles in the blood is different than when we put them in, for example, a water solution," she says. "And we know that in the blood these nanoparticles can lead to gold ions being present, which are toxic to organs."

Depciuch is also exploring the use of different nanoparticle sizes and shapes in novel therapeutic strategies. One is photothermal therapy, a treatment for certain cancers such as skin cancer. "First, we choose a nanoparticle concentration that is non-toxic," she says. "Then we can focus this laser only where we have the cancer cells, which irradiates these nanoparticles to activate the toxic effect." Depciuch says that spherical gold nanoparticles best absorb ~525 nanometer wavelength light, which is of no use for phototherapy. But the nanoparticles she has engineered with rod-like shapes best absorb light around 800 nanometers (near-infrared light) making them ideal candidates for use in photothermal therapy.

The message she hopes the audience took away with them from her BioPhotonics plenary? "I hope that everybody will see the promising future of nanoparticles in medicine, but also that we should be very, very, very careful about using nanoparticles now, when we know, I think, less than we should."

BEN SKUSE

PHOTONICS WEST SHOW DAILY

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Welcome to the optics.org Product Focus which we have published specifically for Photonics West 2025 in partnership with SPIE and the Photonics West Show Daily.

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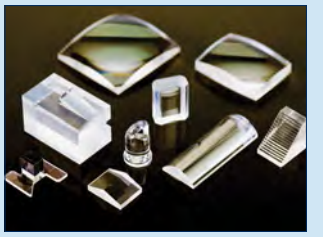

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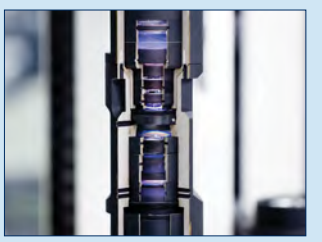

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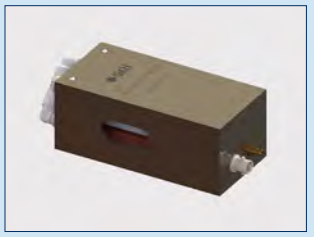

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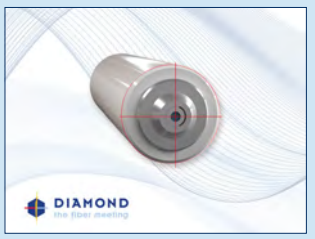

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Industrial machine vision: Overcoming challenges and seizing opportunities

Technical innovation, increased applications, and new markets drive future growth.

The industrial machine vision market has recorded significant fluctuations over the past few years, as Yole Group has tracked in its reports. Machine vision is a technology that enables machines to analyze their environment through image capture. The machine vision industry includes a wide range of components, such as sensors, in which cameras play a central role. Biometrics in smartphones and ADAS in cars are examples of machine vision implementation, but it is primarily known for its impact on industrial automation.

Yole Group estimated the market for cameras used in industrial machine vision in its *Imaging for Industrial — Machine Vision 2024* report. It peaked at $7.1 billion in 2022, following two years of double-digit growth after the COVID-19 crisis. This increase was driven by a resurgence in the production and consumption of consumer electronic devices and the stockpiling of components by manufacturing industries to mitigate supply chain risks. In 2023, the market decreased slightly to stabilize at $6.9 billion, facing headwinds from the end of stockpiling and a global economic downturn that reduced investments in production capacities. Yole Group anticipates a moderate 2.1% compound annual growth, leading to a $7.8 billion value by 2029, powered by a progressive recovery in global demand.

Source: Industrial Imaging — Machine Vision report, Yole Intelligence, 2024.

However, demand varies significantly across regions and applications. For example, demand was very high in China, driven by car electrification, battery inspection needs, and increased investments in local semiconductor supply chains. In contrast, it was weaker in Europe, where key industries such as automotive are experiencing headwinds. In the US, demand for factory automation technologies and robotics appears to be on a positive trajectory.

Reshaping the competitive landscape: Rising Chinese competition and growing verticalization

The changes in demand have numerous consequences for the machine vision ecosystem. Historically, industrial cameras were supplied by US or European players, but serious competition has emerged from China recently, led by Hikrobot and iRayple, subsidiaries of Hikvision and Dahua, respectively. These Chinese leaders registered significant growth after the COVID-19 crisis, with revenues increasing by around 60% between 2021 and 2022. They are now among the top global suppliers of specific products — such as PC-based cameras used in industrial inspection — and are intensifying efforts to expand their sales beyond China. Following these leaders, many smaller companies are emerging rapidly, with differentiating offerings such as 3D sensing modalities.

In Western regions, the economic downturn has forced many machine vision systems customers to reduce expenses. While vision systems were previously developed internally by companies purchasing independent components (cameras, lighting, processing, software…), they now have fewer resources and require more plug-and-play solutions. Consequently, camera suppliers are shifting from component suppliers to solution providers, increasing their efforts in developing software platforms. On the hardware side, this shift translates into the development of more complete systems, such as smart cameras and systems with higher versatility. This trend is verticalizing the industrial camera industry, with many mergers and acquisitions observed in recent years and more expected in the future. The machine vision ecosystem is thus shifting from a fragmented landscape of small players to a more clustered landscape with big players offering broader product portfolios and deeper supply chain control.

Machine vision: A positive momentum in specialized segments

Despite machine vision facing headwinds on a global scale, interest is growing in specialized vision systems, particularly in 3D sensing modalities and non-visible wavelengths.

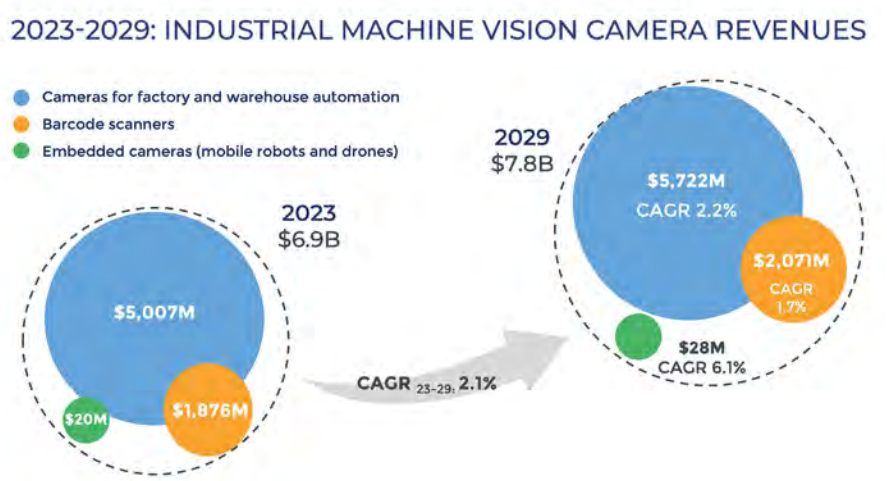
The 3D sensing modality is essential in robotics for the accuracy of movements and safety. It can be achieved through multiple techniques, including stereoscopy, structured light, and time-of-flight. 3D sensing needs are driving numerous innovations at the device level, such as the introduction of new neuromorphic architectures of CMOS image sensors and new integrated micro-optics. Neuromorphic architectures, such as event-based approaches, help reduce the amount of data processed to generate 3D images or point clouds, known for their heavy computational needs. This results in faster processing and lower power consumption. Some start-ups are also introducing passive 3D sensing by integrating dedicated micro-optics directly into the sensor, thus capturing 2D and 3D information simultaneously within the same sensor as well as image acquisition.

In optical components, the emergence of metasurfaces could add value to 3D sensing efficiency. Passive metasurfaces can be used in structured light, providing more flexibility in the design of projected patterns and helping reduce the size and cost of illumination and camera modules. Active metasurfaces can be used in compact LiDAR modules, allowing beam steering without moving parts.

In recent years, there has been growing interest in non-visible wavelengths, such as short-wave infrared (SWIR). This spectral range is used in semiconductor inspection since silicon is transparent in this range. It also has applications in robotics, particularly for 3D sensing in outdoor environments due to reduced parasitic sunlight in this band compared to traditional near-infrared. Traditional CMOS image sensors are not sensitive in this domain, and InGaAs sensors are typically used. Compared to CMOS-based platforms, the higher cost of such components has led to a flourishing ecosystem of start-ups developing alternative low-cost platforms, such as quantum dots and germanium-on-silicon.

Machine vision: Driving the future of automation and intelligent systems

The machine vision market stands at a pivotal juncture, marked by shifting demand patterns, intensified competition, and technological breakthroughs. While the recent slowdown has posed challenges, it also presents opportunities for companies to innovate and redefine their value propositions. By transitioning toward solution-based models and leveraging advanced technologies like 3D and SWIR imaging, the industry is well-positioned to address the evolving needs of its customers. As we move into 2025, machine vision will continue to play a vital role in shaping the future of automation and intelligent systems, delivering value across diverse applications and industries.



Source: Industrial Imaging — Machine Vision report, Yole Intelligence, 2024.

DR. AXEL CLOUET, YOLE GROUP

Photonics industry continued from page 11

of accumulated data, this report delivers a unique perspective on the thriving global ecosystem of photonics components manufacturing, the companies involved, where they are headquartered, their revenues, and the number of jobs created globally by optics and photonics components production," SPIE says.

Other key findings of the report include:

- Production of optics and photonics core components is a global enterprise. In 2023, SPIE identified 4,923 companies headquartered in 59 countries.
- Core components production employs more than 1.32 million people worldwide.
- The global share of the photonics components business continues shifting towards Asia, particularly companies headquartered in Japan, China, and South Korea.
- In 2023, photonics component manufacturers headquartered in Japan generated the most revenue and employed the most people.
- Manufacturing of photonics-enabled products generates more than five million jobs worldwide.

SPIE tracked and evaluated 4,923 companies that produced core photonics components in 2023, 86 percent of which are small to medium enterprises (SMEs). "Although most of the companies are SMEs, the larger entities generate the majority of the revenues. In fact, only ~6 percent of all companies, including such household names as Samsung, Corning, Nikon, and Carl Zeiss, generated more than 86 percent of total revenues in 2023," SPIE reports.

To examine the global distribution of photonics revenue, SPIE follows a methodology that captures the company's global revenues in the local currency of the country where it is headquartered and then converts them to USD for global comparison purposes. For 2023, the report reveals that, the top five revenue-producing countries were the United States, Japan, South Korea, China, and Taiwan.

The predominance of large photonics components manufacturers headquartered in Japan — such as Keyence, Nikon, Olympus, Panasonic, Sony, and Sharp — means that Japan's share of total photonics components revenues is very high. Together, companies headquartered in the US and Japan account for more than half of the total global components revenues.

The report notes that the core photonics components industry "has grown to the point that combined demand for lasers and all other photonics components in 2023 underwrote more than 1.3 million jobs worldwide. As employment has grown, so has the number of countries hosting components manufacturers, making it a truly global industry."

In all, the report notes, the global photonics industry has experienced more than a decade of consistent growth despite headwinds like chip shortages, regional conflicts, rising costs, and a global pandemic. SPIE forecasts continued, but moderate, growth in 2024. More of this data, including challenges ahead, will be explored at SPIE conferences and exhibitions throughout the year.

"Attending Photonics West is the best way to see and experience the size and character of our industry," adds Brown. "Every year, I'm amazed by the number of people, the ingenuity of the companies, and the ever-evolving array of products they create to help address global challenges. If what's on display this week is not enough to convince you of our industry's strength, the *Global Industry Report* has the data to prove it."

WILLIAM G. SCHULZ

Newly-listed Exosens prepares for lift-off

With a recent positive forecast for significant growth in 2025, a string of recent acquisitions, and its IPO in 2024, France-based Exosens is aiming its electro-optical technologies toward the markets of amplification, detection, and imaging. *Show Daily* investigates how the company plans to achieve its objectives.

Exosens, headquartered in Mérignac, near Bordeaux, France is a high-tech company, with more than 85 years of experience in the development of electro-optical technologies in the field of amplification, detection, and imaging. The firm offers its customers detection components and solutions such as travelling wave tubes, advanced cameras, neutron and gamma detectors, and light intensifier tubes.

The company, which is exhibiting at Photonics West (booth #1827), announced earlier this month (January, 2025) that its 2024 estimated results would be "above IPO guidance, with its 2025 guidance for pre-tax growth performance [in the] low twenties, and revenue growth in the high-teens." The statement added that, "based on unaudited estimated figures, the Group expects for full-year 2024: total revenue of between €390–395 million, representing growth of more than 34% compared to 2023; and adjusted EBITDA of between €116–118 million, representing an adjusted EBITDA margin of around 30%."

Jérôme Cerisier, CEO of Exosens, commented, "We anticipate strong performance in 2025, above IPO guidance. Our amplification markets are showing a stronger than initially expected demand which will require further capacity expansion, while our detection and imaging markets are benefiting from new technological developments driven by artificial intelligence for industrial control, nuclear energy, and healthcare stakes. Our main focus will remain customer satisfaction, operational excellence, and accelerated growth derived from synergies with acquisitions, which will fuel performance in 2025 and beyond."

Ahead of this year's conference and exhibition, *Show Daily* interviewed Claire Valentin, Exosens' Chief Strategy Officer, to find out more about the company, its recent activities and how it is engineering success in this competitive sector.

Show Daily: ***Describe the company and its main recent developments at the company, such as the IPO, and how you are achieving such significant growth.***

Claire Valentin: Thanks to our sustained investments, Exosens is internationally-recognized as a major innovator in optoelectronics, with production and R&D carried out on 12 sites, in Europe and North America and with over 1,700 employees. Exosens entered the stock market in June 2024, marking a significant milestone in the company's history. This new direction enables us to capitalize on the strong momentum in our markets, support our development with new targeted acquisitions, and continue to grow our business. Since the IPO, we have already announced four strategic, bolt-on acquisitions to strengthen our capabilities and expand our market reach.

More specifically, our sales reached 274 million euros in the first nine months of 2024, driven by organic growth but also by the successful integration of our acquisitions. We also improved our profitability, with an adjusted gross margin of 132.8 million euros for the first nine months of the year, or 48.4% of sales.

Development plans for Exosens and the company's significant technical achievements?

Our goal today is to accelerate the growth of the Group's activities, improve profitability, and strengthen cash generation. To accelerate our development, we keep investing heavily in innovation, essential for our organic growth. We also intend to develop, through acquisitions, our detection and imaging segment in particular, which has significant growth potential, namely through targeted acquisitions. A major milestone in this journey was our successful IPO in June 2024, which has provided us with the financial flexibility and visibility to drive these ambitions forward.

Recent acquisitions and does the company have plans for future acquisitions?

We have announced four transactions since our IPO last June, namely Centronic (United Kingdom), LR Tech (Canada), NVLS (Spain) and Noxant (France). The transactions for NVLS and Noxant are expected to be finalized in the coming months. The four companies generated a combined total revenue of €38 million in their last reported fiscal year (in local GAAP accounting standards).

We will continue to rely on our M&A strategy, with acquisitions that can bring us high value-added technologies, compatible with our technology platform and complementary to our current product portfolio.

Claire Valentin. Credit: Exosens.

What is the 2025 message from the company for Photonics West?

Exosens is made up of strong, recognized brands — Photonis, Xenics, Telops, and El-Mul — all serving the same ambition: to "reveal the invisible" to make the world a safer place.

- Photonis develops high-end electro-optical technologies for defense, science, and nuclear applications.
- Xenics makes infrared sensors, cores, and cameras for diverse electro-optical functions.
- Telops manufactures hyperspectral imaging systems and infrared cameras for defense, industrial, and academic research applications.
- El-Mul serves OEM vendors in the fields of analytic SEM and STEM, focused ion beam, mass spectrometry, semiconductor inspection, and metrology.

The Photonics West Exhibition is a great opportunity for visitors to discover several of our most advanced components and technologies. To mention a few at this year's exhibition: our Photonis advanced single photon detection and imaging

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Exosens launches, 2024-2025

The following is a selection of new products from Exosenss that are being launched at Photonics West 2025, or were launched in 2024.

(Left) Cheetah+ : Xenics, part of Exosens, is expanding its advanced imaging solutions with the launch of the Cheetah+ series. Designed to set a new standard in high-speed short-wave infrared (SWIR) imaging, the Cheetah+ camera series is specified for process monitoring, medical, scientific and industrial machine vision applications. The Cheetah+ series offers frame rates of 1700 Hz with options available in OEM and CAM versions — consisting of a high-resolution 640 x 512 pixels and pixel pitch of 20 μm. It is also offered with reliable and quick data transfer using CoaXPress interface. Credit: Exosens.

(Center) PhotonPix : For researchers focused on advancing science rather than fine-tuning photon detection electronics, Exosens is introducing PhotonPix™. This detector, powered by Photonis's advanced MCP-PMT technology, is designed for seamless integration into any setup requiring high-frequency and ultra-precise timing resolution. Exosens states, "With superior performance in dark noise reduction, readout speed, and timing accuracy, PhotonPix™ sets a new benchmark for single-photon detection, delivering reliable, high-quality data that accelerates scientific discovery." Credit: Exosens.

(Right) Radia M100 : The Radia M100 is a cooled, small form-factor thermal infrared camera designed to provide high-quality imagery and reliable scientific data. Real-time image acquisition capabilities are complimented by Telops' permanent radiometric factory calibration, allowing the user to display the acquired imagery in units of temperature, radiance, or irradiance without the need for regular blackbody calibrations. Credit: Exosens.

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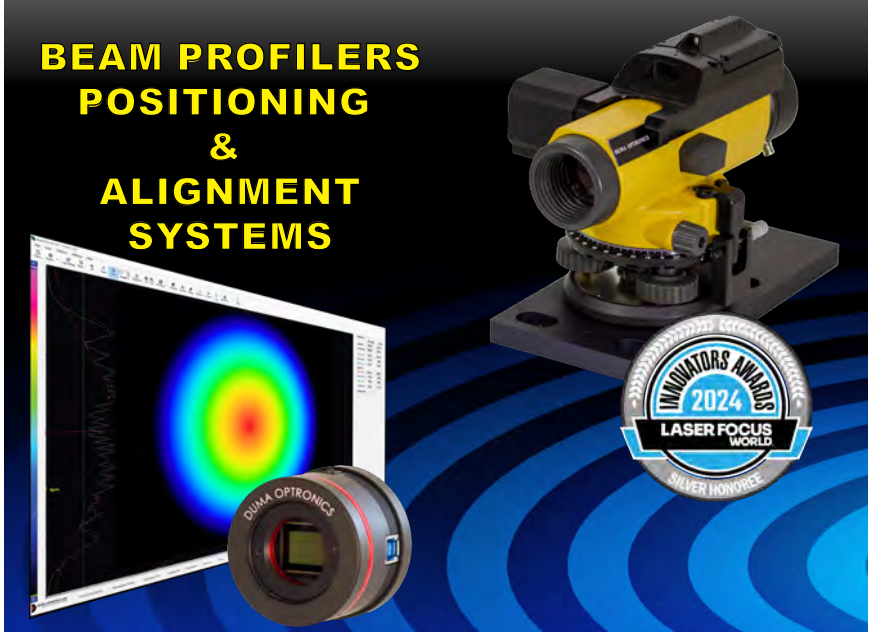

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solutions, engineered for lidar, quantum optics, high-energy physics, and beyond. For thermography measurement applications, we present the Telops Radia Family, designed as an accessible entry-point into the world of scientific IR imaging, with cooled and uncooled imaging systems. Another highlight will be the Xenics Cheetah+ series, the world's fastest SWIR InGaAs camera.

Some of Exosens' key new products will be showcased with live demonstrations available at booth #1827, such as our Cricket™ Pro, PhotonPix and Cheetah+ series.

What has been the company's experience of participating at Photonics West?

Photonics West has been a cornerstone event for Exosens, offering an unparalleled platform to showcase our cutting-edge technologies and innovations to a global audience. Every year we have the opportunity to connect with industry leaders, customers, and partners, gaining valuable insights into emerging trends and fostering collaborations.

The dynamic atmosphere and high-quality interactions at Photonics West align perfectly with our commitment to driving innovation in detection and imaging solutions. It is an event we look forward to, as it enables us to demonstrate our expertise while learning from the broader photonics community.

In the company's view, what is the state of the market and likely main developments and technology trends for 2025?

The evolution of our business is closely linked to trends in both the defense and the tech industrial sectors, which should continue to support our growth in the future, since we are well positioned for significant advancements, driven by technological innovation and evolving market demands. In machine vision, after a slowdown in 2024, the market will probably recover thanks to new development in particular in semiconductor inspection, with new 3D integration components to fulfil artificial intelligence requirements.

Through 2025, geopolitical tensions and rising defense budgets are driving increased demand for night vision technology, a key tactical advantage for low-light operations. Previously reserved for special forces, adoption is expanding across the entire supporting functions, with a shift to more advanced binocular systems. Exosens, as the sole European manufacturer, is well-positioned to capture this growing market.

In commercial sectors like energy and industry, imaging technologies are essential for methane leak detection, industrial defect control, and pharmaceutical quality assurance. In addition to well-known applications, drone development for gas detection, agriculture, and environment monitoring will require enhanced vision systems which needs to work whatever is the weather conditions.

These trends underscore strong growth opportunities for Exosens in both defense and commercial markets.

What is the significance of research and academic inputs into the company?

Research and academic contributions are integral to Exosens' innovation strategy, as demonstrated by our long-standing collaboration with the University of Leicester and Space Park Leicester (United Kingdom). For over 25 years, we have partnered with leading academic institutions to push the boundaries of technology, resulting in groundbreaking advancements like the Mercury Imaging X-ray Spectrometer for space missions.

Our recent £1 million ($1.22 million) investment in the METEOR facility at Space Park Leicester underscores our commitment to fostering cutting-edge research in Earth observation and space exploration. By working alongside over 100 researchers and industry professionals, we aim to drive innovation that not only advances space exploration but also addresses critical challenges in Earth-based applications. These collaborations enable us to remain at the forefront of scientific discovery and technological development.

How does the company encourage students, and attract potential new staff?

Thanks to our significant growth, we're continuously hiring new people. Exosens is proposing exciting challenges in innovation and new products development to remain at the state of the art of the technology. We're also fully engaged in Corporate and Social Responsibility strategy with ambitious objectives to meet our sustainable goals and to attract young talents.

MATTHEW PEACH

Ghana Photonics and Optics Laboratory: A promising partnership

Collaborative international leadership development, facilities, and curriculum design are just a few of the critical elements at the core of a new initiative.

In October 2023, the Kwame Nkrumah University of Science and Technology (KNUST) hosted a one-week Research School on the Frontiers of Light with the collaborative support of SPIE, the Institute of Photonic Sciences (ICFO), and Photonics Ghana. The workshop welcomed 40 physics students from Ghana, as well as participants from Rwanda, Kenya, India, and even Finland. An international team of professors and industry speakers lead sessions on medical photonics, ultrafast spectroscopy, terahertz spectroscopy, quantum sensing, optical metrology, and sustainable technologies.

The outstanding success of the KNUST workshop, together with the eagerness, interest, and initiative of students and faculty, sparked the idea of establishing a more permanent Ghana Photonics and Optics Laboratory (GPOL) on the Kumasi campus of KNUST, to serve as a center of excellence for education and research in West Africa. After a thorough feasibility assessment and following a solid proposal by the University, SPIE approved startup funding for the new GPOL, which will open its doors in the fall of 2025.

The GPOL will start by integrating practical laboratory training into existing university physics, math, and health science courses, develop new programs, and support exploratory research to build local capacity. Looking to the future, the ambition is for the lab to evolve into a full-fledged center for photonics-based solutions addressing local and regional challenges, while preparing a robust workforce for academia and industry.

Initial SPIE funding enables lab upgrades and new equipment, as well as scholarships for two graduate students at the university for two years. Partnerships with ICFO, Europhotonics, Thorlabs, Photonics Ghana, Red Clay Studio, Optica, and other supporters are key to the project's success, assisting in curriculum development, leadership training, additional grants, and identifying low-cost optics-related projects and technologies.

Even as plans for the laboratory develop, there is already a hive of impactful activity. The KNUST Photonics Student Chapter was launched in 2024 with support from SPIE and other partners. Last year, the Chapter created and led outreach programs to introduce students to optics and photonics through interactive demonstrations. Activities reached more than 1,000 high school students to ignite a passion for scientific inquiry and innovation and introduce them to the opportunities and benefits of a STEM education.

KNUST Physics Professors Akyana Britwum and Michael Edem Kweku Donkor are the principal investigators for the GPOL. They are supported by an Advisory Board staffed by 2025 SPIE President Peter de Groot; ICFO Staff Scientist and Head of Academic Affairs and International Relations Robert Sewell; Thorlabs' Manager of Educational Products Jens Küchenmeister; Photonics Ghana's Dr. Benjamin Kofi Asamoah; and Professor Peter Amoako-Yirenkyi of Ghana's National Institute of Mathematical Sciences.

The outstanding success of the KNUST workshop, together with the interest and initiative of students and faculty, sparked the idea of establishing a more permanent Ghana Photonics and Optics Laboratory at KNUST.

Participants of the 2023 Research School on the Frontiers of Light in Ghana. Credit: SPIE

Professor Britwum is a firm believer in the importance of partnerships when launching an initiative such as the GPOL. "The important thing entering any field — and especially the field of photonics — is building a strong network," he said recently, in a LinkedIn post. "[It's to] be able to meet people, make strong connections, and keep those connections going. Because it's the network that makes the science grow, and these days science is about having a good community to collaborate with, to come up with the most cutting-edge ideas and the most cutting-edge solutions." Photonics, he says, is a powerful tool that cuts across almost every discipline. "The idea that you can use light interaction with matter to be able to solve problems from health to technology is just amazing," he notes. "And…the real impact is that it is reducing the cost for a lot of these interventions. Especially [for] someone who is coming from a low-resource environment, the ability to have lower-cost tools to solve problems in our communities is so important. I think that photonics will make a lot of solutions within reasonable reach for many communities in Africa… and that's something very important." Most tellingly of all, Professor Britwum sums up photonics in one descriptive word: "Community."

"The establishment of the Ghana Photonics and Optics Laboratory at KNUST marks an exciting new chapter in the SPIE story," says de Groot. "Part of our mission at SPIE is to support and sustain optics and photonics research on a global scale, and this includes our commitment to growing a technical workforce for this field. We achieve these goals through international partnerships. I look forward to seeing this collaboration grow outward from Ghana to encompass the larger West African region — and beyond."

With a longer-term goal of working with KNUST and other institutions in West Africa on further STEM development in the region, the SPIE project initiated in Ghana is looking very promising indeed.

DANEET STEFFENS

All change at Coherent: New boss and re-entry into former markets

Show Daily interviews Sanjai Parthasarathi, Coherent's Chief Marketing Officer, to find out about the company's latest achievements and announcements for Photonics West 2025, as well as its future plans, following the recent appointment of new CEO Jim Anderson.

One of the world's largest photonics companies, Coherent develops materials, networking systems, and lasers for the industrial, communications, electronics, and instrumentation markets. Based in Saxonburg, Pennsylvania, it was founded in 1971 to manufacture high-quality materials and optics for industrial lasers. Today, Coherent operates in more than 20 countries across the globe.

In June, 2024, Coherent, appointed semiconductor industry executive Jim Anderson as its new CEO. Anderson replaced the retiring Chuck Mattera as the NYSE-listed firm's boss, bringing experience from senior management roles at several of the chip sector's best-known names. Most recently the CEO at Lattice Semiconductor, a major supplier of field-programmable gate array (FPGA) logic devices, Anderson also held senior roles at chipmakers AMD, Intel, and LSI Corporation.

Show Daily*: What is the 2025 message from the company for Photonics West?*

Sanjai Parthasarathi: Coherent is completely vertically integrated and we sell at all levels of the value chain from materials and components to modules and systems into various end markets that can be broadly grouped under networking and industrial. We offer a comprehensive range of products and solutions across our markets. We also bring unparalleled supply chain resilience to our customers that they especially value in the current geopolitical environment. This combination of in-depth knowledge, broad market reach, and worldwide customer support underscores the company's commitment to excellence in photonics: from cutting-edge lasers and optics to precision sensing and next-generation materials, we are showcasing how our technologies drive value in various markets including AI/datacom, telecom, as well as industrial markets such as precision manufacturing, semiconductor and display capital equipment, electronics, and instrumentation.

On show: The new series of EDGE high-power fiber lasers (FL) for cutting applications. Credit: Coherent.

What are Coherent's key new products to look for at Photonics West?

We are presenting our new series of high-power fiber lasers (FL) for cutting applications. Our revolutionary product marks our re-entry into the FL market. The Coherent Edge FL features an expanded portfolio of high-performance laser components. By producing all critical components for our fiber lasers in-house, such as diode pump chips, active fibers, crystals, isolators, optics, and beam delivery components, we ensure supply chain resilience for our customers. These components will also be featured at Photonics West, including new product presentations in diode pump technology.

From Coherent's ARM (Adjustable Ring Mode) fiber laser family, we are presenting a new model with a unique dual ring beam configuration. The ARM FL10D represents a major breakthrough in welding technology, delivering faster processing speeds and enhanced quality across diverse applications, including demanding use cases in EV manufacturing and body-in-white assembly.

In the Life Sciences sector, Coherent will unveil new components for flow cytometry at both BiOS and Photonics West. Additionally, we will showcase our expanded portfolio of high-performance lasers, advanced optics, and thermoelectric technologies.

What has been the company's experience of exhibiting and participating at Photonics West?

Photonics West is one of our most significant events, and we have participated in this key industry gathering for several decades. It provides an exceptional platform to showcase our latest innovations, connect with customers, engage with industrial organizations, exchange perspectives with market analysts, and allows our thought leaders to share insights. The unique convergence of stakeholders at Photonics West has consistently sparked new opportunities and inspired groundbreaking ideas, driving the development of cutting-edge products.

Does the company see enhanced market opportunities arising from the US Chips Act, 2022?

We are excited by the Chips Act and the opportunities it represents for us. We recently announced that Coherent has signed a non-binding preliminary memorandum of terms (PMT) with the US Department of Commerce under the CHIPS and Science Act for a proposed investment of up to $33 million to support the modernization and expansion of a state-of-the-art manufacturing cleanroom in Coherent's existing 700,000 square-foot facility in Sherman, Texas. This project will expand the world's first 150 mm indium phosphide manufacturing line by adding advanced wafer fabrication equipment to produce InP devices at scale. The proposed investment allows Coherent to accelerate our industry leadership in indium phosphide technology and manufacturing.

What is the state of the market and likely developments for 2025?

There are several exciting trends in the photonics market, starting with the most exciting: AI/datacom. Photonics, specifically high-speed optical transceivers, are a key enabler of AI networks. AI chip requirements are pushing the leading-edge semiconductor nodes and in turn driving the need for advanced semiconductor manufacturing equipment and tools, and Coherent envisages increasing photonics content in those tools. Photonics-based advanced sensors are "the eyes and ears of AI," sensing of the world around us as well as biosensors for sensing the body within.

We are excited by the display market, specifically the increasing penetration of OLED technology into smart phones but more recently tablets and IT displays as well as the emergence of micro-LED technology. All of which drives demand for photonics tools specifically laser processing tools.

Sanjai Parthasarathi, Coherent's Chief Marketing Officer. Credit: Coherent.

What is the likely impact on business of changing economic conditions, geopolitics, and market prospects through 2025?

The current business landscape is increasingly unpredictable, shaped by geopolitical tensions, supply chain challenges, and fluctuating demand. At Coherent, we recognize that supplier resilience has become a critical competitive advantage. While global supply chains are more interconnected than ever, they are also increasingly vulnerable to disruptions. Our strategy focuses on maintaining operational continuity and minimizing impacts on our customers by leveraging the breadth and depth of our supply chain and technology portfolio.

For example, in AI/datacom transceiver space, Coherent manufactures many of the key components that power these technologies. From lasers such as VCSELs, EMLs, and high-power CW lasers for silicon photonics to producing passive optics such as filters, lenses, and isolators, as well as critical ingredient materials such as garnets, crystals, and ICs, we ensure quality and reliability at every stage of production.

Enabler of AI networks: Coherent's 800G DR8 QSFP-DD datacom optical transceiver. Credit: Coherent.

To further strengthen our resilience, we have invested in a geographically diverse manufacturing footprint, spanning Malaysia, Philippines, China, Vietnam, as well as the EU and the US. This flexibility allows us to shift production as needed, acting as a safeguard against regional disruptions such as political instability, trade barriers, or natural disasters.

What are the opportunities for the company in AR-VR applications; artificial intelligence developments, and machine vision?

Our photonics innovations position us well to deliver the tools and components necessary for these ultra-compact, low-power, high-performance next gen devices that support AR/VR/MR applications. In addition, our expertise spans laser-based manufacturing processes for display platforms including high-resolution OLED and micro-LED displays and holographic optical elements for waveguide couplers.

Considering AI systems and their applications, the company is a vertically-integrated provider of high-speed datacom transceivers that enable AI networking. Over the years, we have made strategic investments that give us a unique level of vertical integration. We not only design and manufacture our transceivers, we also design and manufacture many of the internal components, including high-speed lasers, detectors, and passive optics. For example, Coherent recently launched multiple leading edge laser platforms that are critical for the upcoming evolution of high speed transceivers at 200 Gbps per lane. These include our unique DFB-MZ laser which enables long links up to 6 km, our differential EML, and our high-power CW laser for silicon photonics.

Emerging AR/VR/MR applications create significant opportunities for us. Coherent supplies key photonic components such as laser diodes, optics, and illumination modules for 3D sensing, eye- or body-tracking, along with advanced high-index materials for AR waveguides. Credit: Coherent

Looking at machine vision, our photonic components and laser sources are critical enablers of 3D vision, a foundational technology for advanced automation. By enabling depth perception, 3D vision supports applications such as robotics and autonomous vehicles that require precise spatial awareness. Key components like dot projectors and flood illuminators provide the structured light and illumination needed for accurate sensing in 3D cameras. This technology is essential for achieving higher levels of automation, enabling reliable operation in complex and dynamic environments across various industries.

Are you finding opportunities in fusion energy?

Coherent has been supplying the fusion community with a variety of photonics components tailored to meet the demanding requirements of generating the laser and the beamlines. We offer many of the building blocks for beam delivery and focusing, such as diode lasers/components, large optics, optical fibers, crystals, laser diagnostics equipment, isolators and laser amplifier. We have a history of successful collaborations with leading fusion research facilities NIF and ITER. These partnerships underscore our ability to meet the stringent requirements of high-profile projects and contribute to significant advancements in the field.

Cooling has now become a really key challenge to be faced and solved. We are seeing an increasing need for innovative thermal management technology, which extends from microelectronics to transportation, semiconductor manufacturing, information technology, life sciences, consumer electronics, and many more applications. Having a robust thermal management solution is in most of the cases imperative for optimizing performance and increasing the service lifetime of systems and components. We call it "thermal management" — which means the tools and technologies used to maintain a system within its operating temperature range — because the requirements in many applications are more involved than simply lowering the temperature of something. Coherent is a world leader in innovative engineered materials and sub-systems for thermal management: we are offering a broad portfolio of different materials that includes SiC, diamond, thermoelectric coolers, just to mention some examples.

MATTHEW PEACH

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Pros and cons of wireless laser power

Optical power delivery (OPD), also known as power by light, was the subject of a Tuesday Photonics West presentation by Hamid Hemmati of U.S. company Viasat, Inc. He said that OPD "shows great potential as a solution for energy transfer in situations where traditional methods are impractical or unfeasible."

The related approach known as Optical Wireless Power Transfer, delivers power to distant autonomous sensors, while ensuring efficient electrical and electromagnetic isolation. Hemmati said, "This technology is applicable, for example, in space exploration for beaming power to satellites to transfer solar-generated power from satellite to ground."

In industrial settings, OPD can provide access to power in remote or difficult-to-reach locations and the technology facilitates the charging of robots and other autonomous devices, for example. Additionally, it can be used for underwater energy transmission.

Notable players in this field include fellow presenter firm PowerLight, plus Broadcom, Luminar, Huawei, Solar Space, and Phion, to name a few.

Hemmati's talk also described the "transformative applications" of this emerging technology, as well as the various technological, safety, and economic challenges that need to be addressed.

He considered the pros and cons of power-beaming, not least the advantages of wireless power transfer when wired delivery is not possible. "A significantly higher power density can be delivered to a target relative to that of sunlight," he said.

But Hemmati also addressed limitations of OPD, such as when it would not be a useful approach or where technological limitations persist: "Why not laser power beaming? High-power lasers are needed for large distances, and these sources are often still inefficient. Also, current OPD systems can take up costly space. The problem of limited power and energy density delivery remains, and attenuation [loss] can be as much as 300dB for through-atmosphere links, caused by clouds and fog."

In special cases, such as military applications, OPD offers benefits in ground-to-ground links, to support remote field units and bases, as well as automated sensor networks. Hemmati also explained that wireless optical communication methods are being developed for underwater links and power delivery.

Viasat's Mercury FSOC Terminal enhances military communications. Credit: Viasat.

MATTHEW PEACH

Awardee Hannah Lear. Credit: Meadowlark Optics.

METALLICA SCHOLARS

Master of Photonics

For Meadowlark Optics technician Hannah Lear, receiving the 2024 Eichenholz-SPIE Photonics Technician Scholarship was an empowering step on her education journey, but one that made sense. After all, SPIE is an international society supporting the optics industry, and she is pursuing a career as an optics technician. Receiving a scholarship from the heavy-metal rock-and-roll band Metallica was a bit more surprising.

Metallica Scholars is a workforce education initiative funded by the rockers that provides direct support to community colleges to enhance their career and technical education programs. Colorado's Front Range Community College is one of the 1,000+ nationwide colleges that receive funding to support the trades.

Lear, a single mother, first learned of optics from an outreach program at Front Range Community College, where Lear would eventually enroll and is still taking courses while also working at Meadowlark. "I really enjoy the variety of work I get to do and the incredible people I get to do it with," said Lear.

"At Meadowlark, we are not alone in having a hard time finding qualified technicians, but we are fortunate to have a program at our local community college," says Vice President of Sales and Marketing Kelly Gregorak. "Not only do we hire graduates from the Front Range Community College program, but we also have our current technicians learning new skills by supporting their continued education at the college."

Having the support of the unlikely pairing of SPIE and Metallica is pushing Lear to new heights, "These scholarships have allowed me to focus on building a career and furthering my education in optics. I feel very supported, and I am grateful I have been able to bring my skills to contribute to producing high-quality work for Meadowlark Optics."

"Seeing someone like Hannah find a career and succeed at Meadowlark is heartwarming and, at the same time, not surprising," adds Gregorak. "There are so many opportunities in optics for hard-working folks willing to learn the necessary skills, and we're thankful for the support scholarships like these provide."

KEVIN PROBASCO

US Chips Act funding boosts regional technology development hubs

Of the many wonders of the US Chips and Science Act is funding for so-called tech hubs, regional centers of technology development — including photonics technologies — meant to strengthen economic and national security, ensuring that critical technologies become industries, and create jobs that remain in the US.

A panel discussion Tuesday at SPIE Photonics West gave details on three regional hubs involved in the photonics space. Moderator Alexis Vogt, professor and chair of the optics program at Monroe Community College in Rochester, New York, noted that the Chips and Science Act provides funding for 31 tech hubs through the Economic Development Agency, part of the US Department of Commerce. The agency defines tech hubs as regional ecosystems built upon concentrations of existing stakeholders in innovation assets. The goal for the hubs would be to become global technology leaders — in the technologies they represent — within 10 years.

Alexis Vogt, professor and chair of the optics program at Monroe Community College in Rochester. Credit: Joey Cobbs.

Timothy VanReken, executive director of the Headwaters Tech Hub in Montana, says his organization plays off of the exceptionally strong history of the optics and photonics industry in the state. He said consortium members like Bridger Photonics (airborne lidar), Aurora (autonomous freight vehicles), Vision Aerial (drones), and Reveal Technologies (drones/sensors) are bringing both a positive economic impact to the state and developing synergies with local universities.

VanReken said, "We're going to build complimentary tech clusters across the region and the state that focus on sectors of strength across [Montana's] geography. So manufacturing, supply chain, natural resources and conservation, precision agriculture, national security, energy, transportation — these are the types of things that we care about."

In western New York state, Joseph Stefko is president and CEO of OneROC, the economic alliance established in 2019 to accelerate growth in the greater Rochester area, that also played a lead role in securing federal tech hub designation for the region's semiconductor industry, including photonics technologies.

"This is the outgrowth of a really intentional strategy that New York State has had for the better part of the last two or two-and-a-half decades to make targeted investments to grow the semiconductor and micro electronics sector," he said. With fab facilities now planned to be built in the area, "a decade from now, one-in-four domestically produced semiconductor chips will be manufactured within 350 miles of our corridor."

Finally, Zachary Yerushalmi, CEO and regional innovation officer for the Elevate Quantum tech hub, said the hub is the nation's first and only area of major investments in the quantum industry by the US federal government. By every measure of the quantum industry, he said, the US mountain west is the center of the world, with more than 3,000 people who are working in quantum.

WILLIAM G. SCHULZ

Celestial AI presents its transformative Photonic Fabric optical interconnects

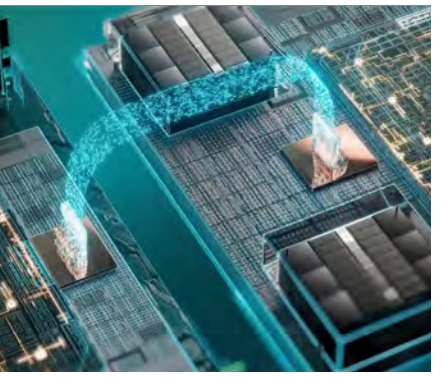
Celestial AI "stormed the beachfront" at SPIE Photonics West, with Founder and CEO David Lazovsky's presentation on the company's Photonic Fabric™ optical interconnect technology for compute and memory for artificial intelligence (AI) applications. He noted that in-package electrical interconnects based on copper are reaching their performance limits. Moreover, conventional "beachfront" — based electrical die interfaces have limited bandwidth and power consumption over increasing chip-package distances. "Beachfront" refers to the edge of a chip or die, specifically the area where the most data can be transferred per millimeter.

Lazovsky said Celestial's Photonic Fabric technology uses thermally stable optical modulators that can be directly packaged within advanced high thermal design power (TDP) application-specific integrated circuit (ASIC) die. He predicts it will deliver a transformative leap in AI system performance.

"It's a full-stack solution," Lazovsky said, noting that the technology addresses the most critical performance chokepoints for advanced AI models, delivering more than 25 times greater bandwidth and memory capacity while reducing latency and power consumption by up to 10 times compared to existing copper and optical interconnect alternatives. "It enables us to deliver data directly to point consumption within the chip, and then it enables package-to-package interconnectivity."

Moreover, Lazovsky said, "it really cracks open a deeper level of integration for a variety of systems. We've developed high-speed scale up network switch capabilities that facilitate not just interconnectivity…but also integrates memory in the network — fast memory — decoupling the ability to scale high bandwidth memory from compute."

Lazovsky said Celestial engages with customers in multi-month programs, beginning with alignment on architectural requirements. "And we design photonic fabric into their systems, both at the device level and at the overall scale, network system level."



Celestial AI's Photonic Fabric is a full-stack solution. Credit: Celestial AI.

Lazovsky continued, "Deep strategic collaborations with hyperscale data center customers focused on optimizing system-level accelerated computing architectures are a prerequisite for these solutions. We're excited to be working with the giants of our industry to propel commercialization of the Photonic Fabric."

WILLIAM G. SCHULZ

MicroLED displays tipped for mass production ramp

MicroLED display developer Mojo Vision hopes to launch a range of products for augmented reality (AR) glasses by the end of this year. Mike Wiemer, CTO, revealed the plans in his talk that opened the session on microLED technology at SPIE AR | VR | MR.

Wiemer told attendees that the plan was to launch three general-purpose products in late 2025, along with two custom designs. "It's within sight, we can see it," he said of a technology that has long held promise but whose commercial crossover has so far proved elusive.

PlayNitride's microLED display. Credit: PlayNitride.

Mojo Vision has been working on microLEDs for nearly a decade, and Wiemer outlined the approach that has now delivered tiny displays on a large silicon wafer platform. "This might be the first time that 300-mm-diameter silicon wafers have had a display on them," he said. The Mojo Vision approach — characterized by Wiemer as "wafers in; wafers out" — combines ultra-small gallium nitride (GaN) LEDs with a layer of quantum dots that convert blue light into green and red, and a top layer of overlapping hemispherical lenses. The GaN-on-silicon LED wafer is bonded to a regular silicon wafer so that the GaN pixels can be controlled directly with CMOS electronics.

The CTO explained that this optical design helps with the final projection efficiency of the display, ensuring that much more light from the emitters is captured and directed towards the eye. Wiemer said that he expects the first generation of microLED microdisplays to revolutionize what he calls "AI-powered glasses" by combining high resolution with high brightness, high energy efficiency and a tiny form factor.

After Wiemer's presentation two more talks from microLED display developers backed up the idea that microLED displays are now on the cusp of commercial adoption for AR. Lynch Wu from PlayNitride outlined the Taiwan company's high-yielding approach using a die-to-die transfer process, saying that it would soon enter mass production. Following that Tongtong Zhu, CEO of the University of Cambridge spin-out Porotech, said that microLEDs were the only solution for smart eyewear. Porotech also uses a wafer bonding approach, based on 200-mm-diameter silicon wafers. "We're getting ready for mass production by the end of Q2," he said.

MIKE HATCHER

SPhotonix brings 'Superman' memory tech to optics applications

Having emerged from stealth mode late last year, SPhotonix is presenting details of its latest innovations in the Moscone Center this week. These include a high-performance birefringent prism for use in differential interference contrast (DIC) microscopy, and a polarization beam smoother for directed energy weapons and laser fusion applications.

Based out of Newark, Delaware, the company is still selling the ultra-high density memory, but is now also targeting the photonics industry with high-specification quartz optical components including waveplates, beam-splitters, and a polarization beam smoother. Like the ultra-high-density memory technology, the quartz components are nanostructured using a femtosecond laser.

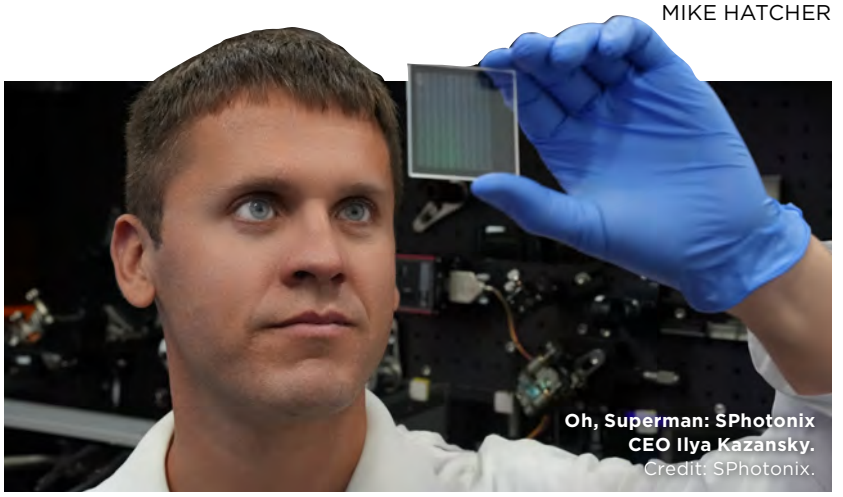
SPhotonix's chief commercial officer Garrett MacDonald told *Show Daily* that the company was in the process of raising $5 million for expansion.

While the company is targeting its 360-terabyte Superman storage disks at individual customers and enterprises, the plan is to license the component manufacturing process, MacDonald said.

"SPhotonix is the only brand currently able to provide both products," states the firm. "Manufactured for microscopy companies, the high-quality optical DIC prisms offer superior performance, enhanced durability, and cost-effective technical features compared to competing products. These prisms are designed to improve image clarity and precision, making them essential tools for advanced scientific research."

CEO Ilya Kazansky added: "As the industry's sole manufacturer of these essential products, we are ready to address researchers' needs in other areas ranging from space technology to life science."

MIKE HATCHER



Oh, Superman: SPhotonix CEO Ilya Kazansky. Credit: SPhotonix.

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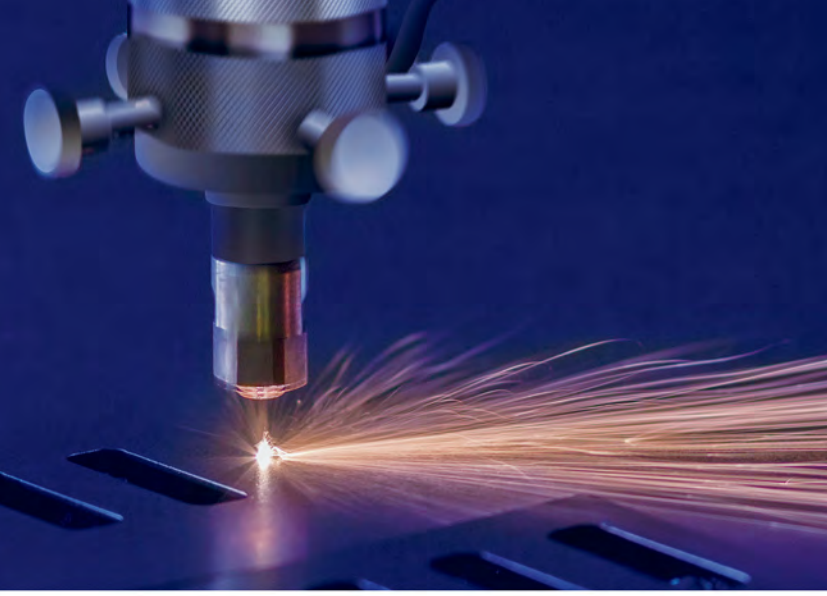

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