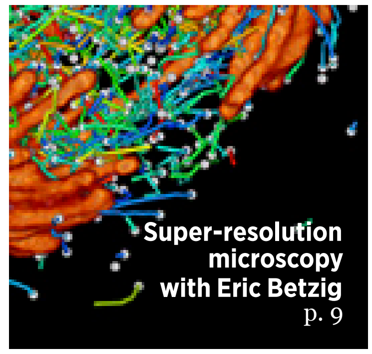
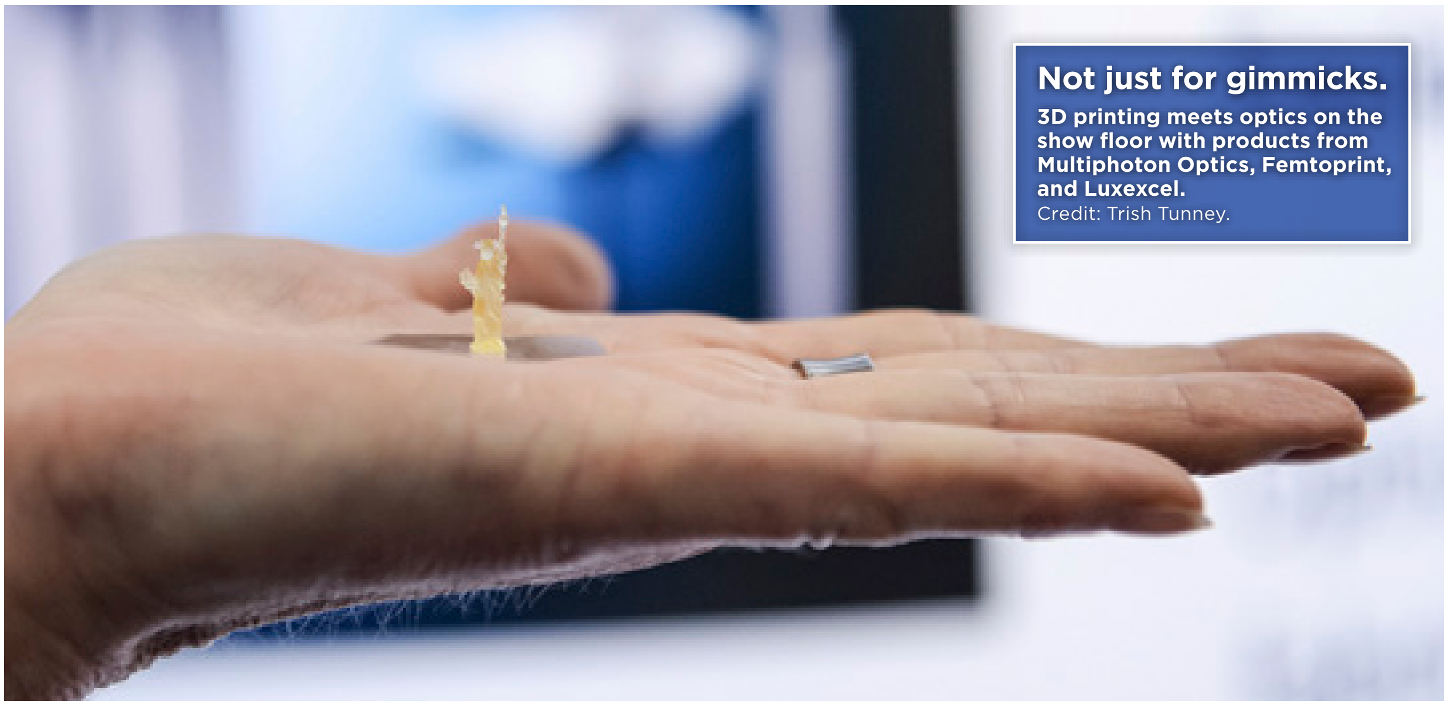
# PHOTONICS WEST. SHOW DAILY

**Not just for gimmicks.**
3D printing meets optics on the show floor with products from Multiphoton Optics, Femtoprint, and Luxexcel.
Credit: Trish Tunney.

TODAY'S NEWS

## 3D printing: the next industrial revolution?

It's being hailed as the next industrial revolution, and it's taken the public's imagination by storm. But 3D printing — also known as additive manufacturing, rapid prototyping, laser deposition, and selective laser melting — isn't just for gee-whiz demos of instantly "printed" toys, car parts, or tchotchkes at industrial and consumer tradeshows.

It's an emerging production process on the verge of truly revolutionizing industrial manufacturing — and opening up new business opportunities for lasers and photonics.

In fact, the widespread adoption of 3D printing could upend currently accepted manufacturing economics by allowing products and components to be produced economically in smaller numbers, with more flexibility and using new materials.

But where does the hype end and commercial implementation begin? That was the focus of a panel session on 3D printing at Photonics West Tuesday.

With its roots in laser sintering and laser welding, additive manufacturing, the process of adding material in layers to create a solid part from a 3D CAD model, has been a work in progress since the technology first emerged in the 1980s. In recent years, advances in hardware, software, lasers, and photonics have yielded additive manufacturing equipment that can produce metal and plastic components at speeds and quantities necessary to support a viable business model.

In fact, the 3D printing market is about

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## DON'T MISS THESE EVENTS TODAY

**LASE PLENARY SESSION**
**10:20 AM-12:30 PM, ROOM 134**

- Tribute to Charles Townes
- Best paper awards
- Donald Cornwell Jr., NASA
- Jens Limpert, Friedrich-Schiller University
- Xiaoyan Zeng, Wuhan National Lab for Optoelectronics

**INDUSTRY EVENTS**

**SPIE Job Fair** (10 AM-5 PM)

**Optics and photonics salaries panel** (8-9:30 AM, Room 101)

**Conflict minerals panel** (8-10 AM, Room 134)

**Inbound marketing workshop** (10:30 AM-12 PM, Room 101)

**Executive perspectives panel** (1:30-2:30 PM, Room 134)

**Getting hired panel** (1:30-2:30 PM, Room 101)

**Hiring talent** (3-4:30 PM, Room 101)

**SPIE Startup Challenge** (3:30-6 PM, Room 134)

*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.*

## IN THIS ISSUE


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**3D Printing** continued from page 01

to hit the big time, according to John Dexheimer, president of Lightwave Advisors, a financial consulting firm that works closely with the technology sector. Companies like Stratasys and 3D Systems have been around since the industry's early days, "but only in the last couple of years have they 'busted out,'" Dexheimer said.

A recent report from McKinsey Global Research projects that the 3D printing market could be worth $550 billion a year by 2025 — a trend that bodes well for the laser and photonics industry.

Technology is enabling the applications in additive manufacturing, and "lasers are the engine that makes it work," Dexheimer said. "What needs to be done to increase throughput, handle multiple metals, enable simultaneous processing and in-line metrology inspection — all of this is laser driven. The whole underlying infrastructure is lasers and photonics."

## Productivity challenge

The Fraunhofer Institute has been at the forefront of developing additive manufacturing with metals for 20 years. Reinhart Poprawe of Fraunhofer ILT said Fraunhofer's additive manufacturing research initially focused on stainless steel and other alloys, and it took about 10 years to get the fundamentals in place, such as 100 percent density, tensile strengths, and fatigue behavior.

Poprawe noted that productivity posed an additional challenge.

"Between 2005 and 2010, we increased the buildup speed by a factor of 10, which I think made the key change in attention on metal additive manufacturing," he said.

> The Applications of 3D Printing symposium at Photonics West highlights papers from BiOS, LASE and OPTO on innovative ways to apply 3D printing technologies.

"We were able to increase the buildup base so significantly that additive manufacturing became macroscopically interesting for production environments, and we have systematically lowered the cost for lightweight components. Less weight at less cost, regardless of the complexity."

## Faster, cheaper, lighter

The aerospace industry has also been a driving force in the development and commercialization of additive manufacturing for metals. GE Aviation, for example, has spent nearly a decade developing 3D manufacturing techniques –what they call "direct metal laser melting" — to streamline the production of very complex parts for aerospace products, according to Todd Rockstroh, a consulting engineer at GE Aviation.

In particular, GE has redesigned a fuel nozzle that previously comprised 20 separate parts made from multiple materials into a single part utilizing one alloy and 19 soldering operations that can be produced via laser melting in a matter of days.

"We'd been toying around with additive manufacturing on this nozzle and took 20 parts, put them into an assembly model, built it, did some testing, and found that the 3D printed part works as well as the machined part and is 20 percent lighter," Rockstroh said.

Rockstroh, who was scheduled to be on the 3D printing panel Tuesday but was unable to attend at the last minute, told the *Show Daily* in a recent interview that the 3D printed part was less expensive to manufacture and is expected to reduce fuel consumption. Using 3D printing also took 10-12 hours out of the build cycle, he said.

"What GE is doing with these nozzles is really just at the cusp of what additive manufacturing can do," said panelist Jim Williams, vice president of Aerospace and Defense at 3D Systems. "As the design community becomes more comfortable in using these tools, and as manufacturers become more integrated into the actual future of what you can do in terms of performance, it will drive innovation throughout the entire process."

As with any emerging market, challenges remain, including the need to develop standards to ensure product quality and consistency and a clearer understanding of the impact additive manufacturing will have on the traditional machine-tool sector.

Some equipment providers, such as DMG Mori, are already developing hybrid systems that combine a machine tool, machining center, and direct laser sintering in a single system.

But in the long run, the opportunities for growth make this an exciting time to be in additive manufacturing. In addition to growing interest in multihead, multiwavelength lasers that can deposit and process different materials simultaneously, other opportunities for photonics in this market include infrared imaging for nondestructive testing and inspection and systems integration software.

KATHY KINCADE

Scan to follow Photonics West news online.

## 3D printing for lab equipment

The growing interest of researchers in the use of 3D printing for healthcare applications ranging from customizable laboratory microscopes to bio-printed organs was evident during the Sunday evening poster session at BiOS.

A poster that drew a lot of attention highlighted recent work undertaken by Craig Brideau and others on a team at University of Calgary using 3D printing technologies in laboratory settings for basic health-science research.

They presented an overview of existing 3D printing technologies like polymer jet printing, fused deposition modelling, selective laser sintering, and stereolithography and demonstrated how these techniques could be used to customize existing lab equipment such as adapters for combining devices, guides, microscopy, sample preparation, MRI, etc.


**Making connections: business being done on the show floor. Meanwhile, Lattice Materials is now offering silicon with diameters greater than 445mm.** Credit: (l) Trish Tunney, (r) Doug Cody

# Optically actuated micro-robotics

David Phillips of University of Glasgow received the best paper award in the Advanced Fabrication Technologies for Micro/Nano Optics and Photonics conference earlier this week at Photonics West for a new kind of scanning probe microscopy (atomic force microscopy) based on optical tweezers.

The technology uses a 2D nanoscale tip, fabricated by direct laser writing and trapped using three focused laser beams through holographic methods, allowing control or read of both the position and torque of the tip. Additionally, they record the view of the same tip from two different angles.

In combination with 2D tracking and the use of three handles (optical traps), researchers are able to achieve six degrees of freedom to measure what objects are doing.

Because they can fabricate any desired shape and size of tip using two-photon polymerization of a photoresist material, researchers can work with 50-nm tips and even manipulate the restoring force of the optical traps. Designed with a slightly conical tip, Phillips said the new probes were able to create a constant force plateau in the restoring force, probing objects with a resolution below 10 nm.

Phillips demonstrated successful experiments in which a microscopic object is visible as well as the tip. While the tip is pushing softly against the object, the tip is moved within the XY plane, tracing the surface of the object, which is monitored by the optical tweezers.

For applications in micro-robotics, Phillips proposes a crank-like mechanism that can pick up an object and rotate it in the microscope, and control flow, as the direction of the flow can now be changed in a flow chamber.

# Kinetic River demos off-the-shelf flow cytometer

Flow cytometry specialists at the Californian biophotonics company Kinetic River have built a versatile new system entirely from commercial off-the-shelf (COTS) parts — in less than two months.

Company president and founder Giacomo Vacca, who is highlighting the dual-laser setup at the Excelitas booth this week, said that the kit went from concept to demonstration in just eight weeks, compared with a normal build time of around 18 months.

**Kinetic River's versatile flow cytometer, built inside two months using all off-the-shelf parts.** Credit: Trish Tunney.

Key to that rapid development was the late-2013 acquisition of Qioptiq by Excelitas. Vacca says that 99 percent of the parts that feature in the flow cytometer have been sourced from the combined company. He says that the difficulty in developing such a system previously was the sheer length of time that it would take to get off the ground — not to mention the costs involved.

"The ability to have a working instrument in less than two months is mind-boggling," said Vacca, who hosted a short course on trends in flow cytometry at Photonics West on Monday. "It usually takes a year and a half."

He adds that the flow cytometry market, worth an estimated $6 billion when the hematology sector is included, is evolving fast. The pure cytometry part is growing at a compound annual rate of around 10 percent. Some users are looking for new developments like better sensitivity to smaller particles, which is needed for clinical studies using nano-scale biomarkers, while others need more channels and greater multiplexing.

The demonstration prototype on view at Photonics West features two fiber-coupled Qioptiq lasers, plus an internally sourced optical system featuring Linos Photonics components, a fluidic control subsystem, and Excelitas fluorescence detectors.

*Excelitas Technologies is at booth 1723.*

# Smart phone kit detects *Giardia* bug

The new BiOS conference strand *Optics and Biophotonics in Low Resource Settings* kicked off with Hatice Ceylan Koydemir, a postdoctoral researcher in Aydogan Ozcan's UCLA research group, presenting a new smart phone-based analyzer that can rapidly identify the problematic water-borne bacterium *Giardia Lambli*.

One of the most common water-borne pathogens worldwide, *Giardia Lambli* is, according to the World Health Organization, responsible for an estimated 280 million nasty cases of illness every year. Symptoms include diarrhea, weight loss and other debilitating ailments of the digestive tract. Infection occurs when dormant microbial cysts are swallowed from contaminated water, food, or by the fecal-oral route.

Although primarily a problem facing the developing world, and arising as a consequence of sewage-contaminated drinking water and poor hygiene, the disease can also be a problem in developed countries.

The Ozcan group is well-known for its work on these types of analyzers. Here, the sampling technology incorporates smart phone, LED illuminator, sample holder and battery pack, but measures only 205 mm x 77mm and weighs just 205g. Koydemir explained that it will analyze a 20ml sample, transmit the resulting image and then receive the result from a central server (which processes the image with a dedicated algorithm) within one hour.

This rapid analysis contrasts favorably with conventional high-tech procedures, which Koydemir said can often take a few days — not particularly helpful if a remote village needed to take preventative measures to deal with a contaminated source of drinking water.

She concluded, "Our water-borne pathogen detection system is a promising tool for the detection of *Giardia Lamblia* cysts in resource-limited settings due to its advantages over traditional methods. Besides its low cost, easy portability and rapid turnaround time, there is no need for opto-mechanical parts or conventional benchtop equipment to analyze a sample."

MATTHEW PEACH

# Oil prospects depend on photonics

Despite the recent shock in prices, the oil industry remains a great opportunity for developers of rugged photonics-based testing and monitoring systems. So says Christopher Jones, an R&D manager at Halliburton Technology. Jones addressed the Lasers and Photonics Marketplace Seminar held Monday this week.

Jones manages Halliburton's fluid identification, pressure testing and sampling technology group and oversees an optics team, a reservoir fluids interpretation team, and a chemometrics team. One of the company's own photonics-based tools is called "ICE" (Integrated Computational Elements). It enables down-hole fluid analysis and delivers "lab-quality results."

"Despite the recent drop, the oil price looks like it may be stabilizing again at about the $50 per barrel mark," said Jones. "I think that oil is currently somewhere below its long-term stable price. And a lot of people in the industry expect that it will increase again soon. In 15 years time I won't be surprised if it's greater than $160 per barrel."

Following a detailed explanation of the economics of oil and gas extraction, Jones listed numerous opportunities for photonics-based systems, including hydraulic fracturing (fracking). Such devices need to be able to cope with extremely harsh conditions, including temperatures up to 450°F, a wide range of acidic and alkaline solutions, pressures of 30,000psi, and extreme vibration.

"The biggest opportunities in oil and gas include pipeline hydrocarbon content assessment and measurement, because we really have to know what's flowing through at any time," Jones told the seminar. "We also need to have reservoir production monitoring down-hole, so that we can see any changes in chemistry in real time."

He added that there was now a huge emphasis on fracking in certain markets. "We need to be able to assess the water supply because this process uses a lot of water. Recycling that water is desirable, [and] optical monitoring of the flow-back water [could] solve a lot of problems."

With an estimated two million miles of oil and gas pipelines worldwide, installation monitoring offers systems developers a great opportunity. "What we really need to be able to do is take an optical chemistry laboratory to the field and then down the hole," he said.

MATTHEW PEACH

# Vivolight expects Chinese OCT boom

Shenzhen-based optical coherence tomography (OCT) specialist Vivolight says that it expects the market for the imaging technology in China to boom in the coming years.

OCT system engineer Qingyun Li from the company told *Show Daily* that the Chinese government was supporting domestic technology developers. "China wants to build its own medical equipment industry," he said, adding that he expected the emerging market for OCT systems there to become "huge."

Vivolight's endoscopic system will be aimed at applications in esophageal and cardiovascular imaging, once clinical certification in China has been approved. But Li believes that, technologically speaking, Vivolight's approach is already capable of competing with similar systems from more established suppliers but with a lower price tag.

The company has also developed a completely different optical system that can be used to locate veins accurately, to aid with injections. Its "Projection Vein Finder" is based on the absorption of near-infrared light by hemoglobin.

Vivolight, set up by researchers from the Xi'an Institute of Optics at the Chinese Academy of Sciences and Tsinghua University, claims to be China's first high-technology enterprise to specialize in biophotonics imaging systems. Among its investors are SAGE-Angel Venture Capital and Shaanxi Xike Angel Venture.


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# Nobel winners light up Paris for International Year launch

Laureates Steven Chu, Ahmed Zewail, Zhores Alferov, William Phillips and Serge Haroche make for a star-studded launch event at the UNESCO headquarters.

More than a thousand delegates converged on UNESCO's headquarters in Paris, France, for the two-day launch ceremony of the International Year of Light (IYL) in January, joining a roll-call of diplomats, Nobel laureates, and photonics industry decision-makers.

Opening the year-long event, United Nations Secretary-General Ban Ki-moon said via video message that the role light-based technologies play in accelerating sustainable development will help the international community meet the challenges of the 21st century.

He told the 1000-strong audience: "As we strive to end poverty and promote shared prosperity, light technologies offer practical solutions to global challenges. They are particularly important in advancing progress towards achieving the future global sustainable development goals and addressing climate change."

The UN chief's "Sustainable Energy for All" initiative is intended to boost access to energy, energy efficiency and the use of renewables by 2030, a move that he believes will translate to "a safer, healthier and more productive future" and bring more light to homes, hospitals and enterprises.

John Dudley, chairman of the IYL 2015 Steering Committee, told delegates: "The International Year of Light is an opportunity to inspire, educate, and connect on a global scale. It is the initiative of a consortium of scientific bodies together with UNESCO, intended to bring together scientific societies and unions and educational institutions.

"The UN has recognized the importance of raising global awareness about how light-based technologies promote sustainable development and provide solutions to global challenges in energy, education, agriculture and health. An International Year of Light is a tremendous opportunity to ensure that international policymakers and stakeholders are made aware of the problem-solving potential of light technology."

Among the high-profile scientists to speak at the launch were Nobel laureates Ahmed Zewail, Steven Chu, Zhores Alferov, William Phillips and Serge Haroche, covering light and life, energy, telecommunications, and the fundamental physics of light-matter interactions.

Zewail, the Linus Pauling Chair professor of chemistry and physics at the California Institute of Technology, said in his "Light and Life" plenary: "From the Big Bang to the current state of the world, roughly 14 billion years on, we recognize that light plays a key part not only in all our lives today, but it has done so throughout the entire period of the evolution of earth and all of its life.

"Sunlight provides us with food, atmosphere and energy through the key reaction of photosynthesis, which converts carbon dioxide and water into sugar and oxygen, and so the essentials for us to live. Identifying this photonics-related reaction led to an earlier Nobel prize in chemistry for Melvin Calvin in 1961."

Like several other presenters at the event in Paris, which took place less than two weeks after the *Charlie Hebdo* atrocity, Zewail acknowledged and deplored the attack. He then stressed to the audience that all civilizations and religions throughout

**The Nobel-winning spectroscopist Ahmed Zewail, a plenary speaker at the recent launch event for the International Year of Light held in Paris.** Credit: Matthew Peach.

history have tried to discover the origins and importance of light, invariably making it a key part of their cultures.

"Many of the ancient civilizations, whether Chinese, Buddhist, Hindu, Jewish, Muslim or Christian, have from early days worked to gain understanding of our relationship with light. Early Egyptians Akhenaten and Nefertiti were some of the first worshippers of the sun, who recognized the importance of our fundamental power source."

Next to the main conference hall in the UNESCO building was a substantial new display commemorating the 1000 years since Egyptian Ibn Al-Haytham wrote his *Book of Optics*, which included chapters on early research into color, visual perception, reflection and refraction.

Zewail concluded by calling for the application of greater investment and training to alleviate people in need around the world suffering from poverty, a lack of education and political exploitation. "Globally, we need to see investment, leadership and, above all, vision," he said.

Steven Chu, who won the 1997 physics Nobel for work on laser cooling of atoms before serving as US Secretary of Energy for four years until 2013, gave the second plenary talk, entitled "Energy and Climate Change: Challenges and Opportunities." He highlighted the importance of photonics and diverse optical techniques for measuring key indicators such as ocean temperatures, atmospheric gas concentrations and glacier thickness.

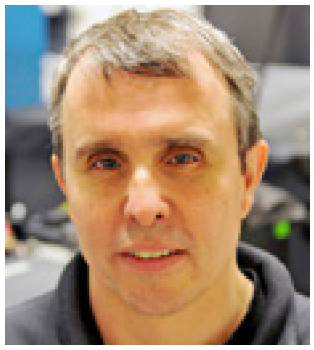
Chu acknowledged the work of James Clerk Maxwell, who almost exactly 150 years ago brought together the ideas of electricity, magnetism, and light as manifestations of the same phenomenon. "Nowadays, we are working with electromagnetic radiation across more than 24 orders of magnitude," he said.

"At the one extreme, 100Hz is rather slow for data transmission although it still exceeds the amount of useful information that the average politician can speak," Chu joked. He reminded the audience that ocean temperature data have showed a general increase from the earliest recorded figures in 1860 through today's satellite-gathered data. "Fourteen of the fifteen hottest temperatures that we have ever recorded have occurred in the 21st century — and we have only had fourteen years of records in the 21st century."

MATTHEW PEACH

# Super-resolution microscopy: only structured light meets the challenges of biology

Eric Betzig's contributions to super-resolution microscopy were recognized by the Nobel committee in 2014, when he was among the laureates of the chemistry prize. His current research on light-sheet microscopy has given him clear opinions on the directions in which super-resolution technology should now be headed.



**2014 Nobel chemistry laureate Eric Betzig spoke alongside co-winners Stefan Hell and William Moerner at a special Sunday evening BiOS plenary session dedicated to their achievements in super-resolution microscopy.** Credit: Eric Betzig, Janelia Research Campus, Howard Hughes Medical Institute.

Super-resolution microscopy, incorporating various ingenious methods of outsmarting the laws of optics just sufficiently to image features smaller than the theoretical diffraction limit of a microscope, hit the headlines last October courtesy of the Royal Swedish Academy of Sciences.

One of the three pioneering researchers who shared the Nobel Prize in Chemistry that month was Eric Betzig, based at the Janelia Research Campus of the Howard Hughes Medical Institute, Maryland. A regular at SPIE Photonics West, Betzig was recognized for his work on the single-molecule microscopy technique he first demonstrated in 2006, but he has since remained heavily invested in the search for new and effective microscopy techniques suitable for biological systems. In particular, that has led to the development of so-called structured illumination microscopy (SIM).

> "At Janelia I'm surrounded by biologists all the time, and that's essential."
>
> ERIC BETZIG.

The latest fruits of this research appeared shortly after the Nobel announcement: a paper in *Science* by Betzig's research group described a new microscope employing ultrathin light sheets derived from two-dimensional optical lattices, which were scanned through a specimen to generate a 3D image.

"The lattice light-sheet microscopy technique evolved from our work on the use of Bessel beams — non-diffractive light beams which do not spread out while they propagate," said Betzig. "Bessel beams help increase the resolution of fluorescence microscopy, but they have problematic side-lobes in the beam profile. Stepping the beam instead of sweeping it helps counteract that problem, and led us to the use of a structured array of beams created using a diffractive optical element. Each beam then only has to step over a fraction of the field of view."

The lattice approach was not only inherently faster and yielded improved signal to noise performance, but turned out to have another even more fundamental advantage: much lower phototoxicity — the damage to specimens from the light used to view them.

"Spreading the energy out has a huge effect in reducing photobleaching and phototoxicity," noted Betzig. "In fact, you get almost the best of all worlds: nearly isotropic 3D resolution at high speeds, but without damaging the cell. In certain cases where the relevant protein is particularly highly expressed, you can essentially image it indefinitely."

## Peak power: a key issue

Inadvertent damage to the fragile living cells and tissues under examination has become a key issue in high-resolution microscopy. Work on lattice-sheet microscopy has convinced Betzig that the peak power delivered to a specimen may be an even more important metric of cell health than the total photon dose it receives. This in turn means that not all super-resolution microscopy techniques are created equal.

Confocal processes in particular are inherently disadvantageous in terms of their impact on cells, and techniques such as stimulated emission depletion (STED) microscopy — another breakthrough recognized by the

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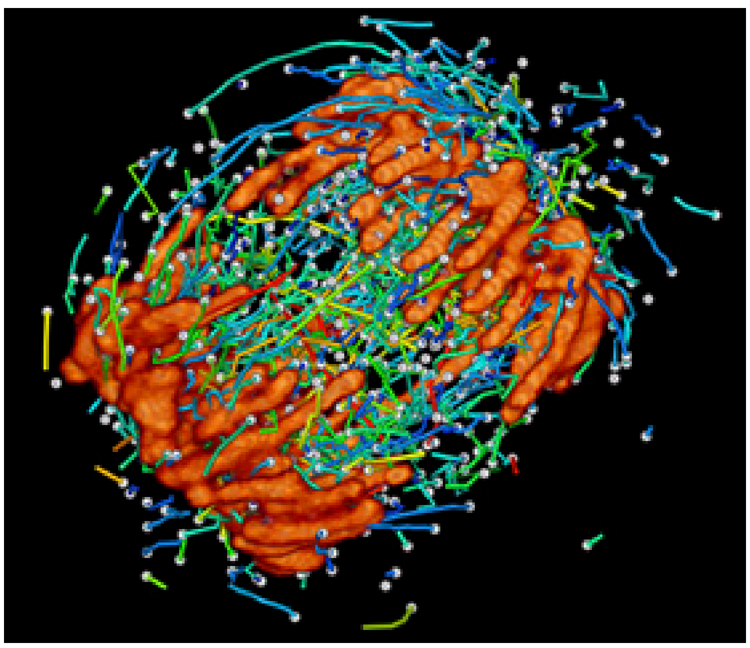


**Betzig's CGI chromosomes: intracellular dynamics in three dimensions, built up from individual non-invasive lattice light-sheet microscopy images during cell mitosis.** Credit: Eric Betzig, Janelia Research Campus, Howard Hughes Medical Institute.

## Microscopy

continued from page 09

Nobel committee last year — need to find ways to control the peak power they deliver.

Photo-activated localization microscopy (PALM), another super-resolution technique of which Betzig was an early developer, exposes cells to much lower levels of energy, but requires in turn a high density of fluorescent labels to produce meaningful images. Betzig commented that the problem of high labelling density can easily turn super-resolution studies into stories of sample preparation, rather than hardware development.

These trade-offs between phototoxicity, spatial resolution, temporal resolution, and imaging depth have increasingly become the norm in high-resolution microscopy, and Betzig believes that while some approaches are technically ingenious, they are inherently unable to meet some practical requirements.

> "Of all the super-resolution methods, the only one with a real prayer of finding a significant application space in live-cell imaging is structured illumination microscopy."
>
> ERIC BETZIG.

"As I see it, the fundamental reasons for doing fluorescence microscopy in the first place are to achieve protein-specific contrast and structural imaging, and do so in live cells," he commented. "Of all the super-resolution methods, the only one with a real prayer of finding a significant application space in live-cell imaging is SIM. Any kind of confocal or point-scanning super-resolution operation is just not compatible."

### Transferring out of the lab

At Janelia, successful structured illumination of live cells is one of Betzig's research priorities, and in particular finding ways to extend the technique to resolutions below the 100 nm mark.

"From 100 nm to 200 nm, I think you would be an idiot to do anything other than SIM; it's easy, fast, non-destructive, and needs no specialized labels. And below 50 nm, localization microscopy is the clear winner, able to provide structural imaging and count individual molecules. So the only area where the jury is currently out is the 50 to 100 nm regime, particularly in the live context. Extended-resolution SIM methods like the ones we are working on will fill that gap."

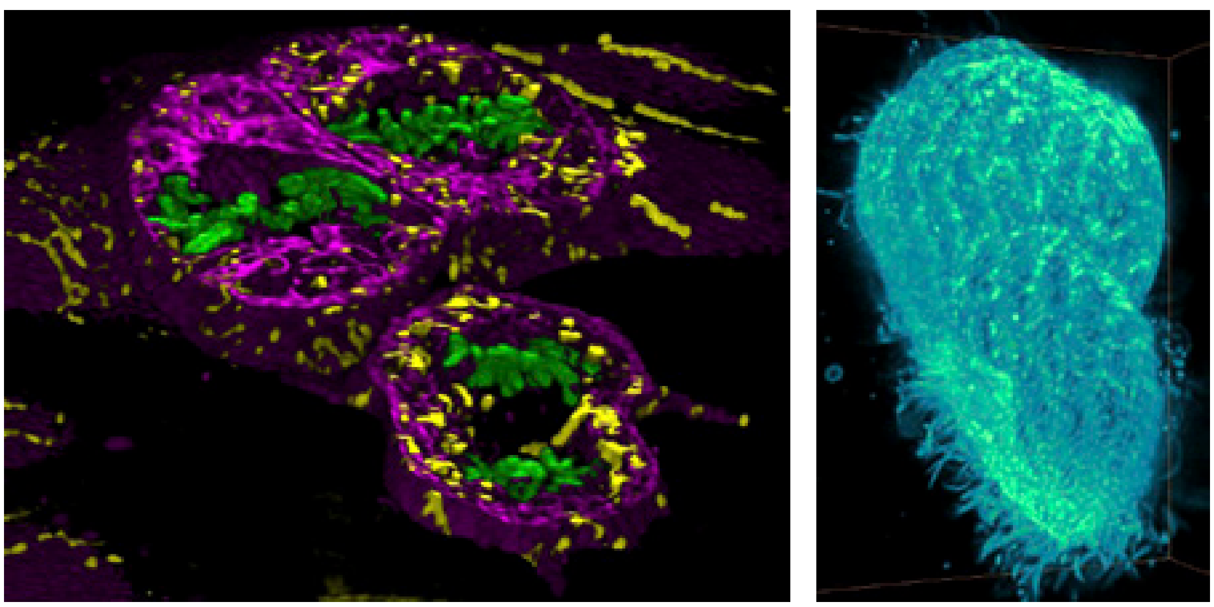
For that to happen successfully, Betzig's techniques need to leave the laboratory and become available to users. Janelia's Advanced Imaging Center (AIC) was created to make the campus's imaging technologies accessible to scientists before the instruments are commercially available.

"Technology transfer is a topic near and dear to my heart," he commented. "The nice thing about PALM is that it's so simple: essentially a microscope, a camera, and a little software that's now available in many open source versions. The tech transfer with PALM happened organically because almost anyone can do it — although sample preparation remains vital, and not everyone does that part well."

Lattice light-sheet microscopy is less straightforward, and the technology transfer operation will need a helping hand. The AIC is intended as the lowest rung of that process, giving researchers hands-on experience. The next level is availability of the platform's design and associated documentation; some 30 groups have executed research licenses on that basis, and Betzig knows of four microscopes currently running. For outright commercialization, the platform is licensed to Zeiss, with a sub-license to 3i in the US. The fruits of that agreement will come to market over the next couple of years.

"The technique is starting to trickle out to biologists by those routes — and that's critical," commented Betzig. "I view all these microscopy innovations as being clever combinations of lasers, computers, labeling technology and detectors; the four different pieces of the puzzle which all came on the scene in the 1980s. But at present, most of the work is not informed by contact with biologists. At Janelia I'm surrounded by biologists all the time, and that's essential to guide the direction of your work and know what the real challenges are. I don't think that happens enough. It's great for this technology to get the Nobel Prize, but I think we still have a lot to prove."

TIM HAYES



**The movements of protozoa can be captured in individual images, although the rapid morphological changes represent a challenge.** Credit: Eric Betzig, Janelia Research Campus, Howard Hughes Medical Institute.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# Into the Valley: Wuhan's rise to global prominence

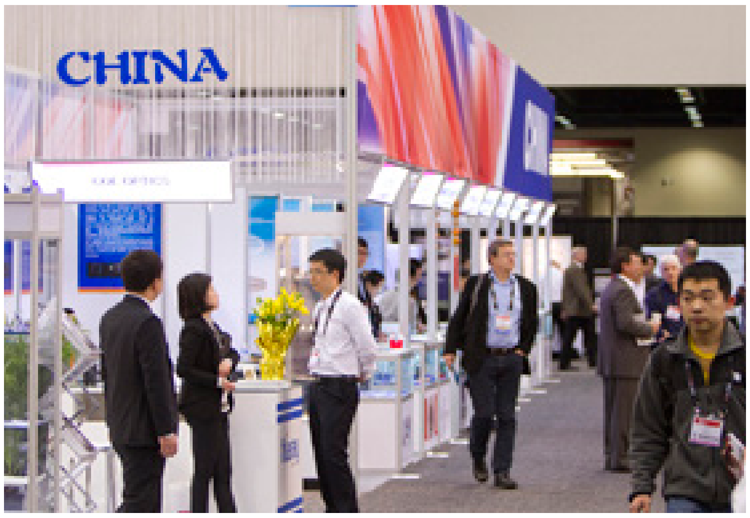
Established nearly 15 years ago, Wuhan's Optics Valley has matured into a powerful and joined-up base for academic research, business incubation and industrial photonics.

In recent years, the Wuhan Optics Valley has emerged as one of the world's key centers for the research, development and production of laser and optics technology — something reflected in the region's ever-growing presence at Photonics West. Also known as the Wuhan East Lake High-tech Development Zone (WEHDZ) and the Wuhan East Lake National independent Innovation Demonstration area, the region is to be found in eastern China, just south of the city of Wuhan itself.

Established back in 1988, the WEHDZ was the first national high-tech Industrial Development Zone (IDZ) set up by China's State Council. In 2001, the Wuhan Optics Valley of China was also approved as a state-level optoelectronic industry base.

"After twenty years of endeavor and development, WEHDZ has formed a comprehensive industry structure covering optoelectronics, bioengineering, energy and environmental protection, modern agriculture and hi-tech service industry," says Professor Qingming Luo, Vice President of Huazhong University of Science and Technology (HUST) and Executive Deputy Director at the Wuhan National Laboratory for Optoelectronics (WNLO).

"It is the biggest manufacturing and research and development base of optical products, optoelectronic communication technology and laser industry in China, taking a firm place in the global industry," he told *Show Daily*.




**China's presence at the Photonics West exhibition has grown solidly in recent years, and the emergence of the Wuhan region as a key center for both research and industry is part of the reason for that.** Credit: Joey Cobbs/SPIE.

## National laboratory

Luo also says that Wuhan is one of the country's key scientific and educational bases, ranking third among the major Chinese cities in terms of scientific and educational capabilities. The region is home to no fewer than 78 universities, among them Wuhan University and HUST. On top of that there are 106 science and research institutes of various kinds, 20 national laboratories, seven state-level key laboratories and engineering research centers, and 15 national enterprise technology centers.

In the field of photonics technology development, the most important of these knowledge centers is the Wuhan National Laboratory for Optoelectronics (WNLO), one of the initial five national laboratories approved by the Ministry of Science and Technology (MoST) in 2003. Co-founded by the Ministry of Education (MoE), Hubei Provincial Government and Wuhan Municipal Government and supported by HUST — a national key university of China — WNLO is now the chief innovation base of Wuhan Optics Valley of China (WOVC) and something of a research powerhouse, hosting more than 120 researchers and 1000 graduate students.

They carry out research across six focused areas of application: biomedical photonics; information storage and optical display; laser and terahertz technology; optoelectronic devices and integration; optoelectronic detection and radiation; and photonics for energy.

Another key institution is the Wuhan Industrial Institute for Optoelectronics (WIIO), described by authorities as a "collaborative innovation platform." It provides the more applied aspects of engineering technology research and development, as well as offering the investment and business incubation necessary to promote the industrialization and commercialization of WNLO's research and development work.

"WIIO is an incubation platform, which is underpinned by WNLO and the Wuhan government with funding, office space provision and favorable policies," says spokesperson Yang Xu. "Most of the incubated projects are initiated by the research teams in HUST university and WNLO, and the platform positions its interests in common technology research and development, industrial pilot trials, and high-end incubation.

"One of the purposes of WIIO is to integrate start-up businesses with local industrial resources in order to promote economic growth along the whole value chain of optoelectronics," he adds, echoing the ethos and language of innovation now being advocated seemingly throughout the western world. "By leveraging the connections with academics, industrialists and venture capitalists, WIIO endeavors to support start-ups and transform their in-lab ideas into industrial innovation and new products."

Xu says that the support work carried out at WIIO ranges across all areas of optoelectronics, choosing to highlight projects focused on the development and commercialization of OLED materials, UV-LED components, laser applications, digital storage solutions, biomedical devices and what he calls a "big data engine."

"Since we don't do the technological research ourselves, it is the incubated project teams who have [the] expertise to drive their business. We provide the services,

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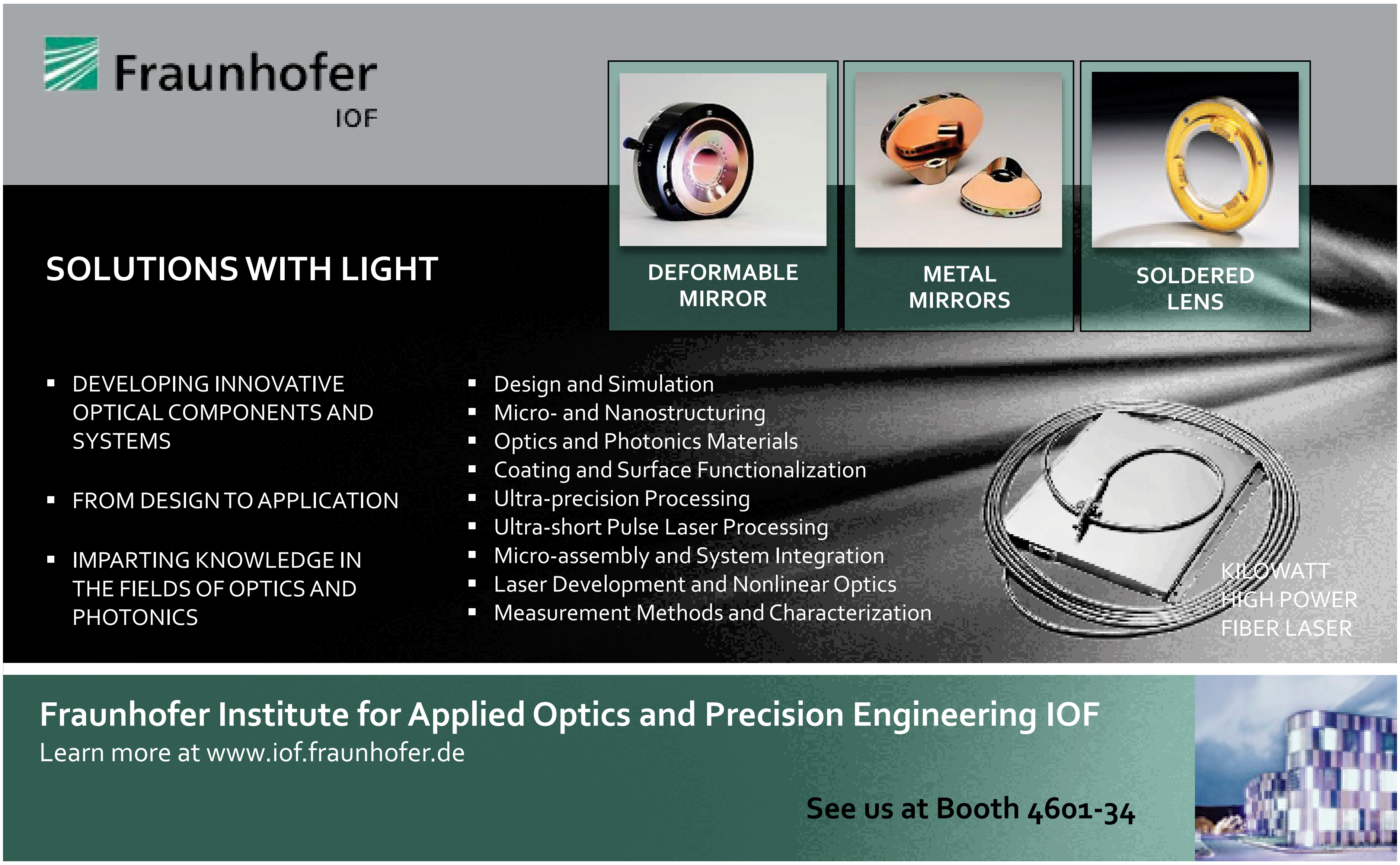
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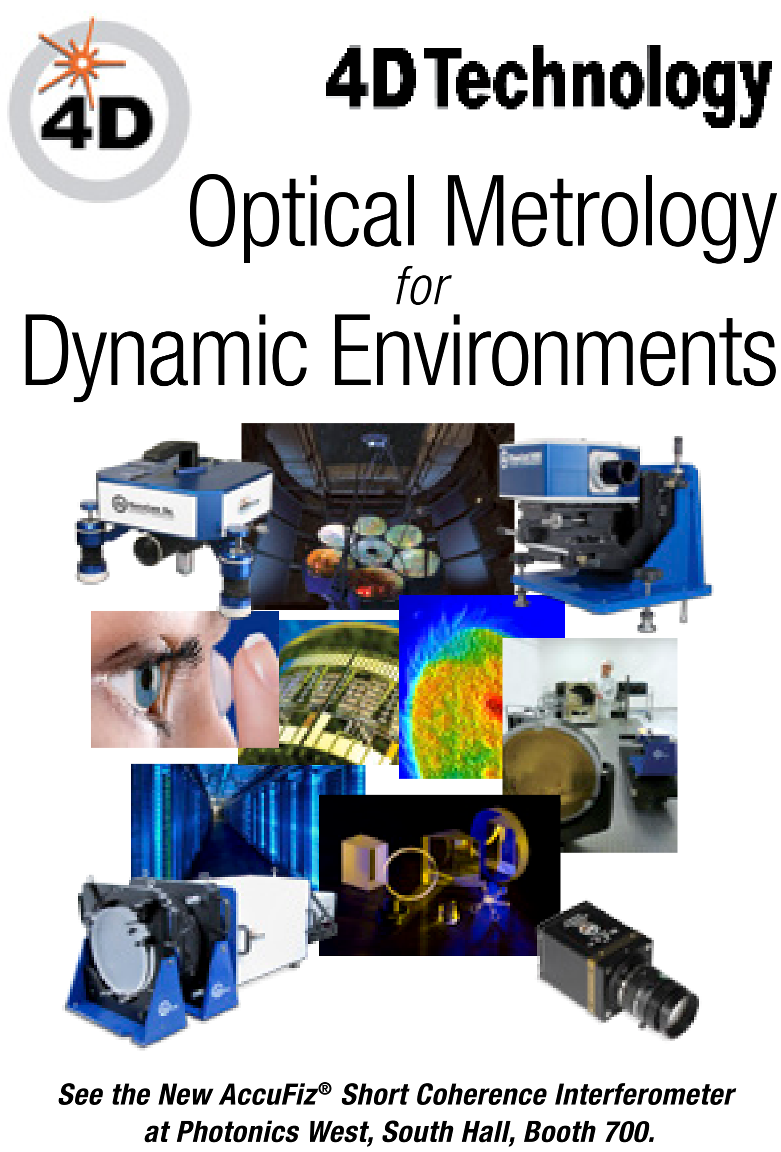
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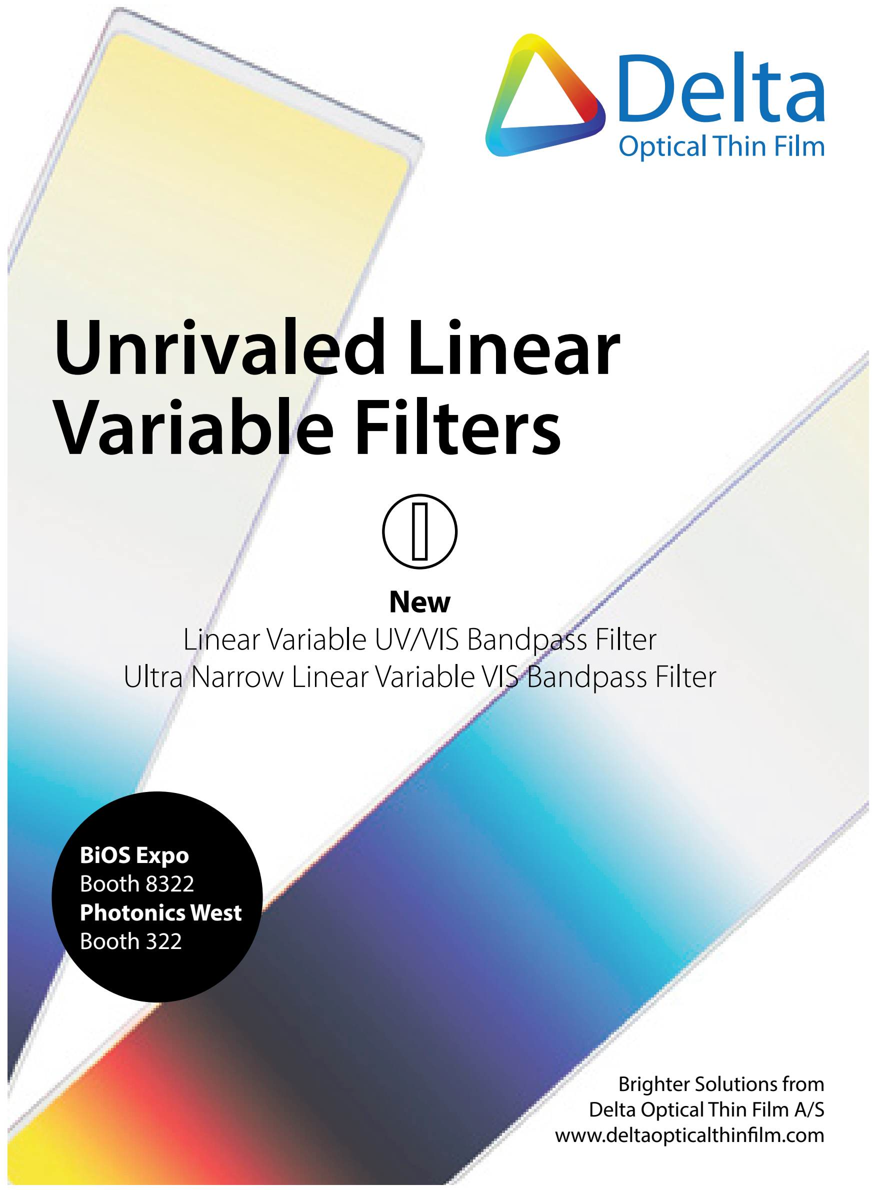
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## Wuhan Optics Valley

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funding (if applicable) and, through WNLO, the support they need to succeed."

### WNLO research themes

One of the six key themes of the work carried out at the WNLO is focused on the field of *Optoelectronic Devices and Integration.* It involves research aimed at improving the acquisition, transmission, exchange and calculation functions of information-based optoelectronics devices through the development of new mechanisms, structures and processes.

Key breakthroughs here include integrated optoelectronic devices for high-speed coherent optical communication networks and high-performance computing (HPC), including optical interconnects. Other devices developed to date include an AlGaN-based ultraviolet detector, integrated optoelectronic devices used for microwave and terahertz photonics and new types of nanophotonics devices.

**Reception area at the Wuhan Industrial Institute for Optoelectronics, a collaborative platform built by China's government and universities and with $80 million initial funding.** Credit: WNLO.

A second theme is *Laser and Tera-Hertz Technology*, involving research into the physical phenomena of lasers and the development of new lasers with high power, high beam quality, high stability and long lifetimes. Other key aspects of the work carried out under this theme include research into the interaction mechanisms between lasers and biological tissues and the development of terahertz wave applications in several fields — including the detection of explosives and contraband. Other uses include the analysis of material defects, moisture detection, medical diagnostics, trace gas detection and biomedical imaging.

WNLO scientists operating in this area have developed high-performance optical fibers based on ra-


**Wuhan Yangtze Soton Laser (YSL Photonics) was set up by University of Southampton alumnus Kang Kang Chen. It is exhibiting at this year's Photonics West.** Credit: YSL Photonics.

re-earth doping — useful for the high-power fiber laser technology that is an increasingly common sight within China's manufacturing base. Wuhan's researchers have also conducted in-depth theoretical and practical research into laser stereolithography (LSL) and micro fabrication technology in laser processing.

With an eye on future semiconductor industry requirements, other efforts are focused on the development of a laser-generated plasma source of extreme ultraviolet (EUV) light.

### Biomedical applications

Among the more obvious application-led themes, WNLO's *Biomedical Photonics Division* stated aim is to provide "new ideas, new technologies and new methods for solving medical and biological problems by using photonics principles and technologies." One of the chief aims here is to improve understanding of neuronal information processing mechanisms, and to carry out research that could lead to early diagnosis and treatment of life-changing chronic conditions like cancer and Alzheimer's, as well as the more acute impact of debilitating events such as strokes.

More specifically, research projects in the area of neurophotonics include high-resolution optical imaging of cranial nerve junctions and super-resolution imaging of neural circuit connections. Other biophotonics laboratory techniques under evaluation include high-resolution blood flow laser speckle imaging applications and new molecular imaging and molecular tomography techniques designed to meet some of the shortcomings of existing scanners.

"Micro-Optical Sectioning Tomography (MOST) technology fills the gap between magnetic resonance imaging and electron microscopy imaging, and is used to study the fine structure of biological tissue, especially in brain research," says Xu. "It provides a powerful tool to establish 3D imaging for bio-mapping [at the scale of] centimeters."

Another theme of the work at the laboratory relates to "information storage and optical display," where staff carry out comprehensive research into a range of areas related to information storage technology, including data storage principles, devices and equipment and storage systems and applications. Some of the key breakthroughs so far include active object-based mass storage systems and technology, and high-speed and low-power consumption phase change memory technology.

Looking ahead, future work carried out under this theme will include the development and commercialisation of service-oriented large-scale storage systems, as well as new glass-based optical memory devices and solid state disk "memristors."

### Flexible solar cells

In an effort to resolve some of the common problems and limitations of conventional solar cells — like low conversion efficiencies and poor stability — the *Energy Photonics Division* at WNLO also conducts research on semiconductor materials, across the fields of energy production, storage, transmission, conservation and utilization. That includes new optoelectronic devices, for example basic research into flexible thin-film solar cells, light-emitting displays and transistor arrays.

One recent breakthrough was the lab's development of a fully printable mesoscopic perovskite solar cell that

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## Wuhan Optics Valley

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does not use a hole-transporting layer. Crucially, it boasted a 12.84% conversion efficiency and more than 1000 hours stability under full sunlight in ambient temperature — sufficiently impressive to earn the work a publication in the journal *Science*.

Prior to that, similar cells have featured a hole-transportation layer and electrodes based on noble metals, which help to promote the efficient movement of electrical current after exposure to solar energy. However, the materials required are expensive, while devices based on them tend to lack long-term stability.

To overcome this challenge, the research team constructed a 'scaffold' made up of a double layer of mesoporous titanium dioxide and zirconium dioxide, infiltrated by a mixed cation lead halide perovskite used as a light harvester. Instead of using a hole conductor or gold reflector — of the sort typically employed in high efficiency perovskite solar cells — the back contact is made up of a simple printed carbon layer.

The perovskite is drop-cast from a solution through this porous carbon layer and the research team has verified that perovskite formed in the presence of the two organic cations forms crystals with a longer exciton lifetime. That and better pore filling of the mesoporous oxide film than the single-cation perovskite are thought to have improved photovoltaic performance "dramatically."

According to the research group, which is led by Professor Hongwei Han at WNLO in collaboration with the renowned Professor Michael Grätzel from EPFL in Switzerland, the innovation is something of a breakthrough — suggesting that low-cost, high-efficiency mesoscopic solar cells based on cheap, clay-like perovskites could find widespread applications. At the time, Professor Han said: "It is only the beginning of a new era of fully printable PV and certainly new efficiency records will follow this first report."

ANDREW WILLIAMS

**YSL Photonics has just launched a new higher-power supercontinuum source with an output of up to 10 Watts, and a picosecond 1064nm fiber laser featuring burst-mode function.** Credit: YSL Photonics.

## Industrial impact: the Southampton connection

The wider Wuhan Optics Valley area is home to several well-known companies. Initially, that meant optical communications primarily — including the likes of FiberHome Technologies Group, Wuhan Telecommunications Devices, Accelink, Chutian Laser Group, Yangtze Optical Fibre and Cable Company, Yangtze Optical Electronic Co. and of course the multinational telecoms giant Huawei Technologies. Less well known perhaps, but appearing at this week's exhibition, are a number of innovative start-up companies, the likes of Wuhan Huaray Precision Laser and Wuhan Raycus Fiber Laser Technologies, both of which have established operations in the region more recently.

One interesting relative newcomer is Wuhan Yangtze Soton Laser (YSL Photonics), an optics company focused on the development and manufacture of ultrafast picosecond and sub-nanosecond fiber laser technology for biophotonic and micromachining applications. The company currently has two product lines, namely a series of supercontinuum lasers and a 1 micron wavelength source for industrial applications.

The supercontinuum focus is a big clue to the background of Kang Kang Chen, CEO at YSL Photonics, who founded the company after studying high-power pulsed fiber lasers at the University of Southampton's Optoelectronics Research Center (ORC) in the UK. "I believe that our semiconductor seeded fiber MOPA has a very high potential in the commercial laser market due to its superb reliability and versatile continuously tunable pulse width," he told Show Daily. "[It] can fill the gap between a traditional mode-locking laser and a Q-switching laser."

According to Chen, the high power output delivered by the MOPA can be used directly in a variety of industrial applications and, when launched into a photonic crystal fiber (PCF), the supercontinuum source.

"At the moment, the systems look decent and we have delivered nearly 100 units to our customers," said the CEO. "We [have now] launched two series for industrial customers, including a picosecond supercontinuum source for the bio-industry [that] has been used for applications like super-resolution imaging, fluorescence spectroscopy and microscopy, flow-cytometry and optical coherence tomography."

Looking ahead, Chen explains that YSL's long-term plan is to extend its laser wavelength to cover applications from the UV to the mid-infrared, to extend the tunable pulse-width range from femtoseconds to a few nanoseconds, and to increase the repetition rate of the source into the gigahertz regime.

He concludes: "And of course higher powers! These features will make our products more flexible but require us to develop better seed lasers, better amplifiers and better wavelength conversion techniques."

*Visit Wuhan's spin-outs: YSL Photonics is at booth #2723; Huaray Precision Laser at booth #2017; Raycus Fiber Laser Technologies is at booth #5412. The WIIO institute is at booth #5417.*

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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.

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The PowerXP is a compact version of Altechna's motorized attenuator. This device attenuates free space laser beam (or pulse) continuously without introducing additional energy fluctuations. Contrast better than 3000:1 (Tp:Ts) is achieved, since this attenuator is mounted with high contrast polarizer. This very compact attenuator version can be easily integrated in custom optical systems.

Product features:

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## Diamond SA

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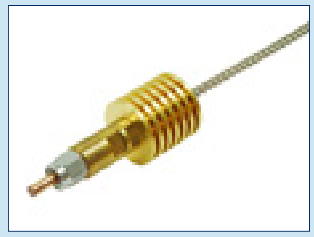
### F-SMA PSi Fiber Optic Power Connector



Diamond has further developed its existing F-SMA (SMA 905) MM connectors specifically for medium-high power laser delivery and thermal management in various applications.

This class of connectors is employed typically for beam injection of medium-high power Diode Lasers (DL) in order to provide a fiber-optic link between the DL source and the target.

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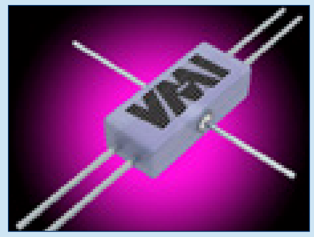
## Voltage Multipliers Inc.

Visit us at Booth #5128

### Visit Voltage Multipliers Inc. to find out more about the 50kV OC500 optocoupler




The OC500 is designed for a push/pull configuration.

The optocoupler has two legs, each capable of 25kV switching voltage. Each leg can be controlled independently via low voltage LED connections. The OC500 features a standoff voltage capability of 50kV between the low voltage LEDs and the high voltage diode, a DC gain of 0.28% minimum (0.40% typical), and compact packaging.

VMI manufactures high voltage diodes, optocouplers, power supplies, and components.

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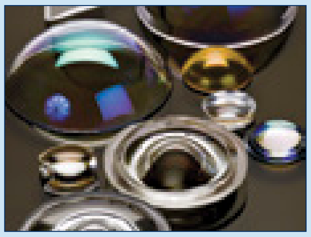

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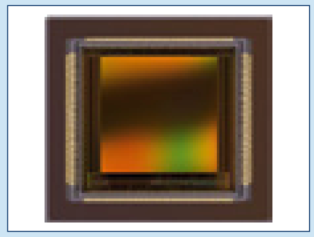

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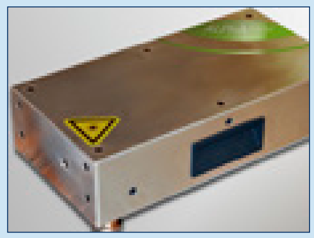

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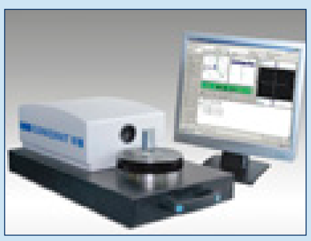
Of course all of the GONIOMAT's features, such as measurement of deflection angles and sophisticated computer-based ray tracing analysis of the measurement data for verification, can also be used for micro-prism measurements.



**Contact Details**

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info@moeller-wedel-optical.com
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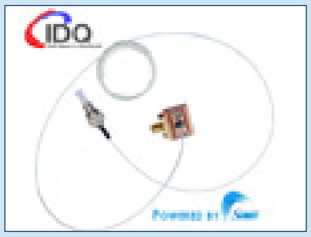

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www.idquantique.com
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Tel: +41 22 301 83 71


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### BQM-50 Beam Propagation Analyzer

The BQM-50 Beam Propagation Analyzer from Arden Photonics. Compact, easy to align and adjust, it measures $M^2$ in less than 20 seconds, with a wavelength range of 400 to 1100nm.

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# Photoacoustic imaging: taking aim at cancer

Lihong Wang is this year's recipient of the Britton Chance Biomedical Optics Award, in recognition of his outstanding contributions to biophotonics. Those achievements include the development of photoacoustic imaging, a technology which is now making the move from animal to human subjects, and which could dramatically impact early-stage detection of cancer.

**Lihong Wang's breakthrough work in the area of photoacoustic imaging was recognized with this year's Britton Chance Biomedical Optics Award — officially presented during the Photonics West BiOS Hot Topics session held on Saturday evening.** Credit: Washington University in St. Louis.

The technology behind photoacoustics (PA) and photoacoustic imaging is developing at a rapid pace, driven by its advantages over other optical techniques for certain clinical applications — potentially including cancer diagnosis in humans. It exploits the long-established photoacoustic effect, whereby the absorption of electromagnetic energy causes thermal expansion, which in turn generates a transient ultrasonic signal that can be detected and used to build up an image.

Although the principle has a venerable history, the current instrumental technique owes much to the efforts of Lihong Wang of Washington University in St. Louis, whose work on the technology and on other biomedical optics breakthroughs has been recognized by his receipt of the Britton Chance Biomedical Optics Award at the Photonics West BiOS event this year.

Two major implementations of photoacoustic technology exist, essentially photoacoustic microscopy (PAM) and tomography (PAT) variants: the former is based on a focused and scanning ultrasonic transducer, allowing dark-field confocal photoacoustic microscopy to be performed. The latter employs an array of unfocused ultrasonic transducers in combination with a reconstruction algorithm to generate its images.

But in applied photoacoustics, these divisions are fluid. "There is quite a bit of overlap, and several different ways of defining the field," explained Wang. "But in each case the key advantages lie in the contrast that the technique can deliver, and in its penetration depth. Its use of optical absorption as the contrast mechanism compares favorably with fluorescence imaging, which has to rely on the fluorescent quantum yield being adequate. All molecules will absorb light to some degree, so in theory PAM could be used to image almost any molecule. That makes it potentially very powerful."

An increased penetration depth arises from the fundamental nature of the photoacoustic effect. Ultrasound scattering in biological tissue happens to be considerably weaker than optical scattering, meaning that a higher spatial resolution is possible and enabling the detection of an emerging ultrasound signal from several millimeters beneath the surface.

"I like to say that we are exploiting photon-phonon synergy, and developing a hybrid modality that allows us to achieve both contrast and resolution," said Wang. "The field is certainly expanding very rapidly, and new concepts are popping up regularly. Proof of that can be seen at Photonics West, where the conference on photoacoustic tomography has grown to become one of the largest at the show, now larger than those concerned with two-photon microscopy or OCT."

Among those fruitful new concepts are the exploitation of non-linear effects in photoacoustic imaging; and the use of specially designed fast-scanning MEMS mirrors, able to scan a designated target sample through a coupling liquid. A fluid-immersible MEMS mirror can allow the scanning operation to be sped up dramatically

> "The [photoacoustics] field is certainly expanding very rapidly, and new concepts are popping up regularly. Proof of that can be seen at Photonics West."
>
> LIHONG WANG.

continued on page 22

**Photoacoustics** continued from page 21

— although new designs and fabrication processes for the mirrors are needed in order to allow them to operate out of their natural atmospheric habitat.

"Photoacoustics may be the only technology that allows you to image all the way from organelles to cells and tissues, and up to organs; a truly multi-scale imaging modality that lets you see cells and tissues *in vivo*," said Wang. "As a result it can accommodate a lot of innovations and new ideas. The wide range of different size scales detectable, and the fact that there are so many different contrast mechanisms to explore, has allowed work in this area to grow exponentially."

## Clinical studies

One major motivation for this level of effort is the potentially significant clinical value of the technology. Photoacoustic systems have already been commercialized by several vendors, primarily for research using small-animal imaging; but the real impact will become apparent as the technology moves towards human imaging.

Clinical studies heading in this direction are already under way — Seno Medical Instruments of Texas is one developer currently involved in a large-scale study of photoacoustics for breast cancer diagnosis — and Wang believes that the full impact of the technology has not yet become apparent.

"My dream is that one day we might be able to use photoacoustics to screen the entire population for early-stage cancer," he commented. "One hallmark of cancer is hypermetabolism — an increased metabolic rate, which affects the rate at which oxygen is consumed. We can use photoacoustic Doppler effects to analyze hemodynamics and compute the metabolic rate of oxygen uptake. We might be able to detect and distinguish between early- and late-stage cancer through assessing some combination of blood oxygen content and hypermetabolism, and do so without needing to introduce a contrast agent."

That latter simplification alone could remove a substantial complicating factor inherent in large-scale trials, removing any concerns for side-effects from added agents while also reducing the complexity of the study.

Other significant applications could include examination of the gastrointestinal tract, where the ability of photoacoustics to detect beneath the surface of the intestinal lining should give functional information about the structure and hemodynamic behavior of hidden lesions and lead to a very sensitive diagnostic tool.

> "My dream is that one day we might be able to use photoacoustics to screen the entire population for early-stage cancer."
> LIHONG WANG.

There is also an effort under way to apply the technology to breast imaging. "I'm a strong believer that this is a very promising direction, using non-ionizing radiation to gather functional information in this manner," noted Wang. "The hope is that we can use it to reduce the terrible rate of false-positives in X-ray mammography."

## Tailored lasers

For photoacoustic imaging to realize this potential, some specific hurdles remain to be tackled. Wang recognizes that while preclinical development of the technology is going well, any clinical translation will take time and effort. "If we want to demonstrate the method's efficacy for, say, melanoma imaging, we will need to determine whether to target patient screening, patient diagnosis, or surgical planning," he commented. "Each will require a different approach."

Another hurdle relates directly to the components used in photoacoustic systems — specifically the bulkiness and complexity of the laser sources involved.

"In some respects, standard lasers are probably overkill for us," Wang commented. "We do not need the longest coherence length, or the narrowest bandwidth, and for some applications we don't need high collimation capability either. Development of new sources better tailored for photoacoustic technology would allow us to build much more compact systems, without compromising on performance. I'm hopeful that developers of laser sources will realize the importance of this technology, and the scale of the new revenue channels that may emerge."

> "Development of new laser sources better tailored for photoacoustic technology would allow us to build much more compact systems, without compromising on performance."
>
> LIHONG WANG.

## Biological guide star: whole body imaging?

Outside of the direct work on photoacoustics, Wang's current research topics include two areas likely to promote discussion at Photonics West. One involves using ultrasound as part of a method to create virtual guide-star reference points within biological tissues, through wavefront engineering.

"I see this as the next growth area," said Wang. "Implanting fluorophores within biological samples is invasive and not particularly flexible, effectively limiting the spot on which the microscopy technique can focus. Our method uses focused ultrasound to create a virtual guide star, through the interaction of that ultrasound with a beam of light. The basic principle can be implemented in a number of different ways."

This kind of wavefront engineering could ultimately be of direct benefit to photoacoustic imaging, if it could be used to counteract scattering and further increase the penetration depth of the technique. Potentially it could boost the penetration depth to reach some tens of centimeters into biological systems — at which point the notion of whole-body imaging of humans starts to become tantalizingly feasible.

The other major research topic is compressed ultrafast photography (CUP), a technique which has proved capable of capturing the flight of individual photons in a laser pulse. "This is the world's fastest receive-only 2D camera," noted Wang, referring to the system's lack of any specialized ultrafast active illumination in capturing its snapshots. "It records at up to 100 billion frames per second."

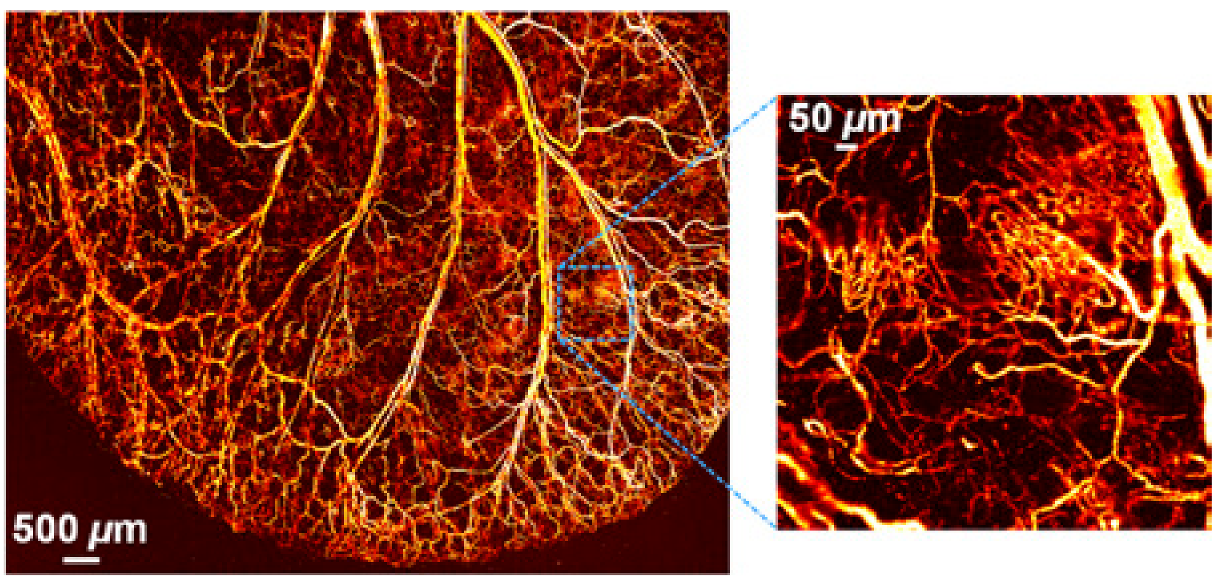
CUP is a computational imaging technique, measuring the one-dimensional intensity variation of a pulse of light over time and building upon it through computation in order to ultimately visualize the pulse in two dimensions.

It could have several important applications, including in bioimaging; snapshots on this timescale could be valuable in fluorescence lifetime imaging, for example. But other likely benefits could well be found in astronomy, where combining this degree of temporal resolution with the spatial resolution available from instruments such as the Hubble Space Telescope could uncover new physical phenomena, or glimpse the very fast events occurring in supernova.

Wang takes a holistic approach to these technologies, looking for the common ground that they share.

"My belief is that, in the end, all these techniques can and should work together, rather than displace each other," he said. "In my lab we built a tri-modality imaging system: we took a confocal and two-photon microscopy platform, and then added photoacoustic microscopy capability into the same system. So you could mount cells or small animals on the same scanning stage and acquire information from three different contrast mechanisms. That really summarizes my position. I think all technologies are, in the end, complementary."

TIM HAYES




**Photoacoustic image of the vasculature in a mouse ear, acquired *in vivo* and without the use of an exogenous contrast agent.** Credit: Song Hu and Lihong Wang, Washington University in St. Louis.

# Supercontinuum goes violet

Supercontinuum sources have been commercially available for several years providing high brightness laser output with tremendous spectral broadness eclipsing even that of incandescent lamps. However, the spectral area below 430 nm has been challenging and many offerings in the market have had sub-par stability, lifetime and mode quality. With many applications, such as bio-imaging, material characterization and spectroscopy, moving to shorter wavelengths, the need for stable single-mode sources in the 400nm region has increased and today NKT Photonics - the World's biggest manufacturer of supercontinuum sources - addresses that need.

With the introduction of the new violet SuperK EXTREME EXU series users now have access to diffraction limited laser sources emitting in the entire 400-2400nm wavelength range. The sources are single-mode over the entire output spectrum and features a maintenance-free lifetime of thousands of hours. The new sources can be paired with variable filters, such as the SuperK SELECT or VARIA, to create a tunable laser with a bandwidth covering the visible and near-infrared part of the optical spectrum and due to the filter quality and superior beam quality of the source, output stability is unrivaled in the industry. Both source and filter are controlled by NKT Photonics new unified software suite, CONTROL, making source and filter work as one integrated system.

The new SuperK EXTREME EXU line of supercontinuum sources are available now and is on display at NKT Photonics booth #811.

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# CDA – We inspire and manufacture value!

## Optoelectronic components and microfunctional optofluidic devices in plastic

CDA GmbH (Suhl, Germany) is an established manufacturer of custom components and solutions in plastic. CDA's technology portfolio includes polymer optical elements and arrays for use in optoelectronics, automotive (HUD), virtual reality (VR) and 3D sensing applications. Portfolio for microfluidic structures include channels, pillars, functionalized surfaces sometimes combined

with conductive polymer printing for the use in point-of-care, diagnostics, environmental monitoring and forensic screening applications.

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A recent development is the ability to stack multiple optical layers in order to further customize performance.

**Optical Module Assembly**

CDA offers optical module design, prototyping and high volume assembly. These small integrated packages require often high precision alignment between light source and optics as well as proper packaging material for high reliability and maximum performance.

**Microfluidic structures for ›lab-on-a-chip‹**

CDA additionally provides the integration of microfluidic structures into compact and sensitive devices, (›lab-on-a-chip‹). Such devices


*Heads-up display*

are becoming increasingly important where chemical, electrical and/or optical properties need to be tested on a small scale. Tried and tested structures and options include:

- channels for separation and mixing
- hydrophobic and hydrophilic surfaces
- combining these with microoptics and printed electronics

Appropriate devices lend themselves well to high levels of parallelization, thus reducing costs, but their manufacture does require a fully integrated process chain and command of several cutting-edge microfabrication technologies.

**Manufacturing services**

According to Pia Harju, Business Development Manager at CDA, "The opportunities for both microoptical elements and for integrated devices are truly global. Our manufacturing services – design, prototyping, assembly and mass production – are designed to benefit our customers' global strategy."

**Contact**

**Booth: North Hall 4318**

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Web: www.cda-microworld.com

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# Choosing a Digital Low Light Camera for Long Range Applications

The ability to observe and record images and scenery undetected are paramount to the safety of both life and infrastructure. Modern warfare techniques, whether static monitoring or mobile surveillance, rely heavily on information gathered via covert long-range surveillance methods such as hidden cameras. The imaging technology is most effective if the camera can produce high quality long range images in both daylight and nighttime conditions. Today, the need to aggregate and share information requires these long range solutions to be digital.

Detection, Recognition and Identification are critical in long range imaging, and each is dependent on proximity. Identification with high probability is a short-range function, as it needs a great level of detail and a high quality image to clearly determine if there is a threat and what it may be. Identification is most difficult under low-light conditions due to poor signal-to-noise ratio and most digital surveillance cameras use supplemental technologies to enhance low light imagery.

The two technologies most often used to supplement CMOS or CCD low light digital imaging are thermal imaging and NIR illumination. Thermal is good for detection and recognition as it relies on differences in adjacent heat signatures. However, thermal technologies do not showcase identifying details, such as cultural signage or facial features, even at short range.

NIR illumination is often used in static surveillance to augment CCD daytime imagery. This is ideal for short range imaging, but the power required to illuminate at long distances is impractical for mobile applications. It can also expose a location to danger, as any reconnaissance with NIR sensitivity can clearly identify a target.

CMOS technology has emerged as a stand-alone digital low light imaging solution. The solid state sensor is impervious to bright light damage, yet can provide superior, high resolution and low noise images from full daylight well into starlight conditions. CMOS sensors can provide high resolution and high speed imaging, without supplemental technology and without cooling.

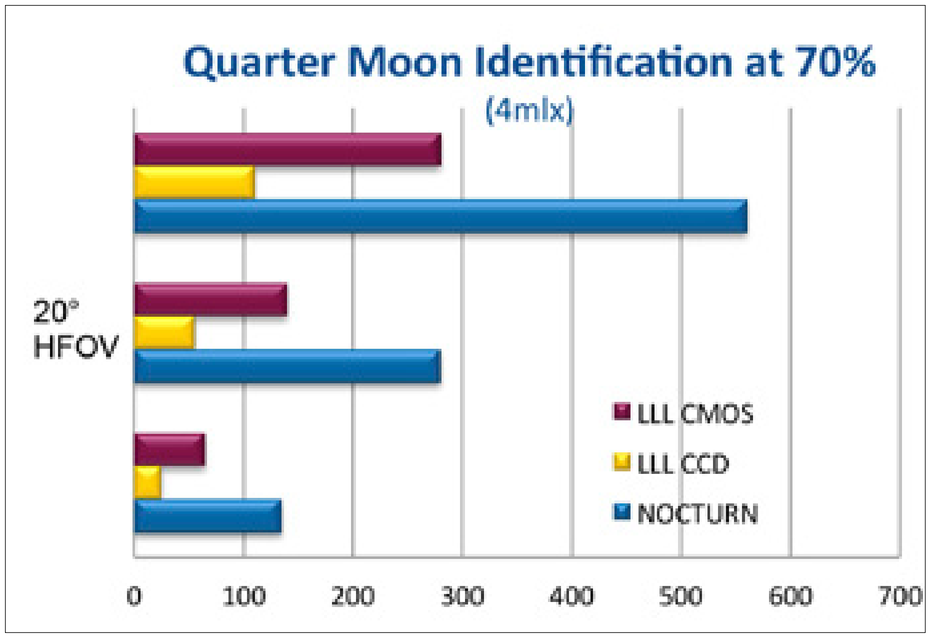


*Figure 1: Nocturn camera provides significantly longer identification under quarter moon lighting conditions than competitive digital technologies and without supplemental technologies.*

PHOTONIS is a global leader in low light technologies. Our expertise in night vision optics has made it possible to create a superior family of low light cameras that provide SXGA resolution (1280x1024) with large 9.7 micron pixels for efficient light collection. The Nocturn family of low-light cameras offer <4e-rms at the full 100Hz, and supports common video frame rates. Nocturn is offered in a wide range of standard connectivity options, and some models can be ordered in color for added certainty of identification in low light conditions.

See for yourself at our live demo at Booth #4314.

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# The Ultimate Visible to Near Infrared Tunable Laser Source Based on Next Generation Supercontinuum Fiber Lasers

*High power Supercontinuum "white-light lasers" have proven to be popular and versatile light sources for research and industry. The latest WhiteLase™ supercontinuum sources from Fianium, with over 20W optical output, provide around three times more tunable power than any other similar system available.*

*Ross Hodder, Head of Sales & Marketing, Fianium Ltd*

*Figure 2: Plug-and-play LLTF Contrast™ tunable filter from Fianium.*

**Introduction**

Fianium (Southampton, UK) released the first high power supercontinuum fiber laser in 2004 and have since supplied over 1200 WhiteLase™ systems to customers around the world.

While the full broadband supercontinuum spectrum is sometimes used simultaneously, in many applications only a single wavelength is required at any one time and the rest of the spectrum needs to be blocked. To achieve this a tunable bandpass filter can be used converting the source into a cost-effective wide range tunable picosecond laser.

The amount of tunable power available from such a source depends on the type of filter and the available power from the supercontinuum laser itself. The new WhiteLase™ SC-480-20 supercontinuum fiber laser provides an unprecedented average power density of more than 10mW/nm, making it the brightest supercontinuum laser available today.

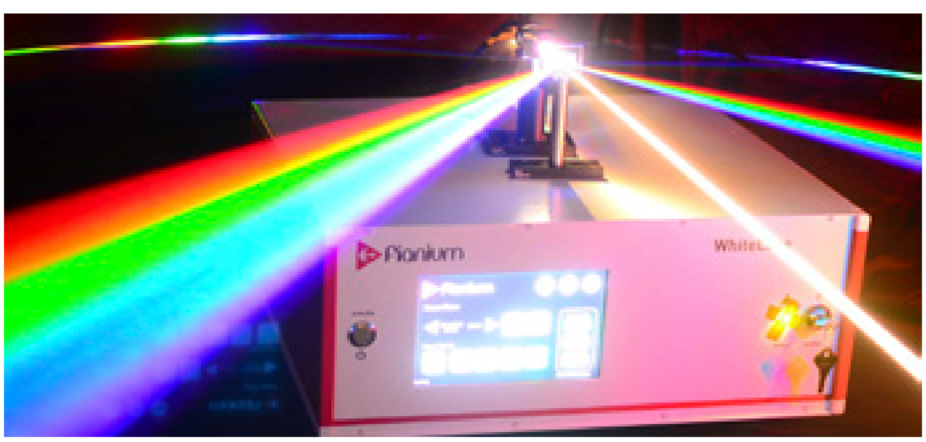

*Figure 1: Fianium WhiteLase SC-480-20 supercontinuum fiber laser.*

**High performance "Laser Line" Tunable Filters**

Grating based filters are used with supercontinuum lasers because of the exceptionally high out-of-band suppression that can be achieved. Using holographic volume Bragg gratings, out-of-band blocking of more than 60dB can be realised while maintaining the spatially single-mode output. This technology is now available in the LLTF Contrast™ compact plug-and play filter from Fianium.

Another unique benefit of this type of filter is the extended tuning range with just two LLTF filter modules able to cover an impressive tuning range from 400nm to 2300nm.

**Summary**

Supercontinuum white light fiber lasers are versatile light sources where the potential range of applications is defined by both the performance of the tunable filter and the light sources itself. The combination of the latest generation WhiteLase™ supercontinuum fiber lasers with high performance LLTF Contrast™ filter can provide greater than 10mW output, in a narrow 2nm bandwidth, creating the ultimate tunable laser source.

**See Fianium's latest products at Photonics West booth #829**

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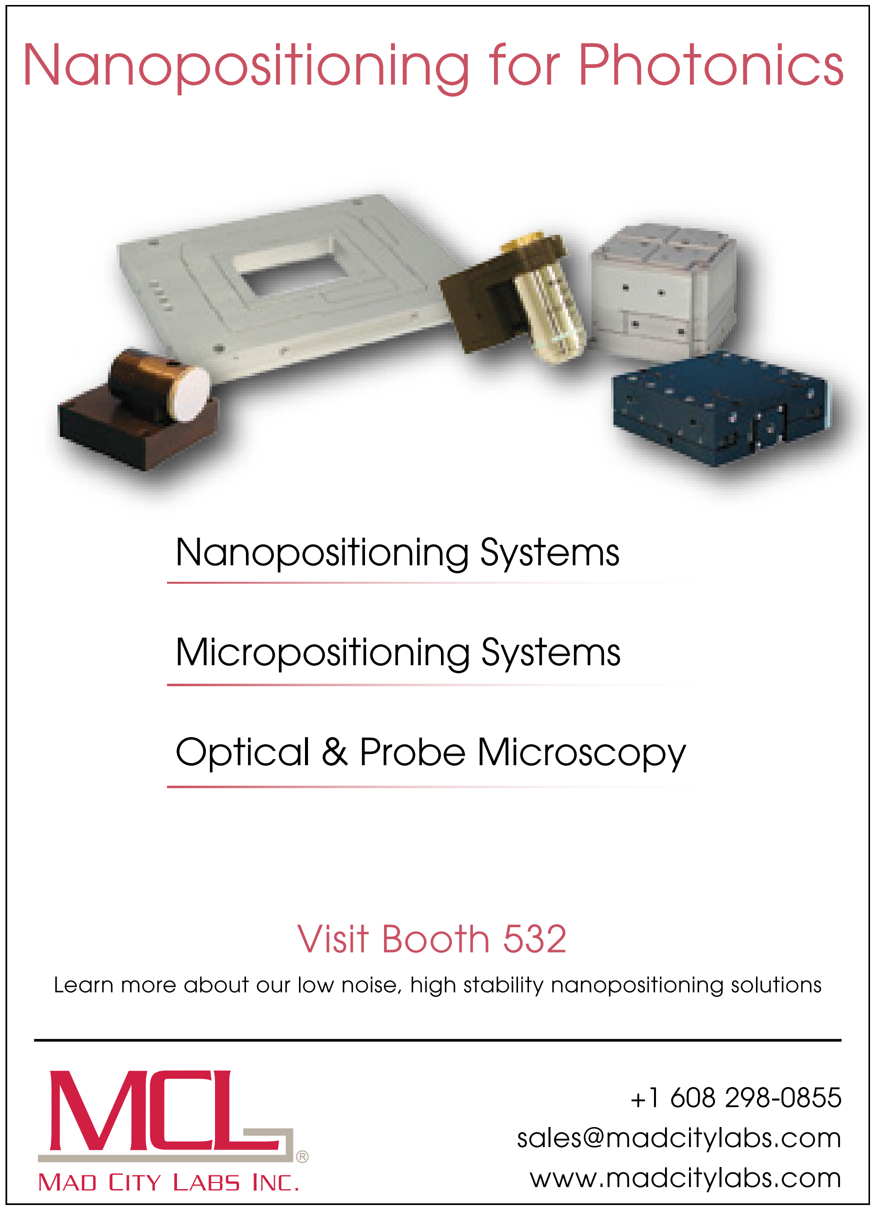
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# New Gooch & Housego chief is cautiously optimistic for 2015

Recently installed CEO Mark Webster brings a healthcare background to the UK-headquartered photonics company as it looks to balance its applications base.

**Mark Webster was officially installed as Gooch & Housego's new CEO at the start of 2015. His long-term predecessor, Gareth Jones, has now taken on the company chairman role.** Credit: Gooch & Housego.

Despite an already solid business performance over the past year — sales up 11 percent, earnings and dividends up 11 percent and 14 percent, respectively, and profits up almost 20% — Gooch & Housego appears to be engaged in something of a reboot.

As of January 1 2015, the UK-based manufacturer of optical components and, increasingly, systems, has a new CEO in Mark Webster. A seasoned executive with experience of refreshing the operations of some major pharmaceutical companies, he is part of a senior executive rejig that saw the long-term incumbent Gareth Jones shift to chairman responsibilities and the appointment of new COO Alex Warnock.

A chemist with a background in the international healthcare and pharmaceuticals sectors, including senior roles at Abbott Laboratories, Bayer, Shire and Bio Products Laboratory, Webster had previously become a non-executive director at G&H in January 2012. He feels that his track record in expanding technology-driven companies means he is the right man for the job of reinvigorating and streamlining an enterprise that has grown a diverse technology portfolio through numerous recent acquisitions.

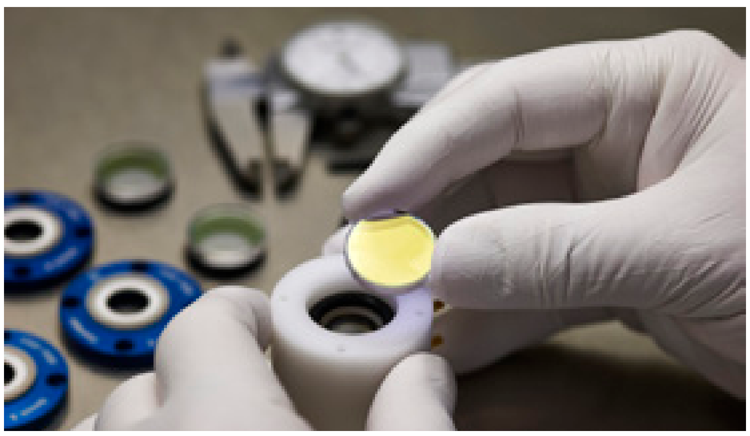
Speaking at the company's rural headquarters in the Somerset town of Ilminster as 2014 drew to a close, Webster declared himself optimistic about growing the G&H business further. "I liked the look of this company, with its strong technology focus and significant presence in the US and internationally," he told *Show Daily*. "It has a good business strategy and under my predecessor, has been very adept at bringing on new technologies and I think also for predicting trends as well."

Nor will that expertise be lost. Under the terms of the CEO succession, predecessor Jones will remain in place as G&H chairman for up to three years.

To many specialist customers in G&H's core market sectors; aerospace and defense, industrial lasers, life sciences, and scientific research, the company has typically been best-known for its solid-state Q-switches. But Webster explained that these devices now account for only around one-tenth of the company's business.

"We have fiber-optic capabilities at our Torquay, UK, site, which actually represents the fiber laser side of things, while the fiber-optic Q-switch and fiber laser components represent about 12 percent of our business now. So the business is generally moving towards fiber-optics and away from the old style Q-switches.

"That's still substantial business but it won't be the growth engine of the future. This business generally is moving towards fiber-optics."



**A wave plate manufactured at Gooch & Housego's Cleveland, Ohio, facility.** Credit: Gooch & Housego.

## Deeper relationships

Looking at the likely routes to growing the business and considering Webster's healthcare and life sciences pedigree, does he expect that healthcare will become a more important market for G&H?

"In the short term, our main growth areas will be in aerospace and defense, which is driven less by the technology and more by customer needs. We have already developed good business relations with a number of key players. That sector will be followed by life sciences and there will also be niche industrial sector growth which includes fiber optics.

"We would like to expand our relationship and develop a deeper relationship with these companies. So we have put in a couple of new people, one in the UK and one in the US, who are very experienced in aerospace and defense marketing. G&H is already strong on ring laser gyroscope systems, fiber gyroscopes and laser guidance systems for targeting."

In life sciences, the sales cycle typically involves a long gestation, so Webster sees that market as a more of a medium-term prospect. G&H technology is already installed in OCT systems, particularly for ophthalmology but also for dermatology applications, as well as laser surgery for varicose veins and prostate treatment, plus the booming aesthetic market of tattoo removal. In the future this could include diagnostic esophageal and cardiovascular procedures.

continued on page 28

## Mark Webster

continued from page 27

In the longer term, Webster sees a fruitful market in optical systems for line-of-sight satellite communications. It was with this in mind that G&H acquired the Greek space technology start-up Constelex in late 2013. Bought for €600,000, it has since been integrated into the company's Torquay operation.

"Constelex already had some grant-funded business with the European Space Agency," Webster said. "Space applications play to our strengths because it's a hostile environment; you need to deal with radiation and high temperature fluctuations, and the systems are not readily repairable. We are already investing in space and satellite but that market is probably three to five years down the line."

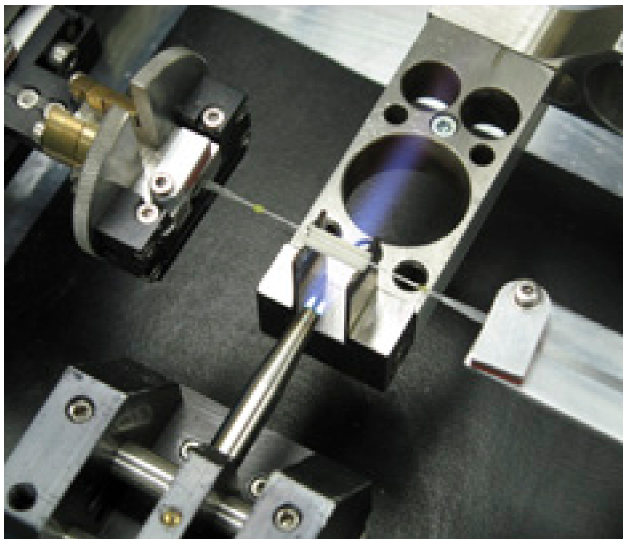
### Systems technology

One key objective of Webster's is to reposition the company's components-to-systems sales revenue split. Currently, that sits at 80:20 in favor of components, and the aim is to achieve a notional balance of 50:50. "The thinking behind expanding our Systems Technology Group [STG] is that while G&H is well-known for producing high-quality components and working with customers on their systems, we have been less effective at putting the systems together ourselves.

"The STG, at Torquay, now consists of 11 people and it's growing rapidly. It has PhD scientists and engineers but it also has electronics and software engineers and we are actively recruiting more of these. We have been reasonably successful putting together some systems in, for example, OCT, fiber-optics and satellite applications. It's not the bulk of our business but we want it to be more significant.

"We also need to consider how we are going to provide some systems development capability in the US and Murray Reed, our CTO, is looking into how we can do that." One possibility is to site an additional electronics development group in the US, perhaps in the company's new Fremont, California, location that should open for business in April after relocating from nearby Palo Alto.

Besides aiming for organic growth through the development of that internal systems capability, G&H is also keen to continue making some strategic acquisitions. Along with Constelex, the most recent of those was in late 2013, when Spanoptic, based in Glenrothes near Edinburgh, became part of the group.



**Production of a fused optical coupler at Gooch & Housego's Ilminster, UK, headquarters.** Credit: Gooch & Housego.

Spanoptic makes aspherical optics, complementing the planar optics produced back at the Ilminster headquarters, as well as infrared components — a good fit for the defense market. Despite being at opposite ends of the UK geographically, the Ilminster and Glenrothes sites are now treated as a single "virtual" business unit.

### Integration challenge

But the various additions made in recent years have inevitably been accompanied by some logistical headaches, and even the company's 2014 annual report included the frank admission that the G&H board of directors "believed that the group had too many operating sites leading to inefficiencies." The Melbourne, Florida, site has already been deemed surplus to requirements, but does Webster feel that the company's still-diverse range of technologies and locations needs further pruning?

"Improving the fit of our divisions is another of my objectives," he admits. "Bringing them together better is something I'm looking at. It's true that in some of the larger companies I have worked for that when you make acquisitions, there is a job to achieve integration. So far, we have managed to make all of the units deliver profit.

"Perhaps what we have been less good at is bringing them all together to create a single G&H company, so the feeling would be that if we can leverage the capabilities that we have across the piece and present them as a single package to customers then we would have a stronger and better company."

At present, there are no plans for consolidation beyond the closure of the Florida site. And another recent decision will result in a significant investment to upgrade the company's crystal and electro-optics facility in Cleveland, Ohio. Webster commented, "Cleveland is a very productive and profitable site, with good revenue growth, but only part of that site is modern, so we have taken the decision to upgrade the rest."

Considering possible personnel changes, he added, "We want to make G&H more efficient. My game-plan is to add a small number of people, who have skills and experience that we perhaps don't have already, for example in aerospace and defense areas, people who are experienced in working with the larger aerospace and defense companies." Besides selected personnel, G&H will also be increasing its research and development budget percentage from the 8 percent of sales invested in 2014.

Webster believes that G&H has historically done a good job of anticipating trends in the photonics marketplace. So what does his crystal ball tell him now? "We are looking at the market in 2015 with cautious optimism," he says. "If we look at the broader macro trends — aerospace and defense, the US budget is now confirmed for the year, so that is good news. But we do not expect the defense budget to grow dramatically.

"The sectors in which we operate, where customers still tend to be upgrading to fiber-optic technologies, seem to be good for us. In the life sciences area, that tends to be affected by budgets, but again the trend towards lasers for surgery and for OCT for diagnostics also seems to be on a good pathway. On the industrial side, I think there are areas that are showing good growth. Fiber lasers, because they are relatively lower cost, are also becoming more ubiquitous. The breadth of their usage will continue to increase."

MATTHEW PEACH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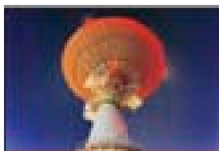

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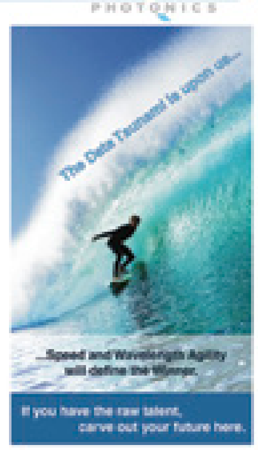


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# Hot Topics shine a light on early cancer detection

White lights, blue lights and the "colors" of collagen lit up the BiOS Hot Topics session on the opening evening of Photonics West 2015, as two speakers on non-invasive cancer screening showed how optical tools could break through old logjams in clinical medicine.

Other speakers in the round-robin, with only 15 minutes per talk, told how optics can spot otherwise hidden brain tumors and how adaptive optics (AO) can assess complex eye diseases.

Paola Taroni from the Politecnico di Milano in Italy described a 200-patient study on collagen, saying her use of light at specific wavelengths was the first clinical work on such a non-invasive way to look for breast cancer.

Because collagen, an agent in breast cancer, absorbs light so differently from other tissue constituents, her images showed it clearly, in contrasting colors, and she could quantify it with a groundbreaking optical approach. The results, also showing breast tissue density without incisions, are dramatic, said Taroni, although she added: "We have years to go before it will help patients."

She said that high false positive rates - up to 30 percent, for in fact benign cells - showed a need for better non-invasive discrimination of malignant lesions.

Meanwhile, a talk on general early-stage cancer detection revealed the first nanoscale measurement, chromatin-based and "label free," of cancer's activity inside cells. "It's what bioscience has needed and waited for, for a long time," said Vadim Backman, a biomedical engineer at Northwestern University. "Every other method uses labels that change the cell function."

His approach instead looks at chromatin structure to address fundamental problems in cancer biology. Analysis of interference spectra is converted to statistical properties, and inside one minute the system can image 100 cells, showing nucleic architecture and nano-scale changes in chromatin in real time.

That reveals changes in nuclear and cell architecture an order of magnitude below the resolution of conventional microscopy, while the technique lets physicians identify pre-cancerous tissue that would otherwise be missed.

Backman said: "A big plus of our nanocytology technique is that not only it can identify early pre-cancerous lesions by analysis of easily accessible cells - checking for lung cancer, or colon cancer - but it can identify clinically significant and potentially dangerous lesions, even when these are small and can be removed easily."

Chromatin structure drives changes in genetic networks, Backman said, letting cells loose to "explore the genomic landscape, what cancer is all about." Those structures can be modulated with drugs, he said, and 90 percent of cancer deaths could be avoided with better early screening.

He said test kits would reach the US medical marketplace, starting with a target of heavy smokers, as early as 2016, with colon cancer screening tests to follow soon. Start-up company Nanocytomics is commercializing the tests, which are now in clinical trials.

"This is how to win the war on cancer," claimed Backman, who studied medicine and engineering at Harvard and MIT. The goal is not just to track existing cancers but "to prevent cancer from happening in the first place."

Aside from Backman and Taroni, the session featured talks on endoscopic OCT, adaptive optics for retinal screening, and 3D imaging of neural activity, while Lihong Wang picked up the 2015 Britton Chance Biomedical Optics Award (see our interview with Wang on page 21 of this issue). Symposium co-chair Rox Anderson told the conference: "I love the melting pot that the SPIE has become. We are actually making a difference for people in the world and what better for the [International] Year of Light."

FORD BURKHART

# Cylite takes tomography "hyperparallel"

Armin Segref (l) and development director Trevor Anderson from Cylite at the weekend's BiOS Expo. Credit: Matthew Peach

Cylite, a company from Melbourne, Australia, used the BiOS Expo to demonstrate its new "hyperparallel" coherence tomography measurement and analysis platform.

The 3D spectral imaging technology, with potential applications in optometry and other biological fields, scans tissues across a roughly cornea-sized (15mm x 9mm) grid, performing more than 1000 simultaneous high-resolution scans to a depth of 7.5 mm at over 50 frames per second.

Trevor Anderson, Cylite's research and development director, told *Show Daily*, "This degree of scanning provides several enhanced performance features from a single tool, which we believe is unique in the field.

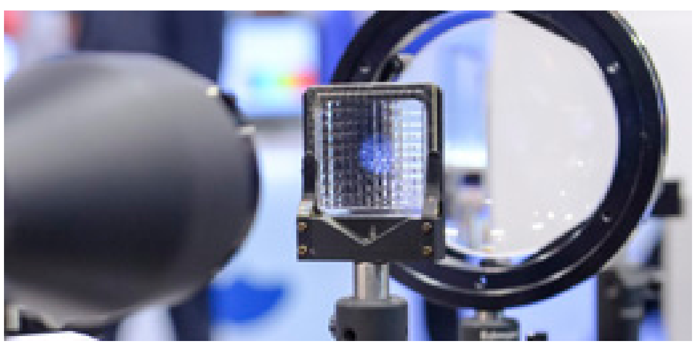
"[Its] capabilities include greatly enhanced frame registration due to multiple simultaneous surface measurements, denser volumetric imaging over a fine lateral grid. Overall it is a lower-cost implementation because we use standard optical components and achieve the functionality of three conventional instruments in one," he said.

Steve Frisken, the company's CEO, added, "Hyperparallel coherence tomography provides a definitive solution for the growing requirements of high-resolution optical imaging tomography and metrology. It enables the capture of en-face images in a single shot with phase registration over a full C-scan. This provides unique capabilities that could also be applied to advanced OCT modalities such as elastography and Doppler OCT."

The technique has yet to be trialed on a representative human sample, although the development team says that under the guidance of a professional optometrist (who is on the company's advisory board) they have tried it on each other — with promising results. One specific application of the kit could be diagnosis of keratoconus, which causes a variety of sight problems including blurred vision, increased sensitivity and "ghosting."

Besides introducing the hyperparallel approach at the BiOS Expo, Anderson also presented the technique in a paper at the associated conference, entitled "3D spectral imaging for anterior segment metrology."

MATTHEW PEACH



**Edmund Optics and LUXeXceL have signed a collaborative agreement to work together on 3D-printed optical components. They are demonstrating a lens array comparison during the Photonics West exhibition to show the performance of the emerging technology. Netherlands-based LUXeXceL is also a Prism Award finalist this week. See Edmund at booth 1615.** Credit: Trish Tunney.

# Turnover up sharply at ALPAO

ALPAO showed off its adaptive optics technology on the show floor with an interactive demo in which attendees could control the company's deformable mirrors through a simple iPad interface.

This year the French firm, a spin-out from Joseph Fourier University in Grenoble, was highlighting its two latest deformable mirrors, which feature 468 and 820 actuators. Sales manager Vincent Hardy said that he is targeting applications in ophthalmology, where ALPAO has developed a 97-actuator deformable mirror that is the same size as a dilated pupil.

The company saw its turnover jump 50 percent last year to around €1.5M, Hardy said, thanks in large part to demand for medical applications, which now make up more than half of ALPAO's total sales.

Astronomy and microscopy make up the other two major application sectors for adaptive optics, and one of ALPAO's deformable mirrors is used in the 8.2 meter diameter Subaru telescope at the summit of Mauna Kea in Hawaii. The company is likely to be one of those competing to provide state-of-the-art adaptive optics technology for the European Extremely Large Telescope (E-ELT) in Chile, which is set to use a 2.6 meter adaptive mirror in conjunction with six laser guide stars to correct for atmospheric turbulence.

# Biophotonics startups, established firms consider numerous financing options

Opportunities abound for lasers and optoelectronics in the life sciences and healthcare markets, but the financial landscape can be tricky to navigate, especially for small- to medium-sized companies. That's why finding the right investors and business model to successfully bring a new product to market is critical — even for ventures that are well beyond the startup stage, according to speakers at a photonics industry session Tuesday on financing life sciences and healthcare ventures.

The market for private placements in development-stage and high-growth life science and healthcare businesses is "robust," according to panel moderator Linda Smith, president of Ceres Tech Advisors, an acquisitions advisory firm that specializes in photonics. Smith, who compiles an annual list of mergers, acquisitions, and private placements made in biophotonics, said she found over $5 billion worth of investment in biotech-enabled businesses in 2014 — three times the investment in 2013.

"Biophotonics is a core enabling technology for many innovations in healthcare and life sciences and fertile ground for investment and economic growth," she said.

According to Smith's analysis, diagnostics accounted for 40 percent of private placements ($1.6 billion) in 2014, dominated by fluorescence-based technologies, molecular imaging, and point-of-care devices. In fact, her survey found 50 investments in point of care devices alone.

Investments in medical imaging were also significantly higher than in previous years, up 26 percent over 2013, with "good, healthy investments" still taking place in optical coherence tomography and endoscopy. In life sciences, which accounted for 15 percent of private placements, much of the investment is also going into fluorescence-based devices, such as drug discovery platforms and equipment used for environmental analysis.

Even so, the biophotonics landscape continues to be centered around a few key players and hundreds of small-to-medium enterprises and startups. In fact, Smith's 2014 analysis found an interesting trend. In 2013, more than 90 percent of private placements were made in early-stage companies with less than $10 million in revenues and no earnings. But in 2014, this number dropped to 15 percent, with a significantly higher concentration of investments in companies with more than $10 million in revenues.

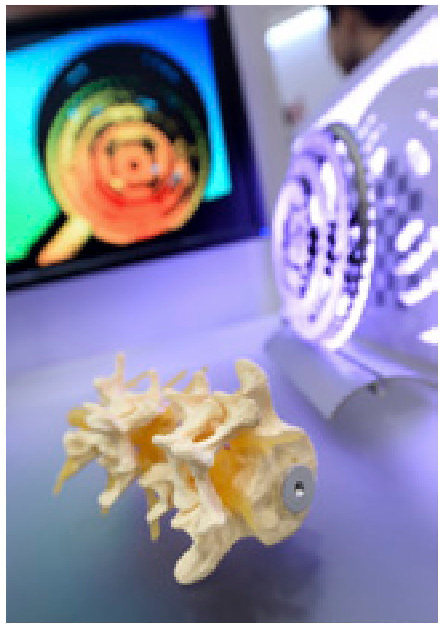
"In this market, the business models to get a company from the startup stage to a $5-to-$10 million dollar company with customers and FDA approval is a challenge," she said. "So whether you are a startup or an established player, access to capital is extremely important."

## Financing options

Fortunately, a variety of financing options are available, ranging from venture capital and private equity to strategic corporate investing, venture debt, angel investing, and patent licensing.

Angel investing has become an increasingly attractive option, given the changing venture capital (VC) industry, according to Faz Bashi, chair of the Digital Health & Sciences Committee at Life Science Angels. Life Science Angels is a nonprofit pro bono operation with about 100 investors that is supported by membership fees and sponsorships. The company looks for deals where it can provide expertise and capital and has funded 42 firms to date. The company's sources of financing include angels, non-dilutive sources, strategic alliances, and VC.

"We would love to see more venture capital involved in our deals, but that market has changed quite a bit," Bashi said. "In fact, the VC industry is redefining itself,



**Core enabler: biophotonics is critical to many innovations in healthcare and life sciences.** Credit: Trish Tunney

for lack of a better word. In 2007 there were more than 1,100 VC funds; today less than half that. And the remaining VCs have moved away from smaller ($1 million to $5 million) investments and are waiting for later rounds. And many VCs have moved away from the life science space."

As a result, angel investment groups have become "quite significant," Bashi said, noting that in 2010, angel investors accounted for more than $20 billion in investments in more than 61,000 deals — numbers that remain about the same today.

When considering a potential investment, Life Science Angels is interested in much more than just a company's business plan, Bashi emphasized.

"We are interested not just in money capital but in psychological, human, and social capital," he said. "These are the things that go into making a company successful." Bashi added that 70 to 80 percent of "why we invest is management."

Another option for financing and managing your business is to consider licensing or selling your intellectual property (IP), according to Jeremy Salesin, VP of acquisitions for Intellectual Ventures, which manages over 40,000 assets and licenses them to companies to help manage their risk and maintain their advantage.

"Patent transactions are an interesting way of raising money," he said, noting that Intellectual Ventures has invested more than $2 billion in patents over the years. The company also sells patent portfolios to small companies that have started recently and don't yet have good patent protection.

However, IP is much broader than just patents, Salesin noted. It includes software, trademarks, trade secrets, copyrights, domain names, social media profiles, databases, IP addresses, even spectrum rights — all things that are not on a company's balance sheet but that represent value.

"All of these things have value down the road if you want to raise money for your business in a non-dilutive way," he said.

Another financing option to consider is loan debt (versus equity), which tends to be more attractive for larger companies.

"Banks offer a broad source of capital from a debt standpoint," said panelist Jim Haack, senior vice president of technology banking at Citibank. "Debt can be a very low-cost source of capital, even lower cost than equity."

With the changing healthcare landscape, health systems, such as doctors, hospitals, cancer centers, and medical schools, represent an emerging source of investment for companies developing products that can improve patient care and lower costs, according to Chuck Sted, former CEO of Hawaii Pacific Health. With the shift from fee-for-service reimbursement to payment for value, the cost of healthcare is shifting from payers to providers. Thus there is growing interest by health systems large and small to support innovation, Sted emphasized.

KATHY KINCADE

## Smartphones used in Haiti for cancer screening

Christophe Millien of the Hôpital Universitaire de Mirebalais in Haiti described a handheld, smartphone-based colposcope system used by mobile clinics in Haiti that is enabling screening for cervical cancer — and resulting in saved lives among a high-risk and underserved population.

"Poverty is a carcinogen," Millien noted in a conference on optics and biophotonics in low-resource settings. Millien said cervical cancer is a leading cause of cancer death for women in communities where there are no clinics or doctors. Haiti is estimated to have a cervical cancer rate 10 times higher than the state of Kentucky in the USA.

The modified smartphone and accompanying software provide an easy-to-use, transportable colposcope with which nurses and midwives can capture and share medical images with doctors in Haiti and the USA, resulting in more accurate diagnoses and successful treatment.

AMY NELSON

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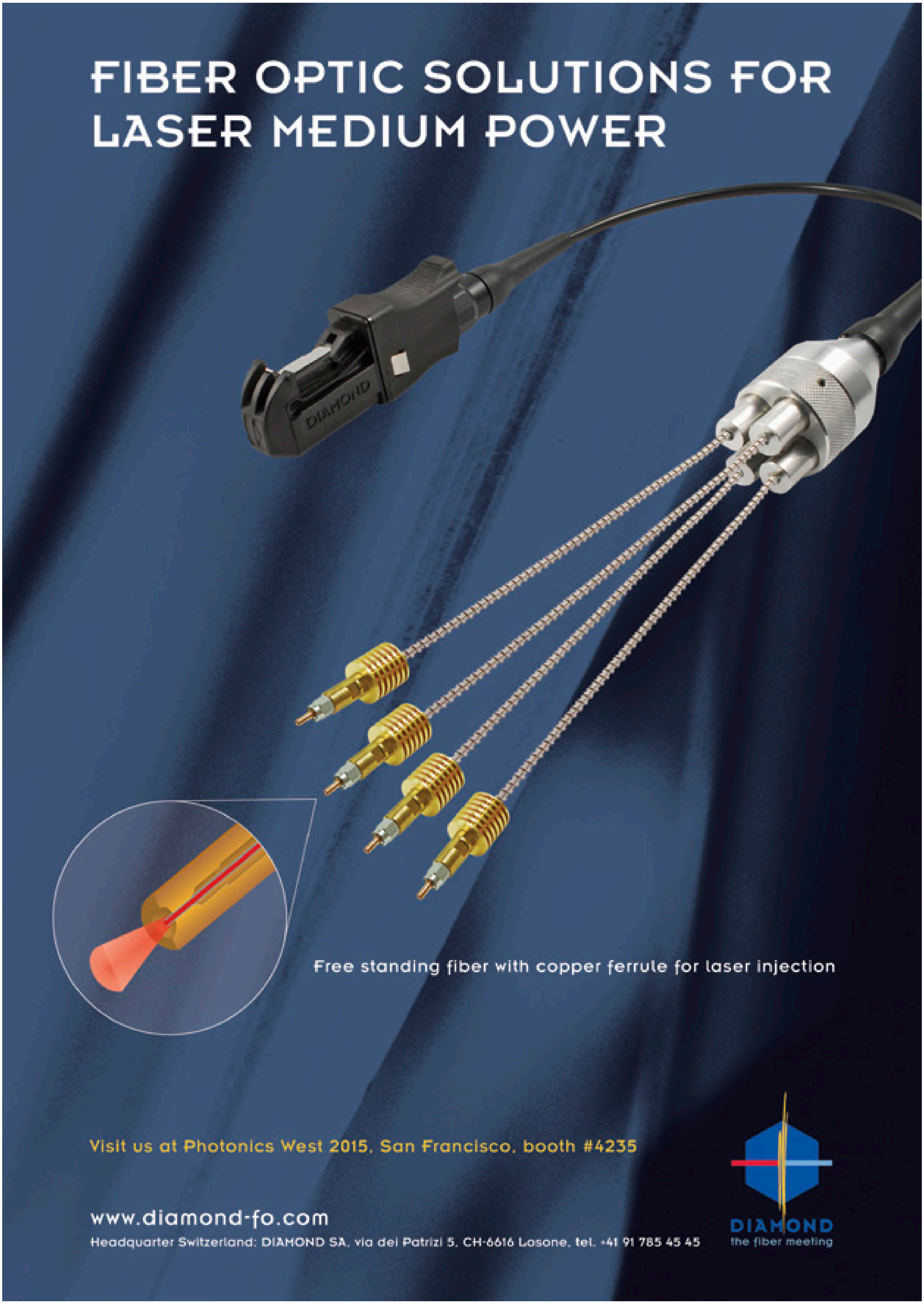
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