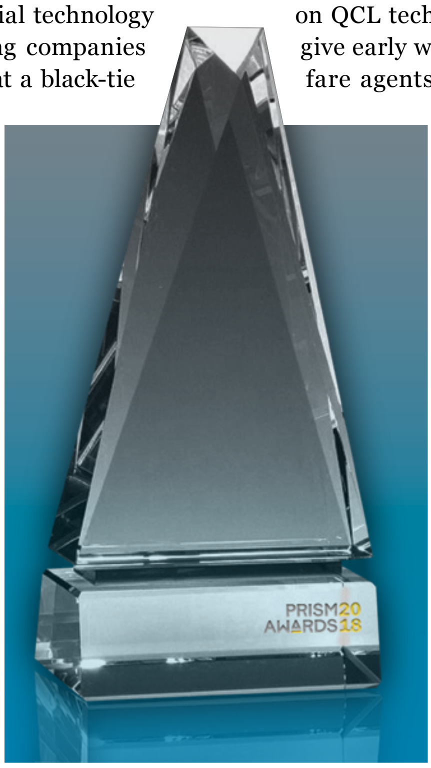
PHOTONICS WEST. SHOW DAILY

PhotoniCare wins Startup Challenge

Cancer-fighting technology bags Prism Award

A single-cell sequencer for cancer phenotyping, quantum cascade laser (QCL) remote gas analyzer, and a high-resolution lidar system for autonomous vehicles were among the winners at last night's tenth-anniversary Prism Awards, held at San Francisco's Marriott Marquis hotel.

Honored for their pioneering work across ten different commercial technology categories, the winning companies collected their prizes at a black-tie gala dinner hosted by Photonics West organizer SPIE and Photonics Media, with Hamamatsu CEO Akira Hiruma, Trumpf vice chairman Peter Leibinger, and BMWi Ventures managing partner Uwe Higgen among the VIPs presenting.



Sunnyvale, California, company QuantumCyte picked up this year's Prism for life science instrumentation. Its "Q1 ArraySeQ" single-cell sequencer is described as the first high-throughput single-cell analysis platform to correlate gene expression with phenotypic data. "QuantumCyte's next-generation optics allows imaging and analysis of phenotypic markers on single cells," states the firm. "Researchers are now able to visually link phenotypic data to gene expression data for each single cell, providing simple, precise, and repetitive reagent transfer."

Winning its second Prism Award was Massachusetts-based Block Engineering. Its "LaserWarn" remote gas sensor, based on QCL technology and designed to give early warning of chemical warfare agents or the release of toxic industrial chemicals, won in the environmental monitoring category.

Another US company to claim a Prism was Luminar Technologies, whose latest lidar system for autonomous driving can be witnessed on board a Mercedes SUV parked inside the Moscone Center's North Hall this week. At the recent Consumer Electronics Show in Las Vegas, the company demonstrated the technology on board an 18-wheeled truck.

In the illumination and light sources category, SoraaLaser — the company co-founded by Nobel laureate Shuji Nakamura — won thanks to its LaserLight Fiber Module, which exploits the advantages of semi-polar gallium nitride semiconductor material to deliver industry-leading performance.

Among the European winners this year are Class 5 Photonics, the high-power femtosecond laser company spun out of the Deutsches Elektronen-Synchrotron (DESY) facility in Hamburg and Helmholtz Institute Jena. Class 5's "Supernova" laser, an optical parametric chirped pulse amplifier (OPCPA), triumphed in the lasers category.

Also based in Germany, though now owned by China's Focuslight Technologies, LIMO claimed the Prism for material processing and additive manufacturing with its "Activation Line" beam shaper. "The Activation Line produces long, narrow laser lines with precise beam parameters," states the firm. "This line beam shaping can be perfectly adapted to fit the customer's individual application and process needs."

Another German company, this time AdlOptica, picked up the Prism for optics and optomechanical components. Its versatile "foXXus" lens is capable of generating multiple foci, while NKT Photonics-owned LIOS was victorious in the detectors and sensors classification with its "EN.SURE" power cable monitor.

Rounding off the awardees were the Tyco-backed Israeli startup ContinUse Biometrics, whose health monitoring sensor won the medical diagnostics and therapeutics category, and New York's Spheryx, whose "xSight" prevailed in the test and measurement section.

MIKE HATCHER

DON'T MISS THESE EVENTS TODAY.

INDUSTRY EVENTS

PHOTONICS MARKET UPDATE
(9:15-9:45 AM, Room 21, North)

PHOTONICS WEST EXHIBITION
(10-AM-4PM, North and South Halls)

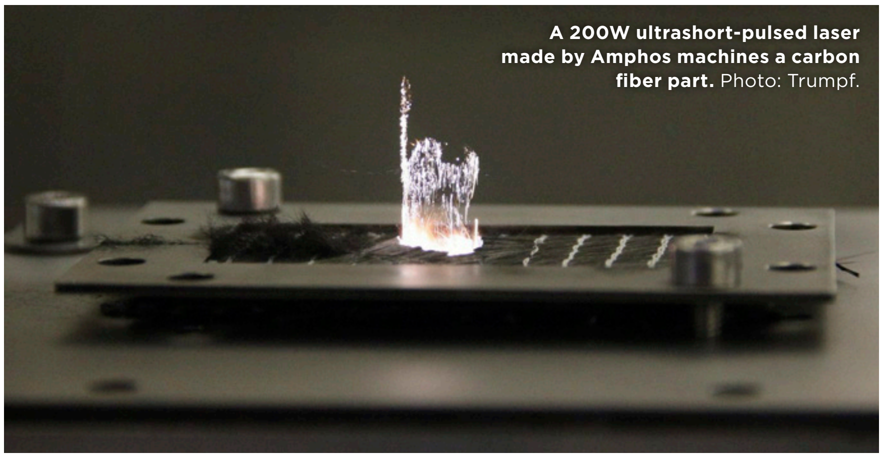
LIGHTING THE PATH TOWARDS AUTONOMOUS MOBILITY
(11 AM-12 PM, Room 21, North)

STARTUP ALLEY
(11 AM-12:30 PM, Demo Area, North Hall)

See the technical program and exhibition guide for more details on daily events. Conference registration may be required. Industry events are open to all registration categories, except where noted. Read daily news reports from Photonics West online: spie.org/PWnews.

IN THIS ISSUE.

Exhibition news, p 04



A 200W ultrashort-pulsed laser made by Amphos machines a carbon fiber part. Photo: Trumpf.

Trumpf snaps up Amphos

Trumpf (booth #817) has acquired fellow German laser manufacturer Amphos (booth #4853), an ultrashort pulsed laser developer that was spun out of the Fraunhofer Institute for Laser Technology (ILT) and RWTH Aachen in 2010. Financial details of the acquisition were not released.

The laser and machine tool giant says the deal will strengthen its portfolio of laser products and technologies. 40-strong Amphos, based in Herzogenrath, near Aachen, has developed high-power ultrashort pulsed lasers for industrial and research applications.

The technology is seen as increasingly important in electronics manufacturing, where the lasers are used to produce items such as printed circuit boards, displays, and cover glass. The key innovation behind the Amphos lasers is the firm's InnoSlab technology, which was co-developed by the company's founders while still a part of ILT.

The Amphos lasers deliver output powers of 200-400 W. The company also offers higher-power lasers for research applications that have an output up to 1.5 kW.

Amphos managing partner Torsten Mans told *Show Daily* that following his request for significant development funding there had been much interest in his company from several big industry names — but that Trumpf was the best option for all concerned.

"I believe that we will retain the Amphos brand as we have established a good network of customers in the past eight years," he said. "The InnoSlab technology will now allow Trumpf to open up an entire new range of parameters for its ultrashort pulsed lasers."

Christian Schmitz, head of Trumpf's Laser Technology division, commented, "Amphos is an innovative manufacturer of lasers and the market leader in this field. And its managers have been developing industrial lasers for over 15 years. We look forward to exchanging know-how, tapping new sales opportunities, and advancing our technology in the near future."

MATTHEW PEACH

WEARABLE DEVICE PREDICTS MUSCLE EXHAUSTION

A team at the Harvard Medical School has concluded that a simple diffuse optical probe is able to reliably monitor oxygen saturation and predict lactate threshold — where muscles suddenly become very tired — in athletes.

Research fellow Parisa Farzam told a BiOS conference session how the "Humon" wearable sensor, which is made by Massachusetts Institute of Technology (MIT) spin-out Dynometrics and is based around dual-wavelength operation, compared with laboratory benchtop kit utilizing eight wavelengths and costing $100,000.

The Harvard team tested the wearable tech on 17 volunteer athletes in a static cycling challenge lasting around 40 minutes, until the athletes were exhausted. And although the Humon sensor yielded different absolute values of oxygen saturation and lactate threshold onset to the benchtop system, it was able to show when the athletes were approaching their lactate threshold, when they had exceeded it, and how quickly they then recovered. "Humon does a good job of predicting that," Farzam said.

She explained that the difference in measured values was partly due to the two probes being tested on different muscles — with the benchtop-based "MetaOx" monitoring the right thigh muscles, and Humon applied to the left thigh muscles.

Following the trial, Farzam concluded that the Humon sensor, which is based around diode emitters at 690 nm and 800 nm, is able to report oxygen saturation changes in local muscles, and can be used to predict the onset of lactate threshold — suggesting that athletes could use the wearable technology to adjust their effort levels to avoid exhaustion.

MIKE HATCHER

AIM TEAM DEVELOPS SARIN GAS SENSOR

A new sensor for deadly sarin gas has been developed as a chemical warfare tool by an AIM Photonics team, with a goal of extending the technology to broader market applications.

The results were described by AIM partners on Monday at the Frontiers in Biological Detection conference session covering integrated photonics. Session chair Benjamin Miller, the AIM Photonics academic lead and a professor at the University of Rochester Medical Center, said the sarin sensor illustrates AIM's goal of producing breakthroughs that will quickly become products fabricated for industrial markets.

The challenge, said Miller, was getting enough of the sarin gas to the waveguide to do the detection and analysis. To solve the problem, the team coated the waveguide with a polymer that helps to concentrate the gas sample.

The headquarters of AIM Photonics, short for the American Institute for Manufacturing Integrated Photonics, was set up in 2015 in Rochester, New York, to forge closer links between industry and academia. The sarin gas detection project began in early 2017.

Details on the sensor for sarin gas, which was used in chemical attacks notably in Japan and Iraq and quickly chokes its victims, were presented by Todd Stievater, a research physicist at the US Naval Research Laboratory, along with AIM collaborator Scott Holmstrom from the University of Tulsa. Rather than using actual sarin gas, the project worked with simulated chemical warfare agents.

"AIM will work not just with sarin but also with other chemical warfare agents and will provide general purpose sensors, for all gases," said Miller. "AIM is looking at several general-purpose sensors, for chemical and biological sensing, and for solution-phase detection of analytes."

In a next step, all the sensors will be combined on a chip featuring spectrometers and lasers. And it will then become a fully integrated tool for non-defense applications, including medical diagnostics and point-of-care uses in a doctor's office, Miller predicted.

FORD BURKHART

Leti's lens-free microscope promises faster meningitis test for earlier diagnosis

Researchers at Leti in France have built a proof-of-concept lens-free microscope that promises to improve screening for meningitis in its early stages of development. Current methods for diagnosing the various forms of the disease, which vary greatly in virulence and can swiftly turn from mild symptoms to a life-threatening condition, require a spinal tap of cerebrospinal fluid, and take up to 48 hours to give a result — by which time a victim could be dead.

Cédric Allier from the development team told BiOS conference delegates that optical techniques need to be able to spot white blood cells at a concentration of ten per microliter to be effective. The Leti researchers built a lens-free microscope comprising a red-green-blue array of LEDs, 10.5 megapixel CMOS sensor, and cell-counting chamber to detect the cells using holographic image reconstruction.

Though initially unable to distinguish between red and white blood cells, Allier said that this problem has since been overcome by observing different z-profile characteristics.

They have recently been testing the system clinically at a hospital in Marseille, analyzing cells in the blood of 215 patients, of which 15 were known to have meningitis. Allier indicated that while not a blind test, initial results look promising. "We established the proof-of-concept that an adapted lens-free microscope protocol could be used in laboratories instead of conventional cell counting."

With computation times now reduced to less than a minute for each sample, Allier told the conference that an automated version of the approach could make meningitis screening both faster and significantly less labor intensive.

MIKE HATCHER

Quantum panel sizes up commercial opportunities

Tuesday's industry event "How Global Investment Is Bringing Quantum Technologies to the Marketplace" brought together a diverse group of photonics and quantum experts. Guided by moderator Anke Lohmann, an expert panel ruminated on how and when this emerging sector might yield significant business.

Lohmann holds an interesting position in this cross-cutting field, having helped develop the UK's Quantum Technologies Special Interest Group, funded by the UK government as part of its National Quantum Technologies Programme. Until last year, she had been co-ordinating the UK's national photonics platform under the Knowledge Transfer Network.

Panelists included Rishiraj Pravahan, data scientists at AT&T Foundry, Robert Rölver from Bosch, Gooch & Housego senior VP Andrew Robertson, VDI Technologiezentrum consultant Lars Unnebrink, and Qiang Zhang, a professor at China's University of Science and Technology.

The session gave a snapshot of the investments now being made globally, and how that funding is focused in each country. The subsequent panel discussion with an engaged audience considered how quantum technology development can be moved forward — progress that will inevitably depend on a diversity of photonics technologies.

On current activity, Pravahan warned: "In the US today there's already a combined effort involving government, academics, industry, and investors to develop quantum technology. We are at the start of a bubble and we need to be careful that we don't oversell this technology."

But commenting on the apparent take-off of the emerging quantum sector, he added: "There has been a lot of progress in the academic community. In 2016, there were more quantum academic papers published than in the preceding three years. This positive atmosphere is making the quantum sector seem more viable."

The panel agreed that there also seemed to be increasing international pressure, with competing efforts in Asia, Europe, and the Americas.

Rölver contrasted the current enthusiasm for quantum with the previous false start, as he saw it, made by nanotechnology, which he considered had not achieved its anticipated impact. "We are now focusing on quantum as a good opportunity and it helps that we have the financial backing of our management," he said.

Robertson echoed the earlier sentiment that recent academic progress in quantum was a catalyst for commercial activity. "Quantum is a photonics- and optics-rich sector," he said. "We are now seeing a lot of PhD students with quantum experience coming into the industry. A lot of people are frightened of the word quantum but you don't actually need to know how it works to make money out of it."

UK-headquartered Gooch & Housego feels it has come into the quantum sector relatively early, and Robertson believes that this is a consequence of applying quantum thinking to the company's range.

Quantum market opportunities were "infinite", said Robertson, citing quantum optical clocks, timing applications for navigation, military, and sensing applications, secure communications, and encrypted time-stamped financial transactions as current and future examples of real commercial activity.

Rölver added that Bosch would initially focus on sensing as a hot market area, while Pravahan favored the much-touted quantum computing sector.

Unnebrink commented that there are already a lot of data and results showing the market feasibility of quantum technologies. On financing he said, "We realize that we cannot be late to this party. Government money is an enabler that allows researchers and startup companies to take the necessary risks."

Unnebrink added, "The quantum bubble is about to start growing but there is a solid backbone that makes me quite comfortable in investing in this area."

Wrapping up, Lohmann suggested that quantum already seemed to be a better bet for investment than nanotechnology or even graphene: "The feeling I get with quantum is that there is an even greater opportunity," she said.

MATTHEW PEACH

Anna Lena Baumann of Fraunhofer HHI has developed the CyberGlove. It captures finger motion using fiber-optic sensors. See it at booth #4529. Photo: Matthew Peach.

Neta seeking support for twin-laser photoacoustics

Bordeaux, France, startup Neta, part of the Alpha-RLH, cluster at this year's Photonics West, says that it is seeking to democratize the complex world of laser photoacoustic technology with its "JAX-M1" turn-key system. The pump-probe setup is based around two synchronized ultrafast lasers with no delay line.

CEO Julien Michelon, who previously worked at Bordeaux laser firm Amplitude Systèmes before co-founding Neta with two partners, says that the key advantage of the system is its speed: he claims it to be 10,000 times faster than single-laser approaches. Applications ranging from non-destructive measurement of the mechanical properties of single cells, to silicon wafer characterization, are envisaged. Michelon emphasizes that the Neta strategy is to deliver a turn-key, user-friendly system, that researchers can put to work with immediate effect.

Self-funded by Michelon and his co-founders to begin with, Neta has attracted financial backing through a national research challenge in France, and after making its first sale now employs six people. That could be set to grow, with the CEO now working to attract venture investment of around €1.5 million to push the development of a system capable of making high-speed photoacoustic "movies" — something that could yield unprecedented insights into cell mechanics.

MIKE HATCHER

AROUND THE EXHIBITION

Egypt-based Prism Awards finalist **Si-Ware Systems** is showing off its second-generation "neospectra" infrared sensor with a novel set of demonstrations on the theme of a "smart" kitchen. With the sensor built into the kitchen worktop at booth #4461, marketing lead Ahmed Korayem and colleagues are able to analyze liquids, solids, powders and gases alike. Examples include distinguishing powdered spices, full-fat, skimmed, and half-and-half milk, and determining the gluten content of flour.

Si-Ware says that it has reduced the volume of its second-generation neospectra package by around 60 times compared with its predecessor, and is aiming the component at high-volume consumer applications. Korayem says that production is set for a ramp in the second quarter of this year, with target volumes of 100,000 units and a long-term target price below $100.

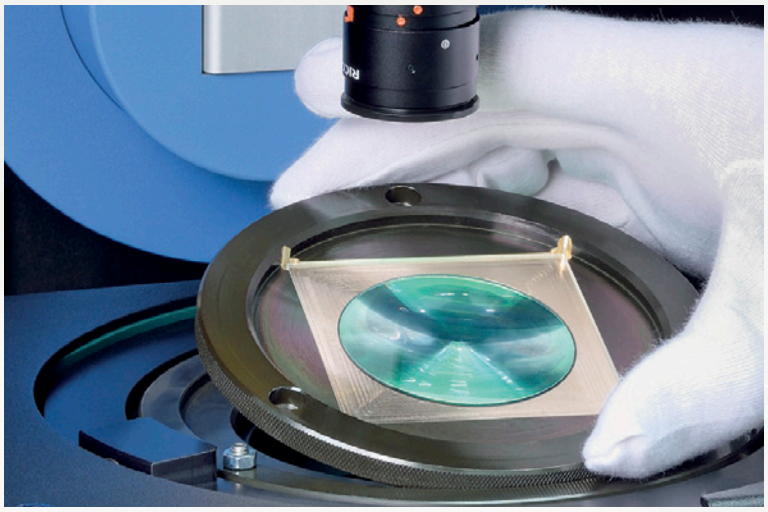
Japan's **Calmar Laser** is showcasing its new battery-powered picosecond fiber laser, aimed at applications in high-resolution lidar and 3D sensing, at booth #1619. The "Mendocino" laser operates at the eye-safe wavelength of 1550 nm and produces 10ps pulses while consuming less than 3W power, provided by a 3500mAh lithium-ion battery. The passively air-cooled source delivers more than 5mW output at a 10Hz repetition rate.

At booth #1123, laser giant **Lumentum** is highlighting its efforts in the 3D sensing sector. On view are examples of collaborations with partners Orbbec, Occipital, and Texas Instruments. The "Astra Mini" depth-resolution camera from Orbbec features Lumentum diode lasers, has a range of 0.6-5 m, and is aimed at gesture control applications. Lumentum's diodes can also be found inside Occipital's structure sensor, designed for mobile devices and aimed at 3D scanning applications, large-scale mapping of rooms and buildings, and inside-out positional tracking for AR/VR headsets. The California firm is also showcasing its latest 9.4kW Corelight fiber laser engine.

MIKE HATCHER

TRIOPTICS

See the Difference.



Measurement Station for Virtual Reality Optics

ImageMaster® Lab VR

Efficient Automated Alignment of Doublets with Air Manipulator

OptiCentric® 3D 100 with
LensAlign 2D Air and Vacuum Unit

Innovative Technologies:

Universal Power and Wavefront Testing for Free-form Lenses

UniWave: New Technology Unbeatably Fast

High-speed Centration Measurement

OptiCentric® Linear: Rotation-free Inspection of Position-sensitive Lenses

www.trioptics.com

Visit us at
Booth #1330

Killer potential: time to raise the profile of QPI

Can quantitative phase imaging help combat dementia and find a cure for cancer? The technology is set but developers need to increase awareness among biologists, hears Rebecca Pool.

Early last year, physicists led by Gabriel Popescu from the University of Illinois at Urbana-Champaign (UIUC) revealed stunning footage, several hours long, of the minuscule microtubules so very critical to cell division and nervous system health.

Only months later, the UIUC professor and his collaborators had delivered 3D images of live cow embryos, a breakthrough for clinical scientists striving to select healthy embryos for *in vitro* fertilization.

Critically, in each case the biological structures were captured label-free, providing crisp, clear, high-resolution imagery — and a wealth of information on structure, growth dynamics and more. Welcome to the wonderful world of quantitative phase imaging (QPI).

The term QPI covers myriad methods that measure how much light is delayed through a specimen at each point in the field of view. This optical path length — or phase information — relates to a sample's refractive index and thickness, enabling detailed studies on cells and tissue.

Popescu first realized the potential of QPI in the late 1990s. Working on his PhD at the College of Optics and Photonics (CREOL), University of Central Florida, he was combining light-scattering techniques with interferometry and phase measurements to analyze inhomogeneous media, including tissue, as well as blood coagulation.

By 2006, and now at the Massachusetts Institute of Technology's G.R.Harrison Spectroscopy Lab, he had developed some key QPI techniques. Fourier phase, Hilbert phase, and diffraction phase microscopies were all designed to extract quantitative phase images from dynamic biological phenomena. A year later Popescu was honing his methods to explore nanoscale fluctuations in red blood cells, vibrational changes in malaria-infected cells and more, while heading up the Quantitative Light Imaging Laboratory at UIUC.

Crucially, and like many in the QPI field, usability was at the forefront of Popescu's mind. In his earlier years at UIUC, he and colleagues developed a "spatial light interference microscopy" (SLIM) module that could be attached to the camera port of a conventional microscope for diffraction tomography. The module converted interference patterns, recorded by a CCD device, to quantitative phase images, giving sub-nanometer path-length sensitivity, and, crucially, generating high-resolution images of unstained cells.

But as Popescu points out: "We had realized that if we continued to use SLIM as it was, we would be the only ones that could use it, as it was occupying an entire optical table and required PhD students to run it."

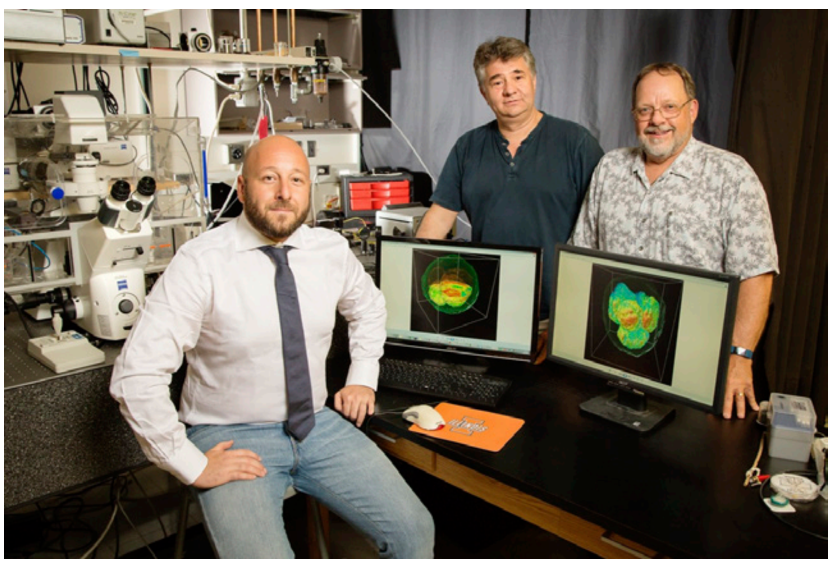
He adds, "I wanted it to be accessible to biology users, without this engineering factor, and have it operate at the push of a button, like any of the major brand microscopes."

So, in 2009, Popescu set up the company Phi Optics to commercialize SLIM. By 2014 its first prototype, the CellVISTA SLIM Basic, was launched. The automated "Pro" version followed in 2015, and could be combined with fluorescence imaging.

"The Pro system allows the user to program different channels of fluorescence while using SLIM at the same time," says Popescu. "This is so important to biologists."

Popescu and his team are not alone in their quest to push the usability of QPI methods for biologists. Belgium-based Ovizio Imaging Systems, along with Phasics in France, Tomocube in South Korea, the Swiss pair Lyncee Tec and Nanolive, and UK-based Phase Focus, are all now delivering market-ready products for label-free cell imaging.

Sweden-based Phase Holographic Imaging is another. Launched by chief executive Peter Egelberg back in 2004, it aims to provide long-term, label-free quantitative analysis of living cell dynamics. After years of persistent research and development, the company today supplies automated, affordable time-lapse cytometry.



Gabriel Popescu (center) and collaborators produced 3D images of live cattle embryos that could help determine embryo viability. Credit: L. Brian Stauffer.

Right from the start, Egelberg and his team wanted to make the instruments simple, reliable and easy to use. The company's initial prototype, HoloMonitor M1, was delivered in 2004, followed in 2008 by a miniaturized QPI module attached to a Nikon microscope — the HoloMonitor M2.

"We placed six M2 units at Lund University but soon realized that we needed to redesign the software and the instrument itself," highlights Egelberg. "The setup was still too complex and way too expensive, and we were

continued on page 09

QPI

continued from page 07

never going to make any money out of it."

The company launched the HoloMonitor M3 in 2011, having set about designing an even smaller, cheaper instrument that, this time, could operate inside a cell incubator for long periods of time — a huge draw for biologists.

"Reducing field-rate failures took some time," recalls Egelberg. "For example, we had to switch to optically-coated components that would deter the formation of micro-organisms. But we increased the mechanical and electronic quality of the instrument, and delivered HoloMonitor M4 in 2014."

Four years on, and Phase Holographic Imaging has sold around 100 of those instruments worldwide. Recent examples include a HoloMonitor Wound Healing Assay that provides data on cells migrating around a wound area, including individual cell tracking information.

Clearly success has ensued but as Egelberg points out: "When you are not working with these instruments on a day-to-day basis, you just don't realize how much can go wrong. We're a small company that uses distributors so we really need to try and keep everything super-simple and reliable, otherwise these sales representatives will simply sell something that they are more confident selling."

Killer applications

Physicist YongKeun 'Paul' Park is a professor at the Korea Advanced Institute of Science and Technology (KAIST), and also co-founder and CTO of Tomocube. He has a slightly different take on QPI. Tomocube has focused on 3D imaging, launching its HT-1 and HT-2 products with fluorescence imaging. They generate high-resolution 3D refractive index tomograms, with example videos of unlabeled single human sperm and cancer cells. Park's team has also combined its platform with a deep convolutional neural network, 'HoloConvNet', designed to classify holographic images of unlabeled living cells.

Park also reckons his company's technology will be used in biofuel applications, to quantify lipids within bacteria and algae. He adds: "[Our technology] is also accessible to medical doctors and biomedical scientists for easy, rapid, and accurate point-of-care diagnosis of pathogens."

Probing deeper

Popescu and his team at Phi Optics have also branched out from their SLIM technology mainstay, launching "gradient light interference microscopy" (GLIM) in late 2017. The GLIM module can be implemented to existing inverted microscopes, and extracts 3D information from unlabeled specimens whether thick or thin.

As Popescu points out: "Light scatters in specimens that are hundreds of microns thick, so essentially we have been trying to image these thicker specimens through a cloud; indeed, the majority of other instruments in this space are used for thin samples."

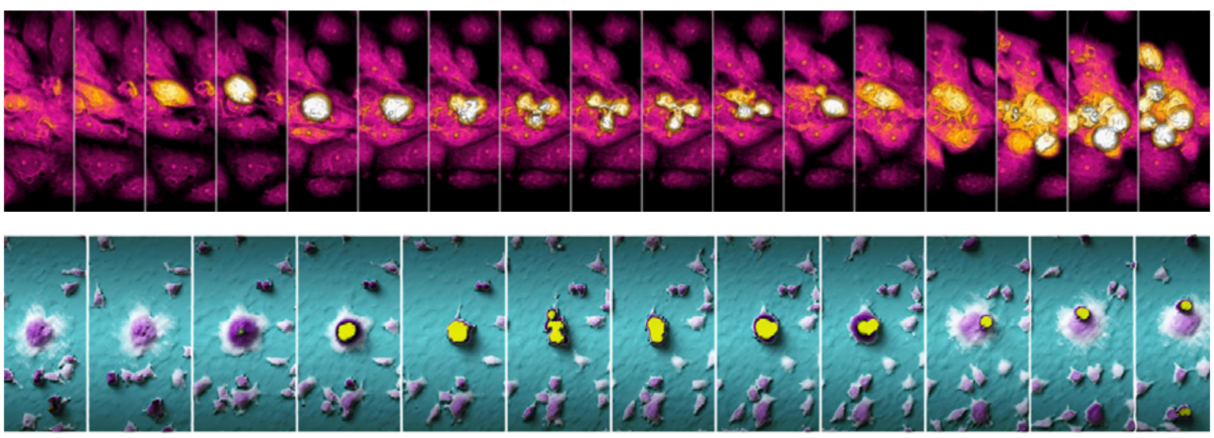
GLIM probes deeper into thick samples by controlling the path length over which light travels through the specimen, allowing users to generate images from multiple depths that are then composited into a single 3D image.

Popescu is convinced this label-free imaging modality will find applications in *in-vitro* fertilization, and has already released detailed images of bovine embryos monitored over several days. And he has high hopes that the method will also be adopted by neuroscientists.

"Brain slices 300-500 microns thick need to be modeled for connectivity over several hours," he points out. "Before GLIM, these were very difficult to image but right now we are looking at this; the method is really opening up new, complementary applications for us."

But as applications proliferate, without a doubt, cancer research remains as important as ever for QPI companies. Popescu: "Look at the way you can get incredible resolution and beautiful images with single cells, as well as quantify cell growth, which is so difficult to measure otherwise."

Importantly, in the last year or so, many in the field



Captured using Phase Holographic Imaging kit, the top sequence shows a highly unusual event; a cancer cell dividing into three daughter cells. The daughter cells then also divided in three. This new information led to the development of improved child cancer treatment. The bottom sequence shows a cancer cell "budding" a daughter cell; another highly abnormal process. Credit: Phase Holographic Imaging.

"The vision of our company has not just been to provide instrumentation," highlights Park. "I believe [that] in a decade, microscopy platforms will be digitized, automated and also powered by artificial intelligence... so we have been developing that artificial intelligence power."

Indeed, after training with QPI images, HoloConvNet can accurately identify single cells including bacteria such as *listeria* and *E. coli*, as well as anthrax spores, outperforming methods such as optical fingerprinting and surface-enhanced Raman scattering.

Beyond combating terrorism and deadly bacteria, have realized that the phase maps produced by QPI methods can present a wealth of information on cancer diagnosis, prognosis and biopsies. As a result, many groups are now working on QPI-based pathology, with Popescu's lab also combining artificial intelligence.

"[QPI methods] analyze the same thin biopsies used in traditional pathology, and our lab has imaged many thousands of these biopsies on several different types of cancer," he says. "Importantly, we have found that there actually is a lot of information in the collagen and

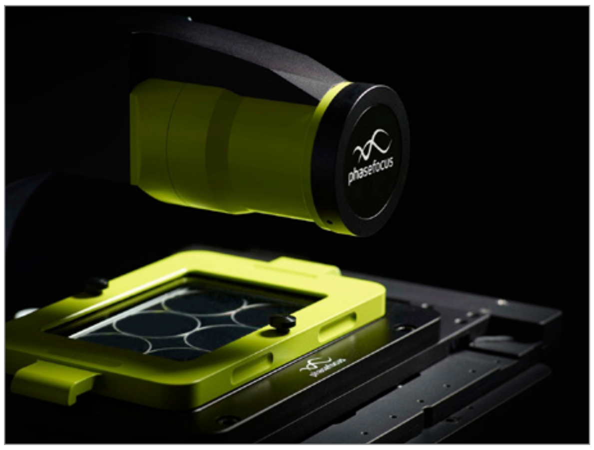
continued on page 11

QPI continued from page 09

the stromal tissue surrounding the tumor that hasn't been accessed in the past by traditional stained pathology."

For Egelberg, cancer biology is also of paramount importance. He noted: "We have other fields such as stem cells and immunology but cancer research is totally dominating."

Egelberg firmly believes that QPI methods will prove instrumental to providing the final cancer cure. "When cancer develops, the controlling mechanisms that have evolved to make cells collaborate have been displaced. The cells start to multiply uncontrollably as their ancestors did a billion years ago, and as micro-organisms still do today," he points out. "Cancer researchers don't really understand why this takes place and need to move from studying at a cellular level to a cell population level."



Label-free kinetic cytometry equipment from the UK company Phasefocus. Credit: Phasefocus.

Right now, Egelberg's company is developing software to automatically extract more detailed information from the time-lapse movies of cells captured by the HoloMonitor M4. In addition to current applications, he would like to provide easy-to-obtain, label-free quantitative cell culture information on viability, division rate, mitosis duration and more.

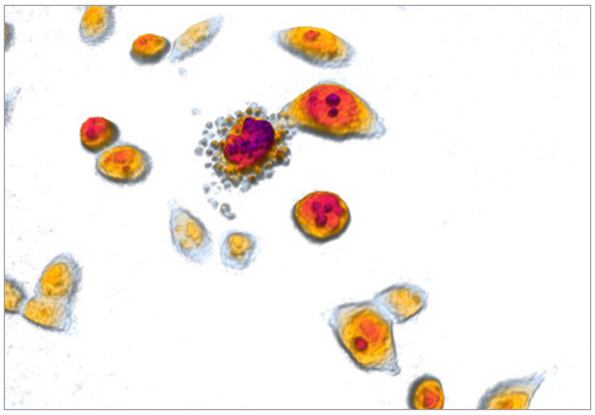
Importantly, Egelberg reckons that if researchers could automatically map thousands of cells throughout cancer treatment, identify and extract the surviving cancerous cells and then study these cells still continuing to divide, a cure for cancer could be clearer.

"Our goal is really to make a contribution to cancer research, and we can do this with commercial success," he emphasizes. "If we are commercially successful, that means we've created a system useful for cancer researchers, and hopefully this will lead to a cure for cancer. Personally, this is why I am involved in QPI."

Like others in his field, Egelberg is certain that software will be critical to future commercial success. He started his company with the QPI technology at the forefront of his mind, but points out: "We assumed that everyone would understand all of this but that just isn't the case. So what we are really doing now is adapting the software so the technology can be more easily used by cell biologists."

Where next for the wonderful world of QPI? Belgium's Ovizio, regarded as a frontrunner, has established a platform for label-free cervical cytology and is set to launch a rapid, low-cost, screening test for cancer.

Over in the UK, Phasefocus has built on the 2016 launch of its "Livecyte" label-free cell analysis platform by expanding distribution chains, and recently penetrated China. CEO Martin Humphry is looking forward to the QPI sector gathering momentum and continuing to enter more conservative markets such as pathology and pharmaceuticals.



Cells in 3D: the central cell is undergoing cell suicide, known as apoptosis. Cerdit: Phase Holographic Imaging.

"Academic sales are leading to more research publications that highlight specific applications," he points out. "This will lead to the technology becoming accepted as a must-have in the more conservative pharma sector, for example, that generally wants a more push-button solution."

Indeed, as Popescu also highlights, Phi Optics' strategy has been to build awareness and sell commercial instruments to the research market while building the necessary performance data for those more conservative sectors.

"The clinical market demands huge amounts of data and validations and this can take years to realize," says Popescu. "But just last year, and for the first time, a whole slide imaging system from Philips used in pathology was approved for clinical diagnostics." He predicts that this milestone will open up pathology: "And I think there will be a special place for QPI in there," Popescu added.

Tomocube's Park also sees more medical doctors adopting the technology. "For the last ten years, this field has been driven by engineers, but to find the killer applications we need the medics to join us, and come up with ways to use our products and images to facilitate diagnosis," he told *Show Daily*.

Without a doubt, today's over-arching challenge for QPI companies is to raise the market profile of the technology in general. While academics have wholeheartedly embraced the technique, industry peers have yet to raise an eyebrow.

"The interest is massive in academia," says Popescu. "Look at the number of papers we have received for this conference alone. Yet 99% of potential biology users in industry don't even know that QPI exists; so we need to go to shows and make demonstrations worldwide to raise awareness and increase market adoption."

Egelberg agrees. In his words, most of the cell biologists that his company targets "don't have a clue" what QPI is. "From very early on, we have been reducing our manufacturing costs and to reach volume sales, we're targeting these end users directly," he says. "But this field is now getting more attention and this is very beneficial for all of us."

He concludes: "If you are the only company in a field you have a hard time attracting customers and investors. To reach success we need many companies working on the technology, or it simply isn't going to happen."

REBECCA POOL

SPIE unveils updated industry analysis

Exhibitor Breakfast attendees will see latest update to SPIE's photonics market study, based on 2016 revenues.

SPIE's Steve Anderson will present the latest market figures at the Exhibitor Breakfast. Photo: SPIE.

The business of making and selling core photonics components and materials continues to grow while supporting a global photonics-enabled marketplace that's been pegged at somewhere between $7 trillion and $10 trillion annually and touches almost every aspect of our daily lives. The upward trend seems likely to continue as novel ways to solve problems with light-based technology keep emerging. Recent examples range from mixed reality (AR/VR) systems to self-driving cars, and from horticultural lighting to new cancer therapies.

At Photonics West in 2016, the SPIE industry team presented an analysis of the core photonics components business for years 2012 and 2014. It provided a unique look at the structure of the global industry, characterizing its size, company composition, geography, employment, and related trends. This year, we will provide an update to the industry study based on actual revenues in 2016, as part of this morning's Exhibitor Breakfast event in Room 21.

The past couple of years have been good ones for the optics and photonics industry. Many of the established firms have reported stellar sales and profits, and their order books continue to grow. Photonics giants like Trumpf, Carl Zeiss, and IPG Photonics have all posted new sales records, while the Rofin-augmented Coherent saw its 2017 revenues more than double, to $1.72 billion.

The prevailing strength of the global economy has certainly helped boost performance, but a diverse array of other factors underpins these results. Companies large and small are reaping the benefits of previous investments into new markets.

Examples of key enabled market performance over the past year include semiconductor fab equipment, as worldwide spending jumped more than 15% between 2016 and 2017, and the life sciences sector, where genomics giant Illumina reported year-on-year growth of 18% for its third quarter. In defense, Northrop Grumman and Lockheed Martin have each reported solid gains.

Also driving new revenue gains is investment in emerging applications, a trend that serves to strengthen the photonics business by diversifying the revenue base across multiple industries and pushing designers to come up with innovative products to meet specific needs.

As recently as December Apple, whose iPhone X facial security feature relies on VCSELs, said it would support device production at Finisar to the tune of $390 million in "anticipated future purchases" – further underlining the growing importance of photonics components at all levels, including consumer products.

Here at Photonics West you can explore the emerging applications for yourself. They include lidar for autonomous mobility, AR/VR systems, and the continuing advance of additive manufacturing/3D printing. All these applications have attracted huge investments by Fortune 500 companies and others. All have challenged optical designers to innovate and come up with new components. And all will drive significant future demand for photonics components.

The trickle-down effect is pushing the photonics components business to new highs, with measurable increases in both the number of companies involved and their global sales. According to our new analysis, the number of companies grew by 4% in 2016, while global revenues of core optics and photonics components increased by more than 10% between 2014 and 2016 and look set to keep increasing at double-digit rates. I will share more details from our new industry analysis at this morning's Exhibitor Breakfast event.

STEVE ANDERSON

METHODOLOGY: COLLECTING THE DATA

SPIE's assessment of the world's optics and photonics components industry is based on a comprehensive "bottoms up" review of companies that manufacture and sell core photonics components like LEDs, lasers, image sensors, lenses etc. We use raw company data to build an industry profile using a four-step process that relies on our expert knowledge of the industry.

First, we identify relevant companies. The list initially includes any commercial entity that has exhibited at one or more of about 30 photonics events worldwide in 2012, 2014, or 2016. We then exclude any entity that does not make and ship photonic components, for example media outlets, distributors and reps, government labs and consultants. For 2016, this process netted 3323 unique commercial entities making and shipping core components.

For each firm we then compute total sales and jobs for the year in question. Public companies file this data regularly. For private companies we use data from Dunn & Bradstreet (D&B), the company's own website, and regional statistical benchmarks derived from the D&B analysis.

Next we look for anomalies like "out of range" data and determine if it's real. For the larger companies that operate in multiple business sectors, we pro-rate revenues and employment based on estimates of actual photonics-related sales. For practicality, we assume that all companies with annual sales of less than $10 million are 100% photonics.

The net result, now in its third iteration, is the *Core Optics and Photonics Industry Assessment*, and the results will be shared in detail at Photonics West.

Zerodur: 50 years of milestones

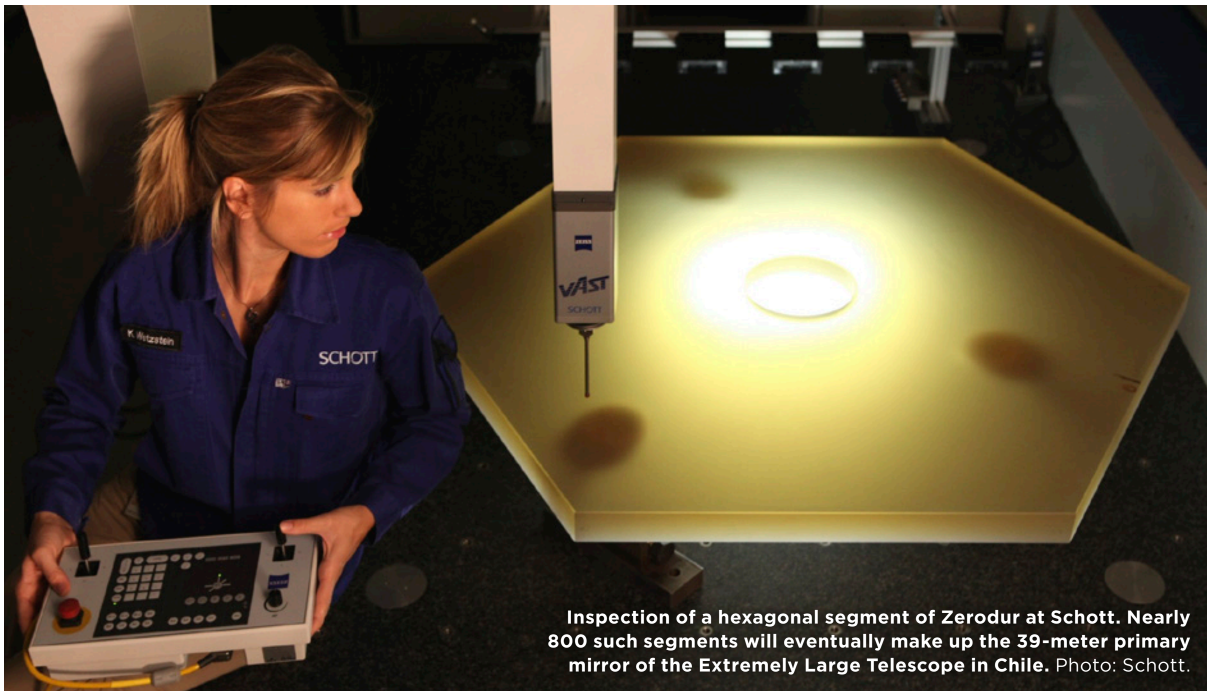
From telescope mirrors to flat-panel display production, low-expansion Zerodur has built up an enviable reputation.

In the early 1960s, German astronomy was falling behind. At the time, the Hale Telescope atop Mt. Palomar in southern California reigned supreme. With a diameter of 5.1 meters, it was the largest in the world, dwarfing the best Germany had to offer: a 1-meter telescope at the University of Hamburg that was already half a century old.

German astronomers needed to catch up. Over the next few years, they set out to build new instruments and telescopes, and would establish a series of Max Planck Institutes in astrophysics and astronomy.

For a telescope to compete with the world's best, in 1966 Hans Elsässer, director of the observatory at the University of Heidelberg, sought the help of a German glass company called Schott. Could they, he asked, fabricate a 4-meter telescope mirror? Schott had recently started working with a new class of promising materials called ceramic glass, which Stanley Donald Stookey of Corning had invented in 1957. It's now a common material found in casseroles and other cookware.

After a couple years of tinkering, Schott came up with the right ceramic glass for telescope mirrors, and called it Zerodur. In 1968, the company agreed to build a 3.6-meter mirror blank and several smaller mirrors for the Max Planck Institute of Astronomy's Calar Alto Observatory in southern Spain.



Inspection of a hexagonal segment of Zerodur at Schott. Nearly 800 such segments will eventually make up the 39-meter primary mirror of the Extremely Large Telescope in Chile. Photo: Schott.

Now 50 years on, Zerodur mirrors can be found in 16 of the world's largest active telescopes, giving astronomers new windows into the mysteries of the cosmos. Zerodur continues to be the material of choice for many telescopes, as well as for commercial applications such as microlithography and the fabrication of flat-panel displays (FPDs).

Unique properties

What makes Zerodur unique is that it barely expands when heated. A meter-thick piece of the lightweight glass will expand by only 0.7 nanometers when heated one-tenth of a degree Celsius. The material is embedded with tiny crystals just 50 nanometers across. When heated, the glass expands but the crystals contract, resulting in a material with an extremely low coefficient of thermal expansion — perfect for telescopes, which must be stable despite large fluctuations in temperature.

That's especially true for solar telescopes, which need to withstand the heat of direct, focused sunlight. Examples include the Daniel Inouye Solar Telescope in Hawaii and the Big Bear Solar Observatory in California, both of which use Zerodur. Other Zerodur telescopes include SOFIA, the 2.7-meter infrared telescope that sits onboard a Boeing 747, the 8.2-meter monolithic mirror on the European Southern Observatory's (ESO's) Very Large Telescope in Chile, and the Chandra X-ray telescope, which has been studying black holes from space since 1999.

Another important property is the material's homogeneity. Even when it does expand, it does so evenly throughout. Zerodur's LiO_2-Al_2O_3-SiO_2 composition has remained the same, even after five decades. But over the years, Schott has refined its techniques and capabilities.

"The developments we've seen in 50 years are so tremendous that nobody could have predicted them in advance," said Peter Hartmann, principal scientist for optical glass at Schott. "Even 10 years ago, if you asked me [about] all the things that are possible that are now routine, I would have said 'forget it.' I'm very confident that in the next 10 years, we'll see additional developments."

Milestones

The first major development, Hartmann says, was simply that initial ability to fabricate a mirror blank as large as four meters. The next milestone came in the 1980s, when Zerodur was chosen for the twin Keck telescopes in Hawaii. The primary mirrors span 10 meters, but are each composed of 36 separate segments 1.8 meters wide, requiring a replicable process that can produce many identical mirrors. "It's something that people usually totally underestimate," Hartmann said.

In the early 1990s, Schott developed methods to grind the material without chipping or damaging it, enabling formation of more complex structures beyond simple discs and meniscuses. This was crucial for commercial applications such as microlithography, because to etch patterns on a silicon wafer, a support structure must hold it with extreme precision. Only a material that's as stable as Zerodur will work — and only if you can build it into the proper form.

Other advances include the ability to build large mirrors that are still thin enough to remain extremely lightweight: one example is a 1.2 meter prototype that weighs only 12% of an equivalent solid piece. Zerodur can even be tailored for optimized performance within a particular temperature range. "You can calculate the expansion so precisely that we can adjust the material to the temperature profile a customer needs," Hartmann said.

For all its advantages, it isn't the only material on the market. Corning has its Ultra Low Expansion doped glass, used in the Hubble Space Telescope's primary mirror (Hubble's secondary mirror is Zerodur), the exoplanet-discovering Kepler space telescope, and the WFIRST space telescope slated for launch in the mid-2020s. The Thirty Meter Telescope in Hawaii will use glass from Japan's Ohara, while the James Webb Space Telescope, set for launch just over a year from now, will use beryllium because its cryogenic performance is critical for extreme sensitivity in the infrared.

"All materials have their advantages and disadvantages," said Philip Stahl, a senior optical physicist at NASA's Marshall Space Flight Center. As a NASA employee, he doesn't advocate for any particular material. But, he said, Zerodur has a proven track record. In particular, Schott has proven its ability to make four-meter blanks, which is why Zerodur was selected for HabEx, NASA's concept mission to directly image planets around other stars. Stahl is part of the HabEx team.

Although no material is perfect for every application, Tony Hull from the University of New Mexico rates Zerodur as one of the best. Hull, who has worked in industry and at NASA's Jet Propulsion Laboratory, is now consulting for Schott and working on Cetus, a NASA concept mission for an ultraviolet telescope. "On balance, to me, where high optical finishes are required, [and] high stability against thermal transients is required, I think Zerodur pretty much reigns," he said. "In terms of the cost-effectiveness of Zerodur, I like it a lot."

The cost-effective reputation can be attributed to Zerodur's commercial applications, Stahl said. In addition to microlithography, Zerodur is used for the imaging systems that imprint electronic patterns onto FPDs.

But Zerodur's prime use will continue to be telescopes that probe the edge of the universe. In 2024, ESO's Extremely Large Telescope is scheduled for first light, pointing its 39-meter mirror toward the heavens. Comprising nearly 800 hexagonal Zerodur segments, that primary optic will allow astronomers to explore exoplanets, galaxies, and the nature of dark matter and dark energy.

Hartmann sees Zerodur as an important basic material that sets the pace for technological progress, similar to optical glass. New telescopes, instruments, and devices rely on such foundational materials. "It's the same with Zerodur," he said, "and we hope we can keep pace with technological developments."

MARCUS WOO

the business of photonics

optics.org

celebrating 22 YEARS online excellence

product focus

Photonics West is the premier photonics and laser event. With more than 1,250 companies, this exhibition continues to be the flagship event to find the latest products, tools, and applications for your research or business needs.

SPIE. PHOTONICS WEST

The Moscone Center, Moscone North and South
San Francisco, California, United States

30 January - 1 February 2018

Welcome to the optics.org Product Focus which we have published specifically for Photonics West 2018 in partnership with SPIE and the Photonics West Show Daily.

Here you will find an effective at-a-glance guide to some of the latest products available on the market with booth numbers if available making it easy for you to check out the products for yourself.

All this information and more can be found on the optics.org website. Simply go to **www.optics.org** for all the latest product and application news.

Alternatively, why not sign up to our **free weekly newsletter (www.optics.org/newsletter)** and get the information delivered direct.

Navitar

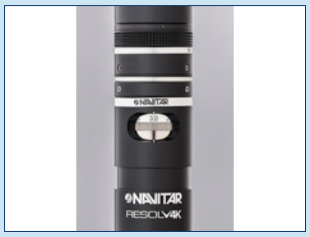
Visit us at Booth #125

Resolv4K Lens System

Navitar's Resolv4K lens system is designed to maximize the usage of modern sensors with higher pixel densities.

The Resolv4K Zoom offers tremendously more resolving power over a traditional zoom imaging system – achieving a 400-600% larger field of view without any loss of detail.

The new Resolv4K Fixed system is ideal for fixed field of view applications with closer working distances and offers higher magnification and resolving power than standard enlarging or SLR lenses in macro mode.



Contact Details

Navitar, Inc.
200 Commerce Drive
Rochester, New York 14623 USA
www.navitar.com
info@navitar.com
Tel: +1 585 359 4000

Nanoscribe GmbH

Visit us at Booth #4368

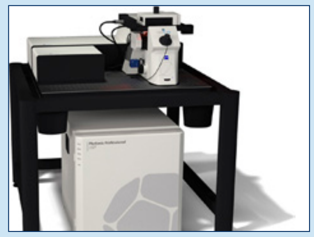
Photonic Professional GT
3D Printer for Nano- and Microfabrication

Nanoscribe´s Photonic Professional GT is the world's most precise 3D printer based on two-photon-polymerization.

It combines additive manufacturing and maskless lithography in one device.

The resolution is approximately 100 times higher than that of stereolithography, submicrometer details down to a feature size of 200 nm are possible, and printed parts with optical quality surfaces can be printed.

This award-winning system sets new standards in a multitude of applications like photonics, micro-optics, plasmonics, micro-fluidics, MEMS, biomimetics and microrobotics.



Contact Details

Nanoscribe GmbH
Hermann-von-Helmholtz-Platz 1
D-76344 Eggenstein-Leopoldshafen
Germany
www.nanoscribe.com
info@nanoscribe.com
Tel: +49 721 981 980 0

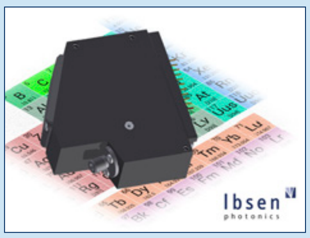
Ibsen Photonics

Visit us at Booth #5232

Ibsen Photonics launches new ultra-compact FREEDOM C spectrometer with improved resolution

The FREEDOM C spectrometers offer a very high resolution; down to 0.15 nm in a small foot print of only 61x65 mm for the UV, VIS and VIS-NIR range. It is equipped with the latest CMOS detector technology with 4096 pixels and a cylindrical lens to increase throughput.

The FREEDOM C can be supplied with Ibsen's own DISB electronics, which offer fast and accurate timing control for applications like LIBS and Raman.



Contact Details

Ibsen Photonics
Ryttermarken 15-21, DK-3520 Farum
Denmark
www.ibsen.com
inquiry@ibsen.dk
Tel: +45 44 34 70 00
Fax: +45 44 34 70 01

ALPhANOV

Visit us at Booth #437

ALPhANOV intoduces a Pocket-size Ultrashort Laser Seeder: PULS

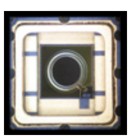
The new laser oscillator developed by ALPhANOV illustrates its expertise in modeling, designing and prototyping innovative fiber laser sources.

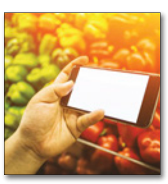
The PULS (Pocket-size Ultrashort Laser Source) is an oscillator offering a unique and monolithic solution for seeding ultrafast laser amplifiers and for applications in multiphoton imaging, laser micromachining and bio photonics.

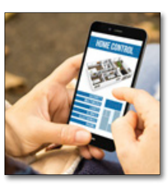
It delivers linearly polarized laser pulses with a nearly Fourier-transform limited pulse duration and a tunable repetition rate in the 20-60 MHz range.

Contact Details

ALPhANOV
Institut d'optique d'Aquitaine
Rue François Mitterrand,
33400 Talence, France
www.alphanov.com
info@alphanov.com
Tel: +33 524 545 200







Spectrum Scientific Inc.

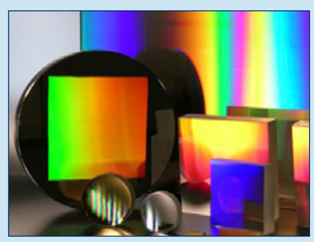
Visit us at Booth #1352

Holographic Diffraction Gratings

Spectrum Scientific, Inc. (SSI) manufactures a range of standard blazed and sinusoidal diffraction gratings as well as supplying OEM customers with high volume, custom gratings.

SSI can replicate a wide variety of holographic diffraction gratings, including plane, convex, concave, toroidal and aspheric gratings. Our gratings are available with blazed or sinusoidal profiles and our proprietary blazing technique offers lower stray light and higher efficiency compared to ion-etched gratings. We are one of the few companies with the capability to manufacture blazed holographic concave gratings.

Website Link URL: http://ssioptics.com/cart/index.php?dispatch=categories.view&category_id=257



Contact Details

Spectrum Scientific Inc.
16692 Hale Ave. Irvine, CA 92606
www.sssioptics.com
sales@ssioptics.com
Tel: +1 949 260 9900

ALPhANOV
Visit us at Booth #437

ALPhANOV launches an Ultra-Compact Electric Pulse Delay Generator: TOMBAK

TOMBAK is a product enabling ALPhANOV to complete its wide range of optoelectronic modules.

TOMBAK is a universal picosecond resolution module that integrates many features gathered in one easy-to-use and compact device which can be controlled via USB connection.

It is used as Pulse/Burst Generator, Delay Generator, Voltage Converter, Pulse-Picker or Frequency Divider. The frequency of the input signals can reach 200 MHz.

Contact Details
ALPhANOV
Institut d'optique d'Aquitaine
Rue François Mitterrand,
33400 Talence, France
www.alphanov.com
info@alphanov.com
Tel: +33 524 545 200

Diverse Optics Inc.
Visit us at Booth #1917

Custom Polymer Optics

Diverse Optics specialize in precision injection molding and single point diamond turning of custom polymer optics. Reduce cost, trim weight, improve performance, and simplify your product design by implementing precision polymer optics!

We do it all; prototyping to series production of free-forms ,spheres, micro-optics, aspheres, domes, convex/concave, plano/convex, bi-convex, diffractives, Fresnels, prisms, light-pipes, lens arrays, collimators, combiners, toroids, CPC's, TIR's, parabolics, off-axis, ellipticals, and more.

Whether its thousands of molded optics or a few diamond turned prototypes, we'll show you how polymer optics are perfected!

Contact Details
Letty Trevino, Sales Engineer
Diverse Optics Inc., 10310 Regis Court,
Rancho Cucamonga, CA 91730
www.diverseoptics.com
info@diverseoptics.com
Tel: +1 (909) 593-9330
Fax: +1 (909) 596-1452

Bristol Instruments, Inc.
Visit us at Booth #215

Wavelength Meters – Fast and Accurate for CW and Pulsed Lasers

Bristol Instruments' wavelength meters are used by scientists and engineers who need to know the exact wavelength of their lasers.

Systems are available for CW and pulsed lasers that operate at wavelengths from 375 nm to 12 µm.

These systems use proven interferometer-based technology to measure absolute wavelength to an accuracy as high as ± 0.0001 nm and offer the fastest sustained measurement rate of 1 kHz.

Continuous calibration with a built-in wavelength standard guarantees the reliable accuracy required for the most meaningful experimental results.

Contact Details
Bristol Instruments, Inc.
50 Victor Heights Parkway
Victor, NY 14564
www.bristol-inst.com
info@bristol-inst.com
Tel: +1 585 924-2620

Spectrum Scientific Inc.
Visit us at Booth #1352

Hollow Retroreflectors

Spectrum Scientific's Hollow Retroreflectors have a monolithic construction made from solid aluminum and consist of three mirrored surfaces resembling the corner of a cube. These optics reflect light parallel to its incidence angle, allowing insensitivity to vibration, position and movement. SSI's replication process allows for high volume production of repeatable performance retroreflectors.

- Return Beam Accuracy: <2 arcsec
- Surface Accuracy: < $\lambda/2$
- Gold & Aluminum Coatings
- Monolithic construction with custom mounting features available
- Wavelength independent, No dispersion

Custom Hollow Retroreflector designs are available upon request in addition to stock units.

Contact Details
Spectrum Scientific Inc.
16692 Hale Ave. Irvine, CA 92606
www.ssioptics.com
sales@ssioptics.com
Tel: +1 949 260 9900

Navitar
Visit us at Booth #125

New Pixelink Machine Vision Camera Models

Pixelink has released new 5, 9 and 12 MP machine vision camera models with Sony Pregius global shutter CMOS technology.

New models include: PL-D795 5MP 2/3" format camera with Sony IMX264 sensor, PL-D799 9MP 1" format with Sony IMX267 sensor, and the PL-D7912 12MP 1.1" camera, based on the Sony IMX304 sensor.

All are available in color, monochrome, enclosed and board level versions.

Contact Details
Navitar, Inc.
200 Commerce Drive
Rochester, New York 14623 USA
www.navitar.com
info@navitar.com
Tel: +1 585 359 4000

ficonTEC Service GmbH
Visit us at Booth #4229 in Hall D North

Photonics Automated Assembly and Testing – From Lab to Fab

ficonTEC provides automated micro-assembly and testing equipment for the photonics industry.

Our modular system architecture is scalable from early device development in the lab, and new product introduction (NPI) all the way up to high-volume manufacturing requirements.

Combined with our depth application and process know-how our technologies bring your 'photonic ideas' to a fast growing market place!

Contact Details
ficonTEC Service GmbH
Rehland 8
28832 Achim, Germany
www.ficontec.com
info@ficontec.com
Tel: +49 4202 51160-0
Fax: +49 4202 51160-090

First Light Imaging

Visit us at Booth #437E, French Pavilion

C-RED 2: High Performance InGaAs camera

Designed for Bio-imagery of Industrial applications, the latest compact InGaAs camera from First Light Imaging is revolutionizing SWIR imaging:

- More than 400 FPS full frame
- from 10 to 30 electrons RON
- 15 µm pixels detector for high resolution
- Electronic shutter <1 µs
- 0.8 to 1.7 µm
- 14 bits for an extreme precision

Air or liquid cooled (no LN), C-RED 2 can operate in any environment, offering at the same time the fastest acquisition rate and the lowest read out noise of all InGaAs SWIR cameras.

More information: www.first-light.fr/c-red-2/

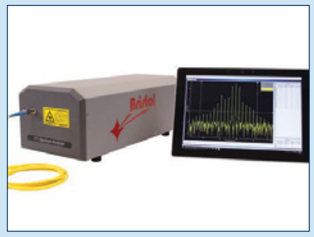
Contact Details

First Light Imaging
Europarc Sainte Victoire, Bat 6
Route de Valbrillant, Le Canet
13590 Meyreuil, FRANCE
www.first-light.fr
contact@first-light.fr
Tel : +33 (0) 4 42 61 29 20

Bristol Instruments, Inc.

Visit us at Booth #215

Spectrum Analyzer - High Resolution and High Accuracy



The Laser Spectrum Analyzer from Bristol Instruments operates as both a high-resolution spectrum analyzer and a high-accuracy wavelength meter.

These systems are for scientists and engineers who need to know the spectral properties of their lasers that operate from 375 nm to 12 µm.

With spectral resolution up to 2 GHz, wavelength accuracy as high as ± 0.0001 nm, and an optical rejection ratio of more than 40 dB, this instrument provides the most complete analysis needed for the most demanding applications.

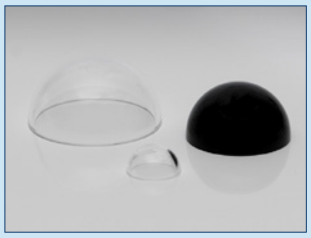
Contact Details

Bristol Instruments, Inc.
50 Victor Heights Parkway
Victor, NY 14564
www.bristol-inst.com
info@bristol-inst.com
Tel: +1 585 924-2620

Knight Optical (UK) Ltd

Visit us at Booth #5137

360° imaging? Give us a dome!



If you are trying to protect your sensor but still achieve a 360° image, Knight Optical's domes are the perfect solution.

Our high quality domes are manufactured from BK7 or equivalent, UVFS, Quartz, Sapphire, Silicon, Acrylic and a range of filter glass option. Antireflective coating options are available.

Stock range from 25mm to 100mm.

Need a different size? Join our team at Booth 5137 to discuss custom domes up to 250mm dia.

https://goo.gl/vF2hM4

Contact Details

Knight Optical (UK) Ltd
Roebuck Business Park,
Harrietsham, Kent, ME17 1AB, UK
www.knightoptical.com
info@knightoptical.co.uk

Spectrum Scientific Inc.

Visit us at Booth #1352

Off-axis Parabolic Mirrors

Spectrum Scientific, Inc (SSI) offers high precision, cost-effective, volume manufacturing of off-axis parabolic (OAP) mirrors with typical surface figures of λ/10 or Better. OAPs eliminate aberrations that are present when trying to use spherical mirrors in off axis conditions and ensure high resolution in compact system designs and offer achromatic focusing on collimation coupled with low scatter for UV applications

The mirrors feature light weight monolithic designs which can incorporate mounting features onto the mirror itself for easy alignment and reduction of assembly costs.

Website Link URL: http://ssioptics.com/cart/index.php?dispatch=categories.view&category_id=263

Contact Details

Spectrum Scientific Inc.
16692 Hale Ave. Irvine, CA 92606
www.sssioptics.com
sales@ssioptics.com
Tel: +1 949 260 9900

MicroCircuit Laboratories LLC

Visit us at Booth #5463

Lower Cost of Hermetic Packaging

MCL will lower your costs of hermetic packaging with particle free internal atmosphere with Leak Rates will slower than most stringent Aerospace MIL-STD-883 TM 1014 Leak Rates for time to specification typically quantified in decades.

- Pre-Clean and Class 1 Cleanroom Processing.
- Low Temperature Hermetic Seal
- Automatic Gross and Fine Leak Testing
- Particle Testing
- Onsite Metrology including SEM and X-Ray for both seal joints and feedthroughs.

Design, Develop, Pilot and HVM solutions from the leader in hermetic package sealing.

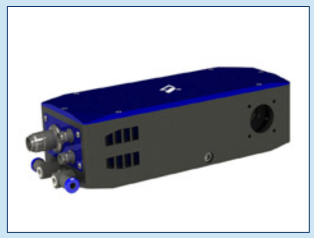
Contact Details

MicroCircuit Laboratories LLC
Kennett square, PA
United States
19348
www.microcircuitlabs.com
Tel: +1 610-228-0161
Fax: +1 610-228-0162

EKSMA OPTICS

Visit us at Booth #639

MP1 Pulse Picking System



EKSMA Optics presents the new MP1 pulse picker that consists of built-in fast driver and a Pockels cell. MP1 is able to select pulses at 600kHz rate.

In setup with pMaster 4.0H digital synchronization and delay pulse generator, MP1 can be synchronized for single pulse picking from max 30MHz repetition rate laser pulse train.

MP1 has BBO Pockels cell and is set for quarter-wave voltage operation. On demand BBO cell can be changed to KTP cell for half-wave voltage operation.

Contact Details

EKSMA OPTICS
Optolita UAB, Mokslininkų str. 11
LT-08412 Vilnius
Lithuania
www.eksmaoptics.com
info@eksmaoptics.com
Tel: +370 5 272 99 00

TOPTICA Photonics AG

Visit us at Booth #4645, North Hall

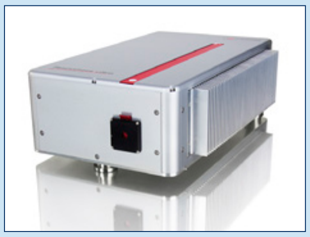
Powerful Femtosecond Lasers

TOPTICA's FemtoFiber ultra is a cost-effective, turnkey laser that provides femtosecond pulses at central wavelengths of 780, 1050 or 1560 nm with up to 5 W output power.

It is a powerful laser source for nonlinear microscopy applications like effective two-photon excitation of fluorescent proteins and SHG-based contrast mechanisms, as well as micro-lithography.

The femtosecond laser combines ultra-high reliability with compact design.

It is easily controlled via Ethernet or USB and a simple graphics user interface (GUI) enables user-friendly access to all laser parameters.



Contact Details

TOPTICA Photonics AG
www.toptica.com
sales@toptica.com

Iridian Spectral Technologies

Visit us at Booth #114

Global leader in optical filter design and manufacturing

Iridian is a global leader in optical filter design and manufacturing for applications such as: tele/data-com, spectroscopy, 3D entertainment, and detection/sensing/imaging *(for example industrial, earth-observation, process control)*.

Current capabilities extend from ~300 nm to 10 µm (UV-LWIR) with filter sizes from < 1mm to >300mm.

Iridian supports all customer needs from prototype to high volume production and focuses on tailoring solutions for specific OEM applications.

Areas of specialization include both multi-band filters *(multiple notch/bandpass filters)* and multi-spectral filter arrays *(assemblies or photo-lithographically patterned filters)*.

Contact Details

Iridian Spectral Technologies
2700 Swansea Crescent, Ottawa,
ON, Canada K1G6R8
www.iridian.ca
sales@iridian.ca
Tel: +1 (613) 741 4513
Twitter: @IridianSpectral

Arden Photonics Ltd

Visit us at Booth #5371

Fast, Functional and Flexible – The FGC Fiber Geometry System

The FGC-G Fiber Glass Geometry systems provide high-speed automated measurements of optical fiber end-face geometry including core diameter, core non-circularity, cladding diameter, cladding non-circularity and core-to-cladding concentricity.

The FGC can measure the widest range of fiber types and diameters including PM, multicore, dual clad, octagonal fibers and more - up to 1000µm in diameter. Clear end face imaging along with our template system gives the ultimate flexibility in a commercial fiber geometry measurement system.

This production ready solution gives reliable, repeatable, operator independent results in seconds, and all in one unit to save on bench space and training.

For more information go to http://www.ardenphotonics.com/product-types/fiber-geometry-measurement/

Contact Details

Arden Photonics Ltd
Royston House, 267 Cranmore Boulevard,
Shirley, Solihull. B90 4QT. UK
www.ardenphotonics.com
sales@ardenphotonics.com
Tel: +44 121 733 7721
Fax: +44 121 733 7797

Spectrum Scientific Inc.

Visit us at Booth #1352

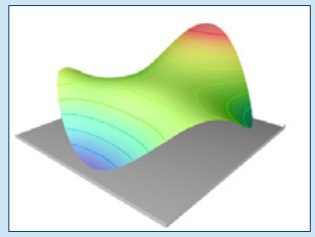
Freeform Mirrors

Freeform mirrors are curved optics with no axial symmetry and offer many advantages over conventional optics.

Their single optical surface allows for compound compensation and a reduction in the number of optics in the system, reducing optical volume, easing alignment and improving throughput. They also provide additional aberration correction and allow for redistribution of tolerances.

Using state of the art replication processes, Spectrum Scientific offers a cost-effective method for the volume manufacture of freeform mirrors at prices equivalent to standard high precision mirrors.

Website Link URL: http://ssioptics.com/cart/index.php?dispatch=categories.view&category_id=290



Contact Details

Spectrum Scientific Inc.
16692 Hale Ave. Irvine, CA 92606
www.ssioptics.com
sales@ssioptics.com
Tel: +1 949 260 9900

Synopsys

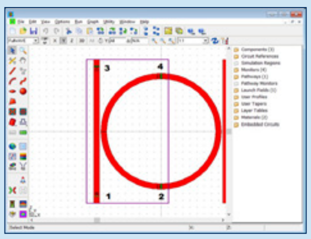
Visit us at Booth #941

RSoft Photonic Design Software

The Synopsys RSoft™ products streamline photonic and optoelectronic modeling:

- S-Matrix/PDK Generation Utility for efficient, multi-level photonic integrated circuit (PIC) design and analysis
- Interface with Synopsys' HSPICE® software for cohesive, precise modeling of optoelectronic circuits
- The RSoft-Sentaurus™ TCAD interface for efficient, robust optoelectronic analysis using native file formats

Visit Synopsys in Booth 941 at SPIE Photonics West 2018 to get a demo, or contact us today for a free evaluation.



Contact Details

Synopsys, Optical Solutions Group
199 S. Los Robles Avenue
Suite 400
Pasadena, CA 91101
www.synopsys.com/optical-solutions.html
optics@synopsys.com
Tel: +1 626-795-9101

Navitar

Visit us at Booth #125

Cleared Tissue Objective

Special Optics and ASI have developed an immersion objective lens specifically designed for light sheet microscopy of cleared tissue samples, including ASI's dual-view Selective Plane Illumination Microscopy (diSPIM).

The lens appeals to researchers building customized microscope setups (e.g. OpenSPIM type) as it is available for separate purchase, unlike other objectives suitable for cleared tissue.

The 0.4 N.A. multi-immersion objective is designed for dipping media RI ranging from 1.33 to 1.56, has NA ~0.4, >1 mm field of view, ~17x magnification, and 12 mm working distance.

Contact Details

Navitar, Inc.
200 Commerce Drive
Rochester, New York 14623 USA
www.navitar.com
info@navitar.com
Tel: +1 585 359 4000

Wasatch Photonics

Visit us at Booth #3003

Transmission gratings with superior efficiency and uniformity

Wasatch Photonics transmissive VPH gratings deliver high efficiency, low polarization sensitivity, and uniform performance over broad bandwidths and large clear apertures – all in a robust, field-tested package.

We draw on our multiple patented design technologies to optimize each grating to its application, from stock gratings for R&D to custom gratings for our valued OEMs.

As an experienced volume gratings supplier, we offer quality, performance, and consistency you can count on.

Contact our experts to discuss your needs in pulse compression, OCT, imaging, and astronomy.

Contact Details
Wasatch Photonics
1305 North 1000 West, Suite 120
Logan, UT 84321 USA
www.wasatchphotonics.com
info@wasatchphotonics.com
Tel: +1 435 752 4301

Voltage Multipliers Inc.

Visit us at Booth #4515

10kV and 15kV High Voltage Optodiodes

OZ100 and OZ150 families feature high voltage isolation in a small package.

Reverse current, in µA, is generated when the diode junctions are exposed to light. The response is linear, meaning the current level can be used to control and monitor isolated systems.

The optically clear over-encapsulation preserves light sensitivity, protects the device, and provides mechanical stability.

Applications include noisy industrial environments and sensitive instrumentation where high isolation is needed, or in controlled feedback systems like high voltage opto-couplers or voltage regulators.

Contact Details
Voltage Multipliers, Inc.
8711 W. Roosevelt Ave.,
Visalia, CA, USA 93291
www.voltagemultipliers.com/Aliases/LPs/OZ150_and_OZ100.html
kspano@voltagemultipliers.com

PASSION IN MOTION™

Novel 5 and 6 axis robotic systems clocking 17 years of creative and unmatched performance leadership building motion systems backed with ultra precision design expertise and exacting metrology knowledge in quantifying Point Precision®

ALIO 6-D

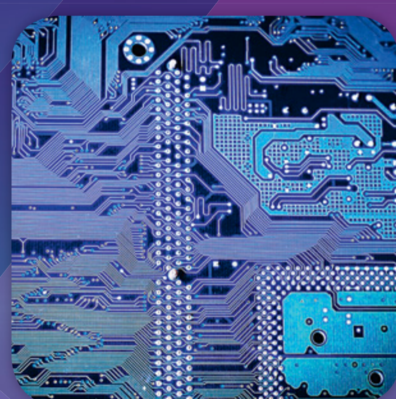
PATENT PENDING HYBRID HEXAPOD®

True Nano Precision®
From $29,900

PRECISION – PERFORMANCE – QUALITY

ALIO Industries, Inc. | +1 303-339-7500 | www.alioindustries.com

Tailored to your spectroscopy applications and needs



Check out our latest innovations at

booth 1815

AVANTES
enlightening spectroscopy

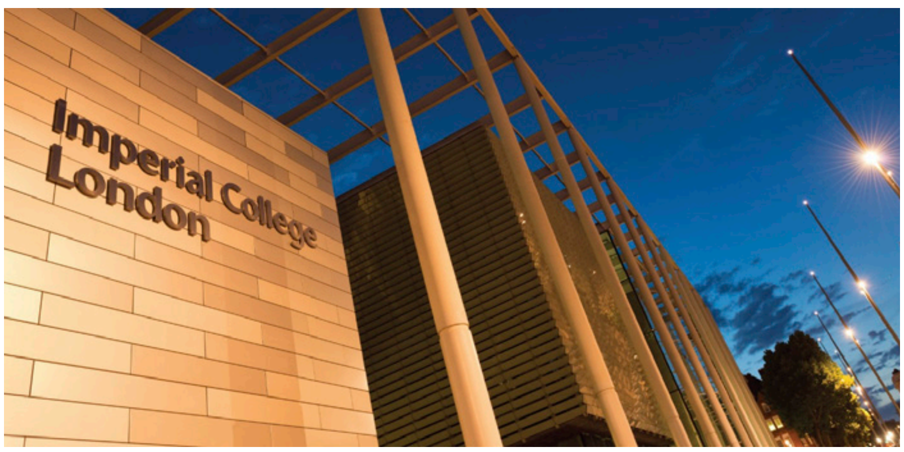
info@avantes.com | www.avantes.com

Imperial marks optics centenary with a look to the future

World's oldest dedicated university optics center celebrates a hundred years of optics-related research and education, but notes the need to widen participation.

With its formation of the Department of Technical Optics in 1917, Imperial College, London is the oldest dedicated center for optics in a higher education institution — in not just the UK, but the world. In September 2017, the university held a day-long Optics Centenary Event to showcase its research and development milestones and the diverse range of applied and fundamental optics-related projects currently being pursued. Among those in attendance were SPIE Past President Emery Moore, Fellow Chris Dainty, Senior Member Tina Kidger, and CEO Eugene Arthurs, enjoying lectures, demonstrations, and displays of Imperial's global impact on the science of light.

The Department of Technical Optics was first formed to address the shortage of optical engineers required by industry, particularly in relation to the military demands of the First World War. The appointment of Germany-born Alexander Eugen "A.E." Conrady as Professor of Optical Design in July 1917 led to the first courses in optics at Imperial during that year; undergraduate courses began in 1918, with postgraduate courses following a year later. Fast-forward to 1973, and the arrival of Professor Daniel Joseph "D.J." Bradley and his group from Belfast at Imperial led not just to the founding of world-renowned research programs in optical and laser physics, but doubled the size of what was then known as the Optics Section. Now called the Photon Science Section, this department continues as the largest university-based optics center in the UK, with research activities covering the whole spectrum of light-based science, from applied photonics systems to quantum optics.



Imperial College, London can claim to have the oldest university optics department in the world: the Department of Technical Optics was set up in 2017. Photo: Imperial College London.

It is also important to mention Harold Hopkins, who worked at Imperial from 1947 until 1967. His Wave Theory of Aberrations (1950) is central to all modern optical design and provides the mathematical analysis that enables the use of computers to create the wealth of high-quality lenses available today. His many inventions are in daily use throughout the world — most notably the rod-lens endoscope, which opened the door to modern keyhole surgery.

Current research

Mike Damzen is Professor of Experimental Laser Physics at Imperial and head of the Photonics Group. The group's research activities include laser technology, applied optics, biomedical imaging, biophotonics, and industrial photonics applications. He was instrumental in organizing the centenary event and spoke to *Show Daily* about Imperial's work at the forefront of optics and photonics research.

"Hot areas of research range from quantum optics to applied biophotonics," Damzen said. "Today's notable figures in these areas include Sir Peter Knight, one of the leading figures in quantum optics, and Ed Hinds, who is currently a Royal Society Research Professor, and Director of the Centre for Cold Matter." Hinds is working on atom interferometry for inertial sensing and navigation, and the measurement of the dipole moment of the electron, something that could ultimately tell us about the asymmetry of the universe — in other words, why we have mainly matter, and not anti-matter.

"Another important area is attosecond and femtosecond pulse generation, involving John Marangos and John Tisch," added Damzen, pointing to cutting-edge work on ultrafast Ti:sapphire laser sources, which they are amplifying to extremely high energies. "Attosecond pulses are very useful at the boundary between fundamental and applied research," said Damzen. "On the applied side what we are doing is very much about laser development, such as Roy Taylor's work with IPG Photonics. He is a pioneer from the fiber laser sector."

Damzen's personal area of interest is in diode-pumped solid-state lasers, where his work includes pulsed high-energy lasers for satellite-based Earth observation, in partnership with the European Space Agency. Applications include monitoring of vegetation, with potential for better understanding of carbon capture, biomass and agriculture.

"Healthcare will undoubtedly be a significant area for research and development, which Imperial wants to sustain and grow," Damzen said. "This will involve cooperation with other departments such as physics and chemistry. We also consider that quantum technologies will be a big area of growth. We are also looking at growing the industrial and environmental application sectors. A lot of our expertise has come through the biotechnology route, so we want to look also at these opportunities."

In the booming area of biophotonics, the key figure is Paul French. He is researching imaging modalities for diagnostic purposes, including drug discovery, cancer analysis and super-resolution microscopy. Mark Neil leads the optogenetics research program, while the wider biophotonics research effort has links to the commercial medical and drug discovery sector via the likes of GSK and AstraZeneca, and there are also strong links to the healthcare sector through the Wellcome Trust and the British Heart Foundation.

Young and old: the centenary event noted the historic under-representation of women in leading academic roles in optics. However, female students for the first time outnumbered males in the latest cohort of Imperial's MSc in Optics and Photonics. Photo: Imperial College, London.

University challenges

So how does a leading university such as Imperial deal with one of the key current challenges facing such institutions: satisfying the educational needs of new undergraduates effectively, while simultaneously meeting the research and development requirements of society and industry?

Damzen answered, "Imperial's mission is to achieve excellence in research and education in science, engineering, medicine and business for the benefit of society. This creates challenges, I would say, along three fronts that must be balanced: to provide our students with knowledge and experience to equip them for the future alongside maintaining a good student experience; harnessing the best staff and talents to remain at the top of the world league through cutting-edge and often multi-disciplinary research and collaborations; and shrinking the time between fundamental discovery and societal benefit, with new entrepreneurial and creative ways including spin-outs."

He adds that in recent years it feels like the pace of change for research to address new societal challenges has been unusually fast for academia. "We are more

continued on page 23

Imperial continued from page 21

strongly positioning our science to address key challenges and achieve impact and the funding system is pushing us in this direction, especially the recent [UK government and research council] Industrial Challenge and Global Challenges Research Funds, but there must be a capacity for just good ideas to be explored in academia."

During the series of presentations at the Optics Centenary Event, besides the wealth of experience and achievement of the key speakers — who included Knight, Taylor, French, Dainty (now at University College, London), Ian Walmsley (Oxford)

Professor of quantum optics Sir Peter Knight was among the speakers at Imperial's Optics Centenary Event last year.

Professor Michael Damzen, head of Imperial's Photonics Group and a professor of experimental laser physics. Photos: Imperial College London.

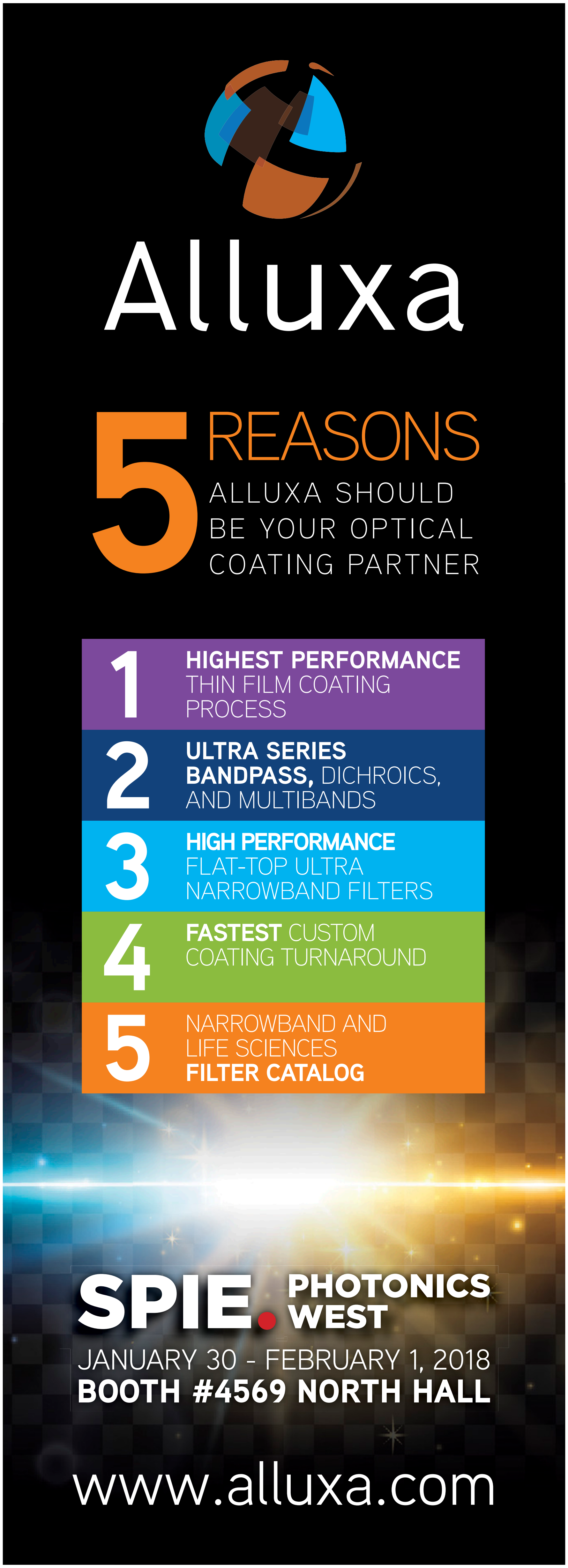
and Chris Dorman (VP at Coherent Scotland) — it was noted by many, with some embarrassment, that there is still a lack of representation of women and ethnic minorities at the top of optics-related academia. What can an institution like Imperial do to encourage wider participation and diversity?

Damzen said the university had long been considering this issue. "We start by recognizing that certain groups in optics, as across physics and engineering, are under-represented," he continued. "It was a repeated theme at the Optics Centenary Event that we have a poor historic record of representation of women in optics. This is sad and it is clear that the future must not be allowed to continue in this way." In an effort to address the under-representation of women, Imperial's physics department established The Juno Transparency and Opportunity Committee back in 2007, Damzen pointed out.

"While we increasingly endeavor to employ these principles in optics to be broad and inclusive in our recruitment and other processes, it is going to take us many years to redress the imbalance," he added. "We can only do this if there is a pool of excellent female and ethnic [minority] candidates at all levels, from undergraduate to postgraduate through to fellowship and academic appointments, so schools and higher education have a part to play."

And there is some recent evidence of change, with Damzen concluding: "We are pleased at least to say that this year our long-standing MSc in Optics and Photonics has, for the first time ever, a cohort with a larger number of female than male students."

MATTHEW PEACH


Alluxa
5 REASONS
ALLUXA SHOULD BE YOUR OPTICAL COATING PARTNER
1 HIGHEST PERFORMANCE THIN FILM COATING PROCESS
2 ULTRA SERIES BANDPASS, DICHROICS, AND MULTIBANDS
3 HIGH PERFORMANCE FLAT-TOP ULTRA NARROWBAND FILTERS
4 FASTEST CUSTOM COATING TURNAROUND
5 NARROWBAND AND LIFE SCIENCES FILTER CATALOG
SPIE. PHOTONICS WEST
JANUARY 30 - FEBRUARY 1, 2018
BOOTH #4569 NORTH HALL
www.alluxa.com


DUTCH BRIGHTEST SEES ALL COLOURS!
TEST AND MEASUREMENT SOLUTIONS FOR COLOUR AND LIGHT MEASUREMENTS IN DEVELOPMENT AND PRODUCTION PROCESSES
RHEA SPECTROMETER SERIES
• High-end cooled 2D CCD sensor
• Dark current compensated, virtually zero over entire integration range
• All calculations done inside
• ND filter wheel for large dynamic range (incl. shutter)
• USB, RS232, Ethernet, ext. in/out trigger interfaces
SPECTRORADIOMETER | IMAGING SPECTRO-COLORIMETER | COLORIMETER | LIGHT METER
DISPLAY MEASUREMENTS | LIGHTING MEASUREMENTS | ANALYSIS SOLUTIONS
admesy
ADVANCED MEASUREMENT SYSTEMS
info@admesy.com
www.admesy.com


QUALITY & PRECISION.
IN PERFECTION.
MULTI-AXIS SYSTEMS.
CUSTOMER SPECIFIC SOLUTIONS.
▪ Highest precision and best dynamics
▪ Synchronized movement
▪ Various designs according to your needs
▪ Scalable strokes
▪ Optimization for different loads and dynamics
▪ Air bearings or clean room options available
▪ Expandable with adapted controllers or software to achieve the best results
BUSCH Microsystems Consult GmbH
An der Altnah 34 | DE-55450 Langenlonsheim
+49 (0)671/201331-0 | sales@busch-microsystems-consult.de
www.busch-microsystems-consult.de
BUSCH MICROSYSTEMS

Quantum technology: paths to commercialization

Quantum computing hogs most of the attention, but commercial activity in the areas of encryption, sensing and imaging is starting to become a reality — with plenty of examples on view at Photonics West.

With the likes of Intel, Google, IBM and Microsoft publicizing their early forays into the field, it's hardly surprising that the potential for qubit-based computing dominates much of the hoopla surrounding quantum technology. The extraordinary potential of superposition-based programming makes for a seductive narrative — and for the first developers of such technology, a huge strategic advantage — but in reality the field of quantum computing remains nascent, likely at least a decade from anything resembling true commercial activity.

In the meantime, plenty of other quantum technologies are starting to make an industrial transition: applications in communications, sensing, and imaging may not stir the public's imagination in quite the same way, but their impact will be felt long before the first useful quantum computers are booted up.

That much was clear at the third UK National Quantum Technologies Showcase, held in London in November. Hosted at the Queen Elizabeth II Conference Centre in Westminster, directly opposite the UK government's Department for Business, Energy and Industrial Strategy, this tradeshow-like event presented the latest evidence that quantum technologies are making that commercial move.

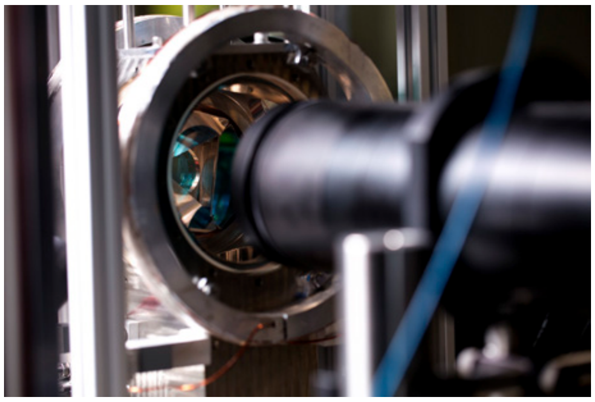
Having coughed up £270 million to support the National Quantum Technologies Programme (NQTP) over five years from 2014, UK funding agencies are particularly keen to see commercial spin-offs — and the recipients of the many grants made under the program are similarly keen to highlight them. But the five-year duration of the effort is a short time to establish any commercial quantum activity from a virtually standing start. An early observation by Sir Peter Knight, professor of quantum optics at Imperial College, London, and part of the NQTP's 12-strong strategic advisory board, that the effort represents a ten-year program with a five-year funding budget still rings true.

But there certainly appears to be some commercial momentum in the UK effort: the showcase event has come a long way since the inaugural version in November 2015, at the nearby but more compact environs of the Royal Society. Quantum technology demonstrations have grown alongside exhibit stands, with jobs created and startup companies emerging.

At a packed industry session during the November showcase, Teledyne e2v's CTO Trevor Cross — another member of the NQTP's strategic advisory board — remarked on what he sees as a genuine commitment to developing real-world technologies under the NQTP. "[It's] remarkable that in three years we have gone from talking with universities, to having things that look astonishingly close to products," he said. Those products will inevitably be used in the scientific sector initially, with Cross anticipating particular opportunities for cold atoms — viewed as a new platform technology for Teledyne e2v.

The company is focused on three key areas: instrumentation for gravimetry; space applications in the form of gravity waves and precision timing; and network synchronization. At the London tradeshow delegates could see exactly what the company has in mind when it comes to space applications, in the form of the planned "CASPA" CubeSat cold-atom mission.

CASPA will become the world's first autonomous cold-atom payload. While not in itself capable of carrying out quantum experiments, if successful it will demonstrate that it is possible to pack all of the necessary equipment to do so inside the compact "6U" CubeSat format. Over on the Teledyne e2v exhibit stand, quantum systems engineer Steve Maddox told *Show Daily* that there should be a completed version around a year from now, and that launch discussions with the European Space Agency have begun.



Photonics West exhibitor M-Squared has enjoyed great success providing lasers for quantum technology researchers, and is moving up the value chain with its development of a quantum gravimeter. Photo: M-Squared Lasers.

The cold-atom hardware includes a frequency-doubled fiber laser for cooling, acousto-optic modulator component from project partner Gooch & Housego, and an image sensor. The system has been shrunk by an order of magnitude from a benchtop equivalent weighing around 60 kilograms, to fit the 6 kilogram CubeSat format.

Teledyne e2v is in a position to benefit from aggregating demand across a variety of quantum applications — including some secret ones — to make the technology more cost-effective. Cross said in London that the company has already invested £12 million on its quantum-related efforts, with 23 employees now working on the topic and more set to be recruited. "We are seeing proper customer pull," he added. Recalling the 2015 version of the quantum showcase, Maddox noted that Teledyne e2v's presence at the event had grown from three people at the Royal Society to 12 at the QEII.

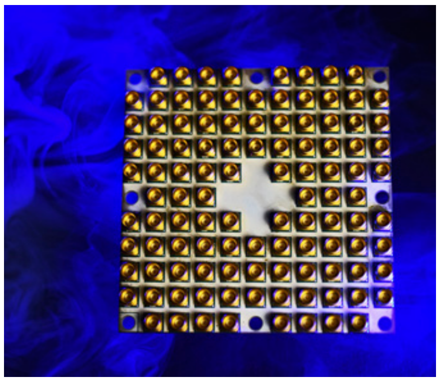
A significant beneficiary of the NQTP so far is M-Squared Lasers. The fast-growing Glasgow laser company specializes in ultra-stable ultrafast sources that are becoming the high-tech "shovels" of the quantum gold rush. And with one of the largest stands at the London showcase, M-Squared certainly stood out as a commercial enterprise. The company is also making an effort to rise up the emerging quantum technology value chain, its exhibit boasting the UK's "first commercial quantum gravimeter". In truth, it's not quite commercial yet: the sensitivity of the fridge-sized instrument first needs to improve by a few orders of magnitude to compete with classical equivalents.

But the cold-atom kit inside the large red box is said to have completed its first gravity measurements in July 2017, and there's a clear roadmap to improved sensitivity provided by better protection from external magnetic fields, isolation of the atom-cooling Raman laser source from mechanical vibrations, lower-temperature operation, and longer coherence time. The latter will demand a taller unit in which to house the rubidium vapor cell — a fundamental physical restriction when it comes to achieving quantum effects.

M-Squared indicated that a full-fledged commercial quantum gravimeter, competitive with classical equivalents on performance, size and cost, looks possible within three years, with the specific size customized according to user sensitivity requirements.

Another sign of impending commercialization comes in the form of startups and spin-outs emerging from the various university research groups working on quantum technologies.

At a dedicated industry session during the London showcase, co-founder Jake Kennard from the University of Bristol startup KETS Quantum Security described the company's aim of "democratizing quantum key distribution (QKD)". With the likes of ID Quantique (IDQ) commercializing QKD a decade ago, this is one quantum technology that has long crossed over into the commercial realm. But where IDQ's hardware closely resembles conventional rack-sized optical communication switches, and is similarly expensive, Kennard and colleagues are aiming to miniaturize that functionality and, eventually, replicate it at chip level, sufficiently small and cheap for hand-held devices.



Intel showed off its 49-qubit test chip at the recent CES 2018 event in Las Vegas, but less exotic applications will emerge from quantum research before the first commercial quantum computers are booted up. Photo: Walden Kirsch/Intel.

They see opportunities emerging in the financial and medical sectors first, with Kennard noting the recent proliferation of security lapses and email hacks. He says that conventional mathematical approaches to secure communications will simply stop working in the near future, with an additional long-term threat posed, ironically, by the eventual emergence of quantum computing.

With optical telecommunications switches and even optical fiber itself now susceptible to hackers, and news of major data breaches on an almost daily basis, the need for better encryption is stark. Kennard says that software-based random number generators (RNGs) will not withstand the threat; hardware-generated

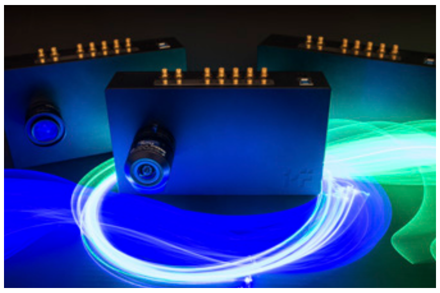
continued on page 27

Quantum tech continued from page 25

solutions are required.

The KETS team is working on both a quantum RNG and on-chip QKD. Neither product is available just yet; Kennard says proof of principle has been achieved, with the company showing off a table-top RNG demonstrator in London — but more significant seed funding is now required to develop a full prototype demonstrator.

Early adopters of that technology might be expected in the defense and space sectors, but ultimately Kennard wants to see QKD technology with the ubiquity and cost to be incorporated inside smart phones. He sees a massive



Edinburgh startup Photon Force is exhibiting its SPAD camera arrays on the QuantIC stand at the Moscone this week. Photo: Photon Force.

opportunity emerging in the hyper-connected "smart cities" of the future, where communications technology will have to be rock-solid.

Last year, KETS was among three firms to win support via the BT, Facebook, and Telecom Infra Project startup accelerator, which identified the Bristol firm as one developing technology critical to future telecom hardware. Kennard told *Show Daily* that venture support for startups in this space is still hard to attract — an extended hangover from the telecom bust of the early 2000s. With the aim of developing a pocket-sized RNG by mid-2019, he added: "[It's] time to engage; the call to action is to connect with investors and customers."

Another startup, represented at both the London event and this week in the Moscone Center, is the University of Edinburgh spin-out Photon Force. More of the quantum "picks and shovels" variety, the company supplies time-resolved single-photon avalanche photodiode (SPAD) cameras that enable "parallelization", with particular utility in the life sciences for typically very slow techniques like fluorescence lifetime imaging (FLIM). CEO and co-founder Richard Walker says the company has made real progress in the past year, and in London showed remarkable videos of plasma formed by a focused femtosecond laser pulse, and light "in transit", both captured by the company's SPAD array detectors.

Established in 2015 by three members of the Edinburgh CMOS Sensors and Systems research group, Walker says Photon Force now employs five PhD-qualified staff. "Our technology brings a disruptive shift to the field of time-correlated single-photon counting," he explained.

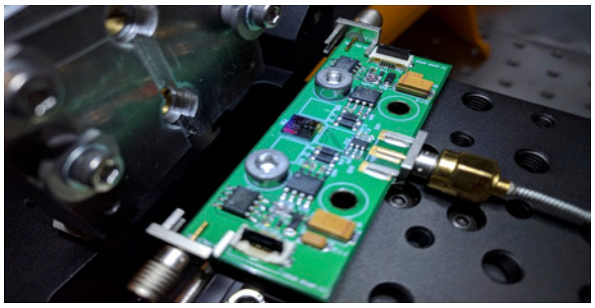
That disruption comes in the form of much cheaper, more efficient and compact SPADs that are much more suited to parallelization. "Our technology delivers several breakthroughs that have potential to both open new opportunities in research and translate them outside of the lab," added Walker. "We have managed to squeeze 1024 existing benchtop instruments into a device the size of a paperback book. This delivers unprecedented measurement speed through parallelization, enabling video-rate advanced microscopy or time-of-flight imaging."

Already finding applications in lidar, quantum technologies, and fluorescence spectroscopy, the plan is to further miniaturize and scale up production — something that Walker says would be impossible with incumbent approaches. "Decreasing the size, weight and power of the technology will enable the shift from the lab to the

continued on page 28

Quantum tech continued from page 27

field, vehicles, medical or personal devices and the consumer market in the future," he predicted. "Through collaborations, we aim to develop photonic integrated circuits and lab-on-chip solutions to demonstrate prototypes of point-of-care medical devices in the next 5-8 years."



University of Bristol spin-out KETS Quantum Security is aiming to shrink quantum key distribution to the chip level. This is the firm's quantum random number generator. Photo: KETS Quantum Security.

This is also a startup with genuine revenues. The business is said to have generated around £170k to date from camera sales, with Walker expecting that figure to double year-on-year. "This crucial early customer revenue has allowed us to leverage grant funding, spurring our product and market development and allowing us to build value in the business prior to seeking equity funding," he says.

Add to that more than £300k of support through collaborative funding from Innovate UK via the NQTP, strong connections with its Glasgow-based QuantIC imaging hub, and the CEO is looking to further develop Photon Force's competitive advantage.

"We are incredibly fortunate to be in the quantum optics space at a time when this economic potential is being recognized with such significant government support for the field, in addition to the usual avenues in the startup ecosystem," Walker told *Show Daily*. "The resources available can have a transformative impact on the research and development capabilities of a small business, and are certainly helping Photon Force to realize its ambitions."

Things could always be improved, he adds, saying that Innovate UK grants are not currently the easiest source of funding for startups to secure and manage. "It would pay dividends if we could see more support to help small businesses get new products closer to market readiness," Walker added.

Not all of the companies at the London showcase were SMEs. Among the largest to be represented was telecoms giant BT, which is involved in the deployment of QKD-encrypted local networks in Cambridge and Bristol, as well as a long-distance connection between the two UK cities.

BT is also planning QKD trials with its major customers, although this is a challenge. "It's a battle to convince customers about QKD," noted its representative Cathy White at the London event. "[They are] mystified and confused." Other activity under the UK's quantum program includes building a link to the company's historic research site Adastral Park, with QKD technology for the project provided by IDQ and Toshiba Research Europe.

More surprising, perhaps, was the presence in London of the Chinese company Tencent — variously described as China's answer to Facebook, Google, or Snapchat, and a household name in its domestic market.

But as Ling Ge, an Oxford University graduate with a PhD in quantum computing who is now the company's chief European representative, told delegates, Tencent is very excited about quantum technology. Part of the reason for that is its investment in companies like Tesla, and interest in emerging technologies like artificial intelligence (AI), big data, and autonomous vehicles — areas where quantum computing could play a critical future role.

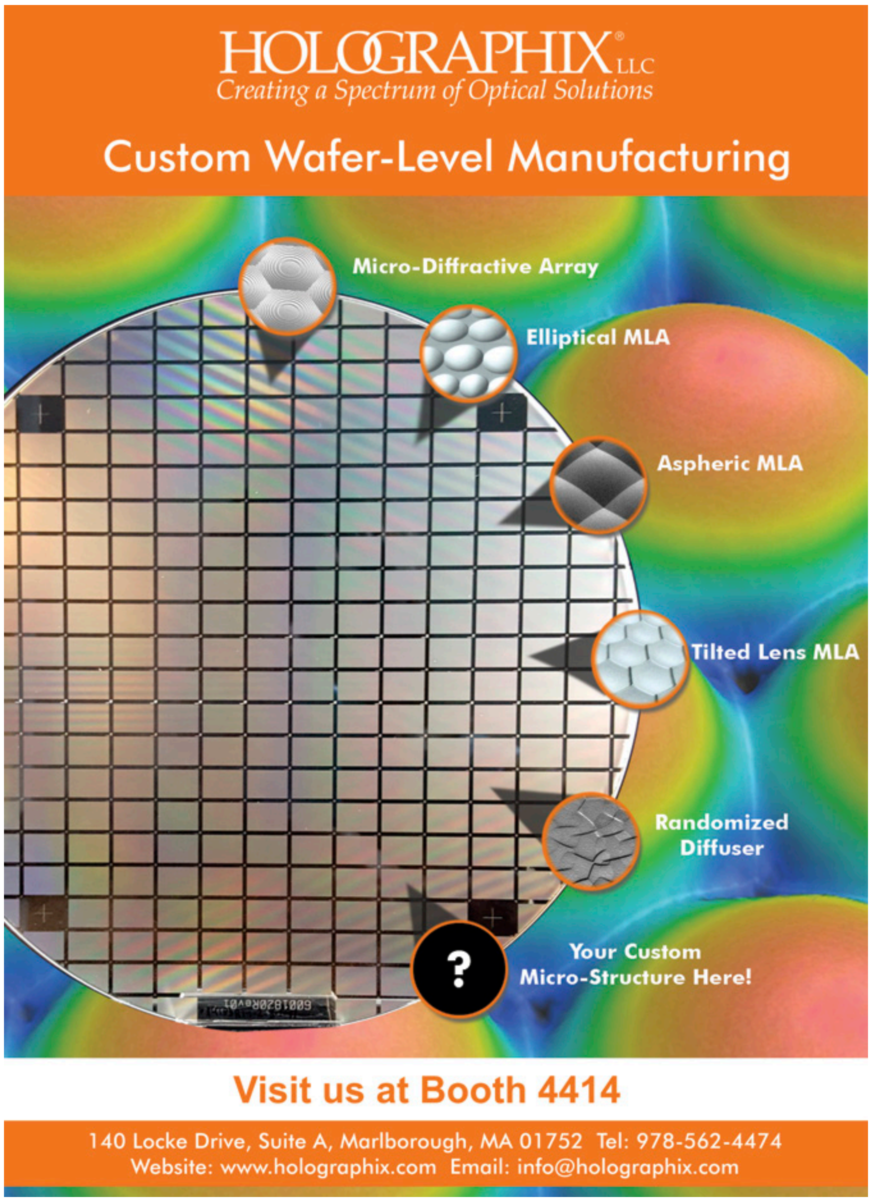
AI is already critical to Tencent business now, and security is a massive issue, Ling said. "In China you have banking and payment platforms connected directly to messaging apps, [and you] need to stay at the forefront of security technology, for example to send quantum-safe photography."

Tencent is also interested in identifying new patterns for personalized services, as well as connecting computing power to autonomous driving — to deliver the kind of processing needed for real-time, image-based decision-making. She predicted that the speed of quantum technology would be "transformative" for computing, with a dramatic impact on the global IT industry.

MIKE HATCHER

SEE QUANTUM TECH AT PHOTONICS WEST

ID Quantique at booth #5142
M-Squared Lasers at booth #2019
Photon Force at booth #5145
QuantIC at booth #5145
Teledyne e2v at booth #1836

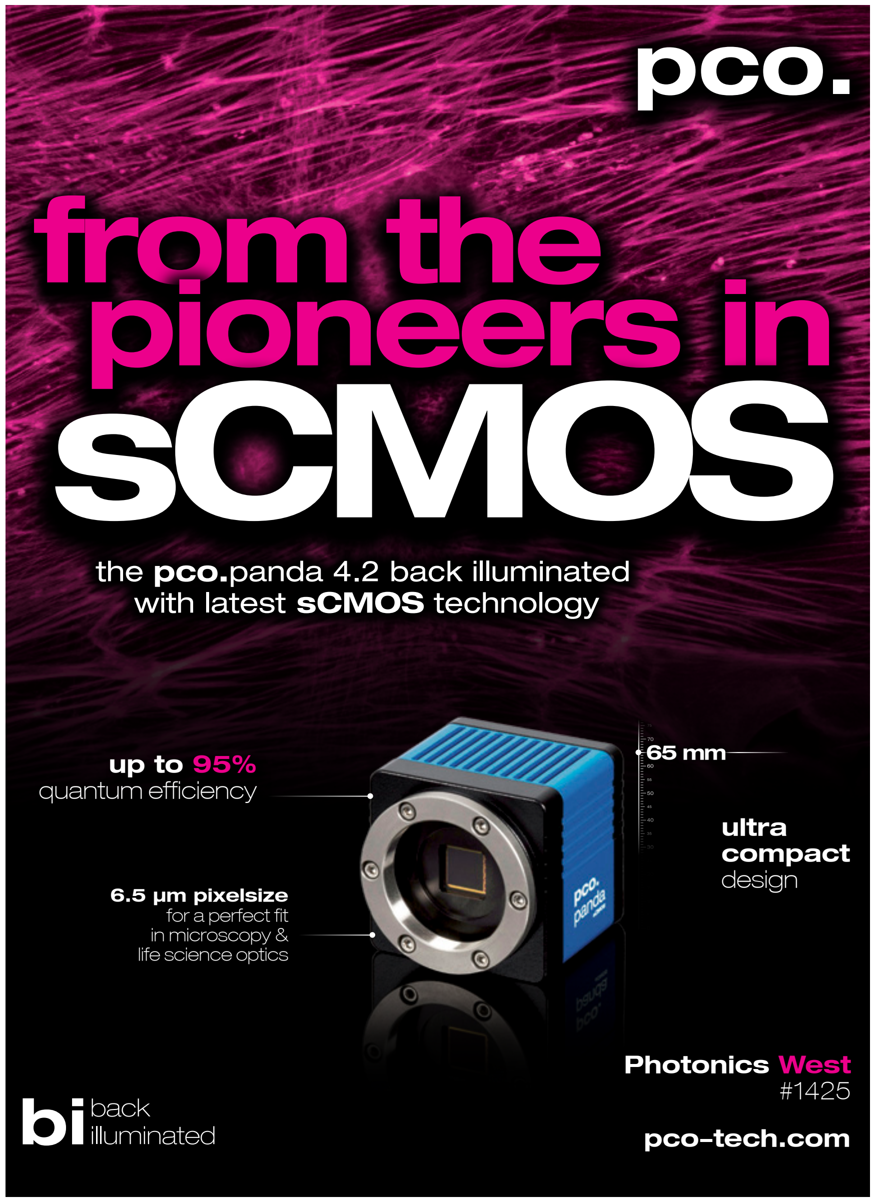

HOLOGRAPHIX LLC
Creating a Spectrum of Optical Solutions
Custom Wafer-Level Manufacturing
Micro-Diffractive Array
Elliptical MLA
Aspheric MLA
Tilted Lens MLA
Randomized Diffuser
?
Your Custom Micro-Structure Here!
Visit us at Booth 4414
140 Locke Drive, Suite A, Marlborough, MA 01752 Tel: 978-562-4474
Website: www.holographix.com Email: info@holographix.com


DUTCH
BRIGHTEST
SEES ALL
COLOURS!
TEST AND MEASUREMENT SOLUTIONS FOR COLOUR AND LIGHT MEASUREMENTS IN DEVELOPMENT AND PRODUCTION PROCESSES
RHEA SPECTROMETER SERIES
• High-end cooled 2D CCD sensor
• Dark current compensated, virtually zero over entire integration range
• All calculations done inside
• ND filter wheel for large dynamic range (incl. shutter)
• USB, RS232, Ethernet, ext. in/out trigger interfaces
SPECTRORADIOMETER | IMAGING SPECTRO-COLORIMETER | COLORIMETER | LIGHT METER
DISPLAY MEASUREMENTS | LIGHTING MEASUREMENTS | ANALYSIS SOLUTIONS
admesy
ADVANCED MEASUREMENT SYSTEMS
info@admesy.com
www.admesy.com


AFR Advanced Fiber Resources
New Product Release
LaseGuard™ Free Space Isolators
As the leading supplier of isolator for fiber lasers, AFR now brings you a series of free space isolators to protect your high power laser at different wavelengths and beam sizes.
Key Features
• Product tested to 200W CW power
• Minimal thermal-lensing
• Optional λ/2 plate available for all isolators
You will also see other new products
• 500W Isolator for Fiber Laser
• Dragon™ QBH-Compatible Connector
• 100W Inline Isolator
• SteadiBeam™ & SeasonBeam™ Isolators
• OCT Fiber Components
• Pump-Signal Combiners
• 6kW 7x1 Laser Combiner
• Cladding Power Stripper (CPS)
• Butterfly Packaging Services
Booth 4153 North Hall
www.fiber-resources.com


SPIE.
CONNECTING MINDS. ADVANCING LIGHT.
the business of photonics
optics.org
He gets it.
Shouldn't you?
Sign up to the free weekly newsletter and we'll send the news to you.
optics.org/newsletter
Get the latest industry news.
celebrating 22 YEARS online excellence
follow us on twitter @opticsorg
optics.org
optics.org: 2 Alexandra Gate, Ffordd Pengam, Cardiff CF24 2SA, United Kingdom Tel: +44 (0)117 905 5330 Fax: +44 (0)117 905 5331


delta
optical thin film
Filters tailored to your needs!
High-performance filters for discerning OEM customers.
Meet us at our booth #6000!
We Are The Optical Filter Company.
http://www.deltaopticalthinfilm.com/


pco.
from the pioneers in sCMOS
the pco.panda 4.2 back illuminated with latest sCMOS technology
up to 95% quantum efficiency
6.5 µm pixelsize for a perfect fit in microscopy & life science optics
65 mm
ultra compact design
bi back illuminated
Photonics West #1425
pco-tech.com


The smallest interferometer
for the biggest jobs
Less than 13" long and vibration-immune, the new PhaseCam® 6100 Laser Interferometer measures from towers, in environmental chambers and over long paths–without isolation.
See further. See better. See beyond.
Image courtesy R. Bertram
4D Technology. See with 4D.
See all the new 4D products at Photonics West Booth 330.


evatec process systems
THE THIN FILM POWERHOUSE
INVITATION
Visit the Optical Thin Film Hotspot at Photonics West
Evatec Booth 5459
Visit the "Thin Film Technology Hotspot" at Photonics West. From Head up Display (HUD) to Diamond Like Carbon (DLC), 3D Imaging and the latest news in optical monitoring technology, visit the technology hotspot at the Evatec booth for a series of mini presentations starting 30th January.
SCHEDULE - DAY 1, 30th JANUARY & DAY 2, 31st JANUARY
11:00 Evatec – Home of the BAK
➔ AR plus DLC in one go
12:00 MSP – The work horse in the optical industry
➔ From HUD to IR cut off
13:00 CLUSTERLINE® RAD – Where Optics meet Semiconductors
➔ Stress free Bandpass Filters on 200mm
14:00 SOLARIS – Where speed is of the essence
➔ Color Filters, Mirrors and Decorative Coatings at the highest speed
15:00 APC – Advanced Process Control in Photonics
➔ Making Evatec's Photonics Solutions possible
EVATEC - Booth 5459 | www.evatecnet.com

sponsored advertorial

New Onefive industrial ultrafast lasers from NKT Photonics

Looking for industrial ultrafast lasers that can handle 24/7 operation in a manufacturing environment? The new Onefive range from NKT photonics is for you!

Known for their supercontinuum and single-frequency fiber lasers as well as their unique photonic crystal fiber technology, NKT Photonics has long been a trusted brand in the photonics industry. With their new range of Onefive ultrafast lasers, the company is now moving into the market for industrial and medical ultrafast lasers.

Leading the industry trend of shorter pulses in more rugged form factors, the new ultrafast lasers offer a wide range of pulse lengths from femtosecond to picosecond and output power up to 100 W. The pulses can be controlled accurately with variable repetition rates from single shot to MHz and burst mode.

As many applications and materials are wavelength sensitive even at the ultrafast level, the Onefive lasers are offered both at their fundamental wavelength of 1030 or 1064 nm, and with robust wavelength conversion to green or UV.

Manufactured at their ISO 9000 and 13485 certified facility in Switzerland, the Onefive lasers offer unparalleled reliability, beam quality, and power in a compact form factor ready for 20/7 operation. Moreover, NKT Photonics have thousands of lasers installed worldwide and offer local service and support in Asia, Europe, and US to make sure your lines stay up.

See all the new Onefive ultrafast lasers at booth #1336 and talk to our product specialists or visit www.nktphotonics.com for more details on models and specifications.

sponsored editorial

Objective Lenses from OptoSigma

OptoSigma offers a high quality portfolio of Objective lenses for imaging, laser processing and water immersion applications. Available wavelengths range from Ultra-Violet and Visible to near Infra-Red. Standard products are infinity corrected, designed for use with coaxial illumination and are parfocal at the design wavelengths and visible to allow for monitoring during processing.

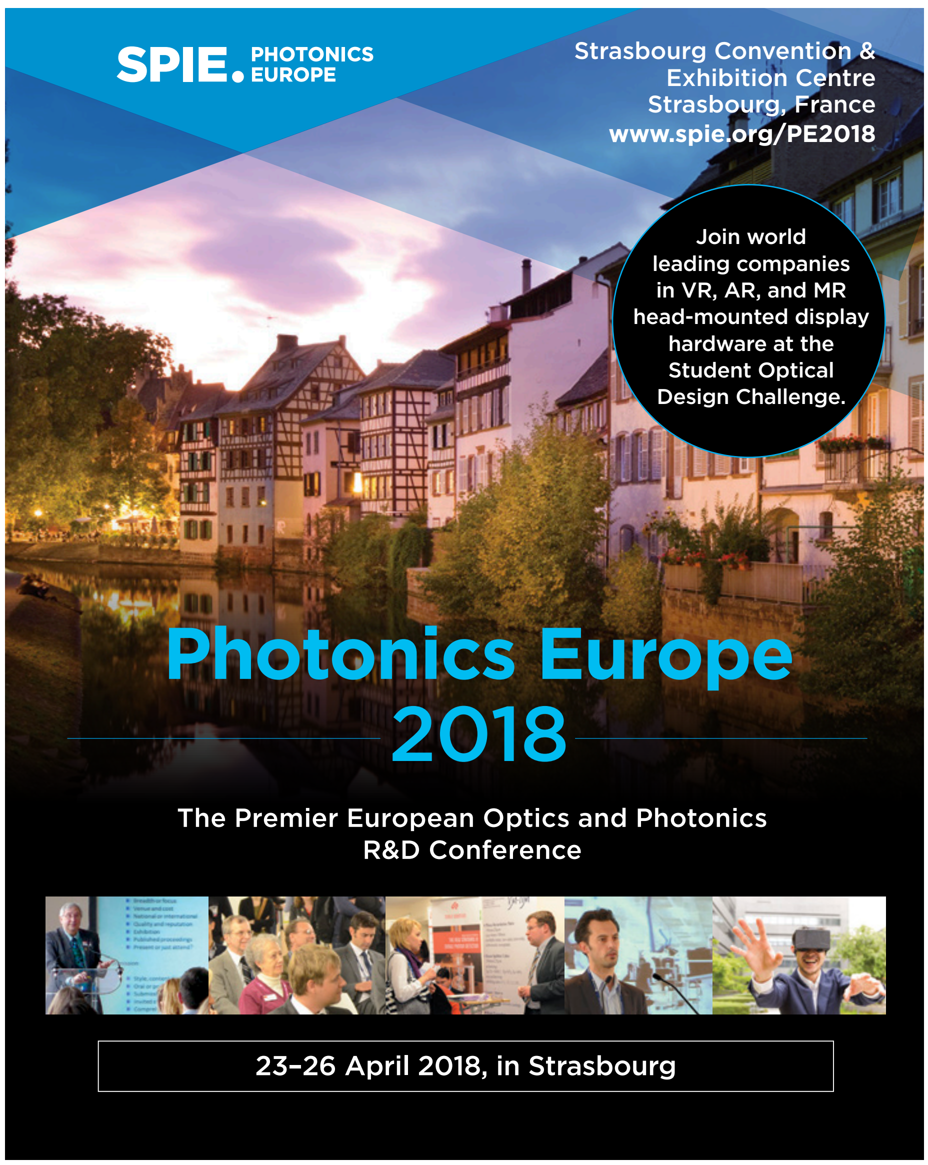
With a large variety of working distances from a few millimeters to a half meter, numerical apertures up to 1.0 and magnifications ranging from 2x to 100x, all of our standard objectives are designed to give the rated magnification with a 200mm tube lens. All of our standard objectives may be found on our website, competitively priced and available for quick delivery.

Additionally, we are actively supporting and working closely with OEMS of laser processing systems to create new designs for cutting edge display applications.

Our design and manufacturing process is in-house and our team of engineers welcome your requests for custom applications.

Experience the difference with OptoSigma products.

See them all at Photonics West, Booth #307



Frequency combs and new lasers measure up

Since its invention near the turn of the century, the optical frequency comb has heralded a new era in optical frequency measurements. A frequency comb is a spectrum with hundreds of thousands of lines at precise, evenly spaced intervals — forming what looks like the teeth of a comb. These teeth are like the markings of a ruler, enabling optical measurements with unprecedented precision. Frequency combs, which garnered the 2005 Nobel Prize in Physics, have enabled optical atomic clocks and advances in everything from telecommunications to high-speed spectroscopy.

> “My approach here is to make it applicable for industry.”
>
> URSULA KELLER, ETH ZURICH

In Wednesday's LASE Plenary session, Ursula Keller, a physicist at ETH Zurich, discussed her group's new method for dual-comb spectroscopy using a single laser. In conventional laser spectroscopy, you take the spectrum of a gas by firing a laser through it. By steadily changing the laser's frequency and comparing its intensity to a reference laser, you can measure the absorption spectrum of the gas. But this method is slow. For example, current tunable diode laser absorption spectroscopy (TDLAS) can tune over about 5 nm using a distributed feedback interband cascade laser with a maximum scan rate of 125 microseconds for one scan.

Koji Sugioka of RIKEN welcomed attendees to the LASE plenary session. Photo: SPIE.

Dual-comb spectroscopy, which uses two frequency combs, allows for more precise measurements that can also be done more quickly. The two frequency combs, which are created by laser pulses, have slightly different frequency intervals, generating a beat frequency in the megahertz range that's accessible by photodetectors. When the dual combs shine through a gas, the changes in beat frequency reveal the absorption of the gas.

Traditionally, dual-comb spectroscopy requires two lasers for each comb. But because they both must be stabilized, the setup is often complex and expensive. Keller's group, however, has developed a new method that needs only a single laser. The laser produces a comb that passes through an intracavity birefringent crystal, which splits the comb into two and generates a shift in the frequency interval.

The researchers used a mode-locked, integrated external-cavity surface-emitting laser, or MIXSEL. The laser is based on optically pumped semiconductor laser technology, which is an established commercial product for continuous-wave operation, Keller says, making the new technique simpler and inexpensive for industrial application.

“What I'm addressing here is not another world record in terms of accuracy,” Keller told the *Show Daily*. “My approach here is to make it applicable for industry.”

The researchers first tested their technique on water vapor. More recently, they went beyond a simple proof-of-principle, expanding their measurable bandwidth ten-fold, and demonstrated their method with acetylene, a gas that's of interest in industry. They showed that they could make a measurement in just 20 microseconds.

In the future, Keller said, this tool could be used for fast, real-time monitoring of methane leaks along a pipeline or factory emissions of gases like NO, CO, and CO_2.

In the second plenary talk, physicist Hidetoshi Katori of the University of Tokyo and RIKEN discussed optical lattice clocks, a new type of atomic clock with a fractional uncertainty down to 10^{-18}. These clocks could be used to test fundamental physics, relativistic geodesy, and even redefining the second.

Ursula Keller of ETH Zurich was one of three LASE plenary speakers. Photo: SPIE.

Lasers for all occasions

The session ended with Berthold Schmidt, the CTO of the business unit of Trumpf Laser Technology and CEO of Trumpf Photonics, who surveyed the progress of industrial lasers over the past 30 years, which, he said, is reflected in the development of Trumpf's laser technology.

One of the oldest workhorse lasers is the CO_2 laser, used primarily for cutting. In 1985, citing the need for lasers with 1 kW of power, Trumpf produced their first CO_2 laser. Investing in that technology has today led to a 30kW master-oscillator power-amplifier system for producing extreme ultraviolet light (EUV) for microlithography. The laser pulses vaporize droplets of tin, producing a mist. The laser then ionizes the mist, creating a hot plasma that radiates EUV light at a wavelength of 13.5 nm. This kind of UV light source can be used to produce next-generation microchips.

Over the past 15 years, however, CO_2 lasers have given way to solid-state lasers, which are now the main laser technology used to process materials. Trumpf's solid-state lasers include thin-disk lasers, direct-diode lasers, fiber lasers, and slab lasers. Each has its own strengths that are suited for a range of industrial applications, giving the market the power of choice, Schmidt said.

A thin-disk short pulse laser can be used as a cavity dump. After maximizing the energy that can be stored in the resonator, you can then dump it all in a single pulse, producing high-energy lasers in the kW range. This concept is also the basis for regenerative amplifier lasers, which generate ultra-short and powerful pulses — useful for precise drilling of materials, and cutting and welding of transparent materials.

You can boost the power of cavity-dumped oscillators or regenerative amplifiers even more by sending the pulses through multi-pass cells. By reflecting the pulses through multiple mirrors, passing them through the amplifying disk over and over again, multi-pass cells can increase the power by up to 25 times. This can open up applications that haven't even been explored yet, Schmidt said.

These high-powered pulses can be used for laser lift-off of ultra-thin flexible displays, laser-based rapid thermal processing of large-area architectural glass substrates, and potentially annealing, which transforms an amorphous material into a high-quality crystal. Another possible application is to shoot down lightning bolts, clearing the way for airplanes. A laser can create a line of plasma in the air, through which a lightning bolt could discharge.

Trumpf has also developed laser systems with smart sensors. “Being an industrial laser manufacturer today doesn't mean you only have a laser source,” Schmidt said. The company is developing systems that constantly monitor the laser, allowing the incorporation of artificial intelligence software to automatically make adjustments on the fly. “It's making its own analysis, and then it's adjusting parameters and optimizing the process,” he said. “There's no human involved anymore.”

Lasers will continue to be a powerful industrial tool, and the company will continue to adapt and optimize laser technology of all kinds, he said. “There is not one laser technology that can serve all applications.”

MARCUS WOO

3D printing is ready to grow up, says panel

As an industry, 3D printing and, more broadly, additive manufacturing is at an awkward stage. “We’re in puberty,” said Peter Leibinger, CTO of Trumpf, at a panel discussion about 3D printing and “Industry 4.0” on Wednesday. While the future of additive manufacturing shows promise, the panelists said, many challenges remain.

When 3D printing was invented in the 1980s, the main application was to build prototypes. “It’s largely because the process wasn’t robust enough,” said Jason Jones, CEO and co-founder of Hybrid Manufacturing Technologies. 3D-printed objects were fine for ensuring something had the right size and shape, but the quality wasn’t good enough for a final product. But things are starting to change. “What you’re seeing now is a transition from prototyping to production,” he said.

In the aerospace industry, for example, improvements in jet engines have been incremental, with advances in individual materials and parts. But additive manufacturing is accelerating that progress, potentially leading to radical new technology, said Andy Martin, technology development leader of GE Additive. “As users explore the technology and the opportunity to make unusual creations and machines, we’ll see what was previously inconceivable being invented,” Martin said.

Leibinger was more circumspect, urging a tempering of expectations. “It will change manufacturing, but it will take longer than many claim,” he said. “It will not disrupt manufacturing, in my mind, but it will be a complementing process that will enrich manufacturing.”

Trumpf’s Peter Leibinger (left) and Jason Jones from Hybrid Manufacturing Technologies at the 3D printing panel session on Wednesday morning. Credit: SPIE.

Indeed, the road won’t be easy. For one, the traditional design mindset must shift. Engineers have been conditioned to think not additively, but subtractively, in which you design a part by drilling or cutting from a chunk of material. “To change this mindset is quite tough,” said Karsten Heuser, the head of additive manufacturing at Siemens AG.

Another challenge arises from the fact that additive manufacturing isn’t a single technology. It’s an umbrella term referring to dozens of technologies and applications that encompass categories ranging from material extrusion to sheet lamination, Jones explained.

Such a range means even communication can be difficult. When discussing the specifications of a certain part, for example, it can take a while before customers and companies figure out how to understand each other, Leibinger said.

According to Heuser, the key to progress is co-innovation. Every segment of additive manufacturing, from the lasers to the software, depends on one another. Innovation must come from experts across all areas.

Some of that innovation will need to include digitization, and the incorporation of sensors and software that monitor the manufacturing process in real-time. High geometric accuracy is still beyond current capabilities, Leibinger said. “You cannot print accurate parts today.” But constant monitoring could help companies improve and ensure the quality of the product.

Better yet, future approaches may incorporate artificial intelligence — which, Heuser said, would be a boon for the industry. Equipped with artificial intelligence, a machine could conceivably learn, on its own, how to improve its manufacturing process.

But for now, additive manufacturing is just starting to mature. “Most of the things that are 3D printed now are far lower [quality] in terms of what we’re capable of,” Jones said. “There’s a lot of space for improvement.”

MARCUS WOO

Spectroscopy solutions assist African network

Very-low-resource settings for photonics might be illustrated by the African sites where Katarina and Sune Svanberg work, where many see a doctor once a year, if they’re lucky.

They say new clinics might be created there with instruments costing as little as $10,000 each, with molecular spectroscopy employed to save many from malaria. A $50,000 laser system, for example, could be crucial in Africa, where a million people die a year following mosquito bites.

The Svanbergs, professors at Lund University in Sweden and South China Normal University in China, described their work in a crowded Saturday keynote talk on “Optics and Photonics in Low-Resource Settings,” at SPIE Photonics West.

In the areas where “resources are almost zero” they strongly advocate local capacity building, bringing in “top notch equipment,” rather than taking Africans to Sweden or the US, which would simply cause a “brain drain,” they said in a joint talk. That way, they said, the West can “help scientists there to help themselves.”

Sune Svanberg, who is the atomic physics division chair at Lund University, said SPIE had been an important partner and supporter of their 25 years collaborating with scientists in “some of the poorest countries of the world.”

Early programs made use of 780nm diode laser spectroscopy lifted from CD players, and compact fiber-optic fluorosensors, with some of the Svanbergs’ students building such equipment for use in their labs. They’ve trained local staff to use compact multi-color UV-LED fluorosensors, and employ GASMAS, for gas in scattering media absorption spectroscopy, technology at five sites.

Their efforts, with many colleagues, to hold workshops in Africa have paid off with formation in 2010 of the African Multi-Spectral and Imaging Network (AFSIN). Along with local researchers in Ghana, Ivory Coast, Senegal, Mali, Togo, Cameroon, Kenya, and Burkina Faso, they put multispectral microscopes to work on malaria diagnostics at six sites, each created for less than $10,000.

In Nairobi, Kenya, remote monitoring of water pollution was their focus, with labs incorporating Chinese CW laser systems, each costing less than $20,000.

Katarina Svanberg, a leading oncologist working with medical lasers, described their work with the environment, ecology, agriculture, food safety, and biomedicine issues in Africa, using principles that they teach at the Centre for Optical and Electromagnetic Research, at South China Normal University in Guangzhou.

She helped start a biophotonics summer school in Senegal, where patients from the “Blue Tribe” walked for days to access clinical treatment.

Her group trained doctors and gave them needed instruments including fluorosensors to continue the treatments working in Dakar, Senegal, with Sheikh Anta Diop University.

With cervical cancer accounting for 40 percent of female cancer, mostly from viral infections, Katarina Svanberg called for more remote use of photodynamic therapy (PDT). “We could use PDT therapy for cervical cancer and treat patients out where they live, not needing to have them in the hospital.”

FORD BURKHART

PHOTONICS WEST. SHOW DAILY

PUBLISHED BY
SPIE, 1000 20th Street
Bellingham WA 98225 USA
Tel: +1 360 676 3290
www.spie.org

EDITORIAL
Original Content Ltd.
Tel: +44 (0)117 939 4887

ADVERTISING SALES
Lucent Media
Tel: +44 (0)117 905 5330

PRODUCTION & PRINTING
Tradeshow Media Partners
200 Valley Drive, Suite 36
Brisbane, CA 94005
Tel: +1 415 371 1525

SPIE. optics.org