WEDNESDAY EDITION

WEDNESDAY, FEBRUARY 17, 2016

SPIE. PHOTONICS WEST | optics.org

PHOTONICS WEST. SHOW DAILY

"We've been slammed."

Exhibition news
page 4

3D panel to discuss "major challenge" of IP theft

The remaking of manufacturing in the guise of 3D printing or additive techniques has captured the popular imagination and produced huge levels of media hype over the past decade or so. More recently, the hype has moderated, the prices of many 3D stocks have fallen, and unrealistic expectations have been recalibrated. Does this mean that real growth of 3D printing revenues has slowed?

Nothing could be further from the truth, according to John Hornick, author of *3D Printing Will Rock the World* and a 3D panelist at Photonics West who says the compound annual growth rate of 3D printing is probably still about 30%.

Aimed at hobbyists, the Autodesk "Ember" 3D printer incorporates a digital light processor (DLP) chip made by Photonics West exhibitor Texas Instruments. Credit: Doug Cody.

Hornick, who is also an intellectual property (IP) lawyer at Finnegan, Henderson, Farabow, Garrett & Dunner, is one of four panelists sharing their expert insight on 3D printing, its opportunities and challenges from 8-10 am Wednesday in Room 103 of the Moscone Center. The panel discussion is chaired by Bo Gu, president of Bos Photonics, chair of the laser applications track at LASE, and chair of the Laser 3D Manufacturing conference.

The other 3D panelists are Jyoti Mazumder (University of Michigan), John Murray (Concept Laser), and Rebecca Taylor (National Center for Manufacturing Sciences).

While there seems little doubt that the breadth of opportunities afforded by 3D printing – from the manufacture of turbine blades to fabrication of biological tissue (bioprinting) – will continue to drive industry growth as well as individual imaginations, widespread adoption of enterprise-level digital-manufacturing technologies will raise some real-world structural challenges.

Taylor, who specializes in cybersecurity issues, notes that, as with any digital technology, storage and transfer of 3D designs and processes will be at risk of being compromised — an especially important consideration in the defense arena where data sharing will likely require additional levels of encryption.

Meanwhile, information technology research company Gartner says that the rapid emergence of this technology will create major challenges because of IP theft. The company predicts that by 2018, 3D printing will result in the loss of at least $100 billion per year in IP globally. A loss that arises, for instance, when stolen IP is used to 3D print counterfeit products such as machine parts, toys, or weapons. Besides the IP problem, this scenario also raises potential product-safety and liability concerns that "could easily dwarf the IP issues," Hornick says.

One of the driving elements of revenue growth is the part played by systems manufacturers. As CEO of Concept Laser, Murray will give a provider's perspective on industry growth and the general rate of penetration at the enterprise level.

More broadly, the additive manufacturing technology landscape is addressed by Mazumder who, among other things, will highlight smart additive-manufacturing systems at the session.

The Laser 3D manufacturing conference continues through Thursday.

STEPHEN G. ANDERSON

DON'T MISS THESE EVENTS TODAY

LASE PLENARY SESSION
10:20 AM-12:30 PM
ROOM 103, SOUTH
Philip Russell (Max-Planck Institute)
Satoshi Kawata (Osaka Univ./RIKEN)
Scott Keeney (nLight)

INDUSTRY EVENTS

3D printing panel
(8-10 AM, Room 103, South)

Great workplaces panel
(8-10 AM, Room 102, South)

SPIE Job Fair
(10 AM-5PM, South Exhibit Hall)

Executive perspectives panel
(1:30-2:30 PM, Room 103, South)

Getting hired panel
(1:30-3 PM, Room 102, South)

Conflict minerals workshop
(3-4:30 PM, Room 102, South)

Startup Challenge
(3:30-6 PM, Room 103, South)

Prism Awards
(6-10 PM, Marriott. Tickets required)

See the technical program and exhibition guide for more details on daily events. Conference registration may be required. Industry events are open to all registration categories, except where noted.

Read daily news reports from Photonics West online: spie.org/PWnews

IN THIS ISSUE

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Industry or academia? You *can* have it both ways

Scientists who found fulfilling careers in the photonics industry explored the rewards and opportunities gained from a career outside of academia during a panel Sunday.

The idea by some in academia and industry that working in the other realm of photonics is inferior is "unfortunate," said panel moderator David Giltner, director of field operations at Zolo Technologies.

Giltner and the four industry representatives on his panel, Charting a Course in the Photonics Industry, offered arguments to dispel the notion that one part of the optics and photonics field is better or more exalted than the other.

Panelists, left to right were: Jason Eichenholz of Open Photonics; Filipp Ignatovich, CTO of Lumetrics; Katie Schwertz, optical research engineer at Edmund Optics; and Marc Himel of Jenoptik. David Giltner moderated. Credit: Kathy Sheehan.

For example, Jason Eichenholz, founder of Open Photonics, said that although he has worked in industry his whole career, he often feels like part of a research team when a business he has worked for develops or designs products and technologies that help academics with their research.

"If you are doing research with a product that my team designed, then I'm doing science" too, he said. "Without our stuff, they wouldn't be able to do their research."

Another panel member, Marc Himel, business development manager of Jenoptik, agreed. "Optics is enabling everything in this world," and scientists in the photonics industry are helping to make that happen just as much as those in academic labs, he said.

Eichenholz, Himel, Filipp Ignatovich, CTO of Lumetrics, and Katie Schwertz, optical research engineer at Edmund Optics, also had some tips for grad students or anyone considering a career in the photonics industry.

Their advice ranged from a basic admonition to avoid typos in your resume to the all-important emphasis on building "social capital" by volunteering and networking at conferences or otherwise helping to solve someone's problem.

"The number one thing every single one of you need to do is to build social capital," Eichenholz advised. "You do stuff for other people without expectation of getting something in return."

KATHY SHEEHAN

Left to right at the Translational Research forum: Oscar Carrasco-Zevallos, Hao Zhang, Bruce Tromberg, Gabriela Apiou, and Rui Li. Credit: Kathy Sheehan.

TRANSLATIONAL RESEARCH POISED TO ENTER MARKET

US scientists from Duke, Purdue, and Northwestern universities with problem-solving biophotonics technologies using optical coherence tomography (OCT) and photoacoustic tomography earned research awards at the SPIE Translational Research virtual symposium at Photonics West.

All three award-winning healthcare solutions are "poised to move from bench to bedside," said Bruce Tromberg, chair of the symposium with Gabriela Apiou. "Hopefully they will take off and improve the standard of care for patients," he added.

Tromberg, of the Beckman Laser Institute and Medical Center and University of California, Irvine, and Apiou of Harvard Medical School, Wellman Center for Photomedicine, and Massachusetts General Hospital, said that more than half of the 229 papers submitted to Translational Research this year, and two of those winning awards, involve new techniques to guide surgeons during operations.

The three winners presented their latest work on Sunday.

Oscar Carrasco-Zevallos of Duke University developed a 4D microscope integrated with OCT to guide eye surgeons during delicate retinal surgery and when measuring the depth of corneal tissue.

Rui Li of Purdue's Label-free Spectroscopic Imaging Group presented a multimodal photoacoustic tomography system for intraoperative assessment of breast tumor margins.

Hao Zhang, director of the Functional Optical Imaging Lab at Northwestern University, developed a new OCT technology to quantify retinal oxygen metabolism *in vivo*.

SPIE Translational Research is designed to facilitate the translation of biophotonics research into clinical practice with technologies that can change patient outcomes.

At the forum, Tromberg invited scientists involved in translational biophotonics research to submit papers to a special section of the *Journal of Biomedical Optics*. Submissions are due 31 March, and the special section is expected to be published in December.

US military looks to photonics to keep one step ahead

An OPTO conference keynote session considered quantum sensing, nano electronics, and their application to the needs of the military, with speakers from the US Defense Advanced Research Projects Agency (DARPA) and Army Research Laboratory bookending four talks on the subject.

DARPA program manager Jay Lewis, from the agency's Microsystems Technologies Office (MTO), told a packed conference room: "Digital imaging devices, which are now ubiquitous in consumer products, have transformed society and how we interact with one another. But advances in infrared imaging technology have been slower due to market volume and technological barriers."

To remedy this DARPA has established several imaging research programs covering the visible to LWIR spectral regions. Advanced Wide FOV Architectures for Image Reconstruction and Exploitation (AWARE) has developed a multiscale digital camera, which can image at once the entire 110 meters of an American football field but with enough detail to show a player's shoelaces. Initial military applications are in boat identification at up to 7 km from a US Navy ship.

DARPA's "PIXNET" project is developing a low size, weight and power (SWaP) soldier-portable digital infrared camera that renders real-time single and multiple-band imagery in both the thermal and reflective wavebands. "The camera sought by DARPA will provide single-band and multiple-band fused imagery on demand, and give troops enhanced situational understanding," said Lewis. "A camera with these features would eliminate limitations posed by current assets to identify targets in low-light, no-light, or a cluttered environment."

"WIRED" is the latest DARPA MTO project to be announced and is due to start imminently. Lewis explained, "The aim here is develop infrared sensors and cameras for low-cost, large-format, and high-performance imaging in the short-wave, medium-wave, and long-wave infrared spectral bands."

Reducing the historic high costs of these technologies is a running theme. Ultimately, DARPA wants high-quality miniature IR detectors with the same kind of affordability as high-quality digital cameras for cell phones in the consumer electronics market. He concluded, "DARPA's mission is to create or prevent strategic surprise – but at the same time we want to create more with less, by getting more useful information out of the same fundamental systems and starting materials. The answer to this is based in new optics and new ways of data processing."

Philip Perconti, of the US Army Research Lab based in Adelphi, Maryland, then told the conference about his agency's vision of the US Army in 2030. He said: "We must be more agile and expeditionary and will require new capabilities to avoid technological surprise while maintaining military superiority."

Examples of the technologies under investigation include quantum-enhanced sensors for improved situational awareness and nano electronics to reduce the size, weight, and power demands of soldier-worn equipment.

MATTHEW PEACH

NECSEL SNAPS UP PD-LD WITH AN EYE ON DIGITAL CINEMA

Active and passive laser component maker PD-LD is set to become a subsidiary of fellow Photonics West exhibitor Necsel, after the two firms announced the deal in San Francisco.

Necsel's parent company Ushio dominates the market for illumination bulbs used in cinema projectors, with Necsel also developing laser sources for new digital projector units designed to improve 3D cinema. The acquisition will give Ushio and Necsel ownership of PD-LD's patented volume Bragg grating (VBG) technology, components that PD-LD's president Uri Abrams told *Show Daily* are "mission critical" for the frequency-doubled green laser elements needed in those digital projectors.

"This is not about the bottom line, this is a strategic acquisition," Abrams added. He says that following the acquisition, which should be completed next month, PD-LD will remain a standalone business unit and keep its existing brand. The New Jersey company also sells into the medical device, telecommunications and defense markets, which should help broaden Necsel's applications base.

Abrams said that Ushio is far and away the market leader in cinema projection currently, selling systems to a blue-chip roster of customers including the likes of Sony, Dolby, IMAX, and its own subsidiary Christie. The market for digital systems is expected to grow to around a billion dollars over the next five years, with IPG Photonics also looking to enter the fray as a supplier of laser illuminators. The fiber laser firm said last week that it had recently delivered a prototype RGB laser to a "top-tier" customer, and that it would be shipping a newer six-wavelength unit to the same client shortly (see page 7).

Necsel CEO William Mackenzie said of the deal to buy PD-LD: "[This acquisition] augments and strengthens our vertical integration strategy to continue to serve the needs of our projection customers and enhance the global rollout of laser cinema."

MIKE HATCHER

Tomocube touts holographic analyzer

A new live-cell imager from South Korea that produces 150 frames a second of "holotomographic" images is attracting plenty of interest in San Francisco this week. The HT-1 from Tomocube looks cool: a snappy, handsome white device not unlike a designer coffee maker.

It is the first – and so far only - product from the new company, based in Daejeon. The high-technology area is sometimes known as "Asia's Silicon Valley."

A cell or tissue sample, either on a slide or in a petri dish, is placed under the instrument's 60x, 0.8 numercial aperture objective, and the data - morphology, chemical composition (including dry mass), and mechanical properties including fluctuation, deformability and cytoplasmic viscosity - analyzed.

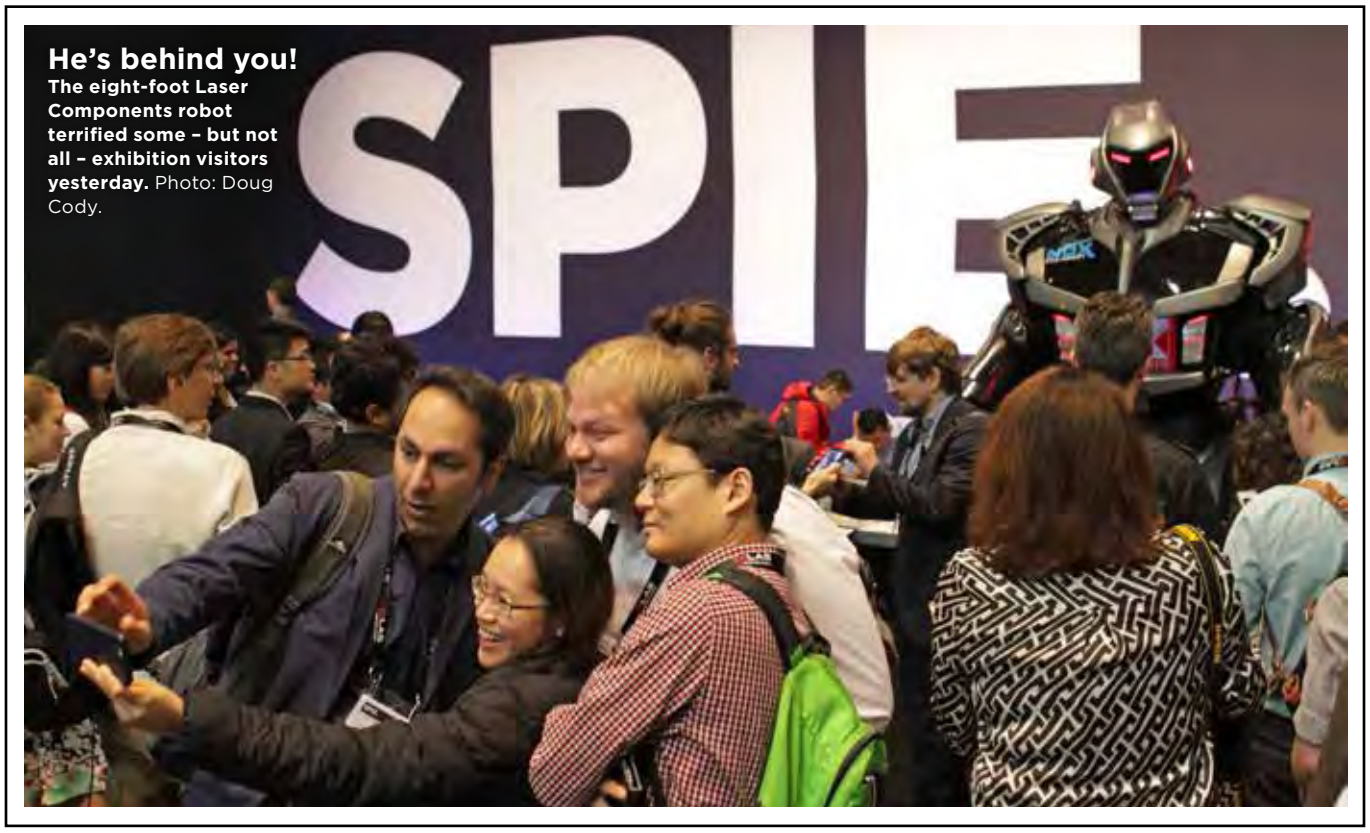
"It can tell you everything that's going on inside living tissue," said CEO Kihyun Hong. He and his partners have been working on the idea for ten years, but it was only 18 months ago that they realized they were ready to launch a company.

Before long, they had three systems at work in hospitals in Seoul. At Photonics West the company was seeking more "early adopters", as well as distributors for an anticipated global market.

The company says there are only two such devices on the world market currently, and that the Tomocube specifications are "far superior."

Applications are expected to include research in cell biology, biophysics, microbiology, immunology, and pathology, as well as drug development.

FORD BURKHART



He's behind you! **The eight-foot Laser Components robot terrified some – but not all – exhibition visitors yesterday.** Photo: Doug Cody.

Nano-printer sets pace

You'll barely see the devices built by Nanoscribe, because they're just a few microns high. But the company's much-lauded micro-nano Photonic Professional GT 3D printer is making big news: it's spreading to global industry customers after quickly becoming a standard tool in leading research centers.

Visitors to the Photonics West floor were stunned to see the kit print tiny components in just hours. It is said to be 100 times faster than earlier versions.

After winning a Prism Award for advanced manufacturing in 2014, and the World Technology Award in 2015, the Photonic Professional GT appeared in nanoscience research labs including the California Institute of Technology, Harvard and Carnegie Mellon. It is now being used in more than 100 institutions, including London's Imperial College, ETH Zurich and Tokyo University.

"Science people are motivated by the combination of nano-scale patterning and 3D," said sales manager Wanyin Cui. "In the past, you would need a diamond to rough-cut the features of a micro-lens, and another diamond, and then a finer one, to polish it. It might take weeks. With our machine it takes a day. You just print it."

The new instrument includes an ultra-precise piezo mode for arbitrary 3D trajectories, and a high-speed galvo technology mode for fast layer-by-layer structuring (hence the "GT" in the name).

FORD BURKHART

Stratium debuts QCLs for gas sensing

UK-based quantum cascade laser (QCL) start-up Stratium made its debut at the Photonics West exhibition yesterday. Commercial director Phil Cornish and colleagues at the University of Sheffield spin-out specialize in short-wavelength versions of the emitters, thanks to the incorporation of antimonide layers in their epiwafer structures. The "Bruar" QCL offers a peak power of 50 mW and options for sensing ethanol, methane and ammonia gas are now available.

Using expertise initially developed at Sheffield's National Centre for III-V Technologies, Stratium has since moved south to Cardiff, where it will be able to take advantage of the UK's £50 million "Catapult" investment in compound semiconductor materials and devices in the region.

Phil Cornish. Photo: Matthew Peach.

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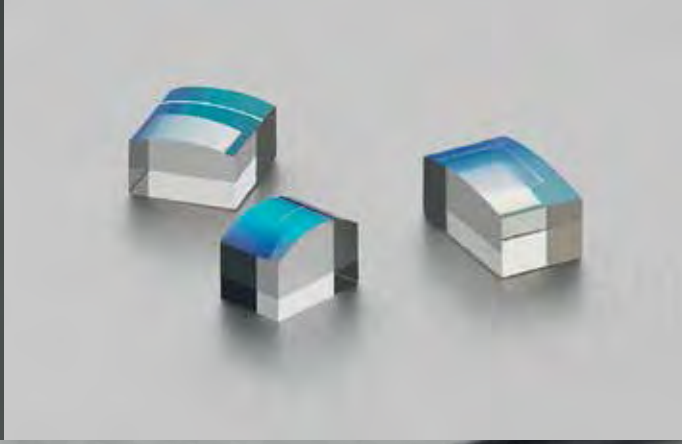
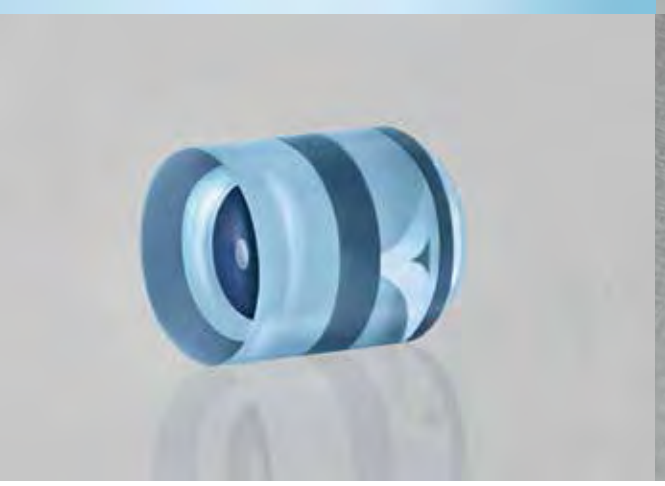
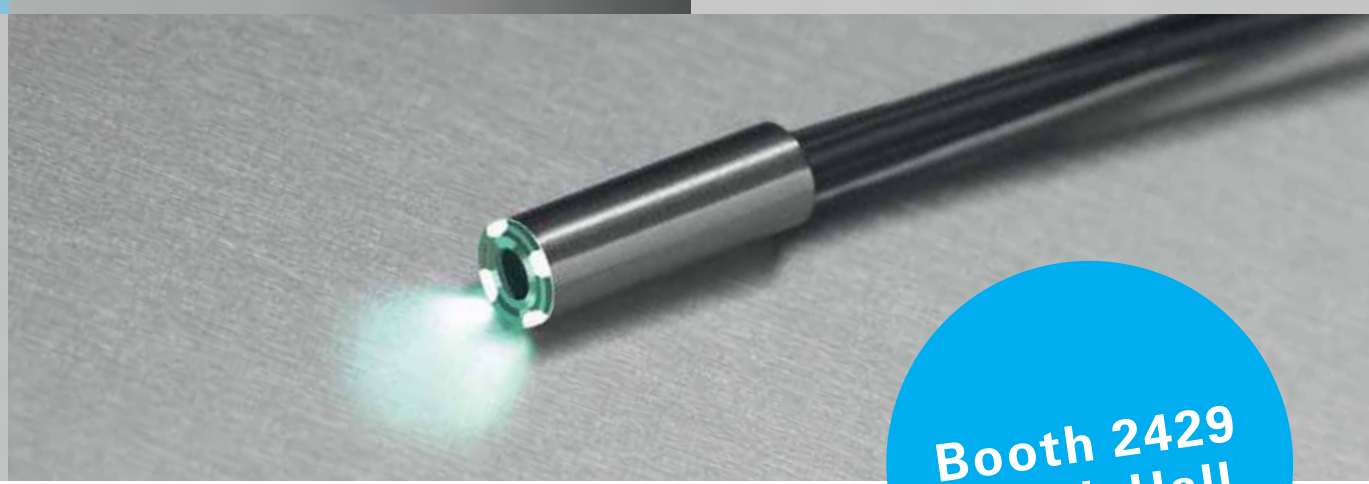

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IPG pushes UV power, green efficiency

Fiber laser maker IPG Photonics has announced new record-breaking figures for its ultraviolet and green lasers in San Francisco. In a busy Tuesday morning keynote talk, Alexey Avdokhin said that the Oxford, Massachusetts, company's engineers had now pushed the wall-plug efficiency of a 715 W green source to 25%, thanks in part to the extremely high quality of its frequency-doubling lithium triborate crystals – which IPG grows in-house.

In the frequency-tripled UV range, the emphasis has been on power, with IPG setting what is claimed to be a new world best with a 267 W output at 355 nm. That represents a huge increase on the 160 W figure that the company reported here last year. Avdokhin also described progress with new red and orange lasers that are based around a Raman-converted quasi-continuous-wave seed. Emitting around 615 nm, the red laser delivers 53 W and has a bandwidth of 6 nm.

All that frequency conversion means that IPG has now developed a pair of red/green/blue commercial luminaires aimed at the cinema projection market – one with three lasers for conventional 2D movies, and a six-wavelength version for 3D projectors. Last week, IPG's CEO Valentin Gapontsev told an investor conference call that IPG was pursuing "a very significant market opportunity" in large-screen 3D cinema and light shows.

IPG is preparing to ship a pre-production version of the six-wavelength unit to its lead customer within weeks, and is also showing off the illuminator at its booth in the Moscone Center this week. In April, the firm will head to the Cinema-Con show in Las Vegas in a bid to woo cinema operators, Hollywood studios and the leading projector makers.

"We believe that IPG's laser luminaire will deliver the brightness and dynamic range the industry is demanding for a new generation of premium large-format 3D cinemas," Gapontsev said.

MIKE HATCHER

'Inpho 2016' investor event to go beyond photonics

Inpho is the new identity of the biennial investment conference and "battle of the startups" competition, previously known as Invest in Photonics. The refresh of the event was announced at Photonics West by Hervé Floch, director general of the Route des Lasers cluster, based in Bordeaux, France.

This year's event takes place October 6-7 in the city's grand Palais de la Bourse, and will be broadened to include investment opportunities in a range of new technologies – many overlapping with photonics – such as naontechnology, the Internet of Things, biotech and healthcare.

Route des Lasers is co-sponsoring the event alongside CEA Leti and the Bordeaux Chamber of Commerce. Floch said, "The new message for Inpho is 'photonics and beyond'. We are expecting to have at least 20 high-tech companies from around Europe presenting to a panel of global investors, both venture capitalists and corporates."

He is seeking at least 100 candidate companies to apply to be assessed by a panel of experts and investors before being shortlisted to the 20 that make "elevator pitches" in Bordeaux. He is also inviting potential speakers to take part in investment coaching and information sessions. At the 2014 event, Netherlands-based Effect Photonics, a developer of optical modules for data centers, won the €5000 award for most promising company.

Explaining the broadened scope, Floch explained: "We must consider the real world, where investors are putting money into a range of technology-based businesses. So we came to the conclusion that the best investment opportunities often involve a cocktail of technologies as well as photonics."

MATTHEW PEACH

OPTICS MEETS MICROFLUIDICS

This "lab on a chip", 3D laser-printed by Photonics West exhibitor and Prism Award finalist LightFab, is used to test for antibiotic resistance. The Aachen, Germany, company uses a Satsuma ultrafast laser from fellow exhibitor Amplitude Systèmes to produce the tiny components by selective laser-induced etching.

Photo: Doug Cody/Bay Area Event Photography.

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Spot the difference: A minerals dealer shows the difference between tin ore from a rebel-held mine and a non-conflict mine. Photo: Image Journeys/Sasha Lezhnev.

Conflict mineral rules: noble or nonsense?

Efforts to stem violence in Africa by tracing the origin of key metals used in optoelectronics are ongoing, despite interruption from a legal challenge.

The offices, cleanrooms and conference floors of the photonics industry seem a long way from metal mines and murder in the Democratic Republic of Congo (DRC). The link between optics and the 5.4 million-plus people estimated to have died as a result of DRC's ongoing humanitarian crisis since 1998 may not be immediately obvious. But they're connected thanks to the global web of trade, and since 2010, also the US Dodd-Frank Wall Street Reform and Consumer Protection Act.

Dodd-Frank makes the US Securities and Exchange Commission (SEC) responsible for regulating disclosures about key metals for optoelectronics that might originate from the DRC or adjoining countries. Specifically those metals are tin, tungsten, tantalum, and gold, collectively known as 3TG in short. Intended to limit cash-flow to armed groups in DRC, the Act's impacts reach far beyond US borders, and not only because the Europe is also considering similar regulations. The Dodd-Frank requirements mean the entire industrial supply chain must know where its metals come from. Publicly traded US companies first had to comply with its requirements in their 2013 financial reports. As firms are now preparing to include these details in their filings for the third year, it's time to ask questions. Where do the 3TG rules stand? How do they affect optoelectronics companies? And are they working?

> "Optoelectronics companies will need to have visibility throughout their supply chains in order to qualify as suppliers."
>
> DYNDA THOMAS,
>
> PARTNER AT SQUIRE PATTON BOGGS.

Where do the rules stand?

The SEC's Conflict Minerals Rule was challenged shortly after it was issued, highlights Dynda Thomas, a conflict minerals expert and partner at law firm Squire Patton Boggs in Cleveland, Ohio, and a speaker at this afternoon's Photonics West panel session *For Wherever You Are in the Supply Chain*. The rule, issued in August 2012, required companies whose products contain the 3TG metals to make 'reasonable country of origin inquiries'. Then, in many cases, they would have to conduct due diligence about the source and chain of custody of their 3TG. Were any metals not shown to be from reputable sources, companies would have had to describe the affected products as 'not found to be DRC conflict-free'.

However, in April 2014, a panel of the District of Columbia Court of Appeals suspended this requirement in response to a suit led by the US National Association of Manufacturers. "The court concluded that compelling companies to make that statement would violate their First Amendment rights," Thomas says. But the need to investigate the supply chain remains, and it's still possible that an effort to restore the statement requirement will be taken to the US Supreme Court. "At this point, we still don't know whether that First Amendment ruling will be finally upheld," Thomas stresses.

Meanwhile, Europe is considering its own draft conflict minerals regulation. "The original proposed regulation was issued in 2013 and was voted on by the European Parliament in May of 2015," Thomas notes. "We expect that a final European Union conflict minerals regulation will be issued around the middle of 2016." That would inevitably raise the current awareness of the issue, Thomas adds. "Companies outside of the US are more likely to believe, sometimes not correctly, that the rule does not

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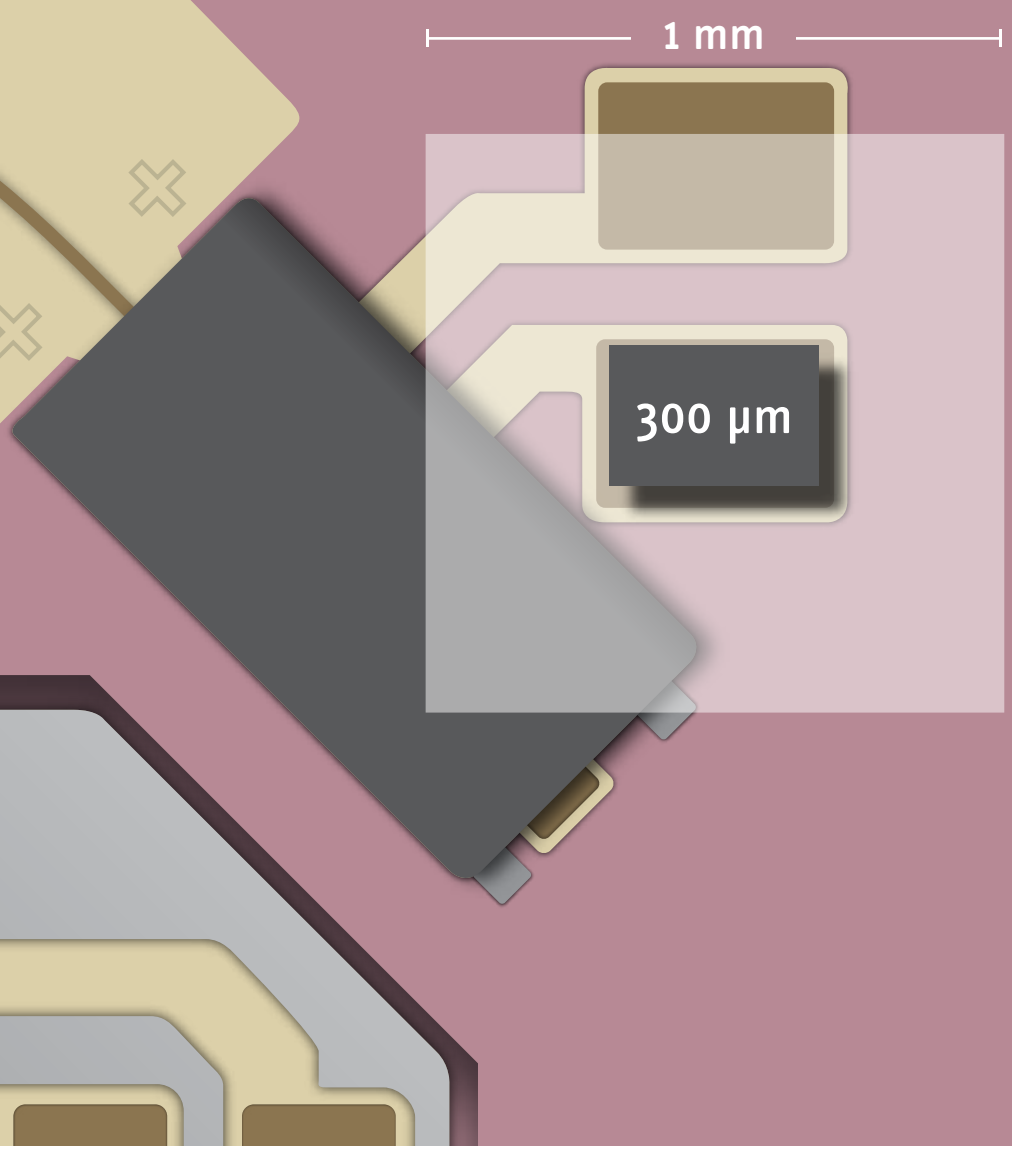

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Conflict Mineral continued from page 09

impact them. When the European Union adopts its own conflict minerals regulation, that will greatly expand the number of companies covered by a regulation and that actively gather and provide information."

How do conflict minerals rules affect optoelectronics companies?

Optoelectronics companies will increasingly be receiving inquiries about the conflict minerals their products contain, Thomas says. "Over time, more of their customers will probably have a 'DRC conflict-free' policy or goal, and optoelectronics companies will need to have visibility throughout their supply chains in order to qualify as suppliers."

The rule's relevance to optoelectronics can be seen in the Conflict Minerals Reports from San Jose's Avago Technologies. Selling a variety of relevant products, including LEDs and fiber-optic components and subsystems, Avago's Conflict Minerals Policy focuses on checking its suppliers' sources of 3TG minerals. "We do not typically have a direct relationship with 3TG smelters and refiners," the company writes. "Avago's relevant suppliers are required to implement measures to prohibit the purchase and use of conflict minerals from the Democratic Republic of Congo ("DRC") and its adjoining countries...that fund armed conflict in those countries."

> "Companies should not dismiss these issues as 'soft stuff'."
>
> DOUGLAS HILEMAN, CONSULTING COMPLIANCE EXPERT.

In December 2013, that involved querying 188 suppliers, who together made 3251 references to a total of 383 smelters and refiners. As of December 2014 that had shrunk to 253 legitimate smelters and refiners, 132 validated as 'conflict free', and 53 being audited for that certification. Avago wrote that it intended to 'implement steps to further mitigate the risk that conflict minerals that are necessary to the functionality or production of our products finance or benefit armed groups in the DRC.'

Leading applications of potential conflict metals in optoelectronics include gold coatings used on mirrors and gratings, observes Rosemarie Szostak, senior analyst at Tolland, Connecticut, research and advisory firm Nerac, and chair of the Photonics West 2015 panel session. Tin used as a solder in mounting devices and tantalum used in capacitors are also important, as they are across the electronics industry. Szostak has been working to help companies meet the SEC's regulations, and emphasizes that full compliance would call for great vigilance and cost.

Are the rules working?

The motivation to audit the supply chain is reduced by the minor consequences of not complying with the regulations, Szostak admits. "Right now, all companies have to do is say 'Oh, well, we tried and we didn't find anything'," she told *Show Daily*. The SEC has limited taxpayer funds for monitoring and enforcement, while the Court of Appeals ruling made it easier for companies not to do anything substantial, Szostak emphasizes. "They do not have to say 'mea culpa' to their shareholders or customers. Best effort, the letter of the law – that's all the SEC can ask for. But some companies are embracing the spirit of the law. They are spurred by Dodd-Frank to clean up their supply chain."

Szostak's experience has led her to call Dodd-Frank's conflict mineral provisions 'a can of worms'. At best it's unleashed problems that are not easily solved, and at worst it's not working at all. "They're using a regulation in one part of the world and expecting it to favorably impact another part," she says. It's impossible to control the outcome of such measures, Szostak adds. "The use of in-country oversight, security forces, and assistance to

continued on page 13

Digging holes: The Luwowo tantalum mine is near Rubaya in North Kivu, one of the most-conflict torn regions of DRC. Photo: MONUSCO/Sylvain Liechti.

Conflict Mineral

continued from page 11

local miners has reduced the illicit mineral trade slightly since the enactment of Dodd-Frank, as noted in the November 2015 US Government Accountability Office (GAO) Congressional testimony. But in the DRC there are bad people and they're not going to let up, no matter how much you try to regulate their source of funding away. Sadly the artisanal miners are ultimately hurt by removing their source of income."

Douglas Hileman, whose eponymous Los Angeles, California, firm performs audits outlined in the SEC's conflict minerals rules, emphasizes that the measures overall might be working. He points to an August 2015 GAO report mentioning two analyses by Fairfax, Virginia consulting firm ICF International on sexual violence in the DRC. It compares data from 2007 and 2013-2014, finding a statistically significant decline in sexual violence. According to Hileman, who is also speaking on today's panel, this stands out from anecdotal evidence on both sides of the debate over whether the rule is effective. "This is the only objective, published report of a statistically based study I'm aware of," he says.

The August 2015 GAO report also found that 1,321 companies filed 'specialized disclosure' conflict minerals reports in 2014. This was substantially lower than SEC's original estimate of 6,000 companies that could possibly be affected by the rule, though SEC officials said that estimate was 'intentionally overly inclusive'. The GAO report also found that 67% of companies that did file reports were unable to determine the country of origin of the 3TG metals they had used. 24% said their metals did not originate in the DRC or its neighbors, while just 4% said that they did. The remaining 5% either used recycled material, or didn't provide a clear determination.

Wolframite: A miner in Kailo, DRC holds up some wolframite, the mineral source of tungsten. Photo: Julien Harneis.

More than money; more than law

Hileman notes that although the SEC is currently unlikely to enforce 3TG rules aggressively, those companies either not filing, 'egregiously flouting' requirements, or making unsupported conclusions do risk SEC action. "The quality of these submissions is also being reviewed and analyzed by non-governmental organizations and other parties," Hileman adds. "They are getting more sophisticated and more demanding. Consequences of inadequate SEC filings can also include adverse publicity. For companies in their supply chain – including the majority of affected companies in the photonics industry – non-responses or inadequate completion of conflict minerals reporting templates risk unwanted attention from customers, or even losing customers."

Back-breaking and barefoot: 'Artisan miners' in Kailo, DRC, looking for tin and tungsten minerals. Photo: Julien Harneis.

Furthermore, the consultant urges manufacturers to consider the full societal context of the regulations. "It is tempting to look at this rule as a single data point," Hileman says. "It is also tempting to look at a single court decision or legal opinion as the defining answer for conflict minerals, or to achieve legal compliance. As a matter of practice and risk management, this is just one of many drivers in the landscape of new, emerging, and stricter requirements for management, oversight, and reporting related to the supply chain. This one happens to be very visible right now because it's an SEC rule, and because some of the requirements are in flux."

Beyond Dodd-Frank, other non-financial information is becoming important for companies to provide. Areas involved include human trafficking, forced labor, fair pay, gender equality, environmental preservation and degradation, energy efficiency and greenhouse gas emissions. Some questions are regulatory, such as on human trafficking in the UK and California, and others are specific to industries or customer requirements, Hileman explains – but all should all be answerable. "Companies should not dismiss these issues as 'soft stuff'," he warns. "They warrant the same approach and rigor as any other compliance or customer requirements."

Lydia Hultquist will chair the Conflict Minerals: For Wherever You Are in the Supply Chain panel session at 3pm today.

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More than skin deep: a wish list for photonics in dermatology

Dialogue between clinicians and technologists is the key to fully exploiting the advantages of photonics for imaging and diagnosis of skin conditions, says dermatologist and BiOS session chair Kristen Kelly.

Photonics technologies have a long tradition of being put to work on the skin of humans and animals – not least because skin presents such a readily accessible target.

In recent years the application of photonics in dermatology for a range of analytical and remedial purposes has entered a new phase of sophistication, thanks to broad advances in instrumental platforms and the beginnings of a dialog between developers and clinicians about the potential benefits to be had.

> "We need much better feedback information than we have now about the effects of photodynamic therapy."

Those mutual discussions now hold the key to fully exploiting the developments that lie ahead. According to Kristen Kelly of the University of California, Irvine, who spoke on the subject during the Clinical Perspective session of Saturday's Photonics in Dermatology and Plastic Surgery conference, clinicians now need to make developers more aware of what they require.

"The technology has made great progress, but from a clinical point of view the conversation needs to move beyond a discussion of what we have available now and start to consider how the tools we have could be improved," Kelly commented. "Which aspects don't fit so well into the work of the clinic, and what would make them fit better? What would help me the most?"

Imaging and therapeutics

One area where photonics has already demonstrated significant potential is imaging of skin tissues showing malignant dermatological conditions – with accurate imaging of skin cancers representing the number one concern.

"A variety of modalities have been used to image skin cancers, but there are still a number of problems with them," said Kelly. "Many do not image deep enough into the tissue. Some can only analyze a very small location, and so cannot image a large enough area to see the entirety of a skin cancer. In others, the resolution is simply not good enough. There are a variety of reasons why we need to greatly improve these parameters, if we want to be able to use the techniques for diagnosis."

In an ideal world, that diagnosis would not involve a conventional biopsy but instead use photonics to scan a skin lesion and confirm a clinician's suspicions on the spot. Biopsies, although clearly valuable, are not without their own risks and introduce an unwelcome time delay into the process while samples are analyzed. A way to avoid them as much as possible would appear high on a clinician's wish list for photonics in dermatology.

Exactly which modalities might best serve this goal is a topic clinicians and developers should jointly discuss, according to Kelly.

"Optical coherence tomography (OCT) has definite advantages over some other techniques, but there are still issues with the resolution and exactly what you can see with it," she noted. "At present, using it is certainly not the same as looking at a biopsy and being able to see precisely how individual cells appear. Other techniques, such as multi-photon microscopy and multi-spectral imaging, may well have much to offer too."

Treatment of birth marks and similar vascular lesions in the skin would also benefit from light-based techniques able to image the tissues quickly and without side-effects. The ability to rapidly ascertain the precise size and depth of blood vessels in a certain area of skin is of obvious importance to a clinician when determining which laser settings are appropriate for effective treatment.

From a therapeutic standpoint, improved imaging regimes would help to accurately track the progress of any treatments and improve the generally too low degree of feedback between diagnosis and therapy – something that Kelly believes may have held back the long-standing efforts to use photodynamic therapy (PDT) for both skin cancers and vascular lesions.

"We need much better feedback information than we have now about the effects of PDT. Once a tumor is accurately delineated, we need to determine whether we have adequately treated the entire area without over-treating and risking scarring. Plus some cancers are large and difficult to completely remove by surgical means, so a good light-based technique to determine that no cancerous cells were left behind would be very helpful."

Aesthetic laser treatments, exploiting the action of lasers on skin tissues and potentially able to deliver a number of improvements to both appearance and condition, represent a substantial market sector for photonics in dermatology. Although slightly removed from the surgical arena, there is plenty of scope for these kinds of treatments to also benefit from improved photonics techniques, as Kelly noted.

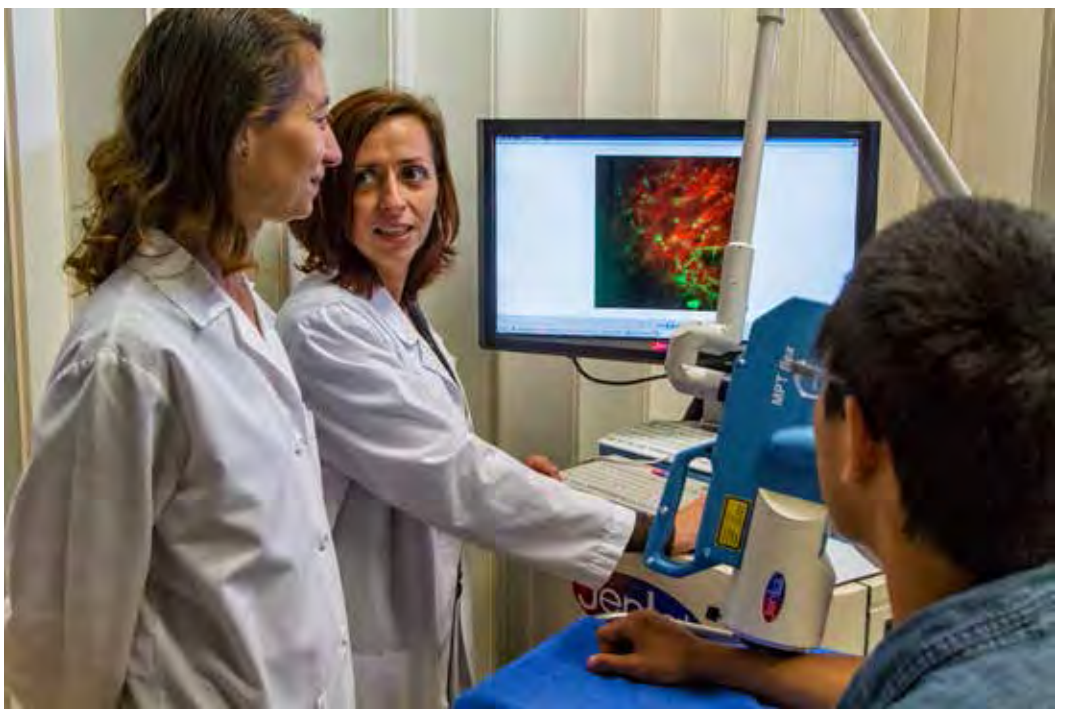
"Treatment of scars is a very significant issue across the world and affects the lives of many people. The ability to image a scar and immediately know exactly how deep it is, prior to setting the parameters of our laser treatments, would be very valuable. Even a cosmetic application like tattoo removal, which has advanced in recent years through the use of picosecond lasers, could be improved further in terms of getting more rapid color removal for patients."

More conversations

The kinds of conversations between clinicians and photonics developers that will assist with all these improvements are under way – especially at a meeting such as Photonics West – but progress has to date been somewhat fitful.

As ever, economics and the potential for some significant cost-savings will provide a powerful motivating factor for this situation to improve. History suggests that once concepts for compact imaging systems advance to the point where they can reasonably fit into the work-flows of clinics at a bearable cost, the process will gather its own momentum. The current interest in smaller and cheaper OCT systems, much in evidence this week at Photonics West, demonstrates that the tide is moving in the right direction for dermatologists to eventually reap the rewards. In the meantime, Kelly and her colleagues intend to keep talking.

"I suspect that many people who could both contribute and benefit from these discussions are unaware of them at all, and that meetings on the topic tend to involve either far more clinicians than engineers, or *vice versa*," Kelly commented.



Clinicians Kristen Kelly (left) and Mihaela Balu using multi-photon microscopy based on JenLab laser equipment for non-invasive imaging of suspected skin cancers. Copyright: Paul Kennedy.

"The more that we are able to bring scientists and clinicians together to talk about these issues and devise solutions to them, the better off we will be."

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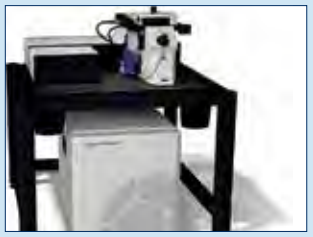

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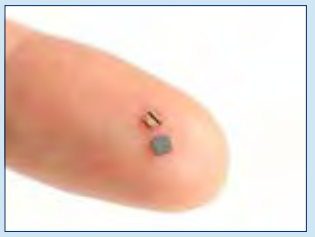

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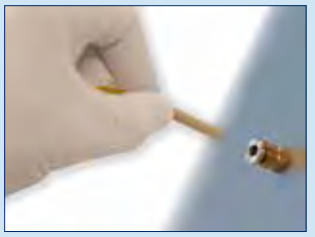

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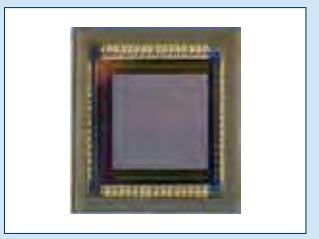

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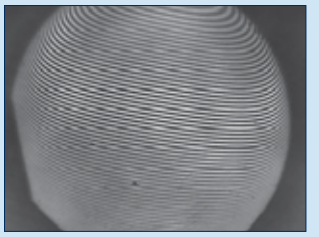
Please see the VFI-2000 at Photonics West 2016 – Arden Photonics booth #5543.



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Photonics: at the heart of the neuroscience hurricane

Optical technologies occupy center stage as the BRAIN Initiative gathers momentum.

The four-day BiOS program on neurophotonics, neurosurgery and optogenetics has a lot of ground to cover. Chaired by Rafael Yuste of Columbia University, it comprises three individual conferences: neural imaging and sensing; optogenetics and optical manipulation; and finally clinical and translational neurophotonics.

Each of these areas is a major focus of attention right now, not least because of the US government's BRAIN Initiative (Brain Research through Advancing Innovative Neurotechnologies), which has positioned neuroscience as one of the key scientific challenges of the age.

And photonics will be critical to that effort, by enabling many of the key analytical methods either already in use or envisioned across the full breadth of the neuroscience agenda.

"The Photonics West program represents a wide set of research areas, but in practice these disparate topics have similar needs and requirements," Yuste told *Show Daily*. "Our agenda is broad, but clear-cut. The common thread is neuroscience, and with the BRAIN Initiative now drawing directly on optical technologies, the use of photonics is becoming a very big deal."

Despite the complexity of the subject, optical techniques for neuroscience will continue to hinge on the two relatively straightforward things that light can do in the brain: either "read" the neural activity underway, or "write" neuronal activity, compelling those neurons to fire.

"Simply put, photonics can image the brain or stimulate it," Yuste said. "The Photonics West program is designed to reflect that, through the two individual conferences on neural imaging and optogenetics. The third stream, on clinical and translational work, recognizes the number of papers now appearing from clinical activities, as these optical techniques start to leave the laboratory."

Playing the piano

On the imaging side of the equation, many of the current advances stem from a wish to image brain activity in three dimensions, with a flurry of recent papers describing ingenious methods for doing just that. Yuste said that these techniques, essentially turning a microscope from a 2D machine into a 3D system, represent a remarkable advance.

"Microscopy since Leeuwenhoek has almost always been thought of as a two-dimensional method, and microscopists working together with neuroscientists are now pushing it into the 3D arena," he said. "What we are witnessing here is a revolution."

This revolution is built on a combination of new hardware and novel experimental strategies, including light-sheet and light-field methodologies, as well as holography-based approaches. There has also been significant progress in software development and the use of new algorithms, arising from recent advances in computational optics. In some cases, progress in hardware and software has gone hand in hand.

"The technique of light-field microscopy has emerged from computational photography and the ability to extract 3D patterns from photographs taken off-axis," Yuste noted. "Meanwhile the use of holography has been greatly complemented by the development of algorithms for non-negative matrix factorization, or NMF. This enables you to do something which would seem to be impossible: take the photons emerging from a volume of tissue and allocate them to their particular points of origin among the layers of tissue present."

Alongside these imaging breakthroughs, recent advances in optical stimulation and optogenetics have made it increasingly feasible to reach neurons in the middle of animal brains and activate them in arbitrary spatio-temporal fashion – "playing the piano," as Yuste puts it. And the most critical development of all has been an increased dialogue between all parties.

"In the past these fields have tended to operate independently, but now there is starting to be a productive back-and-forth discussion between them, and the creation of teams that are genuinely interdisciplinary," Yuste said.

Since 2013, the significant motor behind all these developments has been the BRAIN Initiative – its goal to understand how the human brain functions and the implications of that knowledge. As one of the Initiative's original instigators, Yuste recognizes the impact that it has already had on neuroscience and on related photonics developments, along with the important questions now arising about how best the project should proceed.

"The BRAIN Initiative is going forward very well," he said. "The federal funding agencies – the NIH, NSF and DARPA – are all fully involved. And there are some new kids on the block too. IARPA, the Intelligence Advanced Research Projects Activity, which comes under the remit of the US Director of National Intelligence, has not been heavily involved in biomedical research in the past but has now jumped in."

Commitments from the private sector have also continued. One example is the Kavli Foundation, which along with its university partners committed $100 million to neuroscience research and the BRAIN Initiative in October 2015. Individual private companies are playing a role too – notably Google, which has embarked on a neuroscience research portfolio of its own. Although the company's efforts are taking place largely behind closed doors, Yuste expects that there will be many significant overlaps with the work already under way within the BRAIN Initiative.

Google's neuroscience interests were certainly visible in November 2015, when the Breakthrough Prize awards ceremony recognized optogenetics pioneers Karl Deisseroth and Ed Boyden in a celebrity-packed event held in Mountain View, California, and put advanced neuroscience squarely on the media's radar. Sergey Brin, co-founder of the search-engine giant, is a founding sponsor of the prize, alongside other science and social media entrepreneurs.

"All this is of course fantastic – music to our ears," commented Yuste. "But at the same time, I am conscious that there are some elements currently missing from the BRAIN Initiative."

One problem is the current structure of the Initiative's research program, which allows a large number

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of relatively small laboratories and institutions to dip into the available funding and resources. Although this approach has served neuroscience well enough in the past, Yuste believes that the goals and scope of the BRAIN Initiative would be better served by gathering the players into a smaller number of large research centers, or "brain observatories" – and especially by involving the biggest player of all.

"The logical thing to do, I believe, is to encourage the US Department of Energy to get involved in the BRAIN Initiative," Yuste said. "If it comes on board, that really could change the game."

The national laboratories run by the DoE are among the largest concentrations of scientists in the world; and they are mostly physical scientists – chemists, engineers and mathematicians as well as physicists. Their participation would change the flavor of the BRAIN Initiative significantly, and bring it closer to the kind of "Big Science" projects that the DoE labs have traditionally pursued.

"Right now, the Initiative's work is done by small groups of people in individual labs working in isolation," noted Yuste. "But DoE involvement would turn it into a project similar to those research efforts around particle accelerators and astronomical observatories, where the science is carried out by large international teams. That's why I have been pushing to bring the DoE on board."

Those discussions have inevitably involved some conversations about politics. A 2015 meeting at Argonne National Laboratory in Chicago brought many of the players together and allowed Yuste to make his case for transforming the BRAIN Initiative in such a way.

"The Argonne meeting was intended as a forum for discussion, with representatives of the Initiative and the DoE present," he noted. "But my reading was that there was a lot of goodwill and understanding of the issues on both sides of the table."

A second political dimension involves the ethical implications of advanced neuroscience research, and the safeguards needed to ensure that techniques to view and even modify the workings of the brain are applied appropriately.

"Naturally our intention is to ensure that these methods are developed for the right reasons and put to use in the right way," Yuste commented. "I am involved in a committee created by the NIH to provide ethical guidance to the BRAIN Initiative, and that committee has started working to bring that dimension into the picture. We are today very far from the point at which any form of brain influence or control is on the table, but it's not too early to start the discussions."

In the meantime, the message to engineers and photonics developers attending Photonics West is for them to appreciate the significance of the work being discussed in the neuroscience conferences, and the profound implications it could have. Yuste draws a parallel with genomics, another federally backed science program that has brought about a technological revolution and created entirely new industries – only this time, the effects could be even bigger.

"This is not some obscure corner of science and industry," he commented. "This is the kind of work that will revolutionize neuroscience, neurology and psychiatry – not to mention our understanding of ourselves. My expectation is that fifteen years from now we will see a whole new set of industries that have grown out of these optical imaging and optogenetics techniques. The work is critical for mankind, and the photonics engineers and developers at Photonics West are at the heart of the hurricane."

TIM HAYES

Prism Award finalists show breadth of photonics innovation

Pocket-sized laboratories based on miniature optics, stand-off bomb detectors using Raman spectroscopy, and state-of-the-art laser cinema projection technology are all in the running at this year's awards.

Each year at Photonics West, the industry recognizes the most innovative optics and photonics products to hit the market with the Prism Awards. The 2016 edition represents the eighth in the series and competition has been fiercer than ever. Here we present the 27 products to make the 2016 finals, across nine different categories. The nine winners will be revealed at tonight's gala dinner event taking place at the Marriott Marquis hotel, with the vast majority of the finalists exhibiting at the Moscone Center this week. Check back tomorrow to find out who won!

Biomedical Instrumentation

Avotec – Real Eye Nano: eye-tracking in MRI scanners: Florida-based Avotec might not be a familiar name in the photonics industry, but it has been working on products for magnetic resonance imaging (MRI) systems for more than two decades. Based entirely on glass and plastic materials, the company's new "Real Eye Nano" product is described as the world's only MR-inert eye tracking system. Integrating a fiber optic illuminator with an image guide for the mirror the patient uses to view the projection screen, Avotec claims an order-of-magnitude size reduction compared with previous tracking technologies.

Biodesy – Delta: Aimed at applications in drug discovery and protein analysis, Biodesy's ultrafast mode-locked Ti: sapphire laser system is able to measure subtle structural changes in biomolecules that can have a profound influence on their effect. "The Biodesy Delta is enabling the long-sought goal of detecting protein conformational change in real time," explains the firm. Proteins are the workhorses of the body, performing myriad vital functions. "The system expands our scientific understanding and our ability to find first-in-class medicines against any protein target, and enables drug discovery against protein targets previously thought to be intractable."

Convergent Dental – Solea: Afraid of the dentist? You're not alone – according to the American Dental Association, as many as 90 million people in the US avoid the dentist because of that fear. Based around a novel 9.3 micron laser developed in collaboration with Coherent, Boston-based Convergent Dental's Solea system aims to replace the dreaded drill with a painless procedure that can even be performed without anaesthetic. Said to be the first carbon dioxide laser cleared by the FDA for the full range of soft, hard and osseous tissue treatments, the critical factor is that novel wavelength. Tuned to the absorption peak of hydroxyapatite, it translates to high-speed, precise, pain-free and silent drilling of enamel at a similar speed to the traditional drill. Visits to the dentist may never be the same again!

Detectors and Sensors

Alakai Defense Systems – Portable Raman IED detector (PRIED): Described by Alakai as the "first completely eye-safe stand-off Raman instrument for sale", the key of the company's improvised explosive device (IED) detector is its employment of a deep-UV excitation wavelength to create a much stronger scattering signal. Said to be capable of detecting some explosives at a range of 50 meters in less than 20 seconds – and far more quickly at closer distances – PRIED means users do not have to worry about ambient lighting, fluorescence swamping the signal, or endangering innocent bystanders with reflected laser light.

Hamamatsu Photonics – MEMS FPI Spectrum Sensor: the photonics industry stalwart has developed a miniature Fabry-Perot interferometer that fits inside a standard TO-5 metal can package. Based around MEMS technology and an avalanche photodiode detecting in the 1550-1850nm range (which can be extended for other applications if required), it is set to find employment in any number of handheld devices where infrared detection is needed. *See Hamamatsu Photonics at the Photonics West exhibition, booth #1412.*

Spectral Engines – Wireless IR analyser: Another miniature interferometer technology, the key element in Spectral Engines' tiny spectrometer is a novel monolithic, off-plane Fabry-Perot MEMS device enabling fast and stable operation and resistance to shocks, vibrations and wear. Described by the Helsinki, Finland, company as "an infrared spectroscopic lab in your pocket", it has the added benefit of a spectral range extending beyond 1.7 microns. *See Spectral Engines at booth #5269.*

Displays and Lighting

Crystal IS – Optan SMD: Available in a variety of package configurations and wavelengths, these high-performance UVC-LEDs from Crystal IS are based on the company's proprietary knowledge of aluminum nitride semiconductor material. More specifically, the Optan products are designed to prevent thin "biofilms" of bacteria forming on anything with a wet surface – from contact lenses and catheters to pipes and medical instruments. The upstate New York firm estimates that damage from biofilm costs at least $200 billion every year in the US alone – and that the market for equipment to combat it is growing fast. *See Crystal IS at booth #4061.*

Dolby, Christie, Necsel – Dolby Vision Cinema Laser Projector: Photonics technologies from all three of the collaborators, as well as Texas Instruments' DLP chipset, come together in the completely new digital cinema projector architecture from Christie. Necsel provides the lasers – with six different wavelengths used to produce two RGB images on the screen to create immersive, high-contrast 3D imagery in combination with Dolby's new 3D glasses. "This is the best theater experience ever created," reckons Necsel. *See Necsel at booth #4670.*

QD Laser – Retinal Imaging Laser Eyewear: a tiny laser projector inside the frame of QD Laser's Retinal Imaging Laser Eyewear is the key to providing digital images directly to the wearer's retina. A combination of red, green, and blue laser diodes and a MEMS mirror ensures that the design also works for those with reduced vision. *See QD Laser at booth #4946.*

Imaging and Cameras

First Light Imaging – C-RED One: An ultra-low-noise but fast short-wave infrared (SWIR) camera, First Light Imaging's C-RED One captures more than 2000 images per second – and is the first to offer that in combination with mercury cadmium telluride (HgCdTe) avalanche photodiodes (APDs) and "noiseless" amplification. Using HgCdTe also allows a long cut-off wavelength of 2.5 microns, well beyond the capability of InGaAs APDs. The France-based start-up recently said that it had set a new record of 3500 images per second, and that C-RED was the "fastest scientific low-noise infrared camera in the world". *See First Light Imaging at booth #1123.*

Rochester Precision Optics – CMOS Night Observation Device (CNOD): Incorporating lightweight plastic optics and state-of-the-art sensors, CNOD is aimed squarely at security applications. Combined with its spectral range of 550-1080nm operators can recognize facial features from up to 250 meters away, and detect objects at more than 750m – at night. "Currently, there is no image intensification night vision sight or thermal sight on the market that can perform all these functions," says the firm. *See Rochester Precision Optics at booth #635.*

Stream Technologies – ColorFlow Lens: "Upgrade any camera to hyperspectral" is the claim for this recent launch from Edmonton, Canada's Stream Technologies. It physically segregates an image into ten different spectral bands, and hard-codes them into a custom "lens". Meanwhile users are able to define their own application algorithms, the kind of innovation that could open up applications across the commercial and agricultural realm to hyperspectral imaging. *See Stream Technologies at booth #6053.*

Using carbon monoxide rather than carbon dioxide gas means that this variant of Coherent's Diamond J-3 series is able to produce a powerful beam at the unusual wavelength of 5 microns. In industry, that is useful because it means the beam can be delivered down an optical fiber, and can exploit the higher absorption of some plastic materials compared with conventional lasers. Photo: Coherent.

Industrial Lasers

Coherent – Diamond J-3 Series 5 micron laser: Operating at the unusual wavelength of 5 microns, this new high-power gas laser from Coherent is based on carbon monoxide (CO). Like the much more familiar carbon dioxide sources that have become ubiquitous for industrial machining applications, the CO variants have been around for nearly 50 years – but until now have always been limited by poor lifetimes and operating characteristics.

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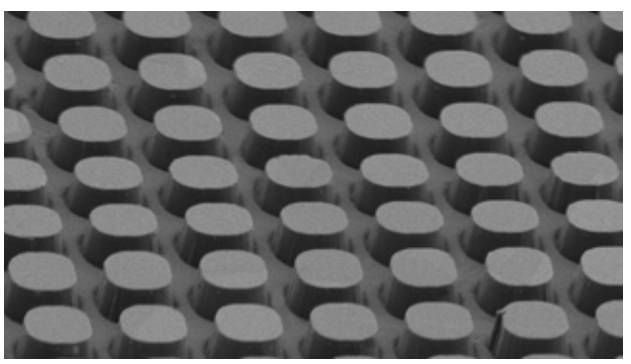
Offering an average power of 200W, the Diamond J-3 design is aiming to change that perception, while taking advantage of the stronger absorption of certain plastics (and water) at 5 microns. *See Coherent at booth #1101.*

LightFab – LightFab 3D Printer: Additive manufacturing and glass processing remain two of the hottest application areas for industrial lasers, and this femtosecond system from Germany's LightFab kills two birds with one stone. It is aimed squarely at digital production of 3D glass parts, using both two-photon polymerization for additive processes and selective laser etching for subtractive effects. LightFab says that the printer can be converted into a mass production tool capable of making millions of identical glass parts. *See LightFab at booth #4629*

Onefive – Katana 06 HP: Primarily aimed at super-resolution microscopy applications, the picosecond source from Onefive represents the first high-power, alignment-free ultrafast laser to function in the orange spectrum. Tunable between 556 and 660nm, the Katana delivers an average power of 1W with pulse durations down to 30 ps. *See Onefive at booth #5254.*

Materials and Coatings

Element Six – Diamond PureOptics: Inspired by nature, the extraordinarily robust MothEye optics technology from Element Six is destined for applications in EUV lithography and other laser systems requiring extremely powerful beams. The all-diamond-design offers 99% transmission and 0.5% reflectance, and the windows are fabricated by etching patterns in sub-micron flat and ultra-low-roughness diamond substrates with high uniformity. *See Element Six at booth #4543.*



Electron microscope close-up of the surface of Element Six's insect-inspired "MothEye" optics for ultra-high-power lasers. Photo: Element Six.

Nanoco Technologies – CFQD (cadmium-free quantum dots): LCD TVs featuring quantum dots to dramatically enhance their color reproduction quality are becoming increasingly popular, but it's probably not very widely known that nearly all of those nano-scale dots are based on cadmium. UK-based Nanoco has been developing a cadmium-free alternative using indium, and is set to scale up production soon thanks to a licensing deal with Dow Chemical and a volume facility in Korea. A recent collaboration with Marl sees the same technology aimed at specialist lighting applications.

Shasta Crystals – all-crystalline clad-ded single-crystal fibers: Targeting the fastest-growing segment of the industrial laser sector, Shasta's laser-heated pedestal growth method is able to produce long and exceedingly thin single-crystal fibers. Core diameters of 25 microns are clad with crystalline materials via a proprietary sol-gel process, with single-, double- and triple-clad options all offered. *See Shasta Crystals at booth #6011.*

Optics and Optical Components

Boulder Nonlinear Systems – Liquid Crystal Polarization Gratings: These new lightweight and low-power beam scanners from the Colorado company specializing in liquid crystal optics are designed to replace the bulky systems traditionally based on galvos and gimbals. Boulder says that its polarization gratings, capable of steering light non-mechanically, will support an order-of-magnitude reduction in scanner weight and an even more dramatic reduction in power requirements. They are set to be aimed at applications in defense, aerospace, automotive markets.

GLOphotonics – Kagome Hollow Fiber: France-headquartered GLOphotonics expects its flexible "Kagome" photonic crystal fiber (PCF) to have a major impact in the laser sector, predicting that more than half of all ultrafast sources will be equipped with the technology by 2018. Micromachining and surgical applications are set to benefit, with the company saying that the broadband, ultra-low-loss guidance mechanism is both the only one capable of handling millijoule-scale bursts of energy, and represents the "first photonic manifestation of [the] quantum

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mechanical concept of a bound or quasi-bound state in a continuum". *See GLOphotonics at booth #1123.*

OZ Optics – Directional Fiber Optic Power Monitors: These power "taps", themselves produced by femtosecond laser writing of waveguides directly inside optical fibers, are another example of photonic crystal fiber innovation. Currently used to provide power feedback inside supercontinuum sources, they are said to be the only commercial power monitors capable of tapping light from a PCF. *See OZ Optics at booth #4529.*

Other Metrology Instrumentation

4D Technology – Flexcam: Weighing in at just a single pound, the Flexcam modules combine custom optics, ultra-high-brightness LEDs, FPGA and ARM processors, and additive manufacturing to meet the extremely challenging needs of roll-to-roll process metrology. 4D's product features a patent-pending optical design that provides extremely good vertical and lateral resolution, and the modules can be deployed in arrays to ensure complete, high-speed inspection of production lines making organic photovoltaic material and other flexible electronic devices. *See 4D Technology at booth #705.*

Neaspec – nano-FTIR: Based solely on reflective optics and featuring some proprietary system design concepts, this Neaspec kit can be deployed for various optical measurements. Applications range from microscopy to femtosecond-speed infrared spectroscopy, with a remarkable spatial resolution of just 10 nanometers. *See Neaspec at booth #4321.*

Physik Instrumente (PI) – Fast Multichannel Photonics Alignment: The positioning specialist Physik Instrumente sees optical communications as the key market for its multi-channel alignment "engine", and silicon photonics applications in particular. Describing the technology as a "true enabler", PI says that there will no longer be any need for the painstaking alignment and re-alignment that has previously dogged on-chip photonics integration. *See PI at booth #4829.*

Scientific Lasers

KMLabs – High Harmonic Generation XUUS4: The University of Colorado spin-out more properly known as Kapteyn-Murnane Laboratories launched its tunable EUV laser for semiconductor metrology applications back in summer 2015. Since then, the company has won financial backing from Intel Capital. The fourth-generation Xuus (pronounced "Zeus") source features numerous upgrades, including alignment cameras and active 4-axis stabilization of the input beam, which the company says represents a "giant leap" towards the industrialization of EUV technology. *See KMLabs at booth #2301.*

The bank of high-power laser diodes made by Lasertel that produce a peak power of 3.2 megawatts for the High-Repetition-Rate Advanced Petawatt Laser System (HAPLS) under development at Lawrence Livermore National Laboratory. This will be the world's highest repetition rate petawatt laser system when completed, and will be used at the Extreme Light Infrastructure (ELI) Beamlines facility in Prague, Czech Republic. Photo: Damien Jemison for LLNL.

Lasertel – Megawatt-class Laser Diode Module: Developed specifically for one of the biggest laser projects in history – the ELI Beamlines operation in Prague – Lasertel's laser diode arrays provide the raw power for the ground breaking laser currently under construction at the Lawrence Livermore National Laboratory (LLNL). The 60% efficiency, megawatt-class diode modules are the laser's initial pump source, representing "first light" in the amplifier chain for a high-repetition-rate petawatt laser that will be shipped to the Czech Republic within a couple of years. *See Lasertel at booth #706.*

Lytid – TeraCascade: Bordeaux-based Lytid has built the compact and fully integrated TeraCascade system around a 2.5 THz quantum cascade laser (QCL) developed at the Paris Diderot University. The company says that it provides real-time imaging with such a small system for the first time in this most elusive of frequency ranges. Described as disruptive both inside and outside the box, and "easier to use than a smart phone", it should allow many more academic and industrial researchers to explore the terahertz realm. *See Lytid at booth #1223.*

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Crystal Optics Engineering

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Due to such limited possibilities many material development scientists work on new crystals' research to solve problems or find better ways to operate the required physical phenomena. In the last 30 years a few hundred different crystals or their isomorphs were developed. Some of them are being widely used, others are only applied to very specific areas, while few are completely forgotten. When needing to find the best suitable crystal and its configuration within many of these materials with different mechanical, optical, nonlinear properties and conditions, it would be best to look for Altechna expert's advice and suggested solutions before investing into expensive crystal optics. We provide technical consulting services with no obligations saving you time and resources. Get the most effective solutions for various crystal applications, the needed technical information, and appropriate simulations with optimal optical setup advice from the people who have seen it all.

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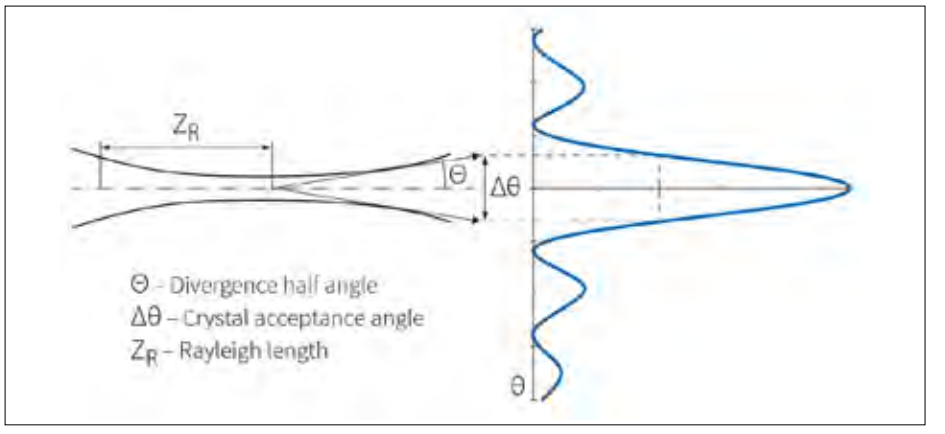

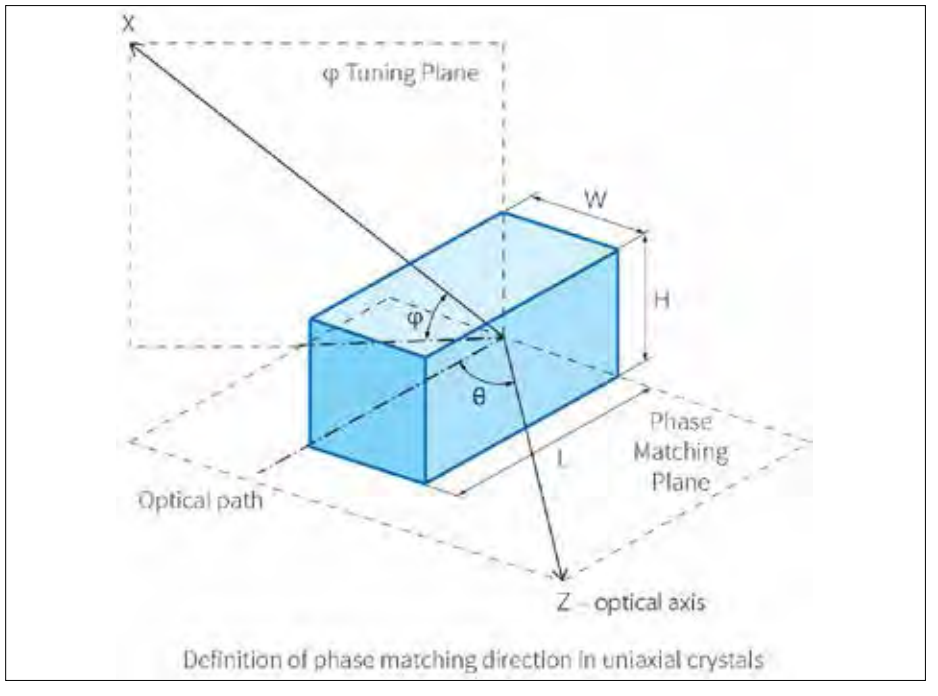

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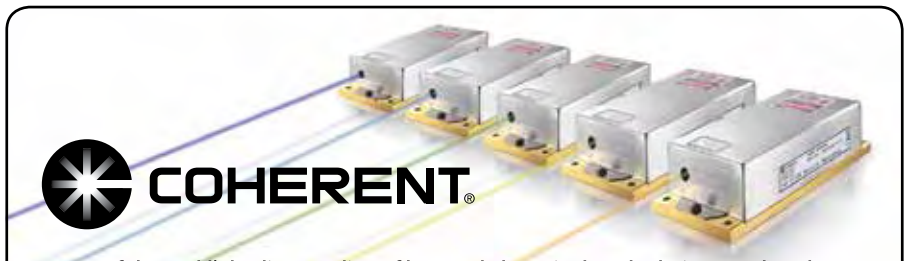

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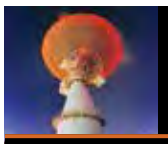

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The Ultimate Visible to Near Infrared Tunable Laser Source Based on Next Generation Supercontinuum Fiber Lasers

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

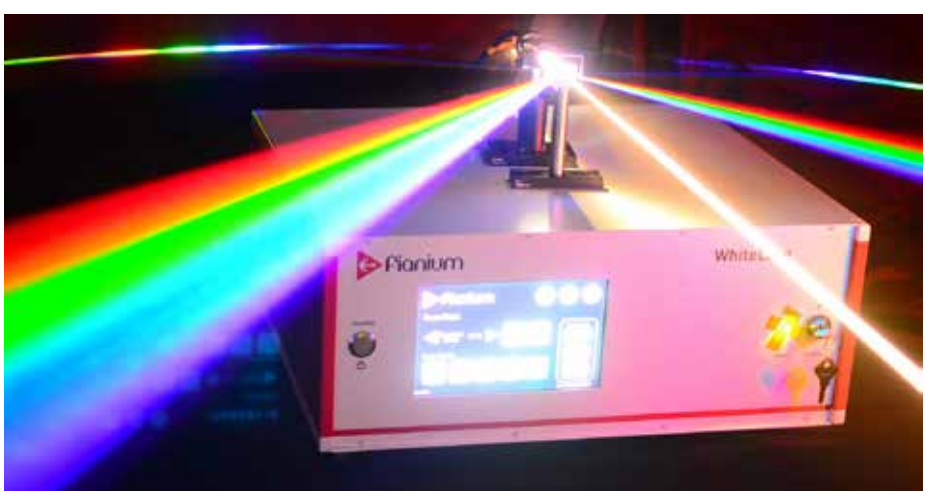
High power Supercontinuum "white-light lasers" have proven to be popular and versatile light sources for research and industry. The latest WhiteLase™ supercontinuum sources from Fianium, with over 20W optical output, provide around three times more power than any other similar system available. In combination with the latest Laser Line Tunable Filter (LLTF) technology you effectively have a high power picosecond laser tunable from 400nm to 2500nm.

Introduction

Fianium (Southampton, UK) released the first high power supercontinuum fiber laser in 2004 and have since supplied over 1800 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-400-20 supercontinuum fiber laser provides an unprecedented average power density of more than 10mW/nm, making it the brightest supercontinuum laser available today.



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 70dB 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.

In combination with the WhiteLase SC-400-20 supercontinuum laser, output powers exceeding 10mW can be achieved in a bandwidth of 2nm giving laser-like performance. As all Fianium lasers are picosecond pulsed sources, the system is ideal for both steady-state and lifetime measurements. 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 2500nm.

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.

Find out about special offers on WhiteLase Supercontinuum plus LLTF Contrast Filter packages at Photonics West booth #2417

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PRISM AWARDS WINNER

Fianium ultrafast fiber lasers

Versatile Measurement Systems for Objective Lenses and Camera Modules

TRIOPTICS offers customers maximum versatility with a combined test system for objective lenses as well as for camera modules. The system is based on the ImageMaster® HR technology – the industry standard for testing the image quality of objective lenses. An additional ProCam® object generator converts the ImageMaster® HR into a test system for measuring the image quality of camera modules. The exchange of the object generator is quick and user friendly giving customers the flexibility to use either the ImageMaster® HR or the ProCam® Test R&D functions alternately.

ImageMaster® HR for testing image quality of objective lenses

The ImageMaster® HR is a fully equipped quality test station for medium sized sample lenses. Its modular and upgradeable design enables the measurement of the image quality (MTF) and a wide range of other optical parameters for today and future needs. The instrument is used in R&D labs as well as in quality assurance or in production. The unique vertical setup of the ImageMaster® HR is space saving and ensures the most convenient and accurate positioning of the sample lens mounts. With the collimator on the precise swinging arm an ultra-wide field angle of ± 105° can be measured for infinity conjugate samples. An upgrade for finite testing can easily be adapted to the system with an additional motorized stage and object generator.

ProCam® Test R&D for camera module testing

The ProCam® Test R&D is a versatile measurement device for testing various image quality parameters of camera modules. It does not only feature on-axis but also a wide off-axis angle range of up to ±110°. The computer-controlled test target distance can be freely selected from finite distances to infinity using a focusing collimator. The ProCam® Test R&D can be used for many different types of camera modules. This high flexibility makes the test instrument an ideal solution for comprehensive measurement tasks in R&D environment.

Both systems the ImageMaster HR as well as the ProCam® Test R&D are available for various wavelength ranges.

Measurement parameters

The ImageMaster® HR and the ProCam® Test system measure the following parameters of visual and infrared lenses:

- MTF on-axis and off-axis
- Effective Focal Length (EFL)
- Distortion
- Field curvature
- Lateral and longitudinal chromatic aberrations
- Etc.

Additional functions for assembled camera modules:

- Determination of shift
- Tilt and defocus of the sensor

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TRIOPTICS

Extremely compact 100mJ, <10ns compact pulsed Nd:YAG laser sources from MONTFORT Laser

The M-NANO product series provides up to 100 mJ, <10 ns laser pulses from an extremely small foot print, based on a patent pending diode-pumping scheme optimized for compactness, enabling handheld and space-constrained applications. The footprint of the laser head measures only 120 mm x 56 mm and has a weight of 0.65 kg, based on a patent pending diode pumping and laser scheme optimized for compactness. The all-in-one system includes the controller and laser diode driver electronics in the laser housing and has a foot print of 132 mm x 140 mm with a total system weight of <2 kg.

The compactness and low weight enable applications not achievable with existing flash-lamp pumped technologies, including portable applications and other applications with critical space and/or weight constraints. Besides scientific uses, applications of such compact laser sources include laser analytics, LIBS (Laser-induced break-down spectroscopy), optical component damage testing (LIDT), PIV (Particle image velocimetry), LIDAR (Light detection and ranging), Defense, etc.

In contrast to existing flash-lamp-pumped Nd:YAG technologies, this laser is diode-pumped and the conductively cooled laser diode is included in the laser head. Not only the compactness but also lower electrical power consumption, lower weight, maintenance-free operation and improved beam quality, divergence and focussability are achieved and result in improved application results.

Please find us to discuss your specific pulsed laser needs at booth #5065 (Austrian cluster). **www.montfortlaser.com**

Optical contrast agents pave the way for targeted cancer treatments

Optical contrast agents that fluoresce when illuminated with laser energy are not new to clinical research and medical diagnostics. But combining these agents with enzymes or peptides that can bind to specific cancer cells and illuminate those cells during tumor surgery is.

As a result, optical imaging is gaining traction in image-guided surgery, especially when coupled with near infrared fluorophores that can be targeted to help spare healthy tissue.

Heather Franklin. Credit: Courtney Rambo

Two BiOS presentations in the Preclinical Applications and Clinical Translation conference described R&D efforts that address the challenges that must be met before these tools can make their way into the surgical suite.

Developers are in the early stages of animal and human clinical trials to demonstrate safety as well as efficacy, and how the US Food and Drug Administration eventually classifies these agents could impact the regulatory landscape. It is also uncertain whether these products are better suited for use by surgeons or pathologists, which could influence workflow and product design.

Defining a way to objectively assess tumor margins during surgery plays a key role in diagnostic precision. Traditionally, surgeons determine the tumor resection margin based on their experience, submit the specimen to the pathology lab, and wait for the results to determine next steps.

"The problem is interpretation and sample error," said Jason Warram of the University of Alabama School of Medicine, which is conducting a clinical trial of IRDye800 from LI-COR for image-guided surgery of head and neck cancer. "Manual sampling of tumors evaluates only a small percentage of the margin, and misinterpretation and sample error can lead to inaccurate diagnosis and recurrence. Detection of close or positive margins in real time is required to improve outcomes."

Blaze BioScience, which has coined the phrase "tumor painting" for the process of illuminating cancerous cells, is developing its own agent for image-guided surgery and tumor pathology. BLZ-100 comprises a fluorescent dye (indocyanine green) attached to a peptide derived from scorpion toxin that latches onto cancer cells' receptors. BLZ-100 is administered via injection, and a NIR camera images the cancerous tissue in real time.

BLZ-100 was specifically designed for intraoperative fluorescence-guided surgery, said Heather Franklin, Blaze co-founder. "It also has some extended benefit in the pathology setting."

Preclinical utility of BLZ-100 has been demonstrated in a wide range of cancer types, including brain, breast, prostate, lung, colorectal, skin, and sarcomas. Blaze has also completed a dose-escalation study for adult glioma and a Phase 1 human trial for skin cancer that found no dose-limiting toxicities. The company is now enrolling patients in three additional Phase 1 studies.

"This is a real-time practice application, with minimal image processing on the fly. But we need to keep the needs of the surgeon, operating room, and hospital in mind," she said.

OPTICAL TWEEZERS: NEW CELL BEHAVIOR INSIGHTS

While one of the most "common and beautiful" uses of light is imaging, Halina Rubinsztein-Dunlop from the University of Queensland in Australia prefers to expand its potential and exploit the properties of light to physically move objects.

That concept is at the heart of optical trapping, and Rubinsztein-Dunlop covered the state of the art in optical tweezers research at her nano/biophotonics plenary talk Tuesday.

Optical tweezers, a tightly focused beam of light capable of holding microscopic particles stable in three dimensions, can trap and move materials noninvasively at length scales ranging from tens of nanometers to tens of micrometers, Rubinsztein-Dunlop noted. As a result, they have provided unprecedented access to physical, chemical, and biological processes at the microscale.

"Optical tweezers are incredibly sensitive and simple in principle, but also a very powerful tool to look for measurements in biological and biomedical applications," Rubinsztein-Dunlop said.

Since a light beam can carry angular momentum, it is possible to use optical tweezers to exert torques to twist or rotate nano and microscopic objects, Rubinsztein-Dunlop noted. These "optical rotors" can be used to map the mechanical properties of cells. Rotating particles could also be used to build optically driven micromachines for applications such as studying mechanotransduction in cells, Rubinsztein-Dunlop added.

Other research efforts are focused on much larger particles, about tens of microns in diameter.

"It is very difficult to trap large objects, but with optical macro-tweezers, we can construct the trap in such a way that it can capture highly motile and very large organisms and keep them still for experiments," she explained.

Toward this end, optical tweezers have been used to study the neural mechanisms of vestibular perception, with particular emphasis on otoliths, calcium carbonate crystals 30-50 microns in diameter located in the inner ear. In experiments with zebrafish, which have some brain regions similar to mammals, researchers have been able to study the balance system to learn more about mammalian brain behavior.

"We are interested in using optical tweezers for trapping large objects. What we are trying to do is show how the optical trap can be used also for very deep penetration and manipulation and provide enough force to change acceleration," she said.

Many studies have looked at otoliths in terms of the proteins involved and exterior factors, but it is difficult to study acceleration encoding, she added.

"So we want to use optical manipulation to move them and see what acceleration is actually taking place," she said. "What we have found is that otoliths are birefringent particles and optical tweezers provide a force sufficient to manipulate them — enough force to see what reaction the zebrafish would have to the manipulation."

KATHY KINCADE AND JACQUELINE ANDREOZZI

WEBINAR MARCH 2ND ON ITAR UPDATE

SPIE will host a webinar 2 March for industry and research universities to learn about the updated, proposed changes to US regulations on the export of technologies and commodities covered by the International Traffic in Arms Regulations (ITAR).

Two industry sessions this week covered the regulations, including an interim update to the Category XII of the US Munitions List (USML), which could affect non-military uses of photonics products and technologies everywhere.

This update has been drafted and will be released in the coming days. The 2 March webinar will cover how it may affect you and how you can participate in the 45-day comment period.

More information and to register for the webinar: spie.org/industry-resources/export-information

Dream it, imagine it and it will happen

David Sampson of the University of Western Australia, known for his advances in the development of microscopes-in-a-needle, dreams of the day that someone will find the "holy grail" of biomedical imaging: a new optical technique for imaging live human cells.

Speaking at the SPIE Fellows lunch on Monday, Sampson summarized the advantages and drawbacks of optical coherence microscopy, reflectance confocal microscopy, and multiphoton microscopy and concluded that what is still left to accomplish is imaging through scattered media using methods that could be adapted clinically *in vivo*.

David Samson. Credit: Stacey Crockett

While this technology is a long way down the road, Sampson said he is certain it will be available some day. "I like to dream," he told the gathering of SPIE Fellows. "If you can imagine it, and if you can't prove physics won't allow it, then it will happen."

BRAIN partners highlight industry opportunity

Industry has a huge role to play in the fast-growing and high-profile areas of neurophotonics and optogenetics, with the potential to imitate the success of companies like Illumina and Affymetrix in the field of genome sequencing.

That was the message from Kunal Ghosh, a biomedical imaging expert who is the co-founder and CEO of Inscopix. Ghosh said that the Palo Alto company, spun out from Stanford University's world-leading neural imaging research activity, intends to extend its optical brain-mapping technology platform beyond the current use in mice to other animals and eventually humans.

"There is a market here," Ghosh told an overflowing conference room hosting the US National Photonics Initiative (NPI) BRAIN Hot Topics session, held for the first time at Photonics West on Sunday. "Look at genomics: when it started a couple of decades back, an entire new sector was born."

Short for Brain Research through Advancing Innovative Neurotechnologies, the BRAIN Initiative is being heavily funded by the National Institutes for Health (NIH) and the National Science Foundation (NSF).

In a session designed to bring together key partners from government, academia and industry, the NIH, NSF and White House Office of Science and Technology Policy were all represented – and joined by leading researchers from Stanford and five industry partners.

Speaking on behalf of NIH, neuroscientist and program director Edmund Talley illustrated why there is a pressing need to better understand disorders of the brain, pointing out that they have already become the most costly of chronic diseases in the US, beyond even cancer and cardiovascular disease.

"We don't know enough about the brain to meet this challenge," he said. "[but] the tools we have, including photonics tools, are starting to look extremely promising." Among the seven key goals of the BRAIN Initiative are the creation of a "census" of all different brain cell types, first in a rodent brain and then in a human – which would contain 1000 times more than the rodent. Photonics can play a role in that and, particularly, in providing the tools and technology for another crucial goal, so-called "circuit mapping" and functional manipulation.

Stanford researcher and Inscopix co-founder Mark Schnitzer highlighted technologies like the company's own nVista "optical helmet" that can image some of the neurons firing in a mouse brain in real time. What he and Stanford colleague Michael Lin said are needed now are new optical reporters of voltage changes indicating neural activity – indicators that need to act within just a few milliseconds. Lin added that there had been huge progress with optical hardware in the past three years, but that faster two-photon systems were still needed to image hundreds of neurons.

Inscopix CEO Kunal Ghosh, speaking at Sunday's special Hot Topics session on the BRAIN Initiative. Photo: Adam Resnick/SPIE.

Providing some of those technologies are the likes of laser firms Spectra-Physics and Coherent, microscopy giant Zeiss and photodetector maker Hamamatsu Photonics, as well as relative newcomer Inscopix. They are already partners in the BRAIN Initiative, and Schnitzer called for a wider discussion to improve academic-industrial interactions further to help speed future research.

Among the related developments on the exhibition floor at Photonics West this week are new femtosecond lasers from both Spectra-Physics and Coherent that extend further into the infrared spectrum, and deliver more power for deeper imaging and three-photon techniques. Hamamatsu, whose key contribution is scientific CMOS detectors, has also developed a new "virtual test camera" that neurophotonics researchers can use to simulate the performance of detectors and see how they meet their requirements.

MIKE HATCHER

INTERFEROMETRY SET FOR "GOLDEN AGE"

With perfect timing, interferometry delivered global headlines with the detection of gravity waves at the Laser Interferometer Gravitational-Wave Observatory (LIGO) on the eve of Photonics West. And in a keynote talk Sunday, an excited James C. Wyant reviewed the history and evolution of the technique.

"There has been nothing else in my life in interferometry that brought me this much excitement," Wyant said. "I would compare this with landing on the moon."

"Interferometry measured just ten to the minus nineteen meters of movement," Wyant reiterated. "I have worked 50 years or so in this field, and I am still amazed we could detect something so small."

A professor emeritus and founding dean of the University of Arizona's College of Optical Sciences, Wyant has been at the center of much of the evolution of interferometry. In that time he has founded a half dozen companies including Wyko and 4D Technology, with the technology used to manufacture hard disks. One of his companies made equipment used to test the mirrors of the James Webb Space Telescope.

Shifting from his awe at measuring tiny warps of spacetime during a few milliseconds of gravity wave action, Wyant emphasized more down-to-earth breakthroughs in the science of ultra-fine metrology, spotting angstrom-level differences in a smooth surface. The lessons learned are being applied in fields like biomedicine, optical fabrication, data storage, machine tools, and semiconductor fabrication.

A dramatic video showed a single-shot holographic polarization dynamic interferometer with a laser and beam splitter. A holographic element split two beams into four beams, creating four phase-shifted interferograms that detected the heat from a cup of hot coffee.

"The nice thing is, it is possible to make good wire grid polarizers now," Wyant said, showing how they can be used as a phase shifter to reveal interference patterns.

"It's a very exciting time," he told his capacity audience. "You can apply all this to biological specimens. And if history repeats, while the hardware is important, the really important part is the software to analyze the fantastic data we will get.

"If I were 20 years younger, I would jump into this area myself," Wyant said. "There's a tremendous future in applying interferometry to biomedical applications."

"With a brilliant history of discovery behind it, interferometry seems poised for a new golden age," he concluded.

FORD BURKHART

PHOTONICS WEST. SHOW DAILY

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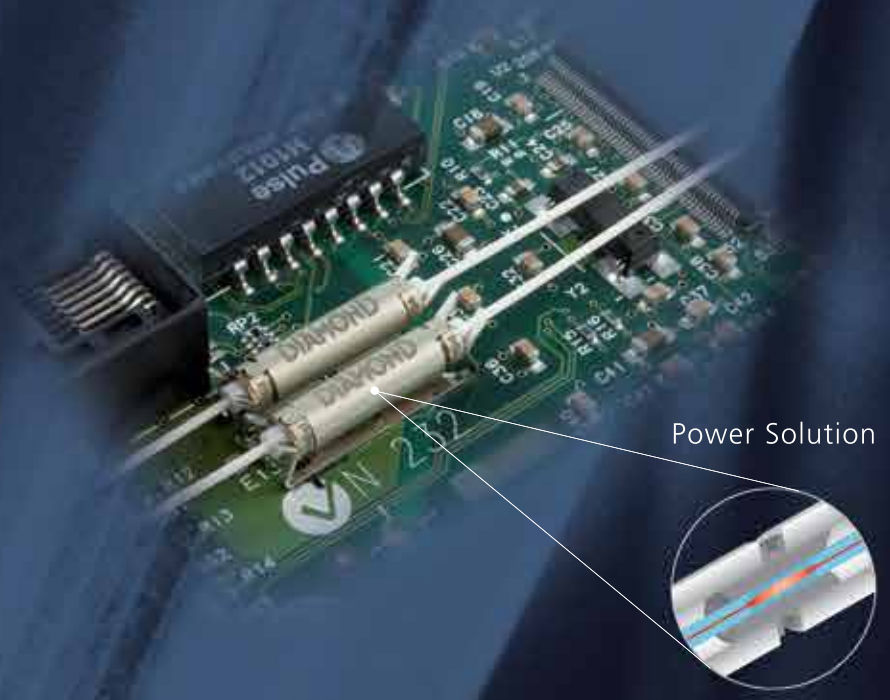

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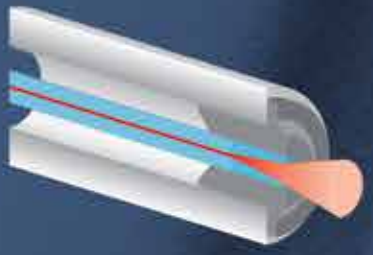

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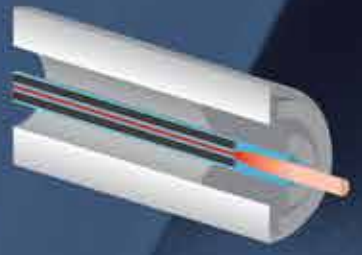

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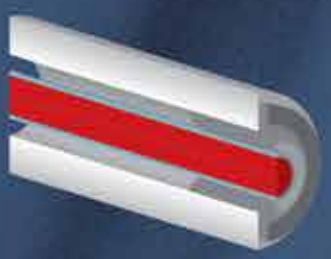

PSm (Power Solution Multimode)

PM (Polarization Maintaining)

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