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A New Window for Photonics in the Brain

Lab Tricks
- Using Python to Automate your Experiments

Get to Know your Society Leadership
- Leslie Rusch, Board of Governors Elected Member 2016–2018

Young Professional Spotlight
- Finding Inspiration and Fostering Collaboration

News
- IEEE Standards Association Propels Global Technology Innovation Into 2018
- National Photonics Initiative Testifies During House Science Committee Hearing on Quantum
- Single-Photon Detector Can Count to Four

Careers and Awards
- John Tyndall Award Winner
- IEEE Photonics Society Fellows—Class of 2018

Spotlight on New Editors-in-Chief
- José Capmany—New Editor-in-Chief of IEEE Journal of Selected Topics in Quantum Electronics
- Jianping Yao—New Editor-in-Chief of IEEE Photonics Technology Letters

Membership
- National Society of Black Physicists "Day of Scientific Lectures"
- Annual Afterschool Conference "Thinking Outside the Box"
- True Diversity in Action: Diversity in STEM Conference and Dia de la Fisica Reaches 4000+ Chicano, Hispanic and Native American Students
- IEEE Photonics Latin America Outreach: OPTOANDINA & Mexico National Meeting of Scientific Outreach

Conferences
- 2018 Optical Interconnects
- Quantum Networks – A Call for Integrated System Design
- What Needs to be Discovered and Invented?
- Call for Papers: IEEE Summer Topicals Meeting Series 2018
- Call for Papers: Group IV Photonics 2018
- Call for Papers: 2018 RAPID
- Call for Papers: 2018 Semiconductor Laser Conference
- Call for Papers: IEEE Photonics Conference 2018
- Avionics and Vehicle Fiber-Optics and Photonics Conference 2018
- IEEE Photonics Society Co-Sponsored Events

Publications
- Call for Papers:
  - JLT: Related Photonics Technologies
  - JSTQE: Biophotonics
  - JSTQE: Nanobiophotonics
  - JSTQE: Metamaterial Photonics and Integration
  - JSTQE: Ultrafast Science and Technology
  - JSTQE: Foundry-Enabled Photonic Integrated Circuits
Happy New Year and Welcome 2018! I hope it is a great year for photonics for everyone!

In this issue we add a new column titled “Lab Tricks.” Here, we ask a different Photonics Society member to share some of their techniques/tricks to be more productive in a photonics laboratory. Jochen Schröeder from Chalmers University describes how he uses the open-source Python programming language to automate his laboratory. I, too, am a big fan of Python and cannot imagine how I could get anything done in the lab without it!

Our fourth Get to Know Your Society Leadership column features Leslie Rusch, a member of the Society Board of Governors. Leslie is a Professor at the University of California at Riverside, attempting to non-invasively deliver photonics to the brain through a transparent window. The research highlight article titled “A New Window for Photonics in the Brain” is from the team led by people are amazing! with people, learn from your mistakes, and photonics ultimately landed in a professorship. She shares her experiences and wisdom including tips such as: collaborate with people, learn from your mistakes, and photonics people are amazing!

The research highlight article titled “A New Window for Photonics in the Brain” is from the team lead by Juan Hernandez-Cordero. The research is a collaboration between several universities in Mexico and the University of Riverside California attempting to non-invasively deliver photonics to the brain through a transparent window in the skull.

We are still looking for some additional associate editors from Asia, Europe to help with the newsletter. Students, young professionals, and experienced members can inquire! The primary tasks would be to help source articles from your region. Please contact me (nicolas.fontaine@nokia-bell-labs.com) if you are interested. As always, enjoy reading the articles! I welcome any feedback, suggestions, and comments.
Welcome to the first Newsletter of the new year. I hope 2018 is a great year for you!

It is a pleasure and honor for me to serve as the President of the IEEE Photonics Society, one of the most dynamic Societies within IEEE. As my first order of business, I want to thank the various past Presidents for their leadership to the Society with special appreciation to our outgoing Past President, Dalma Novak and our current Past President, Kent Choquette. They both have provided excellent leadership to the Society.

As we know, photonics continues to play a significant and growing role in nearly every aspect of modern life: science, culture, education, sustainable development, and in fields as diverse as medicine, communications and energy. To help showcase the importance and ubiquity of the light sciences, UNESCO has designated May 16th as the International Day of Light (IDL). The global photonics community will celebrate this event as an opportunity to educate the general public—and in particular students—about the importance of photonics and its viability as an education and career path. In addition, the IDL will help policy makers understand that investment in science and technology is critical for developing solutions to the grand challenges we, as a global society, must face.

Therefore, as President, I will make it a cornerstone of my term to instill the concept of “Diversity by Design” into the Society’s operations to ensure we better serve all our members and potential members around the world. These groups include those working in industry, women, young professionals, students, and those in the developing world. So, to begin, we need to consider the challenges and opportunities unique to each of these groups...

It is true that a significant proportion of our membership is from industry—but are we serving them well? How can we engage more successfully with our industry-based members? Are standards important for the industry community? What training programs and workshops should we develop to meet the needs of our industry members?

Likewise, our Women in Photonics efforts provide excellent programs to engage women members, but how can we strengthen this further? What are the issues faced by women colleagues working in photonics? How can we promote activities and policies that support the participation and advancement of women in the photonics and optics community?

How do we engage more with our young professionals and meet their needs? They are well versed with internet and social media, so how can we make use of their skills to promote photonics to the broader community? How can we motivate them to volunteer for the Society?

And while we are active in North America and Western Europe, it is important for us to grow Society membership and activities in Asia-Pacific, Eastern Europe, South America, Africa, and the Middle-East. What programs and support can we offer to reach our colleagues working in these regions? How can we grow and sustain our membership? How do we increase the value of membership while keeping fees low?

We have an active conference program but the majority of these events take place in North America while we partner with conferences in Europe and Asia-Pacific. Currently, only about 20% of our members attend our conferences. How can we engage with other 80%?

Chapters play an important role in reaching members in diverse regions. How can we strengthen our chapters and their activities to benefit our members? Distinguished Lecturers (DLs) provide a valued resource to our chapters. However, our DLs can’t travel to all chapters due to limited time. Should we make better use of our DLs resources to reach out to remote chapters? How can we make use of the internet to reach to broader audiences? Can webinars serve this purpose? What else can we do?

Our publications are widely read by our members and the larger photonics community. How can we ensure that our publications are meeting the community’s needs? *IEEE Photonics Journal* is one of the first IEEE open access journals and is enormously successful, but how can we enhance the diversity in our journal editors and associate editors to represent the global community. How do we grow our author and reviewer base? How can we recognize our reviewers for the valuable work they do voluntarily?

How can we strengthen our technical activities? Is it time for us to create technical groups to reach out to members with specific technical interests to create niche communities and discuss issues of common interest, such as including webinars on specific topics in specialized areas?

In this first column, clearly I have raised more questions than answers. But this is just the first step. To take the next step, I need feedback from you—our members—so that we can launch the programs and initiatives to better serve the community. If you have questions, comments, and insights you wish to share, send them to through our feedback form at [bit.ly/IPS-feedback](bit.ly/IPS-feedback) or email [photonsociety@ieee.org](mailto:photonsociety@ieee.org).

This is your Society, get involved!
A New Window for Photonics in the Brain

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Abstract—Current advances in materials processing have lead to the improvement in the optical properties of ceramics. In particular, nanocrystalline Yttria-stabilized-zirconia (YSZ) has shown to provide a novel platform for developing transparent cranial implants. In this article we present our ongoing research efforts for developing a platform to obtain optical access to the brain tissue. This “Window to the Brain” (WttB) is expected to provide a means to extend the reach of photonic tools for diagnostics and therapeutics of brain disorders.

I. Introduction

Photonics is consistently expanding its reach in a wide variety of fields. As an example, biophotonic related applications are continuously evolving thus offering new possibilities to improve our understanding of living organisms. The disruption caused by photonics in medicine is perhaps only comparable to that observed in optical communications, two fields that have greatly evolved changing our everyday life. Current efforts in medical applications aim at combining technologies in order to provide multifunctional capabilities: theranostics and optogenetics, for instance, combine several photonic technologies in order to provide exceptional tools for diagnostics and therapeutics.

Biomedical applications of photonics rely mostly on the optical features of a specific tissue. Light sources are selected trying to optimize the absorption and/or scattering in order to reach specific regions or organs within the human body. As an example, the so-called therapeutic window (600 nm to 1300 nm) allows for significant penetration of light owing to the weak optical absorption of tissue components. Devices such as oximeters and imaging techniques such as optical coherence tomography (OCT), for instance, have been developed within this spectral range. In some cases, however, procedures for theranostics require deeper penetration of light: drugs for photodynamic therapy, or proteins such as opsins commonly used in optogenetics, are activated with light. Increased light penetration would certainly allow for extending the reach of these techniques to organs such as the brain, whose optical access is limited by the highly scattering nature of the cranial bone. In this article, we describe our ongoing research efforts aimed at developing a platform to provide optical access to brain tissue over a wide wavelength range. This “Window to the Brain” (WttB) is expected to grant an effective means to facilitate the diagnosis and treatment of neurological disorders using laser-based techniques.

II. A Multipurpose Window: Multidisciplinary and Binational Research Effort

The WttB platform is evolving through joint collaborative efforts from the United States and Mexico. Six research groups from the University of California and three from different Mexican institutions (CICESE, INAOE and IIM-UNAM) have converged in a multidisciplinary group covering the relevant research topics required to develop this novel concept of a transparent cranial implant. The main goal driving this effort is to enable light and other types of electromagnetic radiation to reach the brain tissue, in order to provide a novel platform for new studies aimed at understanding how the brain works and communicates. Hence, this WttB platform must be capable to provide suitable optical, mechanical and thermal properties for performing these tasks using different theranostics.
tools. Research topics pursued in the project include processing and synthesis of micro/nanstructured materials, biomedical optics including laser-tissue interactions and bioheat transfer, and MEMS-based biomedical devices. Other photonics related research, some of which is covered in this article, focuses on optimizing light coupling and harvesting through the window. Finally, the research group also includes a strong biomedical component that will allow validating the use of the implants, as well as the photonic tools and techniques, in mice models.

III. Nanocrystalline Yttria-Stabilized Zirconia (YSZ): Optical Features and Biocompatibility

Transparent ceramics have been of interest for a wide range of applications. Polycrystalline YSZ in particular has shown to be one of the most versatile ceramic materials owing to its biocompatibility, high hardness and toughness, although for optics related applications, its opacity has been typically a constraint. Using novel processing techniques, the optical scattering can be conveniently reduced thus yielding a highly transparent ceramic.

A. Optical Transparency

The optical properties of ceramics are related to the crystal structure, and more specifically, to the grain boundaries and porosity. A window is fabricated following a densification process of nanocrystalline YSZ powder. Upon adjusting the processing parameters, the optical transparency of the resulting densified ceramic can be modified [2]. For the WrrB cranial implants, YSZ processing involves the use of high pressure and high electrical current in order to increase the sintering temperatures. Among other advantages, this procedure allows to retain the nanometric scale of the grains as well as to reduce the porosity [2], [3]. These features are directly related to the scattering properties of the YSZ ceramic and can be readily tuned to yield adequate transparency. After processing, the densified samples are polished, annealed and cut into proper dimensions.

Characterization of the optical properties of the YZS samples has shown that scattering is effectively reduced upon adjusting the sintering temperatures of the precursor powders [2]. Most of the opacity has shown to be related to absorption within wavelength ranges typically observed in reduced YSZ crystals [3]. Research is still underway to optimize the processing parameters to reduce absorption effects, which can be altered upon adjustments on the processing time. So far, the YSZ windows have shown to have a transmittance near to 60% within the wavelength range of the therapeutic window (see Fig. 2). As for the refractive index, it has been measured to be typically between 2.13 and 2.15 within a wavelength range from 300 to 600 nm.

B. Cranial Implants and Biocompatibility

An early demonstration of the potential of the YSZ as an enabling platform for brain theranostics was performed in mice [3]. The ceramic implant was fixed on top of cranietomies performed on one side of the skull while keeping the other side intact to serve as control. Using OCT as a representative optical imaging modality, images were acquired from both sides of the skull, i.e., through the native cranium and through the YSZ implant. Results showed that the implant indeed provides enhanced transparency, yielding images of brain areas otherwise imperceptible by OCT [3]. As explained in the following section, these promising results have driven efforts to explore the use of the implants with other optical techniques.

Although YSZ has shown to have good biocompatibility when used for dental and orthopedic applications, cranial implants evidently impose different biological challenges. Undergoing efforts in this direction include evaluation of the long-term biological response to this material, as well as potential reduction in transparency of the YSZ due to bone regrowth over the implant. Experiments in this direction are being performed with mice following approved protocols, and involving evaluation of OCT image degradation with time.

IV. A Window for Photonics

Clearly, gaining optical access to the brain tissue will extend the possibilities for using photonics tools. In this section, we present some of the approaches that we are pursuing to increase and control light delivery through the window.

A. Waveguides and Optical Fiber Coupling

Although the transparency of the material already provides optical access over a wide wavelength range, some applications may require for light to be delivered in a more concentrated fashion. Improved and/or directional light coupling through the window is being explored in two ways: direct waveguide femtosecond laser fabrication on the YSZ, and optical fiber coupling.

Waveguide-like structures are possible to fabricate in the YSZ through direct laser writing. Using femtosecond laser pulses, the optical properties of the YSZ samples can be readily modified thereby yielding waveguide-like structures [4]. We have demonstrated two types of structure in the YSZ polycrystalline ceramic, type I waveguides in which the guiding region corresponds to the laser scanned region, and type II waveguides, in which light is confined by a pair of parallel tracks produced by laser irradiation. While for type I waveguides the material increases its refractive index within the laser exposed region (Fig 3a), the confinement tracks in type II waveguides show a reduction in the refractive index (Fig 3b, 3c). The size of these structures depends on the laser parameters such as fluence per pulse and number of scans.

In contrast to conventional ceramics, the energy per pulse required to achieve these structures in the nanocrystalline YSZ is extremely low (around 5 nJ). The mechanisms involved in waveguide formation are still under examination, but so far the...
observed changes in the samples have been associated to the concentration of oxygen vacancies. Thus, processing parameters such as annealing time of the YSZ are thought to play a role in waveguide fabrication [4]. These preliminary results have provided evidence that the refractive index of the samples can be readily changed under laser irradiation. Efforts are underway to quantify this increase in refractive index and hence produce more elaborated waveguide arrays such as diffractive structures. Improved understanding of the mechanisms involved in waveguide formation will certainly provide new guidelines that may lead to fabricate complex waveguide structures in 3-D. Aside from improved light coupling through the ceramic implant, these capabilities may enable the design and realization of optical sensing structures within the WttB.

Light delivery to specific areas of the brain may be attained through optical fibers. Coupling of fibers to the window is being explored following different approaches. Given the nature of the implants, zirconia ferrules such as those regularly used for optical fiber connectors should provide good compatibility for direct connection to the YSZ. Albeit requiring elaborated mechanical arrangements, laser soldering of zirconia ferrules to the YSZ may represent a viable option. However, the index mismatch between standard fibers and the ceramic material has to be accounted for as a potential source for light reflection that may be detrimental for some applications.

Current tools available for optogenetics are also sought to be compatible and easy to adapt to the WttB implants [5]. Efforts in this direction include post processing of the YSZ to host the ferrules and fiber arrangements typically used for light delivery. Increased reach of laser light to targeted opsins could be achieved upon attaching the zirconia ferrules within the implant thereby providing a direct interface for optogenetic procedures. Micromachining techniques may offer a possible option for fitting the fiber ferrules within the YSZ samples, although care must be taken to avoid compromising the mechanical properties of the material.

B. Fiber Optic Devices for Therapeutic Applications

Efficient coupling of fiber optics to the cranial implants will also provide a means to incorporate fiber-based devices. This is relevant among other things for therapeutic applications. As an example, we are currently exploring the use of optical fiber microheaters as photothermal tools for hyperthermia applications. The microheaters are based on gold nanolayers deposited on the tip of standard single-mode fibers [6]. A laser diode coupled to the opposite end of the fiber is used to generate the desired photothermal effect at the gold-coated fiber end. Simultaneously, we are also developing fiber optic temperature sensors that could either operate as stand-alone devices, or as part of a fiber probe that includes the microheater. The sensors are based on fluorescence thermometry, and the devices are fabricated using rare-earth (RE) compounds embedded in a biocompatible polymer matrix (PDMS). As shown in Fig. 4, the RE-PDMS composite is attached and cured on the tip of a dual-fiber arrangement. The RE ions are excited with a NIR laser diode to produce fluorescence bands within the visible spectral range and this upconversion process is temperature dependent. Hence, spectral analysis of the fluorescence captured by one of the fibers can be used for temperature monitoring. Joining both, the fiber microheaters and the temperature sensors should provide a novel way to achieve a controlled temperature set point on demand and in a highly localized manner.

Coupling fiber optic devices through the YSZ implants can certainly provide an effective means to extend theranostics capabilities. Parameters such as pressure and temperature, typically used for monitoring brain recovery after traumatisms and other conditions, could be readily monitored with fiber sensor
technology through a ferule conveniently located in the WtrB. Similarly, optogenetics tools, such as the recently demonstrated all-fiber optodes [7], could also be allocated in the implants housing the zirconia ferules. Developing a practical and versatile multitasking fiber optic interface for the implants is therefore an important goal for the WttB platform.

C. Diagnosis and Therapeutics with Photonic Tools
The availability of a transparent window for brain studies provides an excellent opportunity for extending the reach of optical theranostics tools. Optical imaging technology is perhaps the most natural candidate to be exploited for improved diagnosis of brain disorders. Aside from OCT, which has already shown to increase its resolution through the window, laser speckle imaging (LSI) is being explored as a means for tissue analysis and blood flow monitoring. LSI is a well-known technique used to monitor neurovascular and tissue metabolic activities at high spatiotemporal resolutions over a relatively large field of view. We have been working on different computational techniques to improve the visualization of deep blood vessels up to ~1000 mm [8]. Additionally, the highly scattering nature of the brain tissue could be partially reduced through wavefront correction of the incoming beam. This can be achieved by means of a spatial light modulator allowing, for example, focusing a beam into deeper brain regions even after travelling through the tissue. Enhanced resolution in optical imaging will indeed provide a better insight of ailments such as cerebral edema or others requiring chronic monitoring.

Further information of the brain tissue may be obtained with other techniques such as Mueller matrix imaging [9]. This polarization sensitive technique is capable to provide information about physical parameters of scattering media such as tissue. For the WttB platform, a reflection scheme for imaging is being developed in order to obtain polarization-encoded information through the YSZ implant. Brain tissue features such as inflammation or tissue differentiation may be identified through birefringence and retardance analysis.

Therapeutics with optics typically involves light activated processes. Evidently, the advent of transparent ceramic implants promise a new test bed for both, exogenous and endogenous optical procedures. Although the reach of light activated drugs to the brain tissue may still be challenging, the availability of a window for light delivery offers a new incentive for pursuing more efforts in this direction. As an example, techniques such as photodynamic therapy may extend their reach for brain tumor related treatments [10]. So far, we have shown that PDT can effectively be used with different photosensitizers for treating dermatophyte fungus, bacteria, as well as breast cancer [11]. Research on biological activity triggered by light, such as ionic channel activation at the cellular level, may be also explored through the WtrB platform. Finally, as mentioned earlier, an interface for optogenetics and the implants is also being considered in order to facilitate light delivery for these procedures.

D. Laser-Assisted Antiseptics
Antiseptic methods are important in all medical related procedures. As part of the development of the WttB platform, we are exploring the use of laser-assisted methods for bacterial and microorganisms control. This approach has been extensively studied for dental related applications using near-infrared (NIR) lasers yielding good results for controlling bacterial growth. Cranial surgery or trauma commonly leads to infectious processes involving bacterial growth, posing a challenge for treatment owing to the poor penetration of antimicrobial agents to this tissue. For cranial implant infection in particular, the implant needs to be removed and replaced thus adding inconvenience and cost to an already delicate procedure. A non-contact, light mediated process through the window for antiseptics would therefore be useful for the WttB platform.

Preliminary efforts for laser-assisted control of bacterial growth through YSZ ceramics have shown promising results [12]. Using a NIR laser diode in in vitro experiments, we have observed growth inhibition of Escherichia coli (E. coli), commonly appearing in some forms of meningitis after cranial surgery or trauma. Laser irradiation performed through YSZ showed to disrupt E. coli biofilm formation, thereby providing evidence of the potential for laser-assisted procedures through the implant. Recently, we have also observed mitigation of E. coli growth using femtosecond laser pulses of ultra low energy (<5 nJ) with MHz repetition rates. Interestingly, the process does not seem to be related to thermal effects, as evidenced by thermal imaging measurements during laser irradiation (Fig. 5). Bacterial inactivation monitoring has shown that damage occurs after a characteristic irradiance threshold, suggesting that nonlinear optical effects may play a role in this process. Research in this direction is therefore aimed at exploring the role of nonlinear optical effects (e.g. nonlinear absorption, multi-photon dielectric breakdown) in bacterial damage.

It is important to identify the mechanisms involved in the inhibition of bacterial growth with laser light mostly to prevent any secondary effects that may occur during this process. Photochemical and photothermal effects are being considered as the main contributors to the results observed so far. Ideally, a purely photochemical effect would be desired because this will prevent increasing the temperature in the vicinity of the tissue.
The use of optical methods for monitoring bacterial growth is also being explored aiming at developing an all-optical tool for antiseptics through the WttB platform.

V. Conclusions
Biomedical related applications of photonics are consistently extending their reach to increase our knowledge of living organisms. The challenges posed by the complexity of biological systems demand joint efforts on multidisciplinary research, and photonic tools are undoubtedly valuable. Our ongoing research, focusing on developing a platform for brain related studies, ties activities related to materials science, biomedicine and photonics. We expect that this collaborative effort will provide a novel means to obtain useful information to increase our understanding of the brain and its ailments. More importantly, the WttB platform should provide an effective way to increase the possibilities for performing theranostics in the brain. Photonics plays a fundamental role to achieve this task, offering several optical techniques and devices that could be interfaced through the window.

Acknowledgments
The WttB project is being funded by NSF through grants NSF-PIRE 1545852, NSF-EAGER 1547014 and by Conacyt (México) through FONCICYT, grant 246648. JHC acknowledges support from DGAPA-UNAM and Conacyt during his sabbatical at UCR.

References

Correction
In the December 2017 Issue Research Highlights an author’s name was missing. The online version has now been corrected to include George Papastergiou of Optronics Technologies SA, Athens, Greece.
Lab Tricks

Using Python to Automate your Experiments

By Jochen Schröder, Senior Researcher at the Department of Microtechnology and Nanoscience, Photonics Laboratory

When I began my studies for a PhD in Physics I like many other graduate students had some basic programming skills mainly based around Matlab and a little C. Most of this I learned through beginners courses during my undergraduate studies and the need for some basic numerical analysis for my Masters thesis. At the start of my PhD I felt simultaneously excited and was eager to start and get into the laboratory, and overwhelmed with the what I needed to do. I dove into the literature, reading about my research topic, began implementing some simulations in C, and started some initial experiments. Like many others, my first measurements were essentially manual, adjusting my equipment by hand saving data, such as optical spectrum analyser traces to floppy disks and writing measurement results into my logbook. When I used computers to control equipment, it was typically based on small scripts inherited from previous students written in labview or the matlab instrumentation toolbox. While this approach worked fine initially, as my experiments became increasingly sophisticated I began to realise that I needed a more systematic approach for conducting my measurements. While I greatly enjoyed planning, designing and setting up my experiments, sitting in the lab for hours on end, pushing one or two buttons and noting values in the logbook was not fun, quite apart from the danger of making avoidable mistakes that more than once made me need to retake hours of measurements. At the same time I had found the Python language for some hobby projects around processing web-pages. I am a fan of free software, and the open source nature of the language strongly appealed to me. Moreover, the structure of Python, which makes extended use of whitespace, and the very natural syntax allowed me to learn quickly. After a short time I was able to write my own programs and read other projects code which is a great source of learning. I learned about the powerful scientific programming packages such as numpy, scipy and matplotlib and the growing scientific community that uses Python for their simulations, analysis and experimental control. I was convinced and decided to use Python as the major language to automate my experiments. After a short time I had created fully automated experiments that ran unsupervised allowing me to concentrate on the fun parts of an experimental PhD instead of sitting for hours in the lab taking measurements.

I have graduated a long time ago, but I continue to enjoy programming in Python and use it almost exclusively for my research work. In 2015 Nicolas Fontaine from Bell labs, Binbin Guan from Acacia and myself now a tenured Senior Researcher at Chalmers University of Technology, all big open source and Python fans, decided to share our experiences with others, in particular students and early career researchers, so that they could learn from our mistakes and to bring together the community of open source and Python users in photonics, we knew existed. The labautomation hackathons were born. While the labautomation hackathons are generally language agnostic, we place a strong emphasis on using Python. In our view Python has some strong advantages over other languages:

1) It is a programming language first with a large user base in areas ranging from web programming to automated system administration tools and desktop applications such as video editors. Therefore Python really shines when integrating non-scientific tools into your programs. For example the packages for writing graphical user interfaces (GUIs) are advanced and sophisticated. Unlike in other languages which developed out of scientific tools, advanced programming concepts, such as object oriented constructs, do not feel bolted on.

2) Because Python is so widely used throughout many different industries—e.g. much of Google’s internal tools are based on Python, and dropbox infrastructure is mainly based on Python—Python proficiency is a great skill for students CV, and I know of several post-graduate students who moved on to careers outside of photonics based around Python programming.

3) The scientific community around Python is growing at breathtaking pace, and new sophisticated tools are being released every week. Some examples are the pandas and jupyter packages which are used extensively in data science, which is becoming increasingly dominated by Python. It happens often that if one encounters a problem, we can find someone who has already solved it and released the code under a permissive open source licence.

4) Python’s syntax, use of whitespace, and philosophy that there should only be one way of doing things, forces Python code to generally be very easy to read and understand. While it is possible to write complex, opaque and intelligible code in Python it is generally much more difficult. This is particularly advantages for scientific programming, where we often write code which gets used extensively, but we only come back very sporadically to make changes.

5) Python and all the main scientific packages are open source and therefore free to use. Therefore programming in Python does not incur the high licence costs, that can be prohibitive in particular for small businesses or start-ups.

We held the first labautomation hackathon on Sunday evening at the Optical Fiber Communication Conference (OFC) in March 2017. The speakers at the first event were Nicolas
Fontaine from Bell Labs who gave a short introduction to the event and some basic tips on using Python. I was talking about using the bokeh package to do interactive plotting inside the browser. Ryan Scott from Keysight shared his experiences of switching his labautomation from labview to python and the reasons why he did it. Jorris Geesels and Piere Wahl from Luceda Photonics introduced the IPKISS photonic design software which is written in Python. Finally we had a live demo organised by Binbin Guan from Acacia, where participants could adjust the different parameters of a simulated IQ modulator running on a web server. Many lively discussions developed from the talks, with the less experiences of the about 50 participants asking questions about what packages to use, and some other participants sharing their experiences and reasons why they had already made the switch. The discussions continued well into the evening when drinks and food were served thanks to the generous sponsorship from the Optical Society of America (OSA).

After the great success of the first hackathon we decided to continue the event and held the second hackathon at the European Conference on Optical Communication (ECOC) in September in Gothenburg, Sweden. With 100 pre-registered participants the event looked to be even bigger than the OFC event. However, because the welcome reception which was running at the same time and the difficult to find location of the room, it meant that about 50 of the participants showed up to the hackathon. This second event was strongly focused around industry use cases of Photonics, prompted by many questions to this extend at the OFC hackathon. The speakers at this event were: 1. Ronald Broeke from Bright Photonics who spoke about open source photonic IC design with Nazca 2. Pieter Dumon from Luceda Photonics on regression testing of component libraries and designs 3. Jeff Dralla and Rolf Madsen from Keysight talking about Python Automation for Test & Measurement with TAP 4. Andre Richter and Sergei Mingaleev from VPI Photonics who introduced their Python-based IDE for integrated photonic waveguides and optical fibers. 5. Mikael Mazur from Chalmers University of Technology who talked about his experience of starting with Python and how to control an optical switch. The event again resulted in great discussions about using Python for controlling lab equipment and for photonic design.

Because of the great feedback that we received from these two events we decided that we will hold a hackathon again at OFC 2018. But a lot of feedback that we received also suggested that there is a need for a more permanent resource for using python in the context of photonics, as a place to get advice on how to get started, find events and instructions and howto’s or possibly link to relevant packages. We therefore started the https://python4photons.org website, which we hope to develop into a hub for information on using python aimed photonics researchers. Currently the website contains information about the labautomation hackathons as well as information on how to install python and how to get started in learning python. We are planning to expand the website with more articles about using python in photonics, collections of links to photonics packages. There is also a blog which we aim to update regularly with new posts all around python and photonics.

In conclusion we believe that Python is a great tool for the photonics researcher and that we will see its use grow significantly in the future. If you are a graduate student planning to automate your experiments (and you should do that if you are not already), I seriously recommend considering to use Python. Not only are you using a great tool that is fun to program with a large library of packages for all your needs, you are also developing skills that are extremely useful for a career after your studies, in case you decide not to stay in academia. If you are a more senior researcher, but are unhappy with your current automation tools, do look at Python. In particular if you are working in a non-academic lab moving away from matlab or labview could save you large amounts of money spend on licence fees.
Get to Know your Society Leadership
Leslie Rusch, Board of Governors Elected Member 2016–2018

What is your current professional job?
I am a professor of electrical and computer engineering at Université Laval in Quebec City, Canada. I am also a member of the Center for Optics, Photonics and Lasers there. I teach undergraduate and graduate courses, and have a team of about eight students and postdocs doing research in Optical Communications.

Why photonics? What was your “photonics moment”?
I come to photonics from the communications sector. I began my PhD studies in wireless communications, but always had an interest in the optical side as well. When I graduated I had a few offers, but accepted a position in Canada, where I could join my husband who also had an appointment as an EE professor at Université Laval. Being able to work in the same city as my husband was obviously a big attraction.

I joined a research group with a rich history of experimental work in optical communications. I had some strong mentors who helped me take advantage of that heritage, and create my own experimental research program. I was able to learn from their deep expertise in photonic devices, and bring to the table my background in communications systems.

What I found most exciting with optical communications compared to wireless, was the way optical devices were constantly evolving. Wireless devices are very mature, and innovation is much more likely to focus on digital signal processing. I worked with my colleagues to incorporate their new devices in strategic ways, to create systems adapted to new capabilities. Together we targeted device improvements for particular system requirements. For example, one of my first endeavors was implementing code division multiple access encoders with fiber Bragg gratings developed by Sophie LaRochelle. She joined the university about the same time as I did, and we have been collaborating closely for twenty years now.

What role does a professor in optical communications play?
In two words, our role is teaching and innovating. We teach in classrooms to groups, and we teach graduate students one-on-one in our offices or laboratories. Taking on a graduate student is like taking on an apprentice. We distill all we have learned to guide the student in a very focused topic; but we also instill the capacity to respond to the new problems they will face in their career. This close interaction is for me my most satisfying role.

Innovation is, of course, the research we perform, but it is more than just the technical solutions. It is keeping abreast of trends in the research community, it is seeking funding both from government and Industry by convincing them that our vision has value, and it is gathering the personnel, equipment and collaborations necessary to realize that vision.

What challenges do you face in your role?
The biggest challenge I have is balancing my time with the varied requirements I face. When I interview candidates for a professor position, I warn them that our in-baskets are always full and overflowing. No matter how much you achieve, the pile does not seem to go down. New opportunities and requirements are always appearing. As our resources and experience grows, so do the demands. The great thing about being a professor is that you are your own boss. But sometimes, you can be a really demanding boss.

What specific assets do you bring to the table as a board member?
I am a champion of our field, without being a chauvinist. My background is in communications and that is the expertise I bring to the group. But I am also open to the importance of photonics in a much wider context. Working in the multidisciplinary Center for Optics, Photonics and Lasers has given me a perspective that I can share with the Photonics Society Board of Directors. While I am well established in academia, the research I perform is industrially relevant and I have had prior experience in government and at Intel Labs.

What do you want to accomplish as a board member this year?
I am working with the Technical Affairs Council to create a strategy to maintain the relevance of the Photonic Society to our research community in the long term. Photonics itself continues to morph, as do the applications enabled by new photonic capabilities. As a Society, we must provide the venues (conferences, publications, standards, etc.) that bring together the experts so that magic can happen. Each of our members spends their career innovating and adapting, pushing technology to
meet the goals of industry and of science. We as a Society must do the same.

What aspects of the Photonics community as a whole need to be improved? What are some of the positives?

I believe that our community has the potential to have even greater impact than we now enjoy. I think we can exploit better communications to get our mission known outside our community and to achieve that mission within our community. We are becoming more politically astute, but I believe there is more we can do. The positives are pretty evident: our research results are changing the world, quite literally. I do not think photonics has ever been more relevant than it is today, and the prospects for the future are equally bright.

What about our Society’s mission and work really motivates you?

When I talked about the role of a professor for innovating, the first element I mentioned was staying abreast of trends. I joined the Board because I recognized the importance that the Society had for me in that role. I want to contribute to the Society and ensure that we keep that function active and exceptional.

How would you advise members who want to become more involved in the Society?

There are so many ways that members can contribute. All grassroots efforts to bring new members into the community are important, it is the lifeblood of our organization. That can take the form of the creation of a local chapter, whether at your company or your university. I talked earlier about the importance of the Photonic Society remaining relevant. That requires volunteers to create workshops and special issues that keep our members on top of the latest trends. Having served as a new assistant editor, I know the incredible value of competent reviewers—they provide the peer review for which our Society is renowned. The advancement of knowledge is greatly improved by these reviewers who point out value and whose feedback strengthens research.

Why do you think Members should be involved as Society volunteers? What are the benefits?

Every time I have volunteered for the Society I have learned a great deal, and come away richer for the experience. You are giving your time and expertise, but you are also creating networking opportunities for collaboration or career development. There is tremendous satisfaction in being an active part of an organization that is shaping the future of technology.

Tell us something fun about yourself.

I am from Chicago and a dyed-in-the-wool Cubs fan. Although I haven’t lived in Chicago since 1976, I still flipped out during the pennant and World Series race in 2016. I was so excited, I invited the lab to have pizza the day before game seven of the Series and tried to explain baseball to all the international graduate students. We had a lot fun and learned to sing Go Cubs Go!

“Nick” Cartoon Series by Christopher Doerr
Young Professional Spotlight

Finding Inspiration and Fostering Collaboration: A Conversation with Professor Fatima Toor

With ventures into industry, a national lab, and academia, Professor Fatima Toor has had an incredibly diverse and successful early career. She is now a young leader in the photonics field, being sought for participation in all sorts of societies, institutes, and startups. In speaking with her about all these diverse experiences, one central theme continually emerged: her knack for connecting with inspirational mentors.

Career Profile
Professor Fatima Toor is a Ph.D. in electrical engineering and holds minors in physics and science technology and environmental policy (STEP). In her work at the University of Iowa, she focuses on various aspects of photonics research, including the development of photovoltaics, environmental sensors, and biomedical diagnostics. She has been employed in industry, academia, and a national laboratory. At a glance:

- Started forays into industry early with undergraduate internships at IBM TJ Watson Research Labs
- After obtaining Ph.D., spent 10 months as a postdoctoral researcher at Penn State University and a further 18 months at the National Renewable Energy Laboratory
- From November 2011 to June 2014, advised Innovation 1000 companies on solar technology innovations while working for Lux Research, a technology advisory firm
- In 2014, joined University of Iowa as an Assistant Professor of Electrical and Computer Engineering with joint appointments in the Physics and Astronomy Department, the Informatics Initiative Cluster, and the Optical Science and Technology Center
- Simultaneously, an affiliate member of the University of Iowa Holden Cancer Center—Experimental Therapeutics Program
- Also serves as Vice President of Laser Technology Development at Firefly Photonics, LLC and as an advisor for Advanced Silicon Group—both startup companies

Find Mentors Who Inspire You
Being a woman in a male-dominated field has its share of challenges, to put it mildly. Luckily, it is not entirely uncharted territory at this point, and Professor Toor has had the fortune of connecting with some remarkable women in photonics—and she has made the most of those connections. She has had inspirational female mentors in her undergraduate, graduate, and postdoctoral studies, as well as in her work and research. Like sitting on the shoulders of giants, it has always given her a view of what’s possible: “Having these really successful women in my career has helped a lot in terms of me envisioning, ‘We can do this.’”

Seeing what is possible is a big part of inspiration, and Toor has seen a lot. These women are icons in their field, building and running large research centers, holding influential administrative positions, winning prestigious awards, and making cutting-edge contributions to scientific research. They set a gold standard for both talent and strength of will. As Professor Toor says, “I think having the female role models helps me stay persistent and on the right track without getting discouraged.” And, she is kept on track by their continuous example and support. As truly good mentors do, they continue to advise her, and they remind her of what she can and should do.

It’s important to emphasize, though, that while gender in this field plays a significant role, mentors come in all types, and it’s most important to find the ones who positively influence you. In Professor Toor’s experience, she says, “I’ve had these amazing female mentors and role models, but I must credit some of the male mentors I’ve had as well who have really helped me.” The key is to find people who really care and guide you.

Toor notes, you’re looking for people who say things like this: “Because I care about your career.” That’s exactly the response Toor received when she asked why one of her mentors was going out of his way to help her. “And that was such a wonderful answer.”

Fail Frequently… but Intelligently
Such inspiration is a phenomenal thing, but it is worth little to nothing in the wrong hands. Toor’s are certainly not that. But to appropriately use the guidance received isn’t always such an easy thing; it takes hard work and, more importantly, deliberate thought. It can be a struggle, as in Professor Toor’s case in graduate school. “For the first three years I didn’t have a publication, and I was working really hard.” We all find ourselves in this sort of position at some point, where things just don’t seem to be working no matter how hard we try. What do we do about it?
Well, hard work is foundational and a theme we’ve visited in this article series before. However, it’s half the story. The other half is “work smart.” Hard work is for naught if it isn’t properly directed. That’s a tough lesson to learn, but here it is: “I realized that the long hours don’t actually mean results… you have to be strategic.” Planning, background research, strategic and tactical coordination… these are all integral to successful work.

However, just because everything is well planned, it doesn’t mean it all will go according to that plan. Things don’t work sometimes and failures happen. “That’s part of the process. Every time you fail, you learn something from that failure. Because it hurts, you remember that you did this [one thing] and it’s wrong and this [other approach] is how you fix it. And the more often this process happens, the better.” In other words, it’s in the failures that we learn. So don’t be afraid to fail. Just persevere. “You have to learn from those experiences and keep going.”

That process never stops, and it’s everywhere. Even for Toor, who has been a professor since 2014, it didn’t come without challenges. In looking for her current position, she says, “I did apply to around 20 or 25 universities.” It takes some bravery and strength of character to be in this field.

**Don’t Forget Your Soft Skills**

Speaking of strength of character, it’s one of those more intangible things that we lump into the category of “soft skills.” It’s great, even essential, to have the intellect, knowledge, and technical talent to execute on scientific pursuits. However, those skills alone are not enough. In her current academic career, Professor Toor sees it clearly: “There is no shortage of students with 4.0 GPAs…but if they aren’t willing to work with other people and learn from other people [they won’t be successful].”

The soft skills that are part of our ability to socialize are crucial to success. We’ve touched on this a bit in a previous article, discussing the importance of building a professional network and utilizing conferences and other gatherings to do so. That’s great for making connections for career advancement. But as Professor Toor points out, it’s also crucial for the pure scientific progress as well. A popular adage sums this up well: “Innovation doesn’t happen in a vacuum.” Nowadays, collaborative work is essential to rapid progress. “In the long term, I think that does help the whole group dynamic and the productivity of everybody involved.”

The need for collaboration is particularly prevalent because of the multidisciplinary nature of research today. Professor Toor herself especially embodies this. After all, she seeks to have broad impact in fields as diverse as medicine, energy, environmental sensing, and fundamental science. These actions are a clear echo of her words: “In this day and age multidisciplinary research is key to success.” And that gets to the heart of the matter. “I have realized that real innovation happens when people with different skill sets get together to come up with ideas that would almost be impossible without the contribution from each team member.”

**Photonics Makes a Brilliant Community**

So, we’ve hit on it twice: being connected to people is essential (a) for your network and (b) for your actual work. What’s more, if you don’t include this social aspect, you’re kind of missing out. What are you missing out on, you ask? Well, just Professor Toor’s favorite part of all her different work experiences. “The favorite thing about my jobs have been my colleagues.”

The photonics community is pretty special. Building on that root word, it’s highly specialized, which means it makes for a rather comfortable, close-knit group. At the same time, it’s far-reaching, which makes it very open and inviting. It’s a pretty unique set of characteristics, which is made evident in everything Professor Toor has pointed out to us here.

Let’s leave with this impression of her colleagues that Professor Toor has gained over her fantastic career: “I learn so much from them every day and am inspired by their generosity, patience, and intellect.” That’s a pretty good pitch, particularly because it so succinctly runs true. And with that, I encourage you to engage with your photonics community and us here. We look forward to meeting you.

Connect with the photonics community and join the Photonics Society on Twitter (twitter.com/IEEEPhotonics) and Facebook (Facebook.com/PhotonicsSociety).

**The Highlights**

- Seek out mentorship from people who inspire you, who you can relate to, and who are willing to be personally invested in your success.
- Don’t fear failure, but be smart about it. We learn from mistakes, and we succeed by knowing how to deal with them.
- Develop your soft skills. Collaboration is essential in science today because we get further together than we ever could alone.
- And, take pleasure in the interactions those soft skills interactions bring. The photonics community is filled with wonderful people, so enjoy their company!
IEEE Standards Association Propels Global Technology Innovation Into 2018

World's largest technical professional organization sees record number of standards activities addressing the social, economic and ethical challenges from emerging technologies

As a result of outstanding support and involvement from members, participants and partners, IEEE, the world's largest technical professional organization dedicated to advancing technology for humanity, and the IEEE Standards Association (IEEE-SA) are approaching the end of 2017 with an extraordinary level of activity worldwide in standards development, global partnerships and alliances. The IEEE-SA saw a number of records set in 2017 for new standards projects, approved standards, and new pre-standards initiatives.

Underscoring its mission to foster the development of industry-driven, open standards, the organization promoted 198 Project Authorization Request (PARs) to standards project status, surpassing the previous record set in 2016. It also approved 139 standards, surpassing its previous one-year record of 117 standards approvals, set in 2012.

"The combined efforts of the global IEEE-SA community have truly made this year one for the record books. We're very proud of the accomplishments our dedicated volunteers, members and staff have achieved in 2017, and we offer them our thanks for their hard work," said Forrest D. (Don) Wright, IEEE-SA president. "At December's Standards Association Award Ceremony, numerous volunteers were recognized for their exceptional contributions. As we move toward 2018, we're looking to build on this momentum, while maximizing the benefit of new technology innovation for humanity as a whole."

Addressing challenges arising from emerging technologies and markets was an area of emphasis for IEEE in 2017. Questions encompassing privacy, security, and ethical design in AI, design engineering, robotics, and symbiotic autonomous systems dominated discussions at a global level. The Ethically Aligned Design: A Vision for Prioritizing Human Well-being with Autonomous and Intelligent Systems initiative saw tremendous activity throughout the year, culminating in the release of Version 2 of its Ethically Aligned Design Report on 12 December 2018.

Among IEEE-SA's market-acceleration standardization initiatives is the Industry Connections (IC) program, which serves as an industry incubator for new specifications, and related products and services. In 2017, the IC program saw a 70% growth in the number of activities in the program; current initiatives address opportunities in 3D body processing; automotive; cybersecurity; blockchain applications; healthcare; Internet of Things (IoT); mixed reality; robotics; smart cities; and more.

IEEE-SA also continued to serve as a trusted consensus-builder among key constituencies such as corporations; policymakers; non-governmental organizations (NGOs); and fellow standards development organizations (SDOs). Proactive outreach efforts resulted in an unprecedented number of new collaborations, alliances, and partnerships in Australia; China; Europe, the Middle East, and Africa (EMEA); India; Japan; and Latin America. Additionally, IEEE-SA maintained a meaningful presence at a rising number of professional conferences and technical events, including hosting the IEEE Tech for Humanity series at South by Southwest 2017 (SXSW) in Austin, TX; co-sponsoring the University of Southern California's 11th annual global Body Computing Conference; and taking part in Mobile World Congress (MWC) 2017 in Barcelona, Spain, as well as OSCON 2017. IEEE-SA made progress toward embracing open source activities and shared information about its plans in an open forum on 5 December 2017.

"As we look back on a record year for IEEE-SA activity, I want to personally thank our members and the many other individuals, companies and governments who have contributed to our standards development and related other programs. The IEEE-SA is privileged to have earned your trust and support, and we look forward to continuing our collaborations with you in 2018," said Konstantinos Karachalios, managing director, IEEE-SA.

To learn more about IEEE-SA, visit Facebook, Twitter, LinkedIn and connect via the association's Beyond Standards Blog.
In October 2017, The United States House Committee on Science, Space and Technology Subcommittee on Research and Technology and Subcommittee on Energy held a joint hearing, “American Leadership in Quantum Technology,” featuring testimony from experts including Dr. Christopher Monroe, professor of physics at the University of Maryland and founder and chief scientist at IonQ, Inc., who testified on behalf of the National Photonics Initiative (NPI)—an alliance of top scientific societies uniting industry and academia to raise awareness of photonics.

Dr. Monroe’s testimony addressed the need for a National Quantum Initiative to create the infrastructure—both physical and human capital—needed to move the United States into a leadership position in quantum information technology, a field that will create vast opportunities for job creation, economic growth and betterment of society across areas as diverse as health outcomes and information security. Currently, countries including China, Australia and Canada, as well as the European Union, are heavily investing in major initiatives to advance quantum information science while efforts in the U.S. remain decentralized.

“U.S. leadership in quantum technology will be critical to our national security, and will open new doors for private industry and academia while ensuring America’s role as a global technology leader in the 21st century,” said Monroe. “I appreciate the attention that the House Science Committee is giving to quantum information science, and I thank the Subcommittees on Research and Technology and Energy for allowing me the opportunity to testify today in support of a National Quantum Initiative.”

In a white paper published earlier this year titled, “A Call for a National Quantum Initiative”, the NPI detailed how U.S. investment in a National Quantum Initiative will accelerate the development of commercially available quantum-based technologies to facilitate growth in the U.S. economy and keep pace with accelerating international competition. The initiative would seek to:

- Invest $500 million of new public funding over five years in four “Quantum Innovation Labs.” These will be proving grounds and testbeds for quantum technologies, and will follow the proven model of academia, government and industrial scientists and engineers working collaboratively on shared objectives.
- Define and develop standards for quantum technology elements (e.g. sensors, photonic communication links, quantum memories) and their software interfaces to ensure that quantum technologies can be portable or accessible by authorized users from the cloud.
- Guarantee US leadership in the development and deployment of a new generation of quantum technology which will usher in the next generation of enhanced measurement, communication and data processing.
- Interface with counterparts in the U.S. defense and intelligence communities to ensure the US military and other data-gathering and analysis agencies have access to the most advanced information technologies.
- Provide new opportunities in cybersecurity and communication networks whose security relies on fundamental laws of physics.

“The explosion of worldwide activity in quantum is evidence of the importance the global community is placing on this technology. It is critical for the United States to pay attention to this activity and to invest in this technology,” said NPI Steering Committee Chairman Ed White. “The NPI looks forward to continuing to work with Committee, Congress and the administration to guarantee American leadership in this rapidly growing field.”

Photonics-enabled quantum technologies—based on fundamental particles of nature such as individual atoms and photons—hold great promise to become the computers, networks and sensors of tomorrow. Quantum information science, based on exploiting subtle aspects of quantum physics, can provide greater communication security and enhance navigation, imaging and other sensing technologies in ways that are impossible using binary-based computer systems.

About the NPI
The National Photonics Initiative (NPI) is a collaborative alliance among industry, academia and government seeking to raise awareness of photonics and the impact of photonics on our everyday lives; increase cooperation and coordination among US industry, government and academia to advance photonics-driven fields; and drive US funding and investment in areas of photonics critical to maintaining U.S. economic competitiveness and national security. The initiative is being led by a coalition of scientific societies, including the American Physical Society (APS), the IEEE Photonics Society, the Laser Institute of America (LIA), the Optical Society (OSA) and SPIE, the International Society for Optics and Photonics. For more information, visit www.LightOurFuture.org.

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Single-Photon Detector Can Count to Four

Quantum information scientists teach an old detector a new trick previously believed impossible

By Ken Kingery

DURHAM, N.C.—Engineers have shown that a widely used method of detecting single photons can also count the presence of at least four photons at a time. The researchers say this discovery will unlock new capabilities in physics labs working in quantum information science around the world, while providing easier paths to developing quantum-based technologies.

The study was a collaboration between Duke University, the Ohio State University and industry partner Quantum Opus, and appeared online on December 14 in the journal Optica.

"Experts in the field were trying to do this more than a decade ago, but their back-of-the-envelope calculations concluded it would be impossible," said Daniel Gauthier, a professor of physics at Ohio State who was formerly the chair of physics at Duke. "They went on to do different things and never revisited it. They had it locked in their mind that it wasn’t possible and that it wasn’t worth spending time on."

"When we presented our data, world experts were just blown away," continued Jungsang Kim, professor of electrical and computer engineering at Duke. "It’s neat having a group like ours that got started a bit later decide to try something because we didn’t have any blinders on."

The discovery deals with a new method for using a photon detector called a superconducting nanowire single-photon detector (SNSPD).

At the heart of the detector is a superconducting filament. A superconductor is a special material that can carry an electric current forever with zero losses at low temperatures. But just like a normal piece of copper wire, a superconductor can only carry so much electricity at once.

A SNSPD works by charging a looped segment of superconducting wire with an electric current close to its maximum limit. When a photon passes by, it causes that maximum limit in a small portion of the wire to drop, creating a brief loss of superconductivity. That loss, in turn, causes an electrical signal to mark the presence of the photon.

In the new setup, the researchers pay special attention to the specific shape of the initial spike in the electrical signal, and show that they can get enough detail to correctly count at least four photons traveling together in a packet.

"Photon-number-resolution is very useful for a lot of quantum information/communication and quantum optics experiments, but it’s not an easy task," said Clinton Cahall, an electrical engineering doctoral student at Duke and first author of the paper. "None of the commercial options are based on superconductors, which provide the best performance. And while other laboratories have built superconducting detectors with this ability, they’re rare and lack the ease of our setup as well as its sensitivity in important areas such as counting speed or timing resolution."

For other labs to make use of the discovery, all they would need is a specific type of amplifier for boosting the SNSPD’s tiny electrical signal. The amplifier must work at the same low temperatures as the SNSPD—minus 452 degrees Fahrenheit—to reduce background noise. It also must have wide bandwidth to avoid distorting the signal. Such amplifiers are already commercially available and many labs have them.

The results will allow researchers around the world working in quantum mechanics to immediately gain new abilities with their existing equipment. As one example, the Duke-Ohio State group also recently reported how using the timing of incoming photons in addition to their quantum states could greatly increase the speed of quantum encryption techniques.

The team is now working to optimize their setup to see just how far they can stretch its abilities. They believe with the right electronics and a bit of practice, they could count 10 or even 20 photons at a time. The group has also filed for a patent to create off-the-shelf devices based on their method.

The research was supported by the Office of Naval Research (N00014-13-1-0627) and the National Aeronautics and Space Administration (NNX13AP35A).

Careers and Awards

John Tyndall Award Winner

The John Tyndall Award is presented annually to a single individual who has made outstanding contributions in any area of optical-fiber technology, including optical fibers themselves, the optical components used in fiber systems, as well as transmission systems and networks using fibers. The contributions which the award recognizes should have met the test of time and should have been of proven benefit to science, technology, or society. The contributions may be experimental or theoretical. Established in 1987, this award is jointly sponsored by the IEEE Photonics Society and the The Optical Society (OSA). Nominees need not be members of the sponsoring societies. The Award is endowed by Corning Inc. and consists of a specially commissioned Steuben crystal sculpture, a scroll, and an honorarium. The presentation is made the following year at the Optical Fiber Communication Conference (OFC).

2018 Honoree

For contributions to understanding and advancing the capacity of coherent optical communication systems including advanced modulation formats and spatial multiplexing.

Peter J. Winzer received his Ph.D. from the Vienna University of Technology, where he worked on space-borne lidar and laser communications for the European Space Agency. At Bell Labs since 2000, he has focused on many aspects of fiber-optic communications, including advanced optical modulation, multiplexing, and detection. He has contributed to several high-speed optical transmission records from 100 Gb/s to 1 Tb/s and has been widely promoting spatial multiplexing to overcome the optical networks capacity crunch. He has amply published and patented and is actively involved with the IEEE Photonics Society and the Optical Society (OSA), including service as Program Chair of ECOC 2009, Program/General Chair of OFC 2015/17, and the current Editor-in-Chief of the IEEE/OSA Journal of Lightwave Technology. Dr. Winzer is a Highly Cited Researcher, a Bell Labs Fellow, a Fellow of the IEEE and the OSA, and an elected Member of the US National Academy of Engineering.
IEEE Fellow is a distinction reserved for select IEEE members whose extraordinary accomplishments in any of the IEEE fields of interest are deemed fitting of this prestigious grade elevation. The IEEE Grade of Fellow is conferred by the Board of Directors.

Please join us in congratulating the 16 Photonics Society Members who are included in the Class of 2018.

**Erik Agrell**, Chalmers University of Technology, “for contributions to coding and modulation in optical communications.”

**Glenn Boreman**, University of North Carolina at Charlotte, “for contributions to optical and infrared antenna technologies.”

**Thomas Furness**, University of Washington, “for leadership in virtual and augmented reality.”

**Andrea Galtarossa**, University of Padova, “for contributions to low polarization mode dispersion fibers.”

**Yoshihito Hirano**, Mitsubishi Electric Corporation, “for leadership in the development of 1.5-micron wind sensing lidar.”


**Chee Wee Liu**, National Taiwan University, “for contributions to high-mobility Ge and SiGe MOSFETs.”

**Zhenqiang Ma**, University of Wisconsin, “for contributions to flexible and biodegradable microwave electronics.”

**Hideo Ohno**, Tohoku University, “for contributions to materials and device design for spintronics.”

**Alexei Pilipetskii**, Tyco Telecommunications, “for contributions to transoceanic fiber-optic transmission systems.”

**Paras Prasad**, State University of New York, “for contributions in biophotonics, nanophotonics and novel biomedical technology.”

**Kim Roberts**, Ciena, “for contributions to digital signal processing for coherent optical communication systems.”

**Clint Schow**, University of California, Santa Barbara, “for contributions to high bandwidth optical interconnects.”

**Hong-Bo Sun**, Jinlin University, “for contributions to laser nanofabrication and ultrafast spectroscopy.”

**James Wilkinson**, University of Southampton, “for contributions to integrated photonics.”

**Huikai Xie**, University of Florida, “for contributions to micro-electromechanical optical scanning systems.”
Spotlight on New Editors-in-Chief

José Capmany, Editor-in-Chief of the IEEE Journal of Selected Topics in Quantum Electronics

José Capmany is the new Editor-in-Chief of the IEEE Journal of Selected Topics in Quantum Electronics. Born in Madrid, Spain, he received the Ingeniero de Telecomunicacion degree from the Universidad Politécnica de Madrid (UPM) in 1987 and the Licenciado en Ciencias Físicas in 2009. He holds a PhD in Electrical Engineering from UPM and a PhD in Quantum Physics from the Universidad de Vigo.

Since 1991 he is with the Departamento de Comunicaciones, Universidad Politecnica de Valencia (UPV), where he started the activities on optical communications and photonics, founding the Photonics Research Labs Group (www.prl.upv.es). He was an Associate Professor from 1992 to 1995, and since 1996 he is a Full Professor in Photonics and Optical Communications. He was Vice-Dean of the Telecommunications Engineering Scholle at UPV from 1991 to 1996, and Deputy Head of the Communications Department from 1997 to 2005. From 2005 to 2016, he was the Director of the Research Institute of Telecommunications and Multimedia (iTEAM) at UPV (www.iteam.upv.es). His research activities and interests cover a wide range of subjects related to optical communications including microwave photonics (MWP), integrated optics, optical signal processing, fiber Bragg gratings, and more recently quantum cryptography and quantum-photonic information processing. He has published over 550 papers in international refereed journals and conferences. He was the general chair of the 41st European Conference on Optical Communications (ECOC) held in Valencia in 2015 and of the IEEE International Topical Meeting on Microwave Photonics in 2009. He has been a member of the Technical Program Committees of over 50 international conferences in the field of photonics including ECOC, the Optical Fiber Conference (OFC), the Integrated Optics and Optical Communications Conference (IOOC), CLEO Europe, and the Optoelectronics and Communications Conference (OECC). Professor Capmany is a Fellow of the IEEE, a Fellow of the Optical Society of America (OSA). He has acted as a reviewer for over 30 SCI journals in the field of photonics and telecommunications. He is also a founder and chief innovation officer of the spin-off company VLC Photonics (www.vlc Photonics.com) dedicated to the design of photonic integrated circuits and EPHHOX (www.ephox.com) dedicated to MWP instrumentation.

Professor Capmany is the 2012 King James I Prize Laureate on novel technologies, the highest scientific distinction in Spain, for his outstanding contributions to the field of microwave photonics and in 2016 he was awarded an European Research Council (ERC) Advanced Grant. He is also the recipient of the Extraordinary Doctorate Prize of the Universidad Politécnica de Madrid in 1992. He was a member of the IEEE Photonics Society Board of Governors (2008–10) and a distinguished lecturer for the 2013–14 term, an associate Editor of IEEE Photonics Technology Letters (2010–2016) and the IEEE Journal of Lightwave Technology (2016–2018). He has also been a Guest Editor for the IEEE Journal of Selected Topics in Quantum Electronics, IEEE Transactions of Microwave Theory and Techniques and Optics Express feature issue on microwave photonics.
Jianping Yao, Editor-in-Chief of IEEE Photonics Technology Letters

Jianping Yao (M’99–SM’01–F’12) is the new Editor-in-Chief of IEEE Photonics Technology Letters. He is a Distinguished University Professor and University Research Chair in the School of Electrical Engineering and Computer Science, University of Ottawa, Ottawa, Ontario, Canada. He received the Ph.D. degree in electrical engineering from the Université de Toulon et du Var, France, in December 1997. From 1998 to 2001, he was with the School of Electrical and Electronic Engineering, Nanyang Technological University (NTU), Singapore, as an Assistant Professor. In December 2001, he joined the School of Electrical Engineering and Computer Science, University of Ottawa, as an Assistant Professor, where he became an Associate Professor with tenure in May 2003, and Full Professor in May 2006. He was appointed University Research Chair in Microwave Photonics in 2007. In June 2016, Prof. Yao was conferred the title of Distinguished University Professor of the University of Ottawa. From July 2007 to June 2010 and July 2013 to June 2016, he served as Director of the Ottawa–Carleton Institute for Electrical and Computer Engineering.

Prof. Yao has authored or co-authored over 560 research papers including more than 330 papers in peer-reviewed journals and 230 papers in conference proceedings. Prof. Yao is Editor-in-Chief of IEEE Photonics Technology Letters, an Associate Editor of Science Bulletin, and an Advisory Editorial Board member of Optics Communications. He was a Topical Editor of Optics Letters from 2014 to 2017, and was as a guest editor for a Focus Issue on Microwave Photonics in Optics Express in 2013, a lead-editor for a Feature Issue on Microwave Photonics in Photonics Research in 2014, and a guest editor for a special issue on Microwave Photonics in IEEE/OSA Journal of Lightwave Technology in 2018. Prof. Yao currently serves as the Technical Committee Chair of IEEE MTT-3 Microwave Photonics. Prof. Yao received the 2005 International Creative Research Award of the University of Ottawa. He was the recipient of the 2007 George S. Glinski Award for Excellence in Research. In 2008, he was awarded a Natural Sciences and Engineering Research Council of Canada Discovery Accelerator Supplements Award. He was an IEEE MTT-S Distinguished Microwave Lecturer for 2013–2015.

Prof. Yao is a registered Professional Engineer of Ontario. He is a Fellow of the IEEE, the Optical Society of America (OSA), and the Canadian Academy of Engineering (CAE).
The National Society of Black Physicists (NSBP), collaborative partner of the IEEE Photonics Society and largest organization devoted to the African-American physics community, held their annual meeting for over 300+ attendees in early November 2017 at the Hilton Atlanta and on the campus of Morehouse College in Atlanta, GA, USA, a historically known, African American-led liberal arts college. The Annual Conference brought together a broad range of experts in multiple fields of physics, i.e. astronomy, astrophysics, biophysics, photonics, condensed matter and materials, physics, high energy and more. This conference marked NSBP’s 40th Anniversary and programming throughout celebrated African American pioneers in the field.

The NSBP conference is the largest academic meeting of minority physics students in the United States, with 200+ undergraduates and graduates in attendance, and was co-sponsored by the IEEE Photonics Society, American Physical Society (APS), University of Southern California (USC), Fermi National Accelerator Laboratory (Fermilab) and the United States Department of Energy (DOE). Directly, the IEEE Photonics sponsored several students’ travel and the networking social (dance) on the conference’s final evening.

The annual conference consisted of a “Day of Scientific Lectures” on Saturday. A notable talk was given by Dr. Anthony Johnson, Past IEEE Photonics Society Board of Governors Member and Past NSBP President, on his 40+ years in the field physics and optics, during the National Society of Black Physicists “Day of Scientific Lectures”. Another by Dr. James Gates, who gave a standing ovation talk on his life and career as a black theoretical physicist. From his days growing up on an Army base to MIT to scientific advisor for Obama, he also shared stories about his hero Einstein and how it’s important to find allies from all cultures and backgrounds in the field.

In addition to the Day of Scientific Lectures at Morehouse College, the conference included educational sessions, exhibitions, and interactive networking opportunities. The students then went on to participate in a career fair and poster sessions on cutting edge issues related to current trends in physics and science.

Dr. Arti Agrawal, IEEE Photonics Society Associate Vice-President on Diversity, giving a talk on “Developing Your Personal Networking Style”.

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Dr. Arti Agrawal, IEEE Photonics Society Associate Vice-President of Diversity and Director of Women in Engineering & IT at University Technology Australia, gave a professional development talk on “Developing Your Personal Networking Style”. In this talk, Agrawal explored the connection between a person’s behavioral preferences and how these can be leveraged to build a networking style and skills that suit the individual. It is important to feel comfortable and confident
when networking. She expressed the importance of networking, where best to network and with who to network with. Agrawal’s practical aspects of how to build networking skills reached the undergraduate audience well.

Dr. Yanne Chembo, IEEE Photonics Society Africa Initiative Representative and Research Scientist at GeorgiaTech-CNRS Joint Laboratory, presented on, “Optimizing International Scientific Collaborations.” Chembo discussed with attendees how international scientific collaborations stand at the core of the scholarship spirit. Achieving successful international interactions is of prime importance for both academia and industry. In this talk, the Chembo shared his personal accounts on how to optimize international collaborations, which ignite a career and later support successful encore careers.

The IEEE Photonics Society was also featured in the conference’s “Showcase Alley,” where leaders spoke with undergraduates, graduates and postdocs, about volunteer opportunities within the Society. Over 30 students expressed interest in photonics research and/or are currently pursuing a degree in optics. Others were interested in starting an IEEE chapter, including a joint chapter between Georgia Tech and Morehouse College.

In addition, the IEEE Photonics Society leaders served as “change agents” during the two-day pre-conference workshop, “African American Workforce Development in Physics and Astronomy.” The pre-conference focused on NSF Grant #1663852, issued to the University of Southern California, and included stakeholders from government, academia, industry and nonprofit who strategized about successful intervention strategies to promote workforce development. Such as, what systems the United States has in place to effectively recruit, retain, and provide opportunities for African Americans in physics regarding workforce development, i.e. faculty positions, government agencies, private industry, national laboratories, and are their gaps in these current systems.

Other pre-conference sessions and talks of mention were:

• “Opportunities for Cross-Collaborations”: a session where participants discussed possible educational programming focused on improving the pipeline for African American students in physics. The session showcased the IEEE Photonics Society as a critical stakeholder in providing resources, position power, and leverage in creating solutions and opportunities for African Americans.

• “Panel Discussion with NSBP Students”: the pre-conference included an empowering panel discussion from the NSBP students on challenges they face in navigating their academic and professional careers. From unconscious biases and identifying an ally to finding cultural familiarity in a community that lacks African American mentors.

• Dr. Earnestine Easter, of the United States National Science Foundation’s (NSF), talk on leading the “U.S. Expanding Underrepresented Minority Participation Division” and policy advocating in science.

Annual Afterschool Conference
“Thinking Outside the Box”

IEEE Photonics Society sponsors workshop for teaching light and optics to K-12

In mid-November 2017, the IEEE Photonics Society supported the New Jersey School-Age Care Coalition (NJSACC) on its “Annual Conference for Afterschool”, a conference designed for its statewide network of afterschool communities. As a member of the Afterschool Alliance, a coalition of public, private, and nonprofit groups committed to raising awareness and expanding resources for afterschool programs, the IEEE Photonics Society serves as a technical assistance organization, offering scientific expertise to the coalition’s STEM programs.

The conference theme in 2017 was “Thinking Outside the Box.” At NJSACC events thinking outside the box is more than just a cliché. The organization is dedicated to approaching problems in new and innovative ways and inspiring teachers, instructors and coaches to tackle education in ways never thought of before.

Diane Genco, NJSACC Executive Director, stated, “As educators, we are told to “think outside the box” all the time, but how exactly do we do that? How do we develop the ability to confront problems in ways other than the ways we normally confront problems? How do we cultivate the ability to look at things differently from the way we typically would?” She then emphasized the need for such an annual conference and environment for educators to convene and participate in workshops designed to discover innovative teaching techniques for afterschool play. The Annual Conference for Afterschool included 54 workshops and instructive sessions to choose from.

“Bringing STEM to Light: Teaching About Light and Optics” was one of the STEM workshops featured, twice during the two-day conference. Colette DeHarpporte, Founder of Laser
Colette DeHarpporte, Founder of Laser Classroom, instructing educators that teach STEM to ages 9–13.

Laser Classroom “Bringing STEM to Light: Teaching About Light and Optics” teacher instruction, sponsored by the IEEE Photonics Society, on Day 2 of the NJSACC Annual Afterschool Conference.

Instruction given to Day 1 workshop participants on James Clerk Maxwell and the classical theory of electromagnetic radiation.

A workshop participant displaying a STEM optics activity with one of the light kits donated by the IEEE Photonics Society.

Classroom, led the 2-hour, hands-on instructions by teaching the core disciplines of optics and how light can be fascinating and familiar topic for children. She laid the foundation of teaching this exciting topic to the youngest would-be scientists, through light-based science exercises and lessons.

IEEE Photonics donated two free Laser Classroom kits each to the workshop participants, best suited for teaching ages 9–13. DeHarpporte used the kit to work through understanding the basics of color, shadows, reflection, and refraction. This hands-on workshop offered easy to digest science content designed to build an K–12 educator’s comfort and confidence in teaching optics and photonics. Dr. Sri Priya Sundararajan, Senior Optical Test Development Engineer of Cisco and IEEE Photonics STEM Outreach Rep, also served the workshop by providing examples of the work her Silicon Valley Women in Photonics Section has done to lower the barrier to entry to optical science and encourage more girls of all ages to participate in STEM.

Other workshops of mention that aligned well with IEEE Photonics’ STEM Outreach practices were:

- “Traveling the Career Path”: a workshop that discussed strategies to assist youth in developing lifelong aspirations, making informed choices about careers and identifying career goals through exposure to a wide range of experiences, including STEM.
- “Fostering Family Engagement”: in this workshop instructors provided vital examples, strategies and resources for increasing the level of family engagement in children’s studies.
- “Showcase Alley”: a special 1-day opportunity for nonprofit organizations to promote their outreach offerings to educators and instructors who teach expanded learning afterschool.
The conference, in addition, introduced a series of workshops from Kids Included Together (KIT). Kids Included Together is a center of excellence on disability inclusion. KIT specialize in providing leadership, best practices, training and support to people and organizations who serve children.

This conference renewed a collaboration between the IEEE Photonics Society, Engineering for Kids and Try Engineering.org. Engineering For Kids comes from the mind of educator Dori Roberts. With an extensive educational background in Math and Technology education, Roberts taught Engineering at the high-school level for 11 years. During her teaching career, she saw a dire need for Engineering programs for younger students. To fill this void, she started after-school clubs which participated in various Engineering and Science-based competitions. Later on, these clubs grew into the Engineering For Kids Program.

Today Engineering For Kids has over 160 locations in 36 countries. The IEEE Photonics Society plans to connect its professional chapters with the Engineering For Kids branches in 2018, by providing expert photonics instructors and fun and engaging STEM lessons to prepare students with light based science knowledge of the 21st century. A goal is to better link our local volunteers to after-school programs, summer camps and workshops designed to students interested in STEM, as well as educators and instructors imparting a love for engineering.

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**True Diversity in Action: Diversity in STEM Conference and Día de la Física Reaches 4000+ Chicano, Hispanic and Native American Students**

In October 2017, the IEEE Photonics Society had the privilege of sponsoring and scientifically contributing to the Society for Advancement of Chicanos, Hispanics and Native Americans in Science’s (SACNAS) Diversity in STEM Conference, largest diversity in STEM conference in the United States. This conference installment took place in Salt Lake City, Utah at the Salt Palace Convention Center, in collaboration with the University of Utah. It included three days of cutting-edge science, training, mentoring, and cultural activities for scientists at all levels and disciplines.

Since its inception over 40 years ago, SACNAS has grown to over 25,000 members and partners, all interested in celebrating the unique relationship between science, culture, and community. The IEEE Photonics Society decided to partner with SACNAS as it is ever more committed to providing equal opportunity to scientists and engineers, regardless of ethnicity, race, nationality, religion, gender, age, and/or identity. The Society plans to continually support an environment that reflects the rich diversity of the scientific community.

Both organizations recognize population demographics are changing. As reported by SACNAS, in the United States, for example, it is projected that by 2060 Hispanics will comprise 29% of the population. The Native American population is also growing,
but is consistently overlooked in data, facing severe disparities in terms such as access to education. The STEM workforce isn’t keeping pace as well, with only 6.1% of Hispanics, 4.8% of Black Americans, and 0.2% of Native Americans in science fields.

“A lot of students that come into SACNAS for the first time are first-generation college students. They have a lot of stress and pressure not to go into science,” SACNAS board member and R&D Section Head of Procter & Gamble, Dr. Allyn Kaufmann, said in relation to the conference.

As reported by Science News for Students, an award-winning non-profit, online publication dedicated to providing topical science news, studies also show that Hispanic, Native American and Black college graduates are 40 to 54 percent less likely than Caucasian and Asian men to be interested in faculty positions at research universities. Caucasian and Asian women are 36 percent less likely than their male counterparts to express strong interest, making women even more under-represented in science. The thought is that underrepresented minority researchers might feel they don’t fit in as few of their colleagues may be of the same race or ethnicity.

SACNAS has been working to ensure that those most underrepresented in STEM have the support and community they need to attain advanced degrees, careers, and positions of leadership. As a result, the conference annually consists of: 4000+ undergraduate and graduate attendees; 400 exhibitors (mainly universities recruiting graduate students and PhD candidates); 1000 poster and oral presentations; and 100 professional development sessions. IEEE Photonics was an exhibiting organization and sponsored the Undergraduate Student Poster Competition in Physics.

Professional development session examples included: “The Startup You: Empowering Scientists Through Design Thinking & Innovation Workshop”; “Getting Ready for Advanced Degrees (GRAD) Lab”; Student Presentation Coaching Sessions; “Lasting Impressions—Next Steps Networking Session”; SACNAS Women in STEM; and a “Resume Build Room”.

A like organization, the National Society of Hispanic Physicists (NSHP), has also been making large strides in promoting the professional well-being and recognizing the accomplishments of Hispanic physicists within the scientific community.

While at the SACNAS Diversity in STEM Conference 2017, the IEEE Photonics Society co-sponsored with NSHP and other partners an annual Día de la Física, a field trip workshop to the University of Utah’s Physics and Nanotechnology facilities that over 60 diverse students participated in. The day consisted of tech talks from different physics tracks, such as Helio-physics, Astrophysics and Photonics, as well as facility tours. Dr. Rene Essiambre, of Nokia Bells Labs and IEEE Photonics Vice-President of Membership, represented IEEE Photonics by giving a tech talk titled, “Global Communication Infrastructure: At the Frontier of Nonlinear Optics and Information Theory.”

In addition, IEEE Photonics sponsored (4) under-served women students to attend the SACNAS conference and Dia de la Física and one of the students ultimately won a SACNAS overall poster prize.

IEEE Photonics also participated in an APS “Mentor Self Efficacy Training” to help guide students and mentor relationships amongst members.

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IEEE Photonics Latin America Outreach: OPTOANDINA & Mexico National Meeting of Scientific Outreach

Working effectively in a global society requires learning with an international, diverse perspective and the IEEE Photonics Society understands that diversity is essential to innovation. The Society continues to further diversify the array of individuals and perspectives building the photonics technology and information of tomorrow by leading global outreach strategies in Developing Nations, including those advancing photonics science in Latin America.

Below are two examples of the outreach efforts made by volunteers and staff in Latin America, Region 9.

OPTOANDINA: 3rd Andean School of Optics and Photonics

In November 2017, the IEEE Photonics Society sponsored the OPTOANDINA Conference (3rd Andean School of Optics and Photonics) at the Pontifical Catholic University of Peru (PUCP) in Lima, Peru. OPTOANDINA was designed to be a week-long, theoretical-practical school that focuses on four thematic areas, i.e. Optical Engineering, Lasers & Spectroscopy, Optoelectronic & Photonic Engineering, and Metrology. Speakers from different countries offered tutorial courses in the mornings within the aforementioned themes, including their foundations and applications. Workshops and laboratory practices were held in the afternoon of the conference, in addition to short presentations given by post-graduate students. Twenty speakers were also invited from the US and European countries to help foster international collaboration.

The conference was oriented to undergraduates, postgraduates, and young researchers pursuing photonics science and engineering careers in the Andean Region, a group of nations in South America connected by the Andes mountain range, and Latin America. Main countries of recruitment focus were: Colombia; Venezuela; Ecuador; Peru; Bolivia; Argentina; Argentina; Chile; and Brazil. Although the conference was bilingual, spoke in both Spanish and English, most courses were given in Spanish. OPTOANDINA also included bilingual oral and written report competitions that the IEEE Photonics Society supported financially.

It is worth mentioning that events such as these are generally very scarce and difficult to access in Latin America, but particularly in the Andean region due to the relative low scientific development and lack of technological capacity. During the conference, close interrelation was supported between the speakers and the participants, where there were many opportunities for
one-on-one networking. Organizers motivated students to pursue postgraduate study discussions with mentors and international speakers were encouraged to become more aware of the issues that students face local to the Andean region.

**Mexico National Meeting of Scientific Outreach**

The Mexico National Meeting of Scientific Outreach—ENDC (XXXII Encuentro Nacional de Divulgación Científica) was held at the Colegio Civil Centro Cultural Universitario in Monterrey, Nuevo León, México in late 2017. This is an annual event organized by the Mexican Society of Physics (Sociedad Mexicana de Física) and a rotating host university with the sole purpose of disseminating science. This is carried out through a set of lectures given by experts in the subject, which are aimed at the general public and interactive exhibitions for preschool, primary and secondary school children. The IEEE Photonics Society is in its second year sponsoring, which has increased the general public outreach activities related to Optics and Photonics at this 5-day event series.

The events consisted of conferences for local students divided by ages and three workshops for the general public. The first 2-days were for 4 to 10-year-old students, which included K-5 grades within elementary school. The remaining days were for 11 to 18-year-old students, where a total of 7,500 students attended.

Within the National Meeting, 24 national outreach groups were accepted to participate from 9 Mexican federated states, one from the Universidad de los Andes in Colombia and 7 groups from local state of Nuevo León in México. The activities were diverse, including 14 outreach groups dedicated specifically to topics related to optics, photonics, astronomy or electromagnetism, using waves, lenses, kaleidoscopes, colors, and polarization art. One group even put on a general public play called “Newton y la Luz” (Newton and the Light). In total, 130 students participated as organizers and more than 100 volunteers were involved as staff throughout the week.
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Quantum Networks—A Call for Integrated System Design
What Needs to be Discovered and Invented?

M. Brodsky, V.S. Malinovsky, P. M. Alsing
1U.S. Army Research Laboratory, 2U.S. Air Force Research Laboratory

Quantum information science is a relatively new interdisciplinary area of research that aims at finding powerful functionalities within a new paradigm, wherein logical bits, gates and circuits follow the rules of quantum mechanics. Similarly to classical bits that are realized in hardware as two level systems, their quantum counterpart or qubits are represented by quantum two-level systems. Perhaps two of the most common qubit examples are the polarization of a photon and the half integer spin of an electron. Quantum gates could then be implemented as certain unitary operations on qubits, and several gates acting on a number of qubits could form a circuit. While experimental implementations of quantum circuitry is still in its infancy, the tantalizing hope of novel applications is rooted in inspiring early proposals for powerful quantum computational algorithms and secure quantum communication protocols has given impetus to this promising field.

A part of the wider quantum information science field, the field of quantum communication and networking deals with creation, manipulation, and routing of quantum states from one edge of a network to another. It is worth noting that there are some subtle but inherently fundamental distinctions between quantum and classical networking concepts. First, quantum networks should coherently transport a quantum logical state without knowing what the state is. This is because quantum states exist in superpositions (e.g., here of its logical zero and one), and this superposition has to be preserved during transport. Such a task could be achieved with the teleportation protocol, which requires two end nodes to act in accord with each other or, in other words, to be entangled. Mere operation of the teleportation-based network itself necessitates the distribution of quantum entanglement between remote nodes. Second, the network topology becomes dynamic. Since any two entangled nodes are logical “nearest neighbors,” as entanglement is being established in the course of the network operation the network layer topology varies, and could change dramatically, while the physical layer connectivity remains the same. Finally, the quantum entanglement could in theory encompass any number of network nodes, rather than just two, thus adding to the network complexity.

The contrasting dissimilarity of the quantum with the classical networking concepts is believed to impart an enormous potential for unforeseen algorithms, protocols and powerful functionalities. Indeed, a number of nontrivial quantum network applications have been described theoretically in recent years. To name just a few—long-baseline interferometers, power grid security, quantum games/negotiations, blind quantum computing, voting protocols, distributed computing protocols, quantum secret sharing, quantum digital signatures, symmetric private database information retrieval, and quantum random walks. It remains to be seen if it will be any of these application eventually reach the level of commercial offerings in the years to come. However, the depth, richness and complexity of the underlying concepts guarantee that new ideas could be generated in abundance. There are still fundamentals that need to be understood, but to ensure continued progress in the field, a number of critical technological developments need to be made. Those will allow scientists and engineers to assemble the first testbeds and small-scale networks, and to initiate experimental efforts in this quantum networking field. The need for technological breakthroughs, enabling solutions and other necessary developments, were discussed during the IEEE Photonic Society Summer Topical Meeting on Quantum Networks in July 2017.

The IEEE Photonic Society traditionally holds summer topical meetings in July each year. These meetings address emerging research areas that are of importance to the Photonics Society. One of the topical meetings held in July 2017 was focused on quantum networks. This topical meeting was proposed and co-chaired by scientists from the Army and Air Force Research Laboratories who recently ramped up their efforts in the field within the framework of the Army Quantum Networks programs and the Tri-service DoD Research Laboratories’ Quantum Science and Engineering Program. During two and a half days, about 40 experts in the field discussed a wide scope of topics including novel applications and functionalities of quantum networks; architectures and protocols for a distributed quantum network comprising multiple quantum nodes; high-capacity quantum channels including those utilizing higher-dimensional alphabets and hyper-entanglement; entanglement creation, manipulation and distribution to remote nodes; studies of physical mechanisms of entanglement decoherence; quantum nodes and quantum memories based on neutral atoms, ions, and vacancy-centers in novel materials, as well as the interfaces between them.

The conference culminated with a breakout session, in which the status, technological needs and future directions for the field were discussed. The topical chairs put together three roundtable groups. The Quantum Network Layer group was led by Prem Kumar (Northwestern University) and Nicholas Peters (Oak Ridge National Laboratory); the Quantum Photonic Transport Layer group was led Andrew Weiner (Purdue University) and Michael Raymer (University of Oregon); Peter Reynolds (Army Research Office) and William Munro (NTT) led the Quantum Nodes group. The individual groups’ conclusions...
and recommendations had a large degree of overlap, and so they are summarized below as a single list. In July 2018 the IEEE Photonic Society will hold another Summer Topical Meeting on Quantum Networks, where these points will be addressed again and further focused and refined.

Nework Layer—Integration
Priority should be given to system-level research that aims at interconnecting the available hardware, characterizing its existing functionalities, and exploring how growing the system with newly developed components opens ways to new and unanticipated algorithms, protocols and end-user applications.

Overall optimization of each particular technology with respect to all pertinent parameters, such as the longest storage time, the fastest gate operations, the widest frequency and time bandwidth might be too challenging. Therefore, the system-level integration should permit the use of the quantum networks components with the best characteristics but in implemented different platforms.

Cross-platform integration might require new fundamental understanding to be developed. First, understanding of the relevant network metrics and resulting “cost vs performance” analysis will become important. Second, the hybridized networks might benefit from new measurement paradigms, such as weak measurements and POVM.

Photonics Transport Layer—Enabling Components and Technologies
System-level experimentation could benefit from technological advances in the device and component plane, such as miniaturization of the deterministic single-photon sources, entangled photon pair sources, high-efficiency multipartite entanglement sources, heralded sources, on-chip single-photon detectors, Bell-state measurement units; and on-chip integration of all these devices together with waveguides and an electronic back plane for control and characterization.

Other enablers will include development of nonlinear optical interaction at a few-photon level, e.g. making a photonic CNOT possible; and invention of new time-frequency technologies to explore extremely wide photonic bandwidth and time duration for entanglement manipulation, characterization and measurements. Last but not least is the development of spatial and temporal mode conversion technologies.

Nodes– Fabric and Structure
The general goal for quantum memories is to maximize storage time and achieve high readout quantum-state fidelity. Currently none of the various platforms being investigated (atoms, ions, solids) are the declared winner in the storage contest, and so further investigations need to be continued in parallel, and should also include demonstrations of single-photon operation.

On-chip miniaturization and room-temperature operation would align well with the network integration objectives. Indeed, by combining a storage ion with an optical readout ion on the same platform, one would demonstrate creation of elementary storage/communication modules that, in turn, makes quantum repeater nodes feasible. Finally, practical and easy-to-operate tunable cavities, serving as interconnects between memories and photonics, need to be developed.
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9 - 11 February
2018 3rd International Conference on Microwave and Photonics
Dhanbad, India
www.icmap2018.org

**ICP**
9 - 11 April
2018 IEEE 7th International Conference on Photonics
Langkawi, Malaysia
http://www.aconf.org

**ICLO**
4 - 8 June
2018 International Conference Laser Optics
St. Petersburg, Russia
http://www.laseroptics.ru

**PVSC**
10 - 15 June
2018 45th Photovoltaic Specialists Conference
Waikoloa Village, Hawaii
www.wcpec7.org

**OECC**
2 - 6 July
2018 23rd Opto-Electronics and Communications Conference
Seogwipo City, Korea (South)
http://www.oecc2018.org

**ICCE**
18 - 20 July
2018 IEEE Seventh International Conference on Communications and Electronics
Hue City, Vietnam
http://www.icce-2018.org

**OMN**
29 July - 2 August
2018 International Conference on Optical MEMS and Nanophotonics
Lausanne, Switzerland
http://omn2018.epfl.ch
5G is the next generation wireless network technology that is expected to significantly increase data speeds, produce ultra-low latency times, support the connection of many more devices, and increase energy efficiency of the network elements. It is obvious that for 5G to be successfully implemented it will need significant contributions and innovations from the photonics technology community. Whether it be creating the appropriate transport infrastructure with the necessary high capacity, the relevant x-hauling architectures or even utilizing microwave photonics devices and topologies to distribute the wireless signals. There is no doubt photonic technology will play an important role in 5G. This special issue of the Journal of Lightwave Technology covers all topics in the field of photonics related to the implementation of 5G.

The scope includes:

- 5G network architecture
- 5G standardization,
- Mm-wave and THz wireless
- Digital/analog radio over fiber (RoF) systems
- Integrated microwave photonics technology
- Radio-optical digital signal processing such as MIMO
- Channel equalization
- Multi-RAT networking and related research fields

This will be an open call for papers, in addition to paper solicitation at the 2017 Summer Topicals Meeting which took place 10-12 July 2017. The meeting included workshops on hot topics in this area.

On behalf of the Guest Editors and the Editor-in-Chief, we encourage you to submit your paper to the journal. Typically, these papers 18 pages for the tutorial reviews, 10 pages for invited papers, and 7 pages for the regular papers. Mandatory page charges of $260USD per page are enforced in excess of 7 pages. This paper would appear in an upcoming JLT special issue titled “5G 2019” Target May/June 2019 May issue with accepted papers posted online within 1 week of author final file upload.

Guest Editors: Dr Rod Waterhouse, (Pharad LLC, USA); Professor Thas Nirmalathas, (The University of Melbourne, Australia); Professor A. Stöhr, (Universitat Duisburg-Essen, Germany)

Submissions by website only: http://mc.manuscriptcentral.com/jlt-ieee
Manuscript Type: "5G 2019"
Submission questions: Doug Hargis, Journal of Lightwave Technology d.hargis@ieee.org
Call for Papers

Announcing an Issue of the IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS on Biophotonics

Submission Deadline: April 1, 2018
Hard Copy Publication: January/February 2019

The IEEE Journal of Selected Topics in Quantum Electronics (JSTQE) invites manuscript submissions in Biophotonics. The emerging field of Biophotonics has opened up new horizons for extensive transfer of applicable state-of-the-art technologies coming from the area of quantum electronics, lasers and electro-optics to the life sciences and medicine. Recently developed innovative biophotonics technologies impose significant impact on biomedical research and public health, since they provide advanced minimally invasive, cost-effective and rapid techniques for precise diagnostics, monitoring and treatment of a variety of diseases. The IEEE Journal of Selected Topics in Quantum Electronics invites manuscript submissions in the area of Biophotonics. The purpose of this issue of JSTQE is to highlight the recent progress and trends in developing leading-edge biophotonics technologies. Areas of interest include (but are not limited to):

Advanced biophotonics diagnostic methods and systems
- Ultrahigh-resolution biophotonics imaging including cellular/intracellular, molecular, 3D endoscopic, translational clinical, photoacoustic, photothermal, diffuse, phase-sensitive, OCT, confocal, computational microscopic and multi-photon in-vivo bioimaging
- Spectroscopy-based diagnostics including fluorescence, Raman, elastic scattering, evanescence-wave, near-/mid-IR spectroscopy
- Novel biophotonics sensing techniques
- Multi-modal biophotonics diagnostics

Progress in minimally-invasive biophotonics therapeutic techniques
- Precise laser tissue manipulation in ophthalmology, dentistry, dermatology, cardiology, neurosurgery, photodynamic cancer therapy
- Novel photobiomodulation therapy techniques and dominant light-tissue-interaction mechanisms at cellular/intracellular level
- Light-assisted nerve and neuron-growth stimulation, cellular/tissue repair, optical and laser radiation safety dosimetry

Development of novel laser, fiber-optic and electro-optic biophotonics tools and devices

The Primary Guest Editor for this issue is Ilko Ilev, U.S. Food and Drug Administration, USA. The Guest Editors are: Vadim Backman, Northwestern University, USA; Irene Georgakoudi, Tufts University, USA; Yuji Matsuura, Tohoku University, Japan; William Calhoun, U.S. Food and Drug Administration, USA; and Thomas Huser, University of Bielefeld, Germany.

The deadline for submission of manuscripts is April 1, 2018. Hardcopy publication of the issue is scheduled for January/February 2019.

Unedited preprints of accepted manuscripts are normally posted online on IEEE Xplore within 1 week of the final files being uploaded by the author(s) on ScholarOne Manuscripts. Posted preprints have digital object identifiers (DOIs) assigned to them and are fully citable. Once available, the preprints are replaced by final copy-edited and XML-tagged versions of manuscripts on IEEE Xplore. This usually occurs well before the hardcopy publication date. These final versions have article numbers assigned to them to accelerate the online publication; the same article numbers are used for the print versions of JSTQE.

For inquiries, please contact:
IEEE Photonics Society JSTQE Editorial Office - Chin Tan Lutz (Phone: 732-465-5813, Email: c.tanlutz@ieee.org)

The following documents located at http://mc.manuscriptcentral.com/jstqe-pho are required during the mandatory online submission.

1) PDF or MS Word manuscript (double column format, up to 12 pages for an invited paper, up to 8 pages for a contributed paper). Manuscripts over the standard page limit will have an overlength charge of $220.00 per page imposed. Biographies of all authors are mandatory, photographs are optional. See the Tools for Authors link: www.ieee.org/web/publications/authors/transjnl/index.html.

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Announcing an Issue of the IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS on Nanobiophotonics

Submission Deadline: June 1, 2018
Hard Copy Publication: March/April 2019

The IEEE Journal of Selected Topics in Quantum Electronics (JSTQE) invites manuscript submissions in Nanobiophotonics. Nanobiophotonics is an advanced field of modern science and biomedical nanotechnology. It has been leading recently to the development of innovative nanotechnologies that provide noninvasive optical imaging, sensing, precise diagnostics and therapeutics at cellular, intracellular and molecular levels with an unprecedented ultrahigh resolution beyond the diffraction barrier in the sub-wavelength nanoscale range (below 100 nm). The IEEE Journal of Selected Topics in Quantum Electronics (JSTQE) invites manuscript submissions in the area of Nanobiophotonics. The purpose of this issue of JSTQE is to highlight the recent progress and trends in developing of leading-edge nanobiophotonics technologies. Areas of interest include (but not limited to):

- Novel approaches in ultrahigh-resolution nanoimaging and nanoscopy beyond the diffraction limit in the nanoscale range
- In-vivo cellular/intracellular nanobiophotonics imaging and sensing
- Single molecule spectroscopy and imaging
- Plasmonic, quantum-dot and nanoparticle biosensor probes
- Nanoparticle-enhanced optical diagnostics, therapeutics and theranostics
- Advanced cancer nanobiophotonics
- Nonlinear ultrahigh-resolution imaging and diagnostics
- Optical manipulation of nanoparticles
- Monitoring biomolecular interactions, structures, and functions on the nanoscale
- Novel nanobiomaterials engineered for nanobiophotonics applications
- Noninvasive biophotonics methods for characterizing nanobiomaterials
- Biocompatibility and phototoxicity of novel nanobiomaterials

The Primary Guest Editor for this issue is Ilko Ilev, U.S. Food and Drug Administration, USA. The Guest Editors are: Yu Chen, University of Maryland, USA; Filibert Bartoli, Lehigh University, USA; Gabriel Popescu, University of Illinois at Urbana-Champaign, USA; Kishan Dholakia, University of St Andrews, United Kingdom; Andrew Fales, U.S. Food and Drug Administration, USA; and Niko Hildebrandt, Université Paris-Sud, France.

The deadline for submission of manuscripts is June 1, 2018. Hardcopy publication of the issue is scheduled for March/April 2019.

Unedited preprints of accepted manuscripts are normally posted online on IEEE Xplore within 1 week of the final files being uploaded by the author(s) on ScholarOne Manuscripts. Posted preprints have digital object identifiers (DOIs) assigned to them and are fully citable. Once available, the preprints are replaced by final copy-edited and XML-tagged versions of manuscripts on IEEE Xplore. This usually occurs well before the hardcopy publication date. These final versions have article numbers assigned to them to accelerate the online publication; the same article numbers are used for the print versions of JSTQE.

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Announcing an Issue of the IEEE Journal of Selected Topics in Quantum Electronics on Metamaterial Photonics and Integration

Submission Deadline: August 1, 2018
Hard Copy Publication: May/June 2019

The IEEE Journal of Selected Topics in Quantum Electronics (JSTQE) invites manuscript submissions in the area of Metamaterial Photonics and Integration. The purpose of this issue of JSTQE is to highlight the recent progress and trends in nanostructured engineered optical material, with an emphasis on integrated photonic structures. The topic generally encompasses controlling flow of light in optical materials with properties engineered at subwavelength scale. Much of exciting progress has been made in this area, including optical metamaterials, subwavelength grating engineering in integrated optics, metamaterial photonics, plasmonic structures, high-index-contrast gratings, and resonant and holographic metasurfaces, to name a few. The novel properties found in these structures, coupled with ability to control these properties with unprecedented precision through advanced fabrication techniques, has opened fundamentally new prospects for manipulating light at subwavelength scale. Specific areas of interest include (but not limited to):

- Subwavelength structured effective media and metamaterials.
- Subwavelength refractive index and dispersion engineering in guided-wave optics.
- Subwavelength patterning of optical surfaces. Antireflective gratings.
- Near-zero index and negative-refractive index structures for integrated optics.
- High-index-contrast gratings, guided mode resonance devices and metastructures.
- Subwavelength gratings and metamaterials for integrated photonics and plasmonics.
- Subwavelength engineered nano photonic structures for photonic integrated circuits.
- Resonant and holographic optical metasurfaces. Broadband achromatic metasurfaces, collimators and lenses.
- Photonic nanostructures for light harvesting and manipulation.
- Highly birefringent photonic structures and chiral media.
- Advanced nano-fabrication technologies for meta-structures.

The Primary Guest Editor for this issue is Pavel Cheben, National Research Council, Canada. The Guest Editors are: Pierre Berini, University of Ottawa, Canada; Daoxin Dai, Zhejiang University, China; Iñigo Molina Fernández, University of Malaga, Spain; Laurent Vivien, CNRS, University Paris Sud and Paris Saclay, France; and David R. Smith, Duke University, USA.

The deadline for submission of manuscripts is August 1, 2018. Hardcopy publication of the issue is scheduled for May/June 2019.

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February 2018
Preliminary Call for Papers

Announcing an Issue of the IEEE
JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS on
Ultrafast Science and Technology

Submission Deadline: October 1, 2018
Hard Copy Publication: July/August 2019

The IEEE Journal of Selected Topics in Quantum Electronics (JSTQE) invites manuscript submissions in the area of **Ultrafast Science and Technology**. The purpose of this issue of JSTQE is to highlight the recent progress and trends in ultrafast science and technology with an emphasis on ultrafast optics. The topic generally encompasses the generation, manipulation, characterization, and use of ultrashort pulses. Much exciting progress has been made in all of these areas, including novel developments enabling new applications in spectroscopy and imaging, biomedical applications, materials processing, and research. Specific areas of interest include (but not limited to):

- Generation of ultrashort optical pulses from lasers
- Parametric oscillators and amplifiers of ultrashort pulses
- Ultrahigh peak-power laser systems and related technologies
- High harmonic and attosecond pulse generation technology and science
- Novel methods for shaping and measuring ultrashort pulses
- Few-cycle pulses, carrier-envelope phase
- Ultrashort x-ray pulses; generation, characterization, and synchronization of XFELs
- Ultrafast laser applications that drive technology advancements and innovation
- Pulse synthesis

The Primary Guest Editor for this issue is **Sterling Backus**, KMLabs, Inc., USA. The Guest Editors are: **Daniel J. Kane**, Mesaphotonics, LLC, USA;

The deadline for submission of manuscripts is **October 1, 2018**. Hardcopy publication of the issue is scheduled for **July/August 2019**.

Unedited preprints of accepted manuscripts are normally posted online on IEEE Xplore within 1 week of the final files being uploaded by the author(s) on ScholarOne Manuscripts. Posted preprints have digital object identifiers (DOIs) assigned to them and are fully citable. Once available, the preprints are replaced by final copy-edited and XML-tagged versions of manuscripts on IEEE Xplore. This usually occurs well before the hardcopy publication date. These final versions have article numbers assigned to them to accelerate the online publication; the same article numbers are used for the print versions of JSTQE.

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Preliminary Call for Papers

Announcing an Issue of the IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS on Foundry-Enabled Photonic Integrated Circuits

Submission Deadline: December 1, 2018
Hard Copy Publication: Sept/Oct 2019

The IEEE Journal of Selected Topics in Quantum Electronics (JSTQE) invites manuscript submissions in the area of Foundry-Enabled Photonic Integrated Circuits. The purpose of this issue of JSTQE is to highlight the recent progress and trends in foundries and associated technologies to develop volume manufacturing of photonic integrated circuits. As integrated photonics technology matures and potential market demands increase, foundries become critical for volume production. In recent years the developments in the offerings of foundry services and multi-project wafer (MPW) runs, in both silicon and InP based material systems, enable a path toward volume production of photonic integrated circuits. Fabrication in the foundry environment will also lead to more highly integrated circuits, performance improvements and lower cost.

Specific areas of interest include (but not limited to):

- Topic 1 Electronic Photonic Integration
- Topic 2 Integration of photonics in standard CMOS technology nodes
- Topic 3 Interposer platforms and die attach
- Topic 4 Photonic circuit design for volume manufacture
- Topic 5 Test for volume manufacture
- Topic 6 Wafer level package
- Topic 7 Cost models
- Topic 8 Foundry models for custom, low-volume manufacturing

The Primary Guest Editor for this issue is Madeleine Glick, MIT, USA. The Guest Editors are: Paul Juodawlkis, MIT-Lincoln Laboratories, USA;

The deadline for submission of manuscripts is December 1, 2018. Hardcopy publication of the issue is scheduled for September/October 2019.

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- Create new volunteer opportunities, local affinity groups and recognition programs to empower women members.
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Advertiser . . . . . . . . . . . . . Page #
Albis . . . . . . . . . . . . . . . . . . . . . . . . . . . 18
General Photonics . . . . . . . . . . . . Cover 2
Light in Motion . . . . . . . . . . . . . . . . . . . 10
Optiwave . . . . . . . . . . . . . . . . . . . . . . . Cover 4
Santec . . . . . . . . . . . . . . . . . . . . . . Cover 3

Photonics Society Mission Statement
Photonics Society shall advance the interests of its members and the laser, optoelectronics, and photonics professional community by:
• providing opportunities for information exchange, continuing education, and professional growth;
• publishing journals, sponsoring conferences, and supporting local chapter and student activities;
• formally recognizing the professional contributions of members;
• representing the laser, optoelectronics, and photonics community and serving as its advocate within the IEEE, the broader scientific and technical community, and society at large.

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Photonics Society Field of Interest
The Society’s Field of Interest is lasers, optical and photonic devices, optical fibers, and associated lightwave technology and their systems and applications. The society is concerned with transforming the science of materials, optical phenomena, and quantum electronic devices into the design, development, and manufacture of photonic technologies. The Society promotes and cooperates in the educational and technical activities which contribute to the useful expansion of the field of quantum opto-electronics and applications.

The Society shall aid in promoting close cooperation with other IEEE societies and councils in the form of joint publications, sponsorships of meetings, and other forms of information exchange. Appropriate cooperative efforts will also be undertaken with non-IEEE societies.

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