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Program updates and changes may be found on the Conference Program Update Sheet distributed in the attendee registration bags. Check the Conference App for regular updates.

OSA and APS/DLS thank the following sponsors for their generous support of this meeting:

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THORLABS

Conference Schedule-at-a-Glance

Note: Dates and times are subject to change. Check the conference app for regular updates. All times reflect eastern time zone.

	Sunday 16 September	Monday 17 September	Tuesday 18 September	Wednesday 19 September	Thursday 20 September
GENERAL					
Registration	16:00–19:00	07:00–17:30	07:00–18:00	07:30–18:00	07:30–11:00
Speaker Preparation Room	16:00–19:00	07:00–17:30	07:00–17:30	07:30–17:30	07:30–11:00
Coffee Breaks		10:00–10:30 16:00–16:30	09:30–10:00 13:30-14:00	10:00–10:30 13:30-14:00	10:00–10:30
PROGRAMMING					
Technical Sessions		08:00–16:00	15:00–18:15	08:00–18:00	08:00–12:30
Visionary Speakers		08:30–11:15		09:15–10:00	09:15–10:00
LS Symposium on Undergraduate Research		12:00–18:00			
Plenary Session			08:00–09:30		
Postdeadline Paper Sessions				19:00–21:00	
SCIENCE & INDUSTRY SHOWCASE		09:30–15:00	10:00–15:00		
Science & Industry Theater Programming, See page 11 for complete schedule.		10:00–15:00	10:15–15:00		
Poster Sessions and DynamicE–Posters			10:00–12:00 13:00–15:00	10:00–12:00 13:00–15:00	
OIDA VIP Industry Leaders Networking Speed Meeting Lunch				12:00–13:00	
SPECIAL EVENTS					
Women of Light, a Special Program for Women in Optics	08:00–16:00				
OSA Technical Group Events		12:30–13:30 16:00–19:00			
Meet OSA's Journal Editors		16:00–17:00			
DLS Annual Business Meeting		16:00–17:00			
Career Development Programming		16:00–18:30			
Unconscious Bias Workshop		18:00–19:00			
Awards Ceremony & Reception		18:00–21:00			
OSA Annual Business Meeting			17:30–18:15		
Conference Reception			18:30–20:30		
OSA Family and Friends Tour				10:00–12:00	
Meet the *Physical Review Journal* Editors Reception				15:30–17:00	
Capitol Hill Visits					10:00–16:00

Welcome to FiO + LS 2018

Whether you are in an autonomous vehicle looking to avoid collisions with nearby objects or rambling in a wonderland with a virtual reality/augmented vision device, the Frontiers in Optics + Laser Science APS/DLS (FIO + LS) offers something for you. We are pleased to welcome you to Washington, D.C., the home of The Optical Society and The American Physical Society - Division of Laser Science.

This year's conference experience continues to be thoughtfully revised — taking the best of the past and adding vital, innovative elements. The result is a conference with invaluable opportunities to learn from and meet with your peers and colleagues. On behalf of the FiO Subcommittee Chairs, we would like to thank our colleagues from the Division of Laser Science (DLS) of the American Physical Society (APS) for assisting in cultivating joint topics and sessions that will greatly enhance the experience of the attendees at FiO + LS 2018.

The world-class technical program features more than 75 invited speakers, 200 contributed talks and almost 500 poster presentations by celebrated members of the community describing some of the most exciting advances in their fields.

As technology advances at an ever-increasing pace, the potential applications for optics continue to grow and bring us closer to the edge of amazing discovery and stunning technology. Our plenary speakers, Heike E. Riel from IBM Research Frontiers Institute will share her research activities in the field of information technology and present the new paradigms of cognitive hardware technologies and quantum computing and Gerard Mourou from École Polytechnique will discuss the development of petawatt laser pulse compression and the generation of a single-cycled X-ray pulse leading to exawatt and zeptosecond science and technology. In addition, seven Visionary Speakers who have been paired with four themes will join to share their visions on the cutting-edge advances in the four dimensions: Automotive, Nanophotonics and Plasmonics, Quantum Technologies, and Virtual Reality and Augmented Vision.

While at FiO + LS, we encourage you to visit the Science & Industry Showcase. The FiO exhibition transforms into The Science & Industry Showcase – in which exhibiting companies are partnered with innovative demonstrations, networking events, poster presentations, e-posters and rapid-fire oral presentations. This year we have added additional programing in the theater. Take the time to learn about new products, find technical and business solutions and gain the most up-to-date market perspective of your industry.

Again, we welcome you to FiO + LS 2018 and encourage you to enjoy the dynamic programming incorporated into the next few days ahead.

With best regards,
Christoph Harder and Wei Lee

Christoph Harder
FiO General Chair
Swissphotonics, Switzerland

Wei Lee
FiO General Chair
National Chaio Tung University, Taiwan

Welcome to Laser Science 2018

The leadership of the Division of Laser Science (DLS) of the American Physical Society (APS) is pleased to welcome you to our 34th annual meeting, Laser Science (LS) 2018, in Washington, D.C. We are grateful for the help of our colleagues and technical program organizers, Peter Delfyett and Nathan Newbury, in organizing a broad range of topics in physics and chemistry. This year's program includes many of the areas at the forefront of laser science that are customarily found at the annual DLS meeting. We have collaborated with our colleagues at The Optical Society to coordinate schedules to encourage your intellectual wanderings between DLS and OSA sessions.

In addition to an outstanding technical program with over 50 Laser Science presentations, there are many exciting special Visionary Speakers and events scheduled for the meeting this year. Special attention is appropriate for the Symposium on Undergraduate Research on Monday, which showcases the work of some of our youngest scientists. The Symposium will feature a special poster session to present the work of undergraduate researchers.

The technical sessions for the Laser Science meeting are organized around several broad themes: Quantum Science; Extreme Laser Science; Nanophotonics and Plasmonics; and Precision Spectroscopy.

We welcome you to the Laser Science 2018 Meeting and encourage you to take full advantage of this year's technical sessions, visionary and plenary talks, as well as the Science & Industry Showcase featuring leading suppliers to the laser science community, Rapid-fire Oral Presentations and Poster Sessions including e-posters.

Enjoy!
Peter and Nate

Peter Delfyett
LS Chair
University of Central Florida, USA

Nathan Newbury
LS Chair
National Institute of Standards & Technology, USA

General Information

Registration

Terrace Level Foyer

Sunday, 16 September	16:00–19:00
Monday, 17 September	07:00–17:30
Tuesday, 18 September	07:00–18:00
Wednesday, 19 September	07:30–18:00
Thursday, 20 September	07:30–11:00

Speaker Preparation Room

Albright

Presenters are encouraged to stop by the Speaker Preparation Room during registration hours to test their presentations prior to their session. The room will be equipped with laptops, LCD projectors, and screens.

Media Room

Convention Office on Concourse Level

A staffed media room is available for credentialed members of the media. Badges for pre-registered reporters and reporter registration are in the media room along with media kits, internet connectivity, printers, a quiet work space, and conference information.

Monday, 17 September	12:00–17:00
Tuesday, 18 September	08:00–17:00
Wednesday, 19 September	08:00–17:00
Thursday, 20 September	08:00–12:00

WiFi Access Instructions

To access the complimentary WiFi services during the FiO + LS Conference, please use the following login information.

SSID: FIOLS2018
Password: FIOLS2018

First Aid and Emergency Information

In the event of an emergency at the Washington Hilton, please dial #60 from any courtesy phone. If you happen to dial 911 on your own, please call #60 as well to inform the hotel about the emergency.

Lost and Found

For lost and found please check first at the conference registration desk. Please put your name on all conference materials (including your Conference Program), as they will only be replaced for a fee.

Special Needs

If you have a disability and require special accommodations to fully participate in this conference, please contact Conference Management at the registration desk. Your specific needs will be addressed.

OSA Code of Conduct

It is the policy of The Optical Society that all forms of discrimination and harassment, sexual or otherwise, are prohibited in any OSA or OSA-managed events or activities. All Conference guests, attendees, and exhibitors are subject to OSA's Code of Conduct policy, the full text of which is available at www.osa.org/codeofconduct. Conference management reserves the right to take any and all appropriate actions to enforce the Code of Conduct, up to and including ejecting from the Conference individuals who fail to comply with the policy.

OSA CAM Lounge

Boundary

We're Celebrating All Members (CAM) with quick interviews that highlight you! All OSA members are invited to stop by the CAM Lounge to be filmed talking about what inspired them to pursue their current work, and what excites them most about what they do. The collection of these short videos will be featured on OSA's website, social media, and at various conferences.

Monday, 17 September	08:00-17:00
Tuesday, 18 September	08:00–17:00
Wednesday, 19 September	08:00–17:00

APS Booth

Science & Industry Showcase, Booth #205

Founded in 1899, the American Physical Society (APS) is a non-profit membership organization working to advance and diffuse the knowledge of physics. APS publishes the world's most widely read physics research and review journals: *Physical Review Letters, Physical Review X, Reviews of Modern Physics, Physical Review A-E, Physical Review Accelerators and Beams, Physical Review Applied, Physical Review Fluids, Physical Review Materials, Physical Review Physics Education Research, and Physics.* Please stop by our table near Registration to learn more about the prestigious *Physical Review* collection and our newest journal *Physical Review Materials*, a new broad-scope international journal for the multidisciplinary community engaged in materials research.

Conference Materials

Access Technical Digest Papers

Technical attendees have FREE continuous online access to the FiO + LS 2018 technical digest including Postdeadline papers. These 1 or 2-page summaries of invited and accepted contributed papers can be downloaded individually or by downloading daily .zip files. (.zip files are available for 60 days.)

1. Visit the conference website at http://www.frontiersinoptics.com
2. Select the "Access Digest Papers" link on the right side of the web page
3. Log in using your email address and password used for registration. Access is limited to Full Technical Attendees only. If you need assistance with your login information, please use the "forgot password" utility or "Contact Help" link.

Exhibit Buyers' Guide

After careful consideration, Show Management has decided to take the FiO + LS Buyers' Guide GREEN. Attendees will be directed to the Conference App to access exhibiting companies' detailed information. In addition, you'll find all exhibitors listed on page 12 in this book.

Conference Program Update

Technical program changes will be communicated in the onsite Conference Program Update Sheet distributed with your onsite registration materials. In addition, all updates will be made in the FiO + LS conference app. Check daily for new information and/or reference the FiO + LS conference app.

Poster Presentation PDFs

Authors presenting posters have the option to submit the PDF of their poster, which will be attached to their papers in OSA Publishing's Digital Library. If submitted, poster PDFs will be available about three weeks after the conference end date. While accessing the papers in OSA Publishing's Digital Library, look for the multimedia symbol.

FiO + LS Conference App

Manage your conference experience by downloading the FiO + LS Conference App to your smartphone or tablet.

Download the app one of three ways:

1. Visit www.frontiersinoptics.com/app
2. Search for 'OSA Events' in the app store
3. Scan the QR code below

Schedule

Search for conference presentations by day, topic, speaker or program type. Plan your schedule by setting bookmarks on programs of interest. Technical attendees can access technical papers within session descriptions.

Science & Industry Showcase

Search for exhibitors or view the complete list. Bookmark exhibitors as a reminder to stop by their booth. Tap on the map icon within a description, to find their location on the show floor map.

Access Technical Digest Papers

Full technical registrants can navigate directly to the technical papers right from the FiO + LS conference app. Locate the session or talk in "Event Schedule" and click on the "Download PDF" link that appears in the description. IMPORTANT: You will need to log in with your registration email and password to access the technical papers. Access is limited to Full Conference attendees only.

Need assistance?

Contact our support team, available 24 hours a day Monday through Friday, and from 09:00 to 21:00 EDT on weekends, at +1.888.889.3069 option 1.

Join the Social Conversation at FiO + LS!

We will be tweeting about program highlights and the latest updates throughout the conference. Follow @OpticalSociety on Twitter and tweet about your conference experience using #FIO18 in your tweets. Join the conversation!

Conference Plenary Session

Plenary Presentations

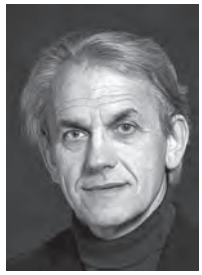
Tuesday, 18 September, 08:00–09:30
International Ballroom Center

Heike E. Riel
IBM Research Frontiers Institute, Switzerland

The Future of Computing

Extraordinary enhancements in computing power over the last 50 years have been driven by "smaller & denser" resulting in "faster & cheaper". The quest for ever-increasing computing performance continues. This raises the fundamental question of 'what is next?' Today, the most exciting new frontiers of information technology are non-von Neumann computing and quantum computing. This talk will give an overview of our research activities in the field of extending the core technology roadmaps and in the new paradigms of cognitive hardware technologies and quantum computing.

About the Speaker: Heike E. Riel is Executive Director of the IBM Research Frontiers Institute, and Director of IoT Technology & Solutions, Switzerland. In 2013, Dr. Riel became an IBM Fellow, achieving the company's highest technical distinction, and became a member of the IBM Academy of Technology. Her research interests include nanoscale materials and novel device concepts for applications in electronics, optoelectronics, and energy harvesting. Dr. Riel studied physics at the Friedrich-Alexander University of Erlangen-Nuremberg (Germany), and received her Ph.D. in 2003 from the University of Bayreuth (Germany) for her work on the optimization of multilayer organic light-emitting devices. After an internship at the Hewlett-Packard Research Laboratory in Palo Alto, California, she joined IBM Research Zurich in 1997, first as a diploma student, then as a Ph.D. student before becoming a Research Staff Member in 2003. From 2008 to 2014, Dr. Riel led the Nanoscale Electronics Group before moving to the Materials Integration and Nanoscale Devices group. In 2003, Dr. Riel was named as one of the world's Top 100 Young Innovators by MIT Technology Review. Since then, she has gone on to receive the Applied Physics Award from the Swiss Physical Society, and the Swiss Association of Women in Engineering Innovation Award. In 2015 Dr. Riel was elected to the Swiss Academy of Engineering Sciences, to the Leopoldina, and to the German National Academy of Sciences. In 2016 she was awarded an honorary doctorate from the Faculty of Engineering at Lund University (Sweden).



Gérard Mourou
École Polytechnique, France

Chirped Pulse Amplification to ELI and Beyond

PW laser could be compressed into high-energy single-cycled laser pulse, offering a fundamentally new laser-matter interaction ambit, which could become the fulcrum of novel scientific and societal applications. Among them, we foresee efficient laser electron and ion acceleration, as well as the generation of a single-cycled X-ray pulse leading to Exawatt and zeptosecond science and technology.

About the Speaker: Gérard Mourou, recipient of the 2018 Arthur L. Schawlow Prize in Laser Science and the 2016 Frederic Ives Medal/Jarus W. Quinn Prize, is Professor Haut-Collége at the École Polytechnique. He is also the A.D. Moore Distinguished University Emeritus Professor of the University of Michigan. He received his undergraduate education at the University of Grenoble (1967) and his Ph.D. from University Paris VI in 1973.

He has made numerous contributions to the field of ultrafast lasers, high-speed electronics, and medicine. His most important invention, developed with Donna Strickland while at the University of Rochester (N.Y.), is the laser amplification technique known as Chirped Pulse Amplification (CPA), a method that is universally used today. CPA's attosecond pulse generation and compact particle accelerators made possible the generation of extremely high laser intensities, making a new branch of optics possible.

In 2005, Prof. Mourou proposed a new infrastructure, Extreme Light Infrastructure (ELI), which is distributed over three pillars located in the Czech Republic, Romania, and Hungary. Prof. Mourou also pioneered the field of femtosecond ophthalmology that relies on a femtosecond laser for precise myopia correction and corneal transplants. Over a million such procedures are now performed annually. Prof. Mourou is member of the U.S. National Academy of Engineering, an OSA Fellow, and a foreign member of the Russian Science Academy, the Austrian Sciences Academy, and the Lombardy Academy for Sciences and Letters. He is Chevalier de la Légion d'honneur.

Visionary Speakers

Monday, 17 September, 08:30–11:15

Teri Odom, *Northwestern University, USA*

Theme: Nanophotonics and Plasmonics

Peering through the Looking Glass: The Next Frontier in Nano-optics

Over the past decade, significant progress in controlling light-matter interactions at the nanoscale has been achieved. Most of the advances, however, have relied on fixed systems limited to as-fabricated nanostructures and singly periodic arrays and simple unit cells. This visionary talk will discuss how the ability to engineer complex nanophotonics responses—on demand—may address key challenges and open unexpected possibilities in nanoscale optics. We will highlight new designs in topological photonics, stimuli-responsive nanostructured substrates for tunable nano-lasing and reconfigurable lensing, and prospects of multi-periodic structured materials.

About the Speaker: Teri W. Odom is Charles E. and Emma H. Morrison Professor of Chemistry, Professor of Materials Science and Engineering, and Associate Director of the International Institute of Nanotechnology (IIN) at Northwestern University. She is an expert in designing structured nanoscale materials that exhibit extraordinary size and shape-dependent optical properties. Odom has pioneered a suite of multi-scale nanofabrication tools that have resulted in flat optics that can manipulate light at the nanoscale and beat the diffraction limit, plasmon-based nanoscale lasers that exhibit tunable color, and hierarchical substrates that show controlled wetting and super-hydrophobicity. She has also invented a class of biological nanoconstructs that are facilitating unique insight into nanoparticle-cell interactions and that show superior imaging and therapeutic properties because of their gold nanostar shape.

Jan-Erik Källhammer, *Veoneer, Inc., Sweden*

Theme: Automotive

From Night Vision to LiDAR: An Automotive Perspective

Work is underway to complement cameras and radar with LiDAR in serial automotive use. There are many considerations besides technical challenges to be made before LiDAR can be launched as a serial product. The talk will draw on experiences of taking Night Vision to the automotive market.

About the Speaker: Jan-Erik Källhammer has almost 20 years' experience with automotive active safety development. He was responsible for the inception and development of a Night Vision Drivers Vision Enhancement based on an uncooled long-wave infrared camera. The system is now on the market in Audi, BMW, Cadillac, Mercedes, Peugeot and some luxury cars. Current works focus on visual enhancement in darkness and inclement weather (Night Vision, LiDAR, gated imaging). Key aspects are functional specifications, coordination with technology provider, suppliers and customer contacts.

Källhammer started 30 years ago with Machine Vision in automotive manufacturing at Borg Warner Corporation in Des Plaines, Illinois. He has also several years of experience with high-speed cameras and data analysis in automotive crash tests. In 1995 he joined Autoliv AB, Sweden — the world's largest supplier of airbag and seat-belt systems — responsible for corporate funded research and development projects. There he launched active safety in the late 1990s. He is now with Veoneer — the electronics spin-off from Autoliv. Källhammer has a PhD in Cognitive Systems from the department of Information and Computer Science at Linköping University, Sweden, an M.S. In E.E. from Duke University, and a an MS in mechanical engineering from Luleå Technical University, Sweden. He has co-authored 29 articles and conference papers and has 19 patent proposals or granted patents.

Prem Kumar, *Northwestern University, USA*

Theme: Quantum Technologies

Quantum Communication and Networking

Machines that process quantum information are likely to be commercially available in the near future. Networking them via quantum communication to achieve a higher level of performance is a topic of current interest. In this talk I will review the current status and speculate on the future possibilities.

About the Speaker: Prem Kumar is Professor of Information Technology in the Robert R. McCormick School of Engineering and Applied Science at Northwestern University. His primary research focus is on photonic devices and their applications utilizing the principles of nonlinear and quantum optics. In particular: generation, distribution, and ultrafast processing of photonic entanglement for applications in quantum information networks; novel quantum light states for precision measurements, imaging, and sensing; and novel optical amplifiers and devices for networked classical optical communications.

Earlier this year, Kumar returned to Northwestern after spending four years at DARPA, where he served as a Program Manager in the Defense Sciences Office. Prior to joining DARPA, he served on the National Academies Committee that issued the 2012 landmark study: "Optics and Photonics: Essential Technologies for Our Nation," which spawned the National Photonics Initiative. Kumar is a Fellow of the OSA, APS, IEEE, IoP (UK), AAAS and SPIE. He has been a Distinguished Lecturer for the IEEE Photonics Society, Hermann A. Haus Lecturer at MIT, recipient of the Quantum Communication Award from Tamagawa University in Tokyo, Japan, and the Walder Research Excellence Award from the Provost's office at Northwestern University.

Wednesday, 19 September, 09:15–10:00

Mark Bolas, *Microsoft Corp., USA*

Theme: Virtual Reality and Augmented Vision

Bending Light to Bend Reality

As we dive head-first into the new medium of mixed reality, we find that the ability to bend light is central to the palette of mixed reality systems and content designers as they bend the reality that is ultimately formed in the user's mind. This talk will look backward and forward in time to explore just how messy that process has been, and how much messier it will become.

About the Speaker: Mark Bolas is a researcher exploring perception, agency and intelligence. He is a Professor of Interactive Media in the USC Interactive Media Division, USC School of Cinematic Arts at the University of Southern California, Director of their Interactive Narrative and Immersive Technologies Lab, Director of Mixed Reality Laboratory at USC's Institute for Creative Technologies, and chairman of Fakespace Labs in Mountain View, California. Bolas is currently on leave from USC, working on the Hololens team at Microsoft.

In 1988, Bolas co-founded Fakespace Inc. with Ian McDowall and Eric Lorimer to build instrumentation for research labs to explore virtual reality. This work resulted in the invention of display and interaction tools used by many VR research and development centers around the world, including the BOOM (Binocular Omni-Orientation Monitor), the Pinch glove, the RAVE, the PUSH, and VLIB software. Bolas was awarded the IEEE VGTC Virtual Reality Technical Achievement Award for 2005 in recognition of seminal technical achievement in virtual and augmented reality.

Mark Brongersma, *Stanford University, USA*

Theme: Nanophotonics and Plasmonics

Activities Shaping the Wavefront of Nanophotonics

In the field of nanophotonics we aim to manipulate the flow of light using optically resonant nanostructures. I will share my personal perspective on a number of exciting recent developments in the field that are transforming the way we create new optical materials and devices.

About the Speaker: Mark Brongersma is a Professor in the Departments of Materials Science and Applied Physics at Stanford University. He leads a research team of ten students and five postdocs. Their research is directed towards the development and physical analysis of new materials and structures that find use in nanoscale electronic and photonic devices. He received a National Science Foundation Career Award, the Walter J. Gores Award for Excellence in Teaching, the International Raymond and Beverly Sackler Prize in the Physical Sciences (Physics) for his work on plasmonics, and is a Fellow of OSA, SPIE, and APS. Brongersma received his PhD from the FOM Institute AMOLF in Amsterdam, The Netherlands, in 1998. From 1998-2001 he was a postdoctoral research fellow at the California Institute of Technology.

Thursday, 20 September, 09:15–10:00

David DeMille, *Yale University, USA*

Activities Shaping the Wavefront of Nanophotonics

Remarkably, certain ultra-precise spectroscopic measurements are sensitive to the existence of certain new, yet-undiscovered particles whose mass far exceeds that of the recently discovered Higgs boson. This talk will describe ongoing and future examples of such measurements, including the ACME experiment, a search for the electron's electric dipole moment.

About the Speaker: David DeMille is a Professor of Physics at Yale University. DeMille received his PhD from the University of California, Berkeley in 1994 and joined the faculty at Yale in 1998. He is the recipient of awards including the Francis M. Pipkin Award of the American Physical Society (APS) (2006), the Cottrell Scholars Award from Research Corporation (2000), a Sloan Foundation Fellowship (2000), and a Packard Foundation Fellowship (1999), and he was named a Fellow of APS in 2005. DeMille's research interests span a wide range of topics in atomic, molecular and optical physics. For example, he and his group have developed pioneering techniques that use polar molecules to enhance the sensitivity of precision measurements to fundamental symmetry-violating effects. In parallel, DeMille and his group have developed methods for laser cooling and trapping of diatomic species. They have proposed many potential applications for ultracold molecules, such as for quantum information processing and for next-generation electric dipole moment searches, including a search for the electric dipole moment of the proton.

Sir Peter Knight, *Kavli Royal Society International Center, UK*

Theme: Quantum Technologies

Quantum Technology for a Networked World

I will describe the worldwide efforts to develop quantum technology, exploiting coherence and superposition. A second quantum revolution is emerging with electronic and photonic devices that use quantum science, harnessing our ability to interact with atoms, photons and electrons with exquisite level of control and with transformative potential for technology.

About the Speaker: Sir Peter Knight is Senior Fellow in Residence at the Kavli Royal Society International Centre at Chicheley Hall and a past President of the Institute of Physics and of The Optical Society. Knight retired at the end of September 2010 as Deputy Rector (Research) at Imperial College where he was responsible for the college's research strategy. He retains his Professorship of Quantum Optics at Imperial. His research centers on theoretical quantum optics and quantum information science. He has a strong interest in fostering multidisciplinary research and set up the Grantham Institute for Climate Change and other centers at Imperial College London.

He is a Thomson-ISI "Highly Cited Author". He was knighted in the Queen's Birthday Honours List in 2005 for his work in optical physics. Knight was chair of the Defence Scientific Advisory Council at the UK Ministry of Defence until 2010 and was a member of the Science and Technology Facilities Council until 2012. He continues to be involved in advising government on science issues. Knight was Chief Scientific Advisor at the UK National Physical Laboratory until the end of 2005 and currently chairs their Quantum Metrology Institute. He is also a Board member of the UK National Quantum Technology Initiative. He led, with Sir Mark Walport, the Government Office of Science Blackett Report in Quantum Technology in 2016. He has won a number of prizes and awards including the Thomas Young Medal and the Glazebrook Medal of the Institute of Physics, the Royal Medal of the Royal Society, and the Frederic Ives Medal/Jarus W. Quinn Prize of The Optical Society, as well as Honorary Doctorates from a number of universities including most recently Birmingham. He is currently a member of the Millennium Prize Jury at TAF, Finland.

Science & Industry Showcase

Tuesday, 18 September, 09:30–15:00
Wednesday, 19 September, 10:00–15:00
Columbia, Terrace Level

The FiO + LS Science & Industry Showcase hosts exhibiting companies partnered with innovative demonstrations, networking events, poster presentations, e-posters and Rapid-fire Oral Presentations. Learn about new products, find technical and business solutions and gain the most up-to-date market perspective of your industry. Don't miss this opportunity to visit companies representing a broad range of the best products and applications in the optics and photonics industry. There is no charge to attend the Showcase—it is open to all registered attendees!

Poster Sessions & E-Posters

E-Poster

Tuesday, 18 September, 10:00–12:00, 13:00–15:00
Wednesday, 19 September, 10:00–12:00, 13:00–15:00

Attend the Poster Sessions and view more than 500 posters scheduled for presentation. Poster presentations communicate new research findings in an intimate setting that encourages lively and detailed discussion between presenters and attendees.

A select number of presentations will be offered as e-posters—which supplements the author's introduction, motivation, results and conclusions with digital capabilities that aid deeper discussion. Look for the symbol to see who will be presenting e-posters.

Science & Industry Showcase Theater

Tuesday, 18 September	
09:45–10:45	Rapid Fire Oral Presentations 1
10:50–11:40	Entrepreneur - That's French for Crazy Person
11:45–12:00	A Look toward the Future — Remarks from the OSA President
12:00–13:00	Job Seeker Tutorial - WORKinOPTICS.com
13:00–14:00	Rapid Fire Oral Presentations 2
14:05–15:00	Leveraging LinkedIn – Building Relationships, Attracting Recruiters, Finding the Best Jobs and Growing Your Network
Wednesday, 19 September	
10:15–11:15	Rapid Fire Oral Presentations 3
11:15–12:15	Frontiers in Funding
12:20–12:55	Enabling and Entangling: the Tools to Innovate in Quantum Technology
13:00–14:00	Rapid Fire Oral Presentations 4
14:05–15:00	Understanding the National Quantum Initiative

Rapid Fire Oral Presentations

RAPID

Held in the Theater during the first hour of each poster session, a select number of poster presenters offer Rapid-fire Oral Presentations, which consist of a brief oral presentation accompanied by slides. This format enables poster presenters to preview key results from their research in brief, three-minute segments. In the session's second hour, presenters are available for more in-depth discussions adjacent to their accompanying posters. View the poster sessions in the abstracts for the the symbol indicates Rapid-fire Oral Presentations.

Entrepreneur - That's French for Crazy Person

Serial entrepreneur and seasoned executive, Sujatha Ramanujan will share her philosophy on creating a successful start-up with an emphasis on building the right team, understanding your market and ensuring your technology, solution or product gives you an advantage over others. She will share information on Luminate (the world's only accelerator for optics, photonics, and imaging) and its focus on bringing visionary entrepreneurs from around the globe together with OPI pioneers and qualified investors to help start-ups speed innovation and time to market. She also detail how entrepreneurs can apply to be a part of Luminate's next cohort by Sept. 24. Sujatha Ramanujan is a Managing Director at Luminate Accelerator, USA.

A Look toward the Future — Remarks from the OSA President

Under the leadership of OSA President Ian Walmsley, the Society has engaged in scenario planning that will shape the future of the Society. What are the biggest disruptors facing The Optical Society in 2030? What are new products and member services that the Society will offer in 2030? OSA is seeking your input. Join President Walmsley and members of the Board of Directors for an engaging presentation and discussion focused on the professional society of the future.

Job Seeker Tutorial - WORKinOPTICS.com

Attend this session and learn how to navigate the WORKinOPTICS career board and maximize your chances of getting the perfect job. WORKinOPTICS is the global talent hub for optics and photonics professionals. Start your search today.

Leveraging LinkedIn – Building Relationships, Attracting Recruiters, Finding the Best Jobs and Growing Your Network

Networking is the primary way people build relationships to learn about unadvertised career opportunities, get their foot in the door at a company, and grow their professional contacts. LinkedIn is a fantastic tool to accomplish all of these goals. LinkedIn is, by far, the most popular social media platform used by professionals in the workforce, as well as recruiters looking to fill open positions. Learning how to create and present a strong LinkedIn profile is essential for building relationships, developing a professional network, establishing your brand and thought leadership, and finding new career opportunities. As LinkedIn frequently enhances its platform to offer new features, this workshop will also introduce any new tools and features that will benefit LinkedIn users. The speaker is Josh Henkin, STEM Career Services, USA.

Frontiers in Funding

This program, featuring representatives from funding agencies, will provide attendees with the opportunity to hear about the latest in science funding with a focus on the conference themes. Throughout the exhibit attendees will be able to further explore and discuss opportunities at agency alley on the show floor.

Enabling and Entangling: the Tools to Innovate in Quantum Technology.

This presentation will be delivered by Vincent Tagliamonti from TOPTICA Photonics. View the Conference App for a complete description.

Understanding the National Quantum Initiative

The U.S. is getting serious about quantum research and technology. Several bills have been introduced in Congress to advance this area of research, and two of which would create a large new coordinated federal effort cutting across academia, laboratories, and Industry. Join this session to learn from where this National Quantum Initiative originated, how it would be structured, and how you can get involved to support it.

OIDA VIP Industry Leaders Speed Meetings Lunch

Wednesday, 19 September, 12:00–13:30
Science & Industry Showcase

This session brings together industry executives to share their business experience with early career professionals, recent graduates and students. Learn how they started their careers, lessons learned and how they are using their degrees in executive positions. Informal networking over lunch is followed by a transition to "speed meetings" — brief, small-group visits with each executive to discuss industry trends or career topics.

Sponsored by GoFoton

Demonstration Areas

VR, AR and MR Headsets Demo

The current and future technologies of VR, AR and MR will be feature during the Virtual Reality and Augmented Vision Theme sessions. During the Science & Industry Showcase attendees can experience this technology hands on by taking part in the VR, AR, MR Demo Area. The following headsets will be available for attendees to experience.

In addition to an invited program of speakers and a visionary talk, you will find the following headsets for live demonstrations in the showcase area:

VR headsets:
- Oculus CV1
- Oculus Go
- HTC Vive

AR headsets:
- Hololens
- Lenovo
- Mira

Come to the FiO Registration desk to sign up for a 15-minute demo slot.

Vehicle Equipped with Ouster LIDAR Demo

Ouster will host live demonstrations of an OS-1-64 LIDAR sensor mounted on a vehicle on the exhibit floor, highlighting its panoramic imaging capabilities, high spatial acuity, and small form factor. Ouster is a leading developer of LIDAR and perception technology for the autonomous vehicle and robotics sectors. The company's flagship product, the OS-1-64, provides industry leading performance, scalability, reliability, and form factor. Ouster's corporate headquarters and manufacturing facility are located in San Francisco. For more information, visit www.ouster.io/.

2018 Participating Companies:
(as of 16 August 2018)

American Institute of Physics www.aip.org	Booth 313
American Physical Society www.aps.org	Booth 205
asphericon, Inc. www.asphericon-inc.com	Booth 214
Dark Field Technologies www.darkfield.com	Booth 209
Energetiq Technology www.energetiq.com	Booth 305
Hamamatsu Corporation www.hamamatsu.com	Booth 404
Inrad Optics www.inradoptics.com	Booth 301
Liquid Instruments www.liquidinstruments.com	Booth 219
Luminate www.nextcorps.org	Booth 303

M Squared Lasers, Ltd. www.m2lasers.com	Booth 210
Menlo Systems www.menlosystems.com	Booth 309
Newport Corporation www.newport.com	Booth 221
NKT Photonics www.nktphotonics.com	Booth 203
Optimax Systems, Inc. www.optimaxsi.com	Booth 201
OptoSigma Corporation www.optosigma.com	Booth 315
OSA Member Zone www.osa.org/membership	Booth 213
OSA - The Optical Society www.osa.org	Terrace Foyer
Ouster, Inc. www.ouster.io	Booth 200
PHASICS Corporation www.phasicscorp.com	Booth 308
Photonics Media www.photonics.com	Booth 318
Santec USA Corporation www.santec.com	Booth 311
SPIE www.SPIE.org	Booth 417
Springer Nature www.springer.com	Booth 419
Synopsys, Inc. www.synopsys.com/optical-solutions	Booth 302
Thorlabs www.thorlabs.com	Booth 400, Sponsor
Tianjin University www.tju.edu.cn	Booth 304
WORKinOPTICS www.WORKinOPTICS.com	Booth 421
Zygo Corporation www.zygo.com	Booth 212

OSA Member Zone

OSA Member Zone – Booth 213

Tuesday, 18 September	09:45-15:00
Wednesday, 19 September	10:00-15:00

Through its world-renowned publications, meetings and membership programs, OSA provides quality information and inspiring interactions that power achievements in the science of light. More than 21,000 Members, residing in over 100 countries and spanning academic, government and industry, call OSA their professional home.

All members are invited to stop by the OSA Member Zone to meet OSA staff, and learn more about our publications, conferences and meetings, and membership for individuals and companies. **Not a member? Definitely stop by and learn more about OSA! All conference attendees who join or renew as an Individual 1-year member will receive 50% off the cost of annual dues.**

Staff and/or volunteer members from the following six division will be in the OSA Member Zone to answer your questions, help you increase your engagement or discuss suggestions you have for future programs:

OIDA (OSA Industry Development Associates) helps corporations optimize product development resources and reduce time to market by giving professionals access to quality information, quality interactions and premium opportunities for collaboration.

OSA Advocacy works to promote optics and photonics globally. One way to ensure this outreach is for OSA members to visit with their elected officials, inform governments about optics and photonics by providing technical insights, and reach out to decision makers so they understand why science - and optics in particular - is an integral part of society. OSA's public policy programs are designed to facilitate this interaction. Stop by to learn about the OSA Congressional Science Policy Fellowships, how you can get involved in OSA's global advocacy programs, write to your members of U.S. Congress, and more.

OSA Foundation provides training, mentoring, recognitions, scholarships and travel support programs as directed by our donors. We are supporting over 30 scholarships, grants, prizes, professional development trainings, and summer schools benefitting students and early-career professionals this year. Stop by to learn more about our **Career Calibrator** and our plans for expanded programming**.**

OSA Meetings convenes more than 40 events throughout the world annually to provide you with opportunities to advance your scientific ambitions, expand your professional network and influence the future of optics and photonics worldwide. Learn more about the 2019-2020 schedule and discuss how you can participate in your favorite meeting.

OSA Publishing (OSAP) provides the largest collection of peer-reviewed optics and photonics content in the world and hosts more than 370,000 articles from 18 publications, as well as conference papers from more than 775 meetings. **EXCITING NEWS** – OSAP has launched a new, inclusive, rapid-publication, Open-Access journal entitled *OSA Continuum*. *OSA Continuum* publishes articles that meet OSA's high standards for technical accuracy, scientific rigor, and presentation quality and without judgment on impact or significance.

OSA Technical Groups offer members the chance to connect with colleagues in their area of expertise through innovative events and focused networking opportunities. Both in person and online events are planned throughout the year. Have an idea for your technical group? Bring it the Zone! Looking to engage with a technical group while at FiO? Browse the special events on the conference app for a list of technical group events or visit www.osa.org/TGevents.

OSA Member Recognition Events

Grab It While it's Cold!
Tuesday, 18 September 13:00–15:00

Ice Cream Social sponsored – grab your favorite ice cream treat, mingle with colleagues and learn more about what OSA has planned for 2019.

If You've Got the Time, We've Got the Beer
Wednesday, 19 September 14:00–15:00

Had enough coffee? Swing by the OSA Zone for a cold beer and snacks. Chat with colleagues, make plans for the evening and discuss how you can get more involved with OSA programs.

Awards, Honors and Special Recognitions

FiO + LS Awards Ceremony & Reception

Monday, 17 September, 18:00–21:00
Carnegie Institute of Science, 1530 P St. NW

Join us for an evening of celebration as we recognize the achievements of award and honor recipients from OSA and APS Division of Laser Science. This is a great opportunity to connect with the OSA Board of Directors, honorees and colleagues. For the most up-to-date information on the ceremony program, please visit frontiersinoptics.com/awards.

Schedule for the Evening
Program: 18:00–19:30
Reception: 19:30–21:00
Note: This is a ticketed event. Limited tickets will be available for purchase on-site at the conference registration desk. Doors open at 17:45.

OSA 2018 Awards and Honors

Frederic Ives Medal/Jarus W. Quinn Prize

90th Anniversary

Rod Alferness, *University of California, Santa Barbara, USA*

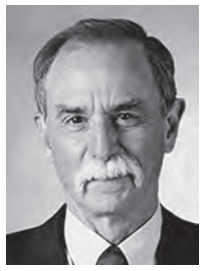
The Ives Medal/Quinn Prize recognizes overall distinction in optics and is OSA's highest award. This year marks the 90th anniversary of the medal's establishment. It was endowed by OSA charter member Herbert Ives, in honor of his father, photography pioneer Frederic Ives. A subsequent endowment in honor of longtime OSA Executive Director Jarus Quinn funds the prize. OSA honors Alferness for basic contributions and leadership in the development of integrated optics, high-speed optical modulation and switching, and configurable WDM networks that have provided significant economic and societal impact.

Alferness is the Dean of the College of Engineering at the University of California, Santa Barbara, USA. A member of the National Academy of Engineering and a Fellow of OSA and the IEEE Photonics Society, he served as OSA president in 2008 and as a member of the OSA Board of Directors from 2001 to 2003. He has authored over 100 papers and 5 book chapters and holds 35 patents. His work and research has earned him numerous awards throughout his career, including the OSA Robert E. Hopkins Leadership Award in 2010, the IEEE Millennium Award and the IEEE Photonics Award.

Alferness is world-renowned for his work on integrated-optic devices and optical switching technology and architecture. His research has been central to the development of global fiber optic communications networks. As chief scientist at Bell Labs, he was responsible for strategic directions, technical excellence and global partnerships. In a prior role, as senior vice president for research, he had overall responsibility for the company's global research laboratories. As chief technical officer for Bell Labs' parent company, Lucent Technologies, Alferness was responsible for transferring the optical technology he and coworkers had invented to the business units.

OSA Honorary Members

The most distinguished of all OSA Member categories, Honorary Membership is awarded for unique, seminal contributions to the field of optics, and is confirmed by the Awards Council and OSA Board of Directors.



David J. Wineland, *University of Oregon, USA*

Wineland is honored for pioneering advances in laser cooling of ions together with unprecedented control of individual ions in foundational experiments of quantum optics and quantum information.

Amnon Yariv, *California Institute of Technology, USA*

Yariv is honored for pioneering scientific and engineering contributions to photonics and quantum electronics that have profoundly impacted lightwave communications, and the field of optics as a whole.

Esther Hoffman Beller Medal

25th Anniversary

Uli Lemmer, *Karlsruhe Institute of Technology (KIT), Germany*
The Beller Medal recognizes outstanding contributions to education in optical science and engineering. The 2018 medal is presented to Lemmer for developing a vision for an international education program in optics that appreciates its importance as an enabling technology, and for successfully establishing the Karlsruhe School of Optics & Photonics.

Max Born Award

Demetrios Christodoulides, *CREOL- The College of Optics & Photonics, University of Central Florida, USA*
The Born Award is presented to a person who has made outstanding contributions to physical optics, theoretical or experimental. Christodoulides is recognized for founding and continuing to lead the fields of Parity-Time non-Hermitian Optics and Accelerating Waves, and for groundbreaking contributions in multiple areas in Physical Optics.

Stephen D. Fantone Distinguished Service Award

Bob Jopson, *Nokia Bell Labs, USA*
The Fantone Award recognizes outstanding service to The Optical Society. OSA celebrates Jopson for 25 years of enthusiastic service, principled leadership, and a tenacious commitment to OSA's publications, conferences, processes, and especially its membership.

Paul F. Forman Team Engineering Excellence Award
The Adaptive Optics Facility on the VLT at ESO's Paranal Observatory
The Forman Team Award recognizes technical achievements in optical engineering. **The Adaptive Optics Facility on the VLT at ESO's Paranal Observatory** is recognized for quipping one of the 8-m Unit Telescopes at ESO's Paranal Observatory in Chile with an Adaptive Optics Laser Guide Star Facility, providing exquisite images to the unique 3D spectrograph MUSE and near-infrared imager HAWK-I.

Robert E. Hopkins Leadership Award
Anna Consortini, *Università degli Studi di Firenze, Italy*
The Hopkins Award recognizes significant impact on the global optics and photonics community or on society as a whole stemming from non-research oriented activities. The 2018 award is presented to Consortini for outstanding dedication to promoting optics at an international level with very valuable leadership in institutions and scientific societies like ICO (International Commission for Optics), ICTP, OSA, and SIOF.

Edwin H. Land Medal
Ann E. Elsner, *Indiana University and Aeon Imaging, LLC, USA*
The Land Medal recognizes pioneering work empowered by scientific research to create inventions, technologies, and products. It is co-sponsored by OSA and the Society for Imaging Science and Technology. Elsner is honored for contributions to the fields of ophthalmic instrumentation and vision science with innovative imaging technologies, state-of-the-art psychophysical research, and entrepreneurial ventures.

Emmett N. Leith Medal
Asher Albert Friesem, *Weizmann Institute of Science, Israel*
The Leith Medal recognizes seminal contributions to the field of optical information processing. The 2018 medal is presented to Friesem for pioneering, seminal and wide ranging contributions to coherent optics, particularly the developments of new techniques and procedures in holographic applications and optical information processing.

Adolph Lomb Medal
Andrei Faraon, *California Institute of Technology, USA*
The Lomb Medal recognizes noteworthy contributions made to optics at an early career stage. Faraon is recognized for seminal contributions to on-chip quantum photonic technologies.

C. E. K. Mees Medal
Stanley Whitcomb, *LIGO Laboratory, California Institute of Technology, USA*
The Mees Medal recognizes an original use of optics across multiple fields. The 2018 medal is presented to Whitcomb for pioneering interdisciplinary contributions to the development of LIGO gravitational-wave interferometers.

William F. Meggers Award
Warren S. Warren, *Duke University, USA*
The Meggers Award recognizes outstanding work in spectroscopy. Warren is recognized for pioneering contributions in the fundamental science of optical and spin coherence and their synergistic applications in optical spectroscopy/microscopy and magnetic resonance spectroscopy/imaging through the development of pulse shaping techniques.

David Richardson Medal
Steven Frisken, *Finisar Australia and Cylite, Australia*
The Richardson Medal recognizes significant contributions to optical engineering, primarily in the commercial and industrial sector. The 2018 Medal is presented to Frisken for seminal contributions as a researcher, inventor, and entrepreneur, to a wide range of photonic technologies which have enabled the growth of the internet, and for inspiring an entrepreneurial culture amongst Australian researchers.

Kevin P. Thompson Optical Design Innovator Award
New Award
Ulrike Fuchs, *asphericon GmbH, Germany*
The Thompson Award recognizes contributions to lens design, optical engineering, or metrology at an early career stage. The inaugural award is presented to Fuchs for interlinking aspects of optical design, tolerancing, metrology, and manufacturing for aspherics to enable their usage as reasonable choice in optical systems.

OSA Treasurer's Award
Naomi Chavez, *The Optical Society, USA*
The Treasurer's Award recognizes an OSA employee who contributes significantly to organizational excellence, promotes and enacts innovative solutions and/or exemplifies inspirational leadership. Naomi Chavez is recognized for outstanding and innovative leadership, on a continued and sustained basis, of the Optical Society's meeting and conference portfolio.

R. W. Wood Prize
Christopher Barty, *University of California, Irvine, USA*
The Wood Prize recognizes an outstanding discovery, scientific or technical achievement, or invention in the field of optics. The 2018 prize is presented to Barty for foundational innovations that have enabled ultrafast and energetic intense lasers around the world.

OSA Awards Presented Elsewhere

Recipients of these OSA and OSA co-sponsored awards were recognized at other conferences this year.

Michael S. Feld Biophotonics Award
Lihong Wang, *California Institute of Technology, USA*
The Feld Biophotonics Award recognizes individuals for their innovative and influential contributions to the field of biophotonics, regardless of their career stage. Wang is recognized for inventing the world's fastest two-dimensional receive-only camera and enabling real-time imaging of the fastest phenomena such as light propagation and fluorescence decay.

Joseph Fraunhofer Award/Robert M. Burley Prize
Bahram Javidi, *University of Connecticut, USA*
The Fraunhofer Award/Burley Prize recognizes significant research accomplishments in the field of optical engineering. Javidi is honored for seminal contributions to passive and active multi-dimensional imaging from nano- to micro- and macro-scales.

Joseph W. Goodman Book Writing Award

Michael T. Eismann, *US Air Force Research Laboratory, USA*
The Goodman Award, co-sponsored with SPIE, recognizes authorship of an outstanding book in the field of optics and photonics, published in the last six years, that has contributed significantly to research, teaching, or the optics and photonics industry. Eismann is honored as the author of *Hyperspectral Remote Sensing* (SPIE Press, 2002).

Nick Holonyak Jr. Award

Dieter Bimberg, *Technische Universität Berlin and King Abdul Aziz University, Germany/ Saudi Arabia*
The Holonyak Award recognizes contributions to optics based on semiconductor-based devices and optical materials, including basic science and technological applications. Bimberg is recognized for fundamental discoveries on growth and physics of semiconductor nanostructures leading to novel nanophotonic devices for information science and communications.

Sang Soo Lee Award

Cheng-Chung Lee, *National Central University, Taiwan*
The Lee Award, co-sponsored with the Optical Society of Korea, recognizes outstanding leadership in founding or growing the optics and photonics community locally. Lee is honored for guiding, educating, developing and inspiring the optical coating industry in Taiwan for over 30 years and serving as a key figure in its growth and success.

Ellis R. Lippincott Award

Peter Hamm, *Universität Zürich, Switzerland*
The Lippincott Award, co-sponsored with the Coblentz Society and the Society for Applied Spectroscopy, recognizes contributions to vibrational spectroscopy. Hamm is recognized for seminal contributions to developing multidimensional infrared, Raman and Terahertz spectroscopy and pioneering studies of protein and hydrogen bonding dynamics in molecular liquids.

Edgar D. Tillyer Award

Martin S. Banks, *University of California, Berkeley, USA*
The Tillyer Award recognizes distinguished work in the field of vision. Banks is honored for applying an innovative and rigorous scientific approach to make significant contributions in the fields of visual development, sensory cue combination and 3D vision.

Charles Hard Townes Award

Peter Fritschel, *Kavli Institute for Astrophysics and Space Research, Massachusetts Institute of Technology, USA*
The Townes Award recognizes contributions to quantum electronics. Fritschel is recognized for advances in quantum-limited precision measurement in the Advanced LIGO detectors, leading to the first direct detection of gravitational waves.

John Tyndall Award

Peter J. Winzer, *Nokia Bell Labs, USA*
The Tyndall Award, co-sponsored with the IEEE/Photonics Society, recognizes contributions to fiber optic technology. Winzer is honored for contributions to understanding and advancing the capacity of coherent optical communication systems including advanced modulation formats and spatial mutiplexing.

Herbert Walther Award

Gerd Leuchs, *Universität Erlangen-Nürnberg & MPI for the Science of Light, Germany*
The Walther Award, co-sponsored with Deutsche Physikalische Gesellschaft (DPG), recognizes distinguished contributions in quantum optics and atomic physics as well as leadership in the international scientific community. Leuchs is honored for pioneering and widespread scientific contributions ranging from ultrasmall focii of light to nonlinear optics, squeezed states of light and their application in metrology and quantum information, as well as for a continuing commitment to the physics community, quantum optics and his students and team members.

OSA Fellows

101 OSA Fellow Members were elected in 2018. The recipients listed below are being recognized at FiO.

Domenico Bonaccini Calia, *European Southern Observatory, Germany*
For fostering the development of Photonics in novel astronomical instrumentation, including the field of Laser Guide Star Adaptive Optics with the invention of narrow-band high power Raman Fiber Amplifiers

Heike Ebendorff-Heidpriem, *University of Adelaide, Australia*
For groundbreaking science contributions to the field of optical glasses and fibers

Anne Myers Kelley, *University of California, Merced, USA*
For innovative work in the theory and practice of resonance Raman and hyper-Raman spectroscopy

François Légaré, *Institut National de la Recherche Scientifique, Centre Énergie, Matériaux, et Télécommunications, Canada*
For major contributions to ultrafast molecular imaging, to the development and application of high-power ultrashort infrared lasers including the concept of Frequency domain Optical Parametric Amplification, and the interpretation of nonlinear optical signals from tissues

Innocenzo Pinto, *University of Sannio, INFN, LVC, and KAGRA, Italy*
For fundamental contributions to thermal noise reduction in the mirror coatings of the LIGO interferometric gravitational wave detectors, and for original contributions to the science of Electromagnetics

Gernot Pomrenke, *US Air Force Office of Scientific Research (AFRL/AFOSR), USA*
For outstanding technical leadership in formulating and advancing the areas of Optical Materials Characterization, Opto-Electronics, Integrated Photonics, Silicon Photonics, Nano-photonics, Metamaterials and Plasmonics

Nickolas Vamivakas, *University of Rochester, USA*
For significant contributions to the fields of solid-state quantum optics and nano photonics

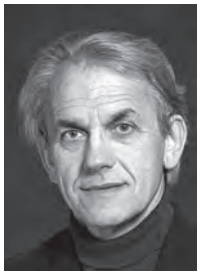
Congratulations, 2018 OSA Senior Members - OSA welcomes the following 169 distinguished individuals to the rank of Senior Member. For more on Senior Member status and how to apply, please visit www.osa.org/seniormember.

Esmail Ahouzi, *Institut National des Postes et Telecomm, Morocco*
Tatiana Alieva, *Universidad Complutense de Madrid, Spain*
Rebecca Andersen, *The Optical Society, USA*
Shamsul Arafin, *University of California Santa Barbara, USA*
Christos Argyropoulos, *University of Nebraska Lincoln, USA*
John Arkwright, *Flinders University, Australia*
Seung-Whan Bahk, *University of Rochester, USA*
Anirudh Banerjee, *Amity University Lucknow, India*
Santanu Basu, *Basu Labs, USA*
Can Bayram, *Univ of Illinois at Urbana-Champaign, USA*
Matthew Berg, *Kansas State University, USA*
David Boertjes, *Ciena Corporation, Canada*
Nicolas Bonod, *CNRS-UPS, France*
Bosanta Boruah, *Indian Institute of Technology Guwahati, India*
Ozdal Boyraz, *University of California Irvine, USA*
Aidan Brooks, *California Institute of Technology, USA*
David Busch, *UT Southwestern Medical Center at Dallas, USA*
Vijayan C, *Indian Institute of Technology Madras, India*
Alejandro Carballar, *Universidad de Sevilla, Spain*
Swapnajit Chakravarty, *Omega Optics, USA*
Guo-En Chang, *National Chung Cheng University, Taiwan*
Ching-Hung Chang, *National Chiayi University, Taiwan*
Chih-Hao Chang, *North Carolina State University, USA*
Yu Chen, *University of Maryland at College Park, USA*
Francesco Chiadini, *Universita degli Studi di Salerno, Italy*
Ricky Chuang, *National Cheng Kung University, Taiwan*
Hsiang-Chen Chui, *National Cheng Kung University, Taiwan*
C. Ciminelli, *Politecnico di Bari, Italy*
Christophe Codemard, *SPI Lasers, UK*
John Corless, *Verity Instruments, USA*
Razvan Dabu, *Institute Nuclear Physics & Engineering, Romania*
Antonio d'Alessandro, *Sapienza University of Rome, Italy*
Hamed Dalir, *Omega Optics, USA*
Kamal Das, *Alcon Laboratories, USA*
Marcelo Davanco, *National Inst. of Standards & Technology, USA*
Nazif Demoli, *Institute of Physics Zagreb, Croatia*
Xinyong Dong, *China Jiliang University, China*
Richard Dorshow, *MediBeacon, USA*
Anthony Durkin, *University of California Irvine, USA*
Achyut Dutta, *Banpil Photonics, USA*
Christoph Englert, *US Naval Research Laboratory, USA*
Dirk Englund, *Massachusetts Institute of Technology, USA*
Oliver Faehnle, *FISBA AG, Switzerland*
Xinyu Fan, *Shanghai Jiao Tong University, China*
Reza Faraji-Dana, *University of Tehran, Iran*
Steve Federman, *University of Toledo, USA*
Ulrike Fuchs, *Asphericon GmbH, Germany*
Qiaoqiang Gan, *State University of New York at Buffalo, USA*
Jaime Garcia-Ruperez, *Universidad Politecnica de Valencia, Italy*
Zabih Ghassemlooy, *University of Northumbria, UK*
Ashish Ghunawat, *MNIT Jaipur, India*
Dana Granciu, *IOR, Romania*
Mark Guardalben, *University of Rochester, USA*
Randolph Hall, *Conejo Valley Research, USA*
Kiichi Hamamoto, *Kyushu University, Japan*
Young-Geun Han, *Hanyang University, China*
Christoph Hauri, *Paul Scherrer Institut, Switzerland*
Joseph Hayward, *Juravinski Cancer Centre, Canada*
Mark Henesian, *Lawrence Livermore Lab (retired), USA*
Wei-Da Hu, *Chinese Academy of Sciences, China*
Zhaoran Huang, *Rensselaer Polytechnic Institute, USA*
Yu-Chueh Hung, *National Tsing Hua University, China*
Boyd Hunter, *Praxis Optics, USA*
Amiel Ishaaya, *Ben Gurion University of the Negev, Israel*
Shudong Jiang, *Dartmouth College, USA*
Alexander Khanikaev, *City College of New York, USA*
Dae Wook Kim, *University of Arizona, USA*
Toshiaki Koike-Akino, *Mitsubishi Electric Research Labs, Japan*
Tanya Kosc, *University of Rochester, USA*
Stephen Kuebler, *University of Central Florida, USA*
G.V. Pavan Kumar, *IISER-Pune, India*
Franko Küppers, *TU Darmstadt, Germany*
Brian Lail, *Florida Institute of Technology, USA*
Geon Joon Lee, *Kwangwoon University, South Korea*
Jiun-Haw Lee, *National Taiwan University, Taiwan*
Feng Li, *The Hong Kong Polytechnic University, Hong Kong*
Yan Li, *Peking University, China*
Juhao Li, *Peking University, China*
Charles Lieber, *Harvard University, USA*
Daniel Litynski, *Western Michigan University, USA*
Zhixin Liu, *University College London, UK*
Jung-Ping Liu, *Feng Chia University, China*
Yanhua Luo, *University of New South Wales, Australia*
Yiran Ma, *Finisar, Australia*
Brian Mangan, *OFS Laboratories, USA*
Onofrio Marago, *CNR-IPCF, Italy*
Alireza Marandi, *Stanford University, UK*
A. Márquez, *Universidad de Alicante, Spain*
Maurizio Martino, *Universita del Salento, Italy*
Goran Mashanovich, *University of Southampton, UK*
Dale McMorrow, *US Naval Research Laboratory, USA*
Yobani Mejia-Barbosa, *Universidad Nacional de Colombia, Columbia*
Charles Middleton, *Harris Corporation, USA*
Uladzimir Minkovich, *Centro de Investigaciones en Optica AC, Mexico*
Paolo Minzioni, *Universita degli Studi di Pavia, Italy*
Eric Mottay, *Amplitude, France*
K.M. Naga Srinivas Nadella, *University College London, UK*
Tamas Nagy, *Max Born Institute, Germany*
Tien Khee Ng, *King Abdullah Univ of Science & Tech, Saudi Arabia*
Mark Niedre, *Northeastern University, USA*
Gregory Nielson, *Nielson Scientific, USA*
Ampalavanapilla Nirmalathas, *University of Melbourne, Australia*
Ioan Notingher, *University of Nottingham, UK*
Tatiana Novikova, *Ecole Polytechnique, France*
Teri Odom, *Northwestern University, USA*
Zhengbiao Ouyang, *Shenzhen University, China*
Megan Paciaroni, *Fort Lewis College, USA*
Mrinmay Pal, *Central Glass & Ceramics Res Institute, India*
Shilong Pan, *Nanjing Univ Aeronautics & Astronautics, China*
Konstantin Pavlov, *University of New England, USA*
Frederick Perry, *Boston Electronics Corp., USA*
Rita Peterson, *US Air Force Research Laboratory, USA*
Peter Pilon, *OFS Laboratories, USA*

Luis Ponce, *IPN CICATA ALTAMIRA, Mexico*
Bryce Richards, *Karlsruhe Institute of Technology, Germany*
Jorge Ripoll, *Universidad Carlos III de Madrid, Spain*
Eduardo Rosa-Molinar, *University of Kansas, USA*
Joachim Sacher, *Sacher Lasertechnik GmbH, Germany*
Prasant Sahu, *IIT Bhubaneswar, India*
Massimo Santarsiero, *Università degli Studi Roma Tre, Italy*
Mohammad Sayeh, *Southern Illinois University Carbondale, USA*
Christian Schäfer, *isarpatent Munich, Germany*
Jochen Schroeder, *Chalmers Tekniska Hogskola, Sweden*
Rainer Schuhmann, *Berliner Glas KGaA Herbert Kubatz GmH &Co., Germany*
Ranjan Sen, *Central Glass & Ceramics Res Institute, India*
Utkarsh Sharma, *Optovue Inc., USA*
Gholamreza Shayeganrad, *Basel University, Switzerland*
Jason Sickler, *Torchlight Solutions, USA*
Hukum Singh, *NorthCap University, India*
Philip Smith, *SEMROCK, USA*
Vincenzo Spagnolo, *Politecnico di Bari, Italy*
Bernhard Stumpf, *University of Idaho, USA*
Lan Sun, *Raytheon Company, USA*
Jun Takeda, *Yokohama National University, Japan*
Herve Tatenguem Fankem, *Sacher Lasertechnik GmbH, Germany*
Alison Taylor, *The Optical Society, USA*
Chao Tian, *University of Science and Tech. of China, China*
Ion Tiginyanu, *Academy of Sciences of Moldova, Moldova*
Atsushi Uchida, *Saitama University, Japan*
Kathleen Vaeth, *Cornell University, USA*
Constantinos Valagiannopoulos, *Nazarbayev University, Kazakhstan*
Stacey Vargas, *Virginia Military Institute, USA*
Philippe Velha, *Scuola Sant'Anna, Italy*
Deepa Venkitesh, *Indian Institute of Technology Madras, India*
Taco Visser, *Vrije Universiteit Amsterdam, The Netherlands*
Josef Vojtech, *CESNET, Prague*
Giovanni Volpe, *Goteborgs Universitet, Sweden*
Matthew Weed, *Luminar Technologies, USA*
Ralf Wehrspohn, *Fraunhofer IMWS Halle, Germany*
Antoine Weis, *Universite de Fribourg, Switzerland*
Ian White, *University of Maryland at College Park, USA*
Rengmao Wu, *Zhejiang University, China*
Haiyun Xia, *Univ of Science and Technology of China, China*
Sanshui Xiao, *DTU Fotonik, The Netherlands*
Huailiang Xu, *Jilin University, China*
Fei Xu, *Nanjing University, China*
Changyuan Yu, *Hong Kong Polytechnic University, Hong Kong*
Shuiqing Yu, *University of Arkansas, USA*
Zhiliang Yuan, *Toshiba Research Europe Ltd, UK*
Jinhui Yuan, *Beijing University of Posts and Telecomm, China*
Robert Zawadzki, *University of California Davis, USA*
Yundong Zhang, *Harbin Institute of Technology, China*
Lin Zhang, *Aston University, UK*
Luming Zhao, *Jiangsu Normal University, China*
Kaiming Zhou, *Aston University, UK*
Chao Zhou, *Lehigh University, USA*
Xiushan Zhu, *University of Arizona, USA*
Weiren Zhu, *Shanghai Jiao Tong University, China*

APS/Division of Laser Science 2018 Awards and Honors

Arthur L. Schawlow Prize in Laser Science



Gérard Albert Mourou, *École Polytechnique, France*

For fundamental contributions in ultrafast, ultrahigh-field laser inventions, such as chirped pulse amplification, that led to the new discipline of relativistic optics.

Gérard Mourou is Professor Haut-Collége at the École Polytechnique. He is also the A.D. Moore Distinguished University Emeritus Professor of the University of Michigan. He received his undergraduate education at the University of Grenoble (1967) and his Ph.D. from University Paris VI in 1973. He has made numerous contributions to the field of ultrafast lasers, high-speed electronics, and medicine. His most important invention, developed with Donna Strickland while at the University of Rochester (N.Y.), is the laser amplification technique known as Chirped Pulse Amplification (CPA), universally used today. CPA's attosecond pulse generation and compact particle accelerators made possible the generation of extremely high laser intensities, making a new branch of optics possible. In 2005, Prof. Mourou proposed a new infrastructure, extreme light infrastructure (ELI), which is distributed over three pillars located in the Czech Republic, Romania, and Hungary. Prof. Mourou also pioneered the field of femtosecond ophthalmology that relies on a femtosecond laser for precise myopia correction and corneal transplants. Over a million such procedures are now performed annually. Prof. Mourou is member of the U.S. National Academy of Engineering, an OSA Fellow, and a foreign member of the Russian Science Academy, the Austrian Sciences Academy, and the Lombardy Academy for Sciences and Letters. He is Chevalier de la Légion d'honneur.

Carl E. Anderson Division of Laser Science Dissertation Award

The Carl E. Anderson Award for Outstanding Doctoral Dissertation in Laser Science was established in 2013 by the American Physical Society (APS) Division of Laser Science (DLS). Its purpose is to recognize doctoral research in the Laser Science area and to encourage effective written and oral presentation of research results. The award consists of $1,000 USD and a certificate citing the contribution made by the recipient. The finalists will present their work at a special session of the Laser Science conference on Monday morning. The winner will be announced at the DLS business meeting late Monday afternoon.

The following presentations will be given during this special session on Monday at 08:00.

Sara Campbell, *Lawrence Berkeley National Laboratory; Univ. of California, Berkeley, USA*
A Fermi-degenerate 3D Optical Lattice Clock

Mark Dong, *University of Michigan, USA*
Quantum-well Diode Lasers for Frequency Comb Generation

Bin Fang, *University of Illinois Urbana-Champaign, USA*
Manipulation of Photonic Quantum States: From Generation, Engineering, and Characterization to Storage and Retrieval

Pablo Solano, *MIT, USA*
Quantum Optics in Optical Nanofibers

APS DLS Fellows

Hui Deng, *University of Michigan, USA*
For pioneering contributions to fundamental physics and applications of matter-light coupled systems.

Munira Khalil, *University of Washington, USA*
For probing coherently coupled vibrational and electronic motion during ultrafast charge transfer processes by using a unique combination of infrared, visible, and X-ray experiments to provide new insights into this mechanism.

N. Asger Mortensen, *University of Southern Denmark, Denmark*
For fundamental explorations of light-matter interactions in nanostructures at the interface of classical electrodynamics and quantum physics.

Gunter Steinmeyer, *Max Born Institute, Germany*
For outstanding contributions to ultrafast nonlinear optics, in particular for the development of pulse characterization techniques, the experimental demonstration of pulse self-compression through laser filamentation, and the investigations of higher-order nonlinear susceptibilities and rogue waves.

Edo Waks, *University of Maryland College Park, USA*
For significantly advancing the field of quantum photonics and for developing new concepts to strongly interact solid-state quantum emitters with nanophotonic components.

OSA Foundation 2018 Prizes and Special Recognitions

OSA Foundation Boris P. Stoicheff Memorial Scholarship -

Established in 2011 by the OSAF and the Canadian Association of Physicists Educational Trust Fund (CAPETF), this program pays tribute to Boris P. Stoicheff, an internationally renowned laser spectroscopist who also served as President of OSA (1976) and CAP (1983-84).This $3,000 USD scholarship is awarded annually to a graduate student who has demonstrated both research excellence and significant service to the optics or physics community.

Past student recipients for this program can be found online at osa.org/stoicheff. Congratulations to our 2018 scholarship recipient:

Robin Puchert, *Universität Regensburg, Germany*

OSA Foundation Emil Wolf Outstanding Student Paper Competition

This competition recognizes the innovation, research excellence and presentation abilities of students presenting their work during FiO and honors Emil Wolf for his many contributions to science and The Optical Society. One winner is selected from each of the seven FiO subcommittees. Winners receive a complimentary OSA three-year student membership, an award stipend of $300 USD and an award certificate.

Past student recipients for this program can be found online at osa.org/wolf. 2018 recipients will also be announced at the FiO + LS Awards Banquet.

Congratulations to our finalists competing at FiO:

Abhijit Roy, *Indian Institute of Technology Kharagpur, India*
Ayan Chattopadhyay, *Princeton University, USA*
Bingchang Wu, *University of Tokyo, Japan*
Erwan Lucas, *Ecole Polytechnique Fédérale de Lausanne, Switzerland*
James D. Gaynor, *University of Washington, USA*
Jingyi Yang, *Baylor University, USA*
João Moura, *Delft University of Technology, Netherlands*
Julie Chang, *Stanford University, USA*
Lorenzo De Angelis, *Delft University of Technology, Netherlands*
Manoj Kumar Dasa, *Technical University of Denmark, Denmark*
Muhammad Faris Shahin Shahidan, *University of Melbourne, Australia*
Muhammed Veli, *University of California, Los Angeles, USA*
Poliane Aires Teixeira, *Federal University of Itajubá, Brazil*
Robert Pettit, *University of Rochester, USA*
Thomas Muir Hird, *University of Oxford, University College London, United Kingdom*
Zhenxu Bai, *Macquarie University, Australia*

OSA Foundation Incubic/Milton Chang Travel Grant

Funded by an endowment from Milton and Rosalind Chang, this program provides 10 grants of $500 USD each to enable students who present papers to travel to Frontiers in Optics. Grants are awarded to the presenter and usually the first author of the paper.

Past student recipients for this program can be found online at osa.org/incubic.

Congratulations to our 2018 Grant Recipients:

Ankan Bag, *Max Planck Institute for the Science of Light, Friedrich-Alexander-University Erlangen-Nuremberg, Germany*
Avijit Chatterjee, *Indian Institute of Science Bangalore, India*
Aysan Bahari, *Texas A&M University, USA*
Hsuan-Hao Lu, *Purdue University, USA*
Jingyang Peng, *RMIT University, Australia*
Liang Xu, *Nanjing University, China*
Luca La Volpe, *Laboratoire Kastler Brossel, France*
Milica Notaros, *Massachusetts Institute of Technology, USA*
Poolad Imany, *Purdue University, USA*
Shahriar Aghaeimeibodi, *University of Maryland, USA*

OSA Foundation Jean Bennett Memorial Student Travel Grant

Established in 2008, in memory of Jean M. Bennett, a highly decorated research physicist who was recognized for her contributions to the studies of optical surfaces and served as OSA's first female president, this $1,000 USD grant is awarded to a student presenting their work at FiO. This competition is administered by the OSA Foundation and is made possible through the generous support of Nanoptek Corporation, the Pennsylvania State University Department of Physics and individual contributors.

Past student recipients for this program can be found online at osa.org/bennett.

Congratulations to our 2018 grant recipient:

Muhammed Veli, *University of California, Los Angeles, USA*

OSA Foundation Robert S. Hilbert Memorial Student Travel Grant

Established in 2009 by Optical Research Associates (ORA), now the Optical Solutions Group at Synopsys, as a memorial to ORA's former President and Chief Executive Officer Robert S. Hilbert, this $1,100 USD grant recognizes the research excellence of students in the areas of optical engineering, lens design and illumination design.

Past student recipients for this program can be found online at osa.org/Hilbert. Congratulations to our 2018 grant recipients:

Ayan Chattopadhyay, *Princeton University, USA*
Abhijit Roy, *Indian Institute of Technology Kharagpur, India*
Nisha Nisha, *Bharati Vidyapeeths College of Engineering, India*

To learn more about these programs, attend the FiO + LS Awards Ceremony & Reception on 17 September from 18:00–21:00. Stop by registration to purchase a ticket.

The OSA Diversity & Inclusion Advocacy

Recognition Honorees

Acknowledged for outstanding dedication and accomplishments, fostering greater appreciation, advancement and celebration of diversity and inclusivity in optics and photonics.

Arlene Maclin
Howard University
United States

Frederique Vanholsbeeck
University of Auckland
New Zealand

Ling-An Wu
Chinese Academy of Sciences
China

Okinawa Institute of Science & Technology (OIST)
Japan

Honorable Mention for Individuals

Ibrahim Abdulhalim, Ben-Gurion Univ. of the Negev, Israel
Grace Mei Ting Chai, Univ. of Southampton, Malaysia
Prasoon Diwakar, Purdue Univ., USA
Alexis Vogt, Monroe Community College, USA

Honorable Mention for Organizations

HPE Technical Career Path, HP Enterprise, USA
Leibniz Inst. of Photonic Technology, Germany
Out in STEM, Univ. of Washington, USA
Respect is Part of Research, UC Berkeley, USA
The Abdus Salam Int'l. Centre for Theoretical Physics, Italy
Univ. of Cambridge, Equality and Diversity Section, UK
Univ. of Oxford, Department of Physics, UK
Women in Engr. and IT, Univ. of Tech. Sydney, Australia
Women in Optics, Univ. of Arizona, USA

Learn more at osa.org/divrec

OSA® | 100

DIVERSITY & INCLUSION IN OPTICS AND PHOTONICS

Special Events

WiSTEE Connect (Women in Science, Technology, Engineering and Entrepreneurship)

Sunday, 16 September, 08:00–16:00
OSA Headquarters

WiSTEE Connect (Women in Science, Technology, Engineering and Entrepreneurship) is collaborating with the OSA Foundation to organize the 3rd International Symposium, "Global Women of Light" (GWL). This GWL symposium will focus on Career Strategies for Women in Science, Technology, Engineering, and Entrepreneurship. Preregistration is required.

Laser Science Symposium on Undergraduate Research

Monday, 17 September, 12:00–18:00
International Ballroom East

Organizers: Chad Hoyt, *Bethel University, USA,* and Harold Metcalf, *Stony Brook University, USA*

The Symposium on Undergraduate Research has been a feature of the annual meeting of the Division of Laser Science of the American Physical Society (APS-DLS) for sixteen years, and has showcased the research of more than 500 students during that time. Students' presentations often describe their work during the previous summer. The NSF has played a vital role by providing the research opportunities for many of the students through its REU programs, as well as by direct support of the event. The symposium has been generously supported by the DLS, OSA, NSF, SPS, and Univ. MD (JQI), along with corporate sponsors Thorlabs, Photonics Industries, East Coast Optical Technologies, and Bristol Instruments.

OSA Therapeutic Laser Applications Technical Group "Birds of a Feather" Networking Lunch

Monday, 17 September, 12:30–13:30
Fairchild West

Join the OSA Therapeutic Laser Applications Technical Group for a guided networking session during lunch on Monday. In addition to learning more about this technical group, you will have a chance to connect with your fellow attendees who share an interest in the same topics as you, such as lasers in ophthalmology, tissue imaging, spectroscopic tools and methods, and light-tissue interactions. An RSVP is required to attend this event. Please contact tgactivities@osa.org to register, pending availability.

Hosted by: OSA Therapeutic Laser Applications Technical Group

OSA Quantum Computing and Communication Technical Group Networking Lunch

Monday, 17 September, 12:30–13:30
Fairchild East

Members of the Quantum Computing and Communication Technical Group are invited to join us for a networking lunch on Monday. The event will provide an opportunity to connect with fellow attendees who share an interest in this field, learn more about this technical group, and provide your input on future technical group activities. An RSVP is required for this technical group event; please contact TGactivities@osa.org to register, pending availability.

Hosted by: OSA Quantum Computing and Communication Technical Group

OSA Senior Member Workshop

Monday, 17th September, 15:00–17:00
Holmead, Lobby Level

This session focuses on the potential to lead lasting and positive change in yourself and the future leaders in optics through quality mentoring and sponsorship. With your guidance, you can help build and strengthen personal brands, leadership skills and business ethics. If you're a senior member and interested in mentoring and sponsorship opportunities, join us at this interactive session. During the session you will reflect on both the impact and the opportunity of having both mentors and sponsors in your life and Evaluate best practices and internal strategies to elevate others while expanding your personal leadership capabilities and Understand and build a business case for mentoring and sponsorship in your organization to drive diversity, retention, knowledge transfer and engagement. This program is open to Senior Members only. Limited space is available, rsvp to gmontanez@osa.org.

DLS Annual Business Meeting

Monday, 17 September, 16:00–17:00
Georgetown West

All members and interested parties are invited to attend the annual business meeting of the APS Division of Laser Science (DLS). The DLS officers will report on the activities of the past year and on plans for the future. Questions will be taken from the floor. This is an opportunity to help define the operations of the DLS and the Laser Science Conference. In addition, the winner of the Carl E. Anderson Dissertation Award will be announced.

Meet OSA's Journal Editors

Monday, 17 September, 16:00–17:00
Concourse Foyer

Join OSA Publishing's Journal Editors for conversation and refreshments. The Editors welcome your questions, concerns and ideas for any of OSA's Journals. Topics that can be covered include best practices when submitting a manuscript, elements of a useful manuscript review, criteria editors look for in submitted manuscripts, and the process to propose a Feature Issue topic for publication in an OSA Journal. All are welcome to attend.

OSA Optical Fabrication and Testing Technical Group Knowledge Café

Monday, 17 September, 16:00–17:30
International Ballroom West

Do you have questions about optical fabrication and optics testing? Join the OSA Optical Fabrication and Testing Technical Group at our Knowledge Café on Monday afternoon for a drink and a chance to seek out the answers to your questions in an informal atmosphere. Our knowledgeable "bartenders", experts in their own fields, will be available to answer your questions and discuss issues related to the group's areas of interest. Please contact TGactivities@osa.org to let us know you will be joining us in the café.

Hosted by: OSA Optical Fabrication and Testing Technical Group

OSA Photonic Metamaterials Technical Group Tutorial on Metalens Design and Simulation

Monday, 17 September, 16:00–18:00
Lincoln West

Join the OSA Photonic Metamaterials Technical Group for a tutorial on metalens design and simulation on Monday afternoon. This tutorial, aimed at students and new researchers, will focus on hands-on skills. Dr. Wei Ting Chen from Harvard University will provide an introduction to metalenses followed by a tutorial on how to simulate the phase of different nanostructures and a real-time simulation demo of metalenses. An RSVP is required for this technical group event; please contact TGactivities@osa.org to register, pending availability.

Hosted by: OSA Photonic Metamaterials Technical Group

Finishing Touches: A Tutorial in Blender for Cover Art and Figures

Monday, 17 September 16:00–18:00
Jefferson West

Join the OSA Optical Materials Studies Technical Group for an opportunity to learn more about putting Blender, a free graphics software, to use to enhance your papers and presentations. Nathaniel Kinsey of Virginia Commonwealth University will take attendees through a live demonstration on the basics of how to use Blender to create scientific figures and cover art as well as more advanced topics related to creating images for optics, such as making laser beams, adding focal blur, creating realistic optical materials, and merging real photo images with CGI images. An RSVP is required for this technical group event; please contact TGactivities@osa.org to register, pending availability.

Hosted by: OSA Optical Material Studies Technical Group

Cheeky Scientist Career Development Workshops

Monday, 17 September, 16:00–18:30
Jefferson East

Isaiah Hankel from Cheeky Scientist works with hundreds of graduate students and postdocs daily assisting them in their transition to industry by first showing them how to present themselves as business professionals. These programs will provide you with a strong understanding of what it takes to have a tailored industry resume and how to showcase your transferrable skills.

Session 1: Networking: An Art & Science: 16:00–17:00

This section is created based on the networking strategies of some of the most strategic networkers in the world and also goes into the science of building rapport and why this is important for the job seeking professional. While this topic tends to be popular, it seems people are still not using it effectively and thus we have detailed specific action steps job seekers can take, and specific scripts to use while networking.

Session 2: The Modern Job Search: 17:30–18:30

Using online profiles to maximize the effectiveness of the job seeking/transition process. Hiring managers use LinkedIn to determine whether they will bring in a candidate for an interview, this topic will cover all the key elements of the LinkedIn profile and how each section should be used to strategically maximize its impact. In addition, we will show candidates how to use LinkedIn algorithms to support their job search, and sell themselves to perspective employers.

Foundational Skills of Professional Networking – How First Impressions and Elevator Pitches Lead to Career Success and Longevity

Monday, 17 September, 16:00–17:00
Cabinet

When you enter a new organization and seek to meet new people or to build relationships to expand your professional network, you are inevitably asked: "Tell me a little bit about yourself." The traditional "elevator pitch"—a 30-60 second introduction about oneself—is commonly practiced, memorized and delivered to initiate this conversation. This initial interaction can often determine you value and "likeability" that can set you on a path of relationship success, or failure. Making a mistake can be costly and difficult to recover from. In a very short time, you must be able to quickly establish a relationship with a new person and show them why it's important to remain connected to you. Once this occurs, this new contact will want to include you in their network and help you achieve the outcomes you desire. The speaker is Josh Henkin, STEM Career Services, USA

After this workshop, you will be able to:

1. Understand the criticality of first impressions, "likeability" and the double edged sword of networking
2. Craft and deliver an elevator pitch that clearly communicates your professional highlights, what you currently do, why you do it and who it benefits, and what is next for you professionally
3. Learn how to express yourself authentically to differentiate from others with similar training/skills/experiences

The Rules of Engagement: Navigating Important Business Relationships

Monday, 17 September, 16:00–17:30
Georgetown East

Important business relationships often are formed and cemented in social settings. Yet, many professionals feel uncomfortable in these environments. Working a crowded room and managing the more formal dining setting—these and other business entertainment opportunities challenge many professionals, junior and more senior alike. This 90-minute program, led by Mary Crane, is specifically designed to help professionals feel competent and comfortable in any business-social setting. Participants will learn ten specific rules for working a reception and ten more rules for managing a business lunch or dinner. To the extent your organization would like, we also cover rules for electronic communications and personal presentation.

OSA Polarization Technical Group Rapid-Fire Presentations & Networking Event

Monday, 17 September, 18:00–19:00
International Ballroom West

Join the OSA Polarization Technical Group for a networking event on Monday evening that will highlight the research being done in this topic area by students and early career professionals. Our event will be an opportunity to hear rapid-fire presentations of the work they will present during Frontier in Optics while networking with your colleagues over refreshments. Attendees can then visit the presenters' posters during the conference poster sessions on Tuesday and Wednesday to learn more about their research and also to cast their vote for the Best Polarization Presentation. Please contact TGactivities@osa.org to let us know you will be joining us for this event.

Hosted by: OSA Polarization Technical Group

Workshop: Understanding Unconscious Bias

Monday, 17 September, 18:00–19:00
Georgetown East

Research demonstrates that we all have unconscious biases. These biases can result in best and brightest talent made to feel unwelcome, invisible, and not important to the success of the organization. This training, led by Sara Bendoraitis, will explore concepts and engage participants to better understand implicit bias, increase awareness and understanding of the impact on organizational culture, and identify ways to promote greater engagement with diversity and inclusion.

Hosted by: OSA | 100 DIVERSITY & INCLUSION IN OPTICS AND PHOTONICS

OSA Annual Business Meeting

Tuesday, 18 September, 17:30–18:15
Kaloroma

Learn more about OSA and join the OSA Board of Directors for the Society's annual business meeting. An update on the Society's activities will be presented and the results of the Board of Directors election will be announced.

Conference Reception

Tuesday, 18 September, 18:30–20:30
International Ballroom Center

Dance the night away and enjoy tasty treats with your fellow conference attendees from around the world. The reception is sure to be a high point in a memorable conference week.

Sponsored by THORLABS

NAS Decadal Assessment and Outlook Report on Atomic, Molecular, and Optical Science

Wednesday, 19 September, 09:05–10:00
Cabinet

Join National Academies of Sciences Committee Chairs Jun Ye (JILA) and Nergis Mavalvala (MIT) to hear about and provide input into their once-a-decade retrospective and prospective assessment of the frontiers of AMO research, funding, and workforce. The resulting report will help guide federal research directions.

OSA Family and Friends Tour

Wednesday, 19 September, 10:00–12:00

Tudor Place is a National Historic Landmark nestled in the neighborhood of Georgetown. Completed in 1816, lived in by six generations of a single family, and opened to the public in 1988, Tudor Place Historic House & Gardens preserves, interprets, and shares with the public and scholars the rich resources of architecture, history, collections, and archives.

With an object collection representing every time period of the estate's occupation since 1805, the estate is a time capsule of culture. Its 15,000-plus objects spans three centuries and include a range of cultural touchstones from Martha and George Washington's personal items to Asian and European decorative arts, musical instruments, garden implements, weaponry, 20th-century couture, and a 1919 automobile.

Ground transportation will be provided to and from the museum.

To register, please email Jennifer Mehltretter at jmehltretter@osa.org

Meet the *Physical Review* Journal Editors Reception

Wednesday, 19 September, 15:30–17:00
Monroe

The editors of the *Physical Review* journals invite you to join them for conversation and light refreshments. The editors will be available to answer questions, hear your ideas and discuss any comments about the journals.

OSA Senior Member Reception

Wednesday, 19 September, 17:00–19:00
Holmead, Lobby Level

Join your colleagues at the first annual Senior Member reception. The reception is an RSVP event for Senior Members of OSA to network, enjoy refreshments, food and mingle with fellow Senior Members. Each Senior Member can bring one guest that can discover the benefits of becoming an OSA Senior Member. RSVP to gmontanez@osa.org.

OSA Capitol Hill Meetings

Thursday, 20 September
Senate and House Office Buildings, Washington D.C.

As U.S. Congress determines spending levels in the FY2019 funding legislation, it is important for members of U.S. Congress to hear directly from their constituents. To facilitate those interactions, OSA will be holding U.S. Capitol Hill meetings to advocate for R&D funding as well as other issues such as the National Quantum Initiative. Prior RSVP required to participate. If you RSVP'd for Capitol Hill meetings and have questions, contact Brandy Dillingham at bdillingham@osa.org.

FiO + LS Committees

Thanks to the technical program committee members! Your time and efforts are appreciated!

Frontiers in Optics General Chairs

Christoph Harder, *Swissphotonics, Switzerland*
Wei Lee, *National Chaio Tung University, Taiwan*

FiO Theme Coordinators

Automotive

Alex Fong, *TruTag Technologies, Inc., USA*
Sabbir Rangwala, *Patience Consulting LLC, USA*

Nanophotonics and Plasmonics

Ortwin Hess, *Imperial College London, United Kingdom*

Quantum Technologies

Nils Hempler, *M Squared Lasers Ltd., United Kingdom*

Virtual Reality and Augmented Vision

Bernard Kress, *Microsoft, USA*

FiO Program Committees

FiO 1: Fabrication, Design and Instrumentation

Byoungho Lee, *Seoul National University, Korea,* **Subcommittee Chair**
Liangcai Cao, *Tsinghua University, China*
Chau-Jern Cheng, *National Taiwan Normal University, Taiwan*
Jessica DeGroote Nelson, *Optimax Systems Inc., USA*
Pietro Ferraro, *Instituto Nazionale di Ottica, Italy*
Groot Gregory, *Synopsys, Inc., USA*
Yoshio Hayasaki, *Utsunomiya University, Japan*
Joohwan Kim, *NVIDIA Corporation, USA*
John Koshel, *University of Arizona, USA*
Pascal Picart, *LAUM CNRS Université du Maine, France*
Jamie Leigh Ramsey, *RPO, USA*
Yunlong Sheng, *Université Laval, Canada*
Simon Thibault, *Université Laval, Canada*

FiO 2: Optical Interactions

Halina Rubinsztein-Dunlop, *University of Queensland, Australia*, **Subcommittee Chair**
Gregory J. Gbur, *University of North Carolina at Charlotte, USA*
Igor Jovanovic, *University of Michigan, USA*
Igor Litvinyuk, *Griffith University, Australia*
Carlos Lopez-Mariscal, *Underwater Photonics, Mexico*
William Munro, *NTT Basic Research Laboratories, Japan*
Kae Nemoto, *National Institute of Informatics, Japan*
Takashige Omatsu, *Chiba University, Japan*
Monika Ritsch-Marte, *Innsbruck Medical University, Austria*

FiO 3: Quantum Electronics

Antonio Badolato, *University of Ottawa, Canada*, **Subcommittee Chair**
Marcelo Davanco, *National Institute of Standards and Technology (NIST), USA*
Rosario Fazio, *Scuola Normale Superiore, Italy*
Dario Gerace, *Università degli Studi di Pavia, Italy*
Brian D. Gerardot, *Heriot-Watt University, United Kingdom*
Evelyn L. Hu, *Harvard University, USA*
Katarzyna Matczyszyn, *Wroclaw University of Science and Technology, Poland*
Joyce Poon, *University of Toronto, Canada*
Luca Sapienza, *University of Southampton, United Kingdom*
Giuseppe Strangi, *Case Western Reserve University, USA*
Richard Warburton, *University of Basel, Switzerland*

FiO 4A: Fiber Optics and Optical Communications Photonics

Greg Raybon, *Nokia Bell Labs, USA*, **Subcommittee Chair**
Anjali Agarwal, *Vencore Labs, USA*
Tymon Barwicz, *IBM, USA*
Mina Esmaeelpour, *Stanford University, USA*
Takuro Fujii, *NTT Device Technology Laboratories, Japan*
Lyuba Kuznetsova, *San Diego State University, USA*
Anna Peacock, *University of Southampton, United Kingdom*
Karsten Rotwitt, *DTU Fotonik, Netherlands*
Alexey Turukhin, *TE SubCom, USA*
Thomas Van Vaerenbergh, *Hewlett Packard Labs, USA*

FiO 4B: Photonic Integrated Devices for Computing, Sensing, and Other Applications

Paul Barclay, *University of Calgary, Canada*, **Subcommittee Chair**
Amy C. Foster, *John Hopkins University, USA*
Femius Koenderink, *FOM Inst. for Atomic & Molecular Physics, Netherlands*
Dangyuan Lei, *Hong Kong Polytechnic University, Hong Kong*
Di Liang, *Hewlett Packard Enterprise, USA*
Qiang Lin, *University of Rochester, USA*
Michelle Lynn Povinelli, *University of Southern California, USA*

FiO 5: Optics in Biology, Medicine, Vision, and Color

David Busch, *University of Texas Southwestern, USA*, **Subcommittee Chair**
Joeseph Angelo, *NIST, USA*
Bernhard Baumann, *Medizinische Universität Wien, Austria*
Félix Fanjul-Vélez, *University of Cantabria, Spain*
Delphine Gourdon, *University of Ottawa, Canada*
Jana Kainerstorfer, *Carnegie Mellon University, USA*
Marina Zannoli, *Oculus VR, USA*

FiO 6: Information Acquisition, Processing, and Display

Kenji Yamamoto, *National Institute of Information and Communications Technology, Japan*, **Subcommittee Chair**
Johannes K. Courtial, *University of Glasgow, United Kingdom*
Nobuyuki Hashimoto, *Citizen Watch Co., LTD, Japan*
Tomasz Kozacki, *Politechnika Warszawska, Poland*
Hong-Seok Lee, *Samsung Electronics, Korea*
Ting-Chung Poon, *Virginia Tech, USA*
Elena Stoykova, *Bulgarian Academy of Sciences, Bulgaria*
Qiong-Hua Wang, *Sichuan University, China*

Laser Science Chairs

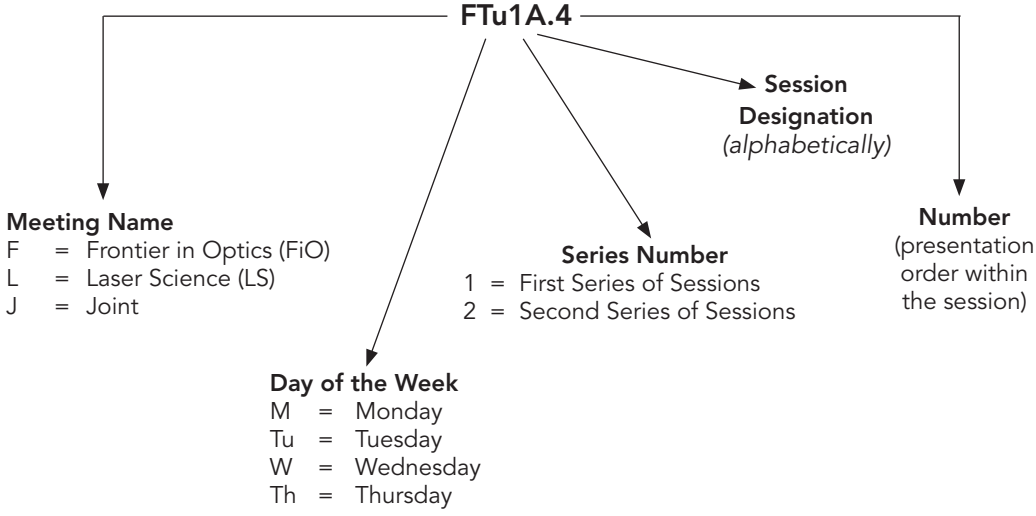
Peter Delfyett, *University of Central Florida, USA*
Nathan Newbury, *National Institute of Standards & Technology, USA*

Laser Science Program Committees

1. **Extreme Laser Science (Wavelength, Power, Time)**
   David Reis, *Stanford University, USA*
2. **Quantum Science**
   Xiaoqin (Elaine) Li, *University of Texas, USA*
3. **Precision Spectroscopy**
   Hiroyuki Sasada, *University of Tokyo, Japan*
4. **Novel Lasers, Plasmonics, Nanophotonics**
   Pieter Kik, *CREOL, USA*

NOTES

Explanation of Session Codes



The first letter of the code designates the meeting (For instance, F = Frontiers in Optics, L = Laser Science, J=Joint). The second element denotes the day of the week (Monday = M, Tuesday = Tu, Wednesday = W, Thursday = Th). The third element indicates the session series in that day (for instance, 1 would denote the first parallel sessions in that day). Each day begins with the letter A in the fourth element and continues alphabetically through a series of parallel sessions. The lettering then restarts with each new series. The number on the end of the code (separated from the session code with a period) signals the position of the talk within the session (first, second, third, etc.). For example, a presentation coded FW2A.1 indicates that this paper is part of the FiO + LS Meeting and is being presented on Wednesday (W) in the second series of sessions (2), and is the first parallel session (A) in that series and the first paper (1) presented in that session.

It is the policy of The Optical Society (OSA) that all forms of bullying, discrimination, and harassment, sexual or otherwise, are prohibited in any events or activities held or managed by OSA.

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Agenda of Sessions — Monday, 17 September

	International Ballroom East	Georgetown West	Georgetown East	Jefferson West	Jefferson East	Lincoln West	Cabinet
07:00–17:30	**Registration,** *Terrace Level Foyer*						
08:00–10:00		**LM1B • Quantum Science I**	**LM1C • Carl E. Anderson Division of Laser Science Dissertation Award Presentations**				
08:30–09:15	**FM1A • Visionary: Jan-Erik Kallhammer**						
09:00–10:00	**FM2A • Visionary: Teri Odom**						
10:00–10:30	**Coffee Break,** *Concourse Foyer*						
10:30–12:30	**LM3A • Visionary: Prem Kumar** (ends at 11:15)	**LM3B • Quantum Science II** (begins at 11:30)	**FM3C • Advanced Beam Shaping and Trapping**	**FM3D • Novel Devices, Manufacturing and Testing**	**FM3E • LIDAR Approaches and the Demands on Optical Components**	**FM3F • Biomedical Optics**	**FM3G • Frontiers of Nanoplasmonics: New Materials – Active – Slow Light**
12:00–18:00	**Laser Science Symposium on Undergraduate Research,** *International Ballroom East*						
12:30–14:00	**Lunch break on your own**						
12:30–13:30	**OSA Therapeutic Laser Applications Technical Group "Birds of a Feather" Networking Lunch,** *Fairchild West* (advanced registration required)						
12:30–13:30	**OSA Quantum Computing and Communication Technical Group Networking Lunch,** *Fairchild East* (advanced registration required)						
14:00–16:00		**LM4A • Quantum Science III** (ends at 15:15)	**FM4B • Light – Matter Interaction**	**FM4C • Imaging and Sensing Technologies**	**FM4D • A Realistic Assessment of Optics for Self-driving Vehicles (panel)**	**FM4E • Advanced Microscopy**	**FM4F • Complex Nanophotonics**
15:00–17:00	**OSA Senior Member Workshop,** *Holmead, Lobby Level (advanced registration required)*						
16:00–16:30	**Coffee Break,** *Concourse Foyer*						
16:00–17:00	**Meet OSA's Journal Editors,** *Concourse Foyer*						
16:00–17:00	**DLS Annual Business Meeting,** *Georgetown West*						
16:00–17:00	**Foundational Skills of Professional Networking – How First Impressions and Elevator Pitches Lead to Career Success and Longevity,** *Cabinet*						
16:00–17:30	**OSA Optical Fabrication and Testing Technical Group Knowledge Café,** *International Ballroom West*						
16:00–17:30	**The Rules of Engagement: Navigating Important Business Relationships,** *Georgetown East*						
16:00–18:00	**Finishing Touches: A Tutorial in Blender for Cover Art and Figures,** *Jefferson West*						
16:00–18:00	**OSA Photonic Metamaterials Technical Group Tutorial on Metalens Design and Simulation,** *Lincoln West*						
16:00–18:30	**Cheeky Scientist Career Development Workshops,** *Jefferson East*						
18:00–19:00	**OSA Polarization Technical Group Rapid- Fire Presentations & Networking Event,** *International Ballroom West*						
18:00–19:00	**Workshop: Understanding Unconscious Bias,** *Georgetown East*						
18:00–21:00	**Awards Ceremony & Reception,** *Carnegie Institute of Science, 1530 P St. NW* (Separate Ticket Required)						

All locations listed are in the Washington Hilton unless otherwise noted.

Locations may change, please check the conference app and update sheet for the latest scheduling updates.

Key to Shading

Frontiers in Optics Laser Science Joint

Agenda of Sessions — Tuesday, 18 September

	International Ballroom East	Cabinet	Jefferson West	Jefferson East	Lincoln West	Georgetown
07:00–18:00	**Registration,** *Terrace Level Foyer*					
08:00–09:30	**Plenary Session,** *International Ballroom Center*					
09:30–15:00	**Science & Industry Showcase,** *Columbia on the Terrance Level* 09:30–10:00 **Coffee Break** 10:00–12:00 **Poster Session I and Dynamic E-Posters** 10:00–11:00 **Rapid Fire Oral Presentations I,** *Science & Industry Showcase Theater* 10:00–15:00 **Vehicle Equipped with Ouster LIDAR Demo,** *Demo Area* 10:00–15:00 **VR, AR and MR Headset Demo,** *Demo Area* 10:50–11:40 **Entrepreneur - That's French for Crazy Person,** *Science & Industry Showcase Theater* 11:45–12:00 **Remarks from the OSA President,** *Science & Industry Showcase Theater* 12:00–13:00 **Job Seeker Tutorial - WORKinOPTICS.com,** *Science & Industry Showcase Theater* 12:00–13:00 **Lunch** 13:00–15:00 **Poster Session II and Dynamic E-Posters** 13:00–14:00 **Rapid Fire Oral Presentations 2,** *Science & Industry Showcase Theater* 13:30–14:00 **Coffee Break** 14:05–15:00 **Leveraging LinkedIn – Building Relationships, Attracting Recruiters, Finding the the Best Jobs and Growing Your Network,** *Science & Industry Showcase Theater*					
15:00–16:30	**FTu4A • Applied Nanoplasmonics: Solar – Sensing – Communication**	**FTu4B • Short Pulse Lasers**	**FTu4C • Terahertz Science**	**FTu4D • Optical Technologies for Autonomy in Realistic Weather (panel)**	**FTu4E • Integrated Nanophotonic Devices**	**LTu4F • Extreme Laser Science I**
16:45–18:15	**FTu5A • Quantum and Near-Field Nanoplasmonics**	**FTu5B • Semiconductor Lasers and SDM**	**FTu5C • Novel Lasers and Applications**	**FTu5D • Optical Technologies for Autonomy in Unstructured Environments (panel)**	**FTu5E • Topological Photonics**	**LTu5F • Extreme Laser Science II**
17:30–18:15	**OSA Annual Business Meeting,** *Kalorama*					
18:30–20:30	**Conference Reception,** *International Ballroom*					

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Frontiers in Optics | Laser Science | Joint

Agenda of Sessions — Wednesday, 19 September

	International Ballroom East	Cabinet	Jefferson West	Jefferson East	Lincoln West	Georgetown
07:30–18:00	**Registration,** *Terrace Level Foyer*					
08:00–09:00	**FW1A • The Coming of Age for Smart Glasses, AR and VR**	**FW1B • Novel Lasers and Photodetectors**	**FW1C • Nanophotonics I**	**FW1D • Quantum Sensing for Industry and Fundamental Physics I**	**FW1E • Nanophotonic sensing and optomechanics**	**LW1F • Novel Lasers, Plasmonics, Nanophotonics I**
09:15–10:00	**FW2A • Visionary: Mark Bolas**	**NAS Decadal Assessment and Outlook Report on Atomic, Molecular, and Optical Science** (starts at 09:05)				**LW2B • Visionary: Mark Brongersma**
10:00–15:00	**Science & Industry Showcase,** *Columbia on the Terrance Level* 10:00–10:30 **Coffee Break** 10:00–12:00 **Poster Session III and Dynamic E-Posters** 10:15–11:15 **Rapid Fire Oral Presentations III,** *Science & Industry Showcase Theater* 10:00–15:00 **Vehicle Equipped with Ouster LIDAR Demo,** *Demo Area* 10:00–15:00 **VR, AR and MR Headsets Demo,** *Demo Area* 11:15–12:15 **Frontiers in Funding,** *Science & Industry Showcase Theater* 12:00–13:00 **OIDA VIP Industry Leaders Speed Meetings Lunch** 12:00–13:00 **Lunch** 12:20–12:55 **Enabling and Entangling the Tools to Innovate in Quantum Technologies** 13:00–15:00 **Poster Session IV and Dynamic E-Posters** 13:00–14:00 **Rapid Fire Oral Presentations IV,** *Science & Industry Showcase Theater* 13:30–14:00 **Coffee Break** 14:05–15:00 **Understanding the National Quantum Initiative,** *Science & Industry Showcase Theater*					
10:00–12:00	**OSA Members, Family and Friends Tour,** *Tudor Place*					
15:00–16:30	**FW5A • AR and VR Ecosystems Developments**	**FW5B • Optical Communications**	**FW5C • Quantum Systems**	**FW5D • Quantum Sensing for Industry and Fundamental Physics II**	**FW5E • Plasmonic and Nanophotonic Materials**	**LW5F • Novel Lasers, Plasmonics, Nanophotonics II**
15:30–17:00	**Meet the *Physical Review* Journal Editors Reception,** *Monroe*					
16:45–18:00	**FW6A • New Optical Hardware is Key to Next Generation AR and MR** (ends at 18:45)	**FW6B • Novel Optical Fibers and Modulators**	**FW6C • Solid State Quantum Optics**	**FW6D • Quantum Computing with Atoms and Photons I**	**FW6E • Meta- and Nanophotonic Devices for Imaging and Applications**	**LW6F • Novel Lasers, Plasmonics, Nanophotonics III**
17:00–19:00	**OSA Senior Member Reception,** *Holmead, Lobby Level*					
18:15–19:00	**Dinner break on your Own**					
19:00–21:00	**Postdeadline Papers** (A complete list of presentations and locations will be in the conference update sheet.)					

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Frontiers in Optics Laser Science Joint

Agenda of Sessions — Thursday, 20 September

	International Ballroom East	Cabinet	Jefferson West	Jefferson East	Lincoln West	Georgetown
07:30–11:00	**Registration,** *Terrace Level Foyer*					
08:00–09:00	**FTh1A • Vision Comfort as a Key to AR Mass Adoption**	**FTh1B • Quantum Information**	**FTh1C • Shaping Light and Design of Quantum Devices**	**FTh1D • Quantum Computing with Atoms and Photons II**	**FTh1E • Computational/ Transformation Optics and Optics in Computing**	**LTh1F • Precision Laser Spectroscopy**
09:00–09:15	**Break**					
09:15–10:00	**FTh2A • Visionary: Sir Peter Knight**					**LTh2B • Visionary: David DeMille**
10:00–10:30	**Coffee Break,** *Concourse Foyer*					
10:00–16:00	**OSA Capitol Hill Meetings,** *Senate and House Office Buildings, Washington D.C.*					
10:30–12:30	**FTh3A • AR/ VR Applications for Enterprise and Consumer Markets**	**FTh3B • Quantum Electronics**	**FTh3C • Optical Comb Metrology**	**FTh3D • Quantum Communications and the Future Quantum Internet**	**FTh3E • Information Processing, Information Display and Optical Device**	**LTh3F • Advances in Molecular Spectroscopy**

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Frontiers in Optics Laser Science Joint

08:30–09:15
FM1A • Visionary: Jan-Erik Kallhammer
Presider: Sabbir Rangwala; Patience Consulting LLC, USA

FM1A.1 • 08:30 VISIONARY

From Night Vision to LiDAR: An Automotive Perspective, Jan-Erik Kallhammer[1]; [1]*Autoliv Sverige AB, Sweden*. Work is underway to complement cameras and radar with LiDAR in serial automotive use. There are many considerations besides technical challenges to be made before LiDAR can be launched as a serial product. The talk will draw on experiences of taking Night Vision to the automotive market.

09:15–10:00
FM2A • Visionary: Teri Odom
Presider: Ortwin Hess; Imperial College, London, UK

FM2A.1 • 09:15 VISIONARY

Peering Through the Looking Glass: The Next Frontier in Nano-Optics, Teri W. Odom[1]; [1]*Northwestern Univ., USA*. Over the past decade, significant progress in controlling light-matter interactions at the nanoscale has been achieved. Most of the advances, however, have relied on fixed systems limited to as-fabricated nanostructures and singly periodic arrays and simple unit cells. This visionary talk will discuss how the ability to engineer complex nanophotonics responses—on demand—may address key challenges and open unexpected possibilities in nanoscale optics. We will highlight new designs in topological photonics, stimuli-responsive nanostructured substrates for tunable nano-lasing and reconfigurable lensing, and prospects of multi-periodic structured materials.

08:00–10:00
LM1B • Quantum Science I
Presider: Evan Meyer-Scott; Universität Paderborn, Germany

LM1B.1 • 08:00

Hong-Ou-Mandel Effect Between Single-Photon Source and Thermal Light, Elisha Siddiqui[1], Tim Byrnes[2], Jonathan P. Dowling[1]; [1]*Louisiana State Univ., USA;* [2]*New York Univ., China*. We describe the theory of Hong-Ou-Mandel (HOM) interference, between a single photon source and thermal light and demonstrate the maximum visibility attainable for non-ideal single photon resources.

LM1B.2 • 08:15

Quantum-Limited Discrimination between Laser Light and Noise, Jonathan Habif[1], Saikat Guha[2]; [1]*Information Sciences Inst., Univ. of Southern California, USA;* [2]*College of Optical Sciences, Univ. of Arizona, USA*. We evaluate quantum limits and structured receiver performance for discriminating between a mode excited in a thermal or a coherent state, and show an interesting inversion in receiver performance going from single-shot to collective measurements.

LM1B.3 • 08:30

Characterizing Photon Statistics in an Unbalanced Beam Splitter, Hamed Pourbeyram[1], Cody Bassett[1], Arash Mafi[1]; [1]*Univ. of New Mexico, USA*. A theoretical framework has been developed and examined experimentally for photon statistics in an unbalanced beam splitter. We show that it is possible to determine the photon statistics of a lights source without coincidence counting.

LM1B.4 • 08:45

Quantum Enhanced Measurement Using SU(1,1) Interferometer with Dual-beam Sensing, Yuhong Liu[1], Jiamin Li[1], Liang Cui[1], Nan Huo[1], Xiaoying Li[1], Zheyu Ou[1,2]; [1]*Tianjin Univ., China;* [2]*Dept. of Physics, Indiana Univ.-Purdue Univ. Indianapolis, USA*. Using an SU(1,1) interferometer with dual-beam as the sensing field, we experimentally demonstrate the sensitivity of phase measurement is 2.4 dB higher than the standard quantum limit achieved by directly measuring a probe beam.

LM1B.5 • 09:00

Observation of One-way Einstein-Podolsky-Rosen Steering, Sabine Wollmann[1,2], Travis J. Baker[2], Nathan Walk[2,3], Adam Bennet[2], Nora Tischler[2], Howard M. Wiseman[2], Geoff J. Pryde[2], Jonathan C. Matthews[1]; [1]*Univ. of Bristol, UK;* [2]*Griffith Univ., Australia;* [3]*Dept. of Computer Science, Univ. of Oxford, UK*. We prove and experimentally demonstrate that EPR-steering can be rigorously asymmetric, unlike Bell tests, by constructing quantum states which are steerable in one direction, whilst two-way steering is impossible with arbitrary quantum measurements.

LM1B.6 • 09:15

Generation of Photon-Subtracted Two-Mode Squeezed Vacuum States, Roberto d. Leon Montiel[1], Omar Magana Loaiza[2], Armando Perez Leija[3,4], Alfred U'Ren[1], Kurt Busch[3,4], Adriana E. Lita[2], Saw W. Nam[2], Thomas Gerrits[2], Richard Mirin[2]; [1]*Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de Mexico, Mexico;* [2]*National Inst. of Standards and Technology, USA;* [3]*Max-Born-Institut, Germany;* [4]*Inst. für Physik, Humboldt-Universität zu Berlin, Germany.* We experimentally demonstrate that the simultaneous subtraction of photons from a two-mode squeezed vacuum state leads to the generation of entangled states with increasingly larger average photon number.

LM1B.7 • 09:30

Tailored photon-pair generation in optical fiber through dual-pump spontaneous four-wave mixing, Yujie Zhang[1], Ryan Spiniolas[1], Kai B. Shinbrough[1], Fang Bin[1], Offir Cohen[1], Virginia O. Lorenz[1]; [1]*Dept. of physics, Univ. of Illinois at Urbana-Champaign, USA*. We experimentally tailor the joint spectra of photon pairs produced via dual-pump spontaneous four-wave mixing, achieving a joint spectral intensity without sidelobes, presenting a new route towards generating spectrally uncorrelated photon pairs.

LM1B.8 • 09:45

Generation of quantum correlated photons in different spatial modes using few-mode fibers, Cheng Guo[1], Jie Su[1], Zhenzhen Zhang[1], Liang Cui[1], Xiaoying Li[1]; [1]*Tianjin Univ., China*. We generate photon pairs at 1550 nm telecom through the intermodal four-wave mixing between LP_{01} and LP_{11} mode in a few-mode fiber. The ratio of coincidence to accidental coincidence rates is measured to be 28.

08:00–10:00
LM1C • Carl E. Anderson Division of Laser Science Dissertation Award Presentations

LM1C.1 • 08:00

Frequency Comb Generation from Laser Diodes, Mark Dong[1], Herbert G. Winful[1], Steven T. Cundiff[1]; [1]*Univ. of Michigan, USA*. We model and experimentally characterize frequency combs generated from laser diodes. Their optical and RF spectra are measured and analyzed.

LM1C.2 • 08:30

An Optical Frequency Atomic Clock Based On Quantum Matter, Sara L. Campbell[2,3], Ross B. Hutson[2,3], G. E. Marti[2], Akihisa Goban[2], Nelson D. Oppong[2], Rees L. McNally[2,3], Lindsay Sonderhouse[2,3], John M. Robinson[2,3], Wei Zhang[2], Benjamin J. Bloom[2,3], Jun Ye[2,3]; [2]*JILA, NIST and Univ. of Colorado, USA;* [3]*Dept. of Physics, Univ. of Colorado, USA*. We present the first atomic clock based on quantum degenerate matter, which reaches a record spectroscopic quality factor of Q = 5.2e15 and can measure a frequency difference to 3e-19 in 2 hours.

LM1C.3 • 09:00

Coupling Atoms Through An Optical Nanofiber Waveguide, Pablo Solano[1,2]; [1]*Joint Quantum Inst. and Dept. of Physics, Univ. of Maryland, USA;* [2]*Dept. of Physics and Research Lab of Electronics, MIT, USA*. We present our results on using ultra-high transmission optical nanofibers to couple cold atoms to the evanescent field a guided electromagnetic mode, and realizing infinite-range atom-atom interactions mediated by the guided field.

LM1C.4 • 09:30

Manipulation of Photonic Quantum States: From Generation, Engineering, and Characterization To Storage And Retrieval, Bin Fang[1]; [1]*Dept. of Physics, Univ. of Illinois at Urbana-Champgian, USA*. We present our work on various critical aspects of manipulation of photonic quantum states, including the generation of entangled states, engineering of the spectral correlations of photon-pairs, characterization of quantum states and ultra-broadband storage.

10:00–10:30 Coffee Break, *Concourse Foyer*

International Ballroom East	Georgetown West	Georgetown East	Jefferson West
LS		FiO	

10:30–11:15
LM3A • Visionary: Prem Kumar
Presider: Peter Delfyett; University of Central Florida, USA

LM3A.1 • 10:30 VISIONARY
Quantum Communication and Networking, Prem Kumar[1]; [1]*Northwestern Univ., USA*. Machines that process quantum information are likely to be commercially available in the near future. Networking them via quantum communication to achieve a higher level of performance is a topic of current interest. In this talk I will review the current status and speculate on the future possibilities.

11:30–12:30
LM3B • Quantum Science II
Presider: Peter Rakich; Yale University, USA

LM3B.1 • 11:30 Invited
Engineering Integrated Sources of Entangled Photon Pairs, Evan Meyer-Scott[1], Nidhin Prasannan[1], Nicola Montaut[1], Johannes Tiedau[1], Georg Harder[1], Linda Sansoni[1], Harald Herrmann[1], Christof Eigner[1], Raimund Ricken[1], Viktor Quiring[1], Tim J. Bartley[1], Sonja Barkhofen[1], Christine Silberhorn[1]; [1]*Univ. of Paderborn, Germany.* We present progress on our optimization of photon pair sources using waveguides. The sources show high heralding efficiency, indistinguishability, brightness, and entanglement visibility, and require low pump power.

10:30–12:30
FM3C • Advanced Beam Shaping and Trapping
Presider: Carlos Lopez-Mariscal ; Underwater Photonics, USA

FM3C.1 • 10:30 Invited
Structured Light-Matter Interactions in Nano-Engineered Nonlinear Photonic Media, Natalia M. Litchinitser[1], Jingbo Sun[1], Wiktor Walasik[1], Salih Silahli[2], Yun Xu[2], Mikhail Shalaev[1], Jesse Frantz[3], Jason Myers[3], Robel Bekele[4], Jasbinder Sanghera[3], Alexander Tsukernik[5]; [1]*Duke Univ. , USA; [2]Univ. at Buffalo, The State Univ. of New York, USA; [3]US Naval Research Lab, USA; [4]Univ. Research Foundation, USA; [5]Univ. of Toronto, Canada*. We discuss theoretical and experimental studies of the nonlinear beam shaping in engineered nano-colloidal suspensions with negative polarizability and saturable nonlinearity and in all-optically reconfigurable chalcogenide glass based metasurfaces.

FM3C.2 • 11:00
Self-imaging of Azimuthal Intensity Petal Based on Orbital Angular Momentum Beams, Jianqi Hu[1], Camille-Sophie Bres[1], Chen-Bin Huang[2]; [1]*École polytechnique fédérale de Lausanne, Switzerland; [2]National Tsing-Hua Univ., Taiwan.* We demonstrate for the first time azimuthal Talbot effect based on orbital angular momentum beams. The intensity petal is self-imaged in the azimuthal angle. We also draw the analogy between azimuthal and temporal Talbot effect.

FM3C.3 • 11:15
The zoo of topological singularities in 2D random waves: from phase and polarization singularities to polarization vortices, Lorenzo De Angelis[1], Filippo Alpeggiani[1], L. Kuipers[1]; [1]*Kavli Inst. of Nanoscience, Delft Univ. of Technology, Netherlands.* With experiments and theory, we demonstrate that the correlation of C points in random light undergoes dramatic changes when confining waves propagation to 2D, concluding a comprehensive overview on topological singularities in random light.

FM3C.4 • 11:30
Measuring Geometric Phase Without Interferometry, Rodrigo Gutiérrez-Cuevas[1], Tanya Malhotra[1], Jeremy Hassett[1], Mark R. Dennis[2,3], Anthony N. Vamivakas[1], Miguel A. Alonso[1,4]; [1]*Univ. of Rochester, USA; [2]Univ. of Bristol, UK; [3]Univ. of Birmingham, UK; [4]Aix Marseille Universite, Centrale Marseille, Institut Fresnel, France*. A simple, non-interferometric method for measuring geometric phases of structured-Gaussian beams is presented. By studying the intensity distribution of an occluded beam, the Gouy and Pancharatnam-Berry phases can be determined.

10:30–12:30
FM3D • Novel Devices, Manufacturing and Testing.
Presider: Jamie Ramsey; RPO, USA

FM3D.1 • 10:30
Performance of an Adaptive Optics System in the Presence of Diffractive Grooves, Emily Finan[1], Tom D. Milster[1], Youngsik Kim[1]; [1]*Univ. of Arizona, USA*. Diffractive phase introduced by light reflected from grooves on optical storage media might be problematic for AO correction in high-performance systems. Simulations and experiments are presented to examine the performance of AO with media samples.

FM3D.2 • 10:45
Three-dimensional Direct Laser Writing of Ultra-low Density Neuron-inspired Steiner Tree Structures, Haoyi Yu[1], Qiming Zhang[1], Min Gu[1]; [1]*RMIT Univ., Australia.* We fabricate neuron-inspired Steiner tree structures using the three-dimensional direct laser fabrication method. An ultra-low density three-dimensional Steiner tree structure with the feature size of 1 μm is achieved.

FM3D.3 • 11:00
Full-Field Optical Coherence Tomography Using Acousto-Optically Tuned External-Cavity Laser Diode and Wavelet Transform, Takamasa Suzuki[1], Gen Suda[1], Samuel Choi[1], Osami Sasaki[1]; [1]*Niigata Univ., Japan*. An acousto-optically tuned external-cavity laser diode using Littrow configuration is proposed. The thickness distribution of a cover glass was obtained using this light source with maximum scanning range of 45 nm and continuous wavelet transform.

FM3D.4 • 11:15
Development of Flexible Pad Polishing for Freeform Surface, Vinod Mishra[1,2], Daliramu Burada[2], Vinod Karar[1], Alakesh Manna[3], Gufran Khan[2]; [1]*Optical Devices and System, CSIR-CSIO, India; [2]IDDC, IIT Delhi, India; [3]Mechanical Engineering, PEC Chandigarh, India*. A method for polishing of freeform mould is demonstrated by using flexible pad polishing on a diamond turning machine. The results show that the presented polishing setup is capable to polish low slope freeform optics.

FM3D.5 • 11:30
Describing Mid-Spatial Frequencies consistently for Optical Design, Manufacturing and Metrology, Sven Wickenhagen[1], Anna Möhl[1], Ulrike Fuchs[1]; [1]*Asphericon GmbH, Germany.* This paper is dealing with different specifications and tolerancing of Mid-spatial frequency (MSF) for aspheric and freeform surfaces. Various models are discussed with respect to suitability for optical design, manufacturing, and metrology.

10:30–12:35
FM3E • LIDAR Approaches and the Demands on Optical Components
Presider: Sabbir Rangwala; Patience Consulting LLC, USA

FM3E.1 • 10:30 Invited
Think like a Robot, Perceive like a Human, Barry Behnken, *AEye, Inc., USA*. AEye is an artificial perception pioneer whose multi-sensor iDAR technology brings the power of agile scanning and edge computing to the LiDAR market, changing the way all autonomous vehicles perceive the environment.

FM3E.2 • 10:54 Invited
Geiger-mode LiDAR for Autonomous Vehicles, Mark Itzler, *Argo AI LLC, USA*. We describe disruptive automotive Geiger-mode LiDAR performance essential to future autonomous vehicle navigation enabled by the combination of single-photon sensitivity and greater eye-safety at wavelengths beyond 1400 nm.

FM3E.3 • 11:18 Invited
Next Generation Compact LIDAR Systems: Making Every Photon Count, Angus Pacala, *Ouster, USA. Ouster has developed the world's first compact, long range imaging LIDAR employing single photon avalanche diode detectors in standard CMOS. This talk will review our approach, some unique advantages of the CMOS SPAD architecture, as well as future outlook for the technology and challenges still to be overcome.*

10:30–12:30
FM3F • Biomedical Optics
Presider: David Busch; UT Southwestern Medical Center at Dallas, USA

FM3F.1 • 10:30 Invited
From Man To Mouse: Translational Studies in Stroke Recovery, Adam T. Eggebrecht[1], Adam Q. Bauer[1]; [1]*Radiology, Washington Univ. in Saint Louis, USA*. This joint talk will cover 1) Bedside neuromonitoring with high density DOT during the acute phase of stroke recovery and 2) Understanding and optimizing endogenous mechanisms of stroke recovery in mouse models of stroke.

FM3F.2 • 11:00
Evaluation of Oximetry Measurement Accuracy of Multispectral Photoacoustic Imaging Systems Using a Dynamically Tunable Blood Flow Phantom, Xuewen Zhou[1], William C. Vogt[1], Rudy Andriani[1], Keith Wear[1], Brian Garra[1], Joshua Pfefer[1]; [1]*US Food and Drug Administration, USA*. A blood flow phantom with tunable oxygen saturation (SO_2) was developed as an oximetry performance test method for emerging photoacoustic imaging systems. Results highlight the importance of fluence corrections in improving SO_2 measurement accuracy.

FM3F.3 • 11:15
Porcine Tissues Characterization by Diffuse Reflectance Spectroscopy, Felix Fanjul-Velez[1], Jose Luis Arce-Diego[1]; [1]*Univ. of Cantabria, Spain*. Biological tissues characterization can be made by diffuse reflectance spectroscopy (DRS). Tissue discrimination is critical in surgery. In this work data from porcine tissues are statistically analyzed for estimating discrimination potential.

FM3F.4 • 11:30
Pulsed-Laser-Induced Modification of Gold Nanorods: Damage Thresholds and Impact on Photoacoustic Imaging in Turbid Media, Andrew M. Fales[1], William Vogt[1], Keith Wear[1], Ilko Ilev[1], Joshua Pfefer[1]; [1]*U.S. Food and Drug Administration, USA*. Nanorod reshaping during photoacoustic imaging (PAI) may severely impact performance. Nanorod damage thresholds were studied with electron microscopy and spectrophotometry, and the effect of laser exposure on PAI was studied in a turbid phantom.

10:30–12:30
FM3G • Frontiers of Nanoplasmonics: New Materials – Active – Slow Light
Presider: Ortwin Hess; Imperial University, UK

FM3G.1 • 10:30 Invited
Solids in Ultrafast Strong Laser Fields: Optical Control of Electronic State, Mark Stockman[1]; [1]*Georgia State Univ., USA*. When a strong optical field with amplitude comparable to the internal fields acts on a solid, it creates, for a femtosecond duration of the pulse, a new state of solid where fundamental properties are modified.

FM3G.2 • 11:00 Invited
Nanophotonics with metal nitrides and carbides: from bulk to 2D, Alexandra Boltasseva[1]; [1]*Purdue Univ., USA*. We explore emerging materials for nanophotonics, plasmonics and optical metasurfaces namely transition metal nitrides and carbides in their bulk, ultra-thin and 2D form known as MXenes for applications in on-chip circuitry, sensing, energy.

FM3G.3 • 11:30 Invited
Bose-Einstein Condensation and Ultrafast Lasing in a Plasmonic Lattice, Paivi Torma[1], Tommi Hakala[1], Antti Moilanen[1], Aaro Väkeväinen[1], Rui Guo[1], Jani-Petri Martikainen[1], Konstantinos Daskalakis[1], Heikki Rekola[1], Aleksi Julku[1]; [1]*Aalto Univ., Finland*. We demonstrate a Bose-Einstein condensate (BEC) of surface plasmon polaritons in lattice modes of a metal nanoparticle array interacting with molecules. A crossover from BEC to ultrafast lasing is realized by tailoring the band structure.

LS

LM3B • Quantum Science II—Continued

LM3B.2 • 12:00 Invited

Optical-Fiber Source of Energy-Entangled Three-Photon W-State, Virginia O. Lorenz[1]; [1]*U. Illinois at Urbana-Champaign, USA.* We experimentally demonstrate an energy-entangled three-photon W-state source based on spontaneous four-wave mixing in polarization-maintaining optical fiber. We characterize the source using reduced density-matrix tomography, without the need for frequency conversion.

FiO

FM3C • Advanced Beam Shaping and Trapping—Continued—Continued

FM3C.5 • 11:45

Generation of Quantum Airy Photons, Santosh Kumar[1], Stephanie Maruca[1], Yong Meng Sua[1], Yu-Ping Huang[1]; [1]*Dept. of Physics, Stevens Inst. of Technology, USA.* Airy beams have been studied for many exciting applications. Here we extend those studies to the quantum domain by creating quantum-correlated photons in Airy spatial modes and explore their potential applications.

FM3C.6 • 12:00

Huygens Dipole for Nanolocalization, Ankan Bag[1,2], Martin Neugebauer[1,2], Pawel Wozniak[1,2], Gerd Leuchs[1,2], Peter Banzer[1,2]; [1]*Max Planck Inst. for the Science of Light, Germany;* [2]*Inst. of Optics, Information and Photonics, Dept. of Physics, Friedrich-Alexander-Univ. Erlangen-Nuremberg, Germany.* We discuss a nanolocalization technique with sub-nanometer localization resolution based on position dependent transverse Kerker scattering, obtained via interference of tailored electric and magnetic dipole moments.

FM3C.7 • 12:15

Arrays of dark optical traps on a toroidal surface, Jakub Belin[1], Vassilis Lembessis[2], Andreas Lyras[2], Omar Aldossary[2,3], Johannes K. Courtial[1]; [1]*Univ. of Glasgow, UK;* [2]*Dept. of Physics and Astronomy, College of Science, King Saud Univ., Saudi Arabia;* [3]*The National Center for Applied Physics, KACST, Saudi Arabia.* We have theoretically constructed light fields containing arrays of dark optical traps distributed on the surface of a torus. The array dimensions are not diffraction-limited and their period can be, in principle, deeply sub-wavelength.

FM3D • Novel Devices, Manufacturing and Testing—Continued

FM3D.6 • 11:45

Vibration Testing and Thermal Vacuum Flight Qualification of NASA's Global Ecosystem Dynamics Investigation (GEDI) Laser Transmitters, Furqan Chiragh[3], Donald B. Coyle[1], Erich Frese[2], Paul R. Stysley[1]; [1]*NASA Goddard Space Flight Center, USA;* [2]*ASRC Federal Space and Defense, USA;* [3]*Velos LLC, USA.* The GEDI Mission will employ three lasers systems developed, built, and tested by NASA Goddard Space Flight Center. We discuss the flight level Thermal Vacuum (TVAC) and vibrational qualification testing each unit must pass.

FM3D.7 • 12:00 Invited

Electrically Tunable Liquid Crystal Lenses for Augmented Reality, Yi-Hsin Lin[1]; [1]*National Chiao Tung Univ., Taiwan.* We demonstrate an optical-see-through system via liquid crystal lenses for augmented reality (AR) in order to solve the challenges of vision correction and image registration. The optical zoom function is also added in the AR system.

12:00–18:00 Laser Science Symposium on Undergraduate Research, *International Ballroom East*

12:30–14:00 Lunch break on your own

FM3E • LIDAR Approaches and the Demands on Optical Components—Continued

FM3E.4 • 11:42 Invited

Integrated Optical Phased Arrays for Solid-State LiDAR, Matthew Byrd; *Analog Photonics, USA*. LiDAR with integrated optical phased arrays provides an attractive solution to the automotive industry by enabling solid-state, small form factor systems. Here, we review this technology and present beam steering and real-time coherent LiDAR results.

FM3E.5 • 12:06 Invited

A vehicle platform perspective on 3D sensing, Matthew Weed, *Luminar Technologies, USA*. Photons are the currency of LiDAR design, but time is the currency of self-driven vehicles. High-resolution, long-range 3D data with low latency gives these vehicles enough time to make safe, informed decisions about their environment.

FM3F • Biomedical Optics—Continued

FM3F.5 • 11:45

Supercontinuum Laser for Spectroscopic Photoacoustic Imaging of Lipids in the Extended Near-Infrared Region, Manoj Kumar Dasa[1], Christos Markos[1], Michael Maria[1], Ivan Gonzalo[1], Christian Petersen[1], Peter Morten Moselund[2], Ole Bang[1,2]; [1]*Technical Univ. of Denmark, Denmark;* [2]*NKT Photonics, Denmark*. We demonstrate a cost-efficient high-power supercontinuum laser source based on a telecom range diode laser system and few meters of a standard optical fiber for spectroscopic photoacoustic imaging of lipids in the extended near-infrared region.

FM3F.6 • 12:00 Invited

Lowering the Cost and Improving the Usability of Retinal Imaging and Visual Function Assessment, Ann E. Elsner[1,2], Matthew S. Muller[2], Joel Papay[1], Bryan P. Haggerty[1], Thomas J. Gast[1,2], Stephen A. Burns[1]; [1]*Indiana Univ., USA;* [2]*Aeon Imaging, LLC, USA*. Cost, size, and complexity are all barriers to the use of improved optical technology to provide eye care. Resolution, wavelength, and computer-assisted detection of imagers can be targeted to the optical signature of biomarkers.

FM3G • Frontiers of Nanoplasmonics: New Materials – Active – Slow Light—Continued

FM3G.4 • 12:00 Invited

Non-Equilibrium Photonics with Self-Adaptive Order, Xiang Zhang[1], Chad Ropp[1], Nicolas Bachelard[1], David Barth[1], Yuan Wang[1]; [1]*UC Berkeley, USA*. Structures driven far from thermodynamic equilibrium can self-organize and behave as artificial living matter. We show how such dynamic order emerges in an array of initially disorganized photonic resonators, coupled through thermo-optic feedback.

12:00–18:00 Laser Science Symposium on Undergraduate Research, *International Ballroom East*

12:30–14:00 Lunch break on your own

14:00–16:00
LM4A • Quantum Science III
Presider: Peter Rakich; Yale University, USA

LM4A.1 • 14:00 Invited
Photons Probe Processes in the Brain, Robert R. Alfano[1]; [1]*CUNY City College, USA.* The salient properties of photons as they enter and excite quantum processes in brain tissue: spin and orbital angular momentum, complex wave front, polarization, classical and quantum entanglement will be presented.

LM4A.2 • 14:30
Correlation Properties of Photon Pairs Generated near the Pump in the Normal Group-Velocity-Dispersion Regime, Kyungdeuk Park[1], Dongjin Lee[1], Yong Sup Ihn[1], Yoon-Ho Kim[1]; [1]*POSTECH, South Korea.* We present photon pairs generated near the pump wavelength in the normal GVD regime by spontaneous four-wave mixing. The generated photons have temporal and spectral correlations and can be exploited as telecom-band quantum light sources.

LM4A.3 • 14:45 Invited
Quantum Acoustics: Controlling Phonons Using Light and Superconducting Circuits, Peter Rakich[1]; [1]*Yale Univ., USA.* We demonstrate powerful new strategies to control high frequency (10-40GHz) bulk acoustic phonons using optomechanical interactions and superconducting circuits. We identify a path towards robust ground-state control in cavity optomechanics and realize complex quantum states using circuit QED techniques.

14:00–16:00
FM4B • Light – Matter Interaction
Presider: To be Determined

FM4B.1 • 14:00 Invited
Motion Rectification and Transport Control in 2D Optical Brownian Ratchets, Karen. Volke-Sepulveda[1], Alejandro Vasquez Arzola[1], Mario Villasante-Barahona[1], Petr Jakl[2], Pavel Zemanek[2]; [1]*Univ Nacional Autonoma de Mexico, Mexico;* [2]*Inst. of Scientific Instruments of CAS, Czechia.* We create a reconfigurable 2D ratchet formed with a static asymmetric potential, based on holographic optical micromanipulation techniques, and an unbiased driving generating a rocking mechanism. Motion rectification is obtained along different directions.

FM4B.2 • 14:30
Multi-photon Fabrication of Compact Low-loss Optical Waveguides in Polydimethylsiloxane, Giulia Panusa[1], Ye Pu[1], Jieping Wang[1], Christophe Moser[1], Demetri Psaltis[1]; [1]*EPFL, Switzerland.* We report the fabrication of compact flexible optical waveguides in polydimethylsiloxane through multiphoton direct laser writing, for the first time without a photoinitiator. A transmission loss of 0.03 dB/cm was measured in the 650-700 nm band.

FM4B.3 • 14:45
Probing lipid membranes with vibrational sum-frequency scattering, Jan Dedic[2,1], Halil Okur[2], Sylvie Roke[2]; [1]*EPFL Photonics Chapter, Switzerland;* [2]*Lab for Fundamental Biophotonics, EPFL, Switzerland.* To understand how biological membranes work we must study the behavior of their constituent molecules in-situ. With vibrational sum-frequency scattering, we now have a non-invasive way of accessing this information.

FM4B.4 • 15:00
Advanced Multiphoton Polymerization Using Tunable Shaped Laser Wavepackets, MARIA MANOUSIDAKI[1,2], Vladimir Y. Fedorov[3,4], Dimitrios G. Papazoglou[1,2], Maria Farsari[1], Stelios Tzortzakis[3,1]; [1]*IESL-FORTH, Greece;* [2]*Materials Science and Technology Dept., Univ. of Crete, Greece;* [3]*Texas A&M Univ. at Qatar, Qatar;* [4]*Lebedev Physical Inst. of the Russian Academy of Sciences, Russia.* Tunable abruptly autofocusing ring Airy beams enable advanced multiscale photo-polymerization. Scaling down to the paraxial regime, these beams can approach the wavelength limit while presenting a strong enhancement of their focal intensity.

FM4B.5 • 15:15
Evidence of Magnetic Torque Dynamics in Optically-induced Magnetization, Krishnandu Makhal[1], Minh T. Trinh[1], Stephen C. Rand[1,2]; [1]*Electrical Engineering and Computer Science, Univ. of Michigan, USA;* [2]*Dept. of Physics, Univ. of Michigan, USA.* Rotational assignments and polarization states of inelastic components in the cross-polarized spectrum of light scattered by liquid samples of tetrahedral molecules provide direct evidence of a theorized enhancement mechanism for induced magnetism.

14:00–16:00
FM4C • Imaging and Sensing Technologies
Presider: Byoungho Lee; Seoul National University, South Korea

FM4C.1 • 14:00 Invited
Fundamental Limits in Imaging: A Computational Imaging Approach, Amit Ashok[1]; [1]*Univ. of Arizona, USA.* While the computational imaging approach has been explored and applied to various imaging problems, such as compressive imaging, it is has been only shown recently that it can achieve fundamental limits using rigorous information-theoretic analysis.

FM4C.2 • 14:30 Invited
Progress on Optical Trap Volumetric Displays, Daniel Smalley[1], Erich Nygaard[1], Wesley Rogers[1], Kamran Qaderi[1]; [1]*Brigham Young Univ., USA.* We review the fundamentals photophoretic trap displays and discuss the possibility of creating occlusion capable image points. Anisotropic scattering is observed independently in single and double point traps.

FM4C.3 • 15:00
Digital Aberration Correction with Single-Pixel Spatial Frequency Projection Imaging, Jeffrey J. Field[1], Jeff Squier[2], Randy Bartels[1]; [1]*Colorado State Univ., USA;* [2]*Colorado School of Mines, USA.* We show that single-pixel with CHIRPT microscopy encodes optical aberrations in temporal modulations of fluorescent light emitted from a specimen. We recover aberrations from several test objects and remove them digitally after image collection.

FM4C.4 • 15:15
Towards Scalable Fabrication of Plasmonic Colour via Nanoimprint Lithography, Muhammad F. Shahidan[1], Jingchao Song[1], Evgeniy Panchenko[1], Paul Mulvaney[2], Timothy James[1,3], Ann Roberts[1]; [1]*School of Physics, The Univ. of Melbourne, Australia;* [2]*ARC Centre of Excellence in Exciton Science, Bio 21 and School of Chemistry, The Univ. of Melbourne, Australia;* [3]*Reserve Bank of Australia, Australia.* We demonstrate the versatility of nanoimprint lithography to fabricate scalable 'plasmonic pixels' which producing non-diffractive color. Several designs are present and the colors produced shows their dependence upon the direction of polarization.

14:00–16:00
FM4D • A Realistic Assessment of Optics for Self-driving Vehicles

Moderator: Sabbir Rangwala, Patience Consulting LLC, USA

LIDAR and other ADAS (Advanced Driver Assistance Systems) imaging technologies promise to enable driverless cars, with potentially wide-ranging impacts to the vehicle manufacturing industry, vehicle-enabled services such as trucking and taxis, shared transportation and urban planning. But how close are we to ramping production for actual vehicle sales? What are the hurdles ahead for LIDAR and other optical systems and components? Where else does optics play a role in autonomous vehicles? What other factors impact the success of these optical technologies, from narrow technical issues to broader issues of regulation, standards, safety and customer acceptance? This panel of experts will conduct a lively discussion of these issues on this timely subject.

Panelists:
Brandon Collings, *Lumentum, USA*
Kevin Dopart, *US Department of Transportation, USA*
Rob Murano, *II-VI Inc., USA*
Martin Zirngibl, *Finisar, USA*

14:00–16:00
FM4E • Advanced Microscopy

Presider: Felix Fanjul Velez; University of Cantabria, Spain

FM4E.1 • 14:00 Invited
Optical Imaging for Cardiac Ablation, Christine P. Hendon[1]; [1]*Columbia Univ., USA.* I will discuss developments within optical coherence tomography and near infrared spectroscopy to enable monitoring of cardiac radiofrequency ablation, including extraction information on energy delivery, tissue composition, and fiber orientations.

FM4E.2 • 14:30
Fiber-Laser-Based Ultrasound Sensors for Fast-Scanning *in vivo* Photoacoustic Microscopy, Long Jin[1], Yizhi Liang[1], Lidai Wang[2], Jinwei Liu[1]; [1]*Inst Photonics Tech, Jinan Univ, China;* [2]*Dept. of Mechanical and Biomedical Engineering, City Univ. of Hong Kong, Hong Kong.* We present a new fiber-laser-based ultrasound sensor with high sensitivity and large field-of-view, based on which a fast-scanning optical-resolution photoacoustic microscope was built for *in vivo* microvascular imaging with a frame rate of 2 Hz.

FM4E.3 • 14:45
Quantification of *Staphylococcus aureus* on Contact Lenses using Mobile Holographic Imaging of Curved Surfaces and Machine Learning, Muhammed Veli[1], Aydogan Ozcan[1]; [1]*Electrical and Computer Engineering, Univ. of California, Los Angeles, USA.* We present a cost-effective mobile sensor based on 3D imaging of contact lenses and machine learning for quantification of Staphylococcus aureus. Compatible with human tear, this wearable-sensor can detect various pathogens and analytes in tear.

FM4E.4 • 15:00
Chip-based Total Internal Reflection Fluorescence Microscopy, Vishesh Kumar Dubey[1,3], Rajwinder Singh[2], Azeem Ahmad[1,3], Dalip S. Mehta[1], Balpreet S. Ahluwalia[3]; [1]*Indian Inst. of Technology Delhi, India;* [2]*Cell Biology and Biophysics Unit, EMBL, Germany;* [3]*Dept. of Physics and Technology, UiT The Arctic Univ. of Norway, Norway.* In present study we have performed total internal reflection fluorescence microscopy on optical waveguide chip. This enables large field of view of imaging with high axial solution and signal to noise ratio with low phototoxicity.

FM4E.5 • 15:15
Holographic Region-of-Interest with Oblique Illumination, Alexander Jügler[1], Jan Becker[1], Patrick Then[1], Rainer Heintzmann[1,2]; [1]*Leibniz Inst. of Photonic Technology, Germany;* [2]*Inst. of Physical Chemistry and Abbe Center of Photonics, Friedrich-Schiller-Univ. Jena, Germany.* Our programmable holographic microscopy approach allows an adaptive oblique regions-of interest illumination. This reduces phototoxicity and out-of-focus blur and improves potentially Single-Molecule-Localization-Microscopy while easy to integrate.

14:00–16:00
FM4F • Complex Nanophotonics

Presider: Ortwin Hess; Imperial University, UK

FM4F.1 • 14:00 Invited
Structuring Light with Metastructures, Nader Engheta[1]; [1]*Dept. of Electrical and Systems Engineering, Univ. of Pennsylvania, USA.* Sculpting waves with metamaterials may lead to useful functionalities. In this talk, I will present several scenarios in which metastructures and metasurfaces can be used as platforms for structured light with desired features.

FM4F.2 • 14:30 Invited
Topological Photonics in Gyroids: 3D Nano-Printing of Weyl Points, Min Gu[1], Benjamin P. Cumming[1]; [1]*Royal Melbourne Inst. of Technology, Australia.* The gyroid is a useful platform for the study of topological photonics. In this talk we demonstrate the creation and characterization of gyroid Weyl points at optical frequencies using 3D Nano-Printing and high refractive-index coating.

FM4F.3 • 15:00 Invited
Next Generation Photonics Based on 2D Materials, Michal Lipson[1]; [1]*Columbia Univ., USA.* Two dimensional materials such as monolayer transition metal dichalcogenides (TMD) are expected to have large changes in their optical sheet conductivity by controlling their carrier densities. We demonstrate a platform for waveguide-integrated phase modulators in the nearinfrared regime based on Tungsten disulphide (WS2) gating.

Monday, 17 September

LM4A • Quantum Science III—Continued

FM4B • Light – Matter Interaction—Continued

FM4B.6 • 15:30
Remote Detection Sodium Cell Magnetometry using Amplitude Modulated Light, Renu Tripathi[1], Christiane Ebongue[1], Lorna Caesar[1], Gour S. Pati[1], Anthony Yu[2], Michael Krainak[2]; *[1]Delaware State Univ., USA; [2]NASA GSFC, USA.* We investigated performance of a remote-detection sodium cell magnetometer using synchronous optical pumping. This magnetometer is used to measure ambient geomagnetic field with high-sensitivity using backscattered resonance fluorescence.

FM4B.7 • 15:45
High Sensitivity CPT and Pulsed CPT based Axial Magnetic Field Measurements, Gour S. Pati[1], Bruce Barrios[1], Robin Depto[1], Renu Tripathi[1], Anthony Yu[2], Michael Krainak[2]; *[1]Delaware State Univ., USA; [2]NASA GSFC, USA.* We have demonstrated high-sensitivity axial B-field measurements based on coherent population trapping (CPT) and pulsed CPT phenomena.

FM4C • Imaging and Sensing Technologies—Continued

FM4C.5 • 15:30
Incorporating Polarization into Phase Retrieval Methods, Scott Paine[1], James R. Fienup[1]; *[1]Univ. of Rochester, USA.* Traditional wavefront-sensing phase retrieval problems often neglect the effects of polarization. In order to improve simulated point-spread functions, we present a method to parameterize and include polarization in phase retrieval models.

FM4C.6 • 15:45
Sensing polarization rotation through scattering media, Abhijit Roy[1], Rakesh K. Singh[2], Maruthi Manoj Brundavanam[1]; *[1]Dept. of Physics, Indian Inst. of Technology Kharagpur, India; [2]Dept. of Physics, Indian Inst. of Space Science and Technology, India.* We present a technique based on an interferometric approach to sense the polarization rotation through scattering media with the help of a known reference speckles, by studying the degree of coherence of the mixed speckles.

15:00–17:00 OSA Senior Member Workshop, *Holmead, Lobby Level (advanced registration required)*

16:00–16:30 Coffee Break, *Concourse Foyer*

16:00-17:00 Meet OSA's Journal Editors, *Concourse Foyer*

16:00–17:00 DLS Annual Business Meeting, *Georgetown West*

16:00–17:00 Foundational Skills of Professional Networking – How First Impressions and Elevator Pitches Lead to Career Success and Longevity, *Cabinet*

16:00–17:30 OSA Optical Fabrication and Testing Technical Group Knowledge Café, *International Ballroom West*

16:00–17:30 The Rules of Engagement: Navigating Important Business Relationships, *Georgetown East*

16:00–18:00 Finishing Touches: A Tutorial in Blender for Cover Art and Figures, *Jefferson West*

16:00–18:00 OSA Photonic Metamaterials Technical Group Tutorial on Metalens Design and Simulation, *Lincoln West*

16:00–18:30 Cheeky Scientist Career Development Workshops, *Jefferson East*

18:00–19:00 OSA Polarization Technical Group Rapid- Fire Presentations & Networking Event, *Cabinet*

18:00–19:00 Workshop: Understanding Unconscious Bias, *Georgetown East*

18:00–21:00 Awards Ceremony & Reception, *Carnegie Institute of Science, 1530 P St. NW* (Separate Ticket Required)

FM4D • A Realistic Assessment of Optics for Self-driving Vehicles—Continued

FM4E • Advanced Microscopy—Continued

FM4E.6 • 15:30
A Portable Optical Diagnostic System for Malaria Screening, Dongyu Chen[2], Samantha E. McBirney[1], Kristina Kaypaghian[1], Alexis Scholtz[3], Hossein Ameri[4], Andrea M. Armani[5]; *[1]Dept. of Biomedical Engineering, Univ. of Southern California, USA; [2]Ming Hsieh Dept. of Electrical Engineering-Electrophysics, Univ. of Southern California, USA; [3]Dept. of Biomedical Engineering, Johns Hopkins Univ., USA; [4]USC Roski Eye Inst., Dept. of Ophthalmology, Keck School of Medicine of the Univ. of Southern California, USA; [5]Mork Family Dept. of Chemical Engineering and Materials Science, Univ. of Southern California, USA.* We developed a portable optical diagnostic system for rapid malaria screening in low-resource areas. Detection limits well below the clinical relevance are demonstrated using β-hematin in unprocessed, whole rabbit blood.

FM4E.7 • 15:45
cellSTORM – Super-Resolution on a Cellphone, Benedict Diederich[1], Patrick Then[1], Alexander Jügler[1], Ronny Förster[1], Rainer Heintzmann[1,2]; *[1]Leibniz Inst. of Photonic Technology, Germany; [2]Inst. of Physical Chemistry and Abbe Center of Photonics, Friedrich-Schiller-Univ. Jena, Germany.* We present a way to use smartphones for Single-Molecule-Localization-Microscopy. Using consumer-grade smartphone cameras and neural networks instead of scientific-grade cameras we achieved optical resolution below 80 nm.

FM4F • Complex Nanophotonics—Continued

FM4F.4 • 15:30 Invited
Linear Frequency Conversion in a Rapidly Time-variant Metasurface, Bumki Min[1]; *[1]Korea Advanced Inst of Science & Tech, Korea (the Democratic People's Republic of).* The frequencies of electromagnetic waves are converted as the waves propagate through a temporally varying medium. Interestingly, this frequency conversion is not based on well-known nonlinear processes. Here, we explain basic principles of linear frequency conversion and show various interesting properties of rapidly time-variant metadevices.

15:00–17:00 OSA Senior Member Workshop, *Holmead, Lobby Level (advanced registration required)*

16:00–16:30 Coffee Break, *Concourse Foyer*

16:00-17:00 Meet OSA's Journal Editors, *Concourse Foyer*

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18:00–19:00 Workshop: Understanding Unconscious Bias, *Georgetown East*

18:00–21:00 Awards Ceremony & Reception, *Carnegie Institute of Science, 1530 P St. NW* (Separate Ticket Required)

08:00–09:30
JTu1A • Plenary Session

JTu1A.1 Plenary
The Future of Computing, Heike E. Riel; *IBM Research Frontiers Institute, USA*. Extraordinary enhancements in computing power over the last 50 years have been driven by "smaller & denser" resulting in "faster & cheaper". The quest for ever increasing computing performance continues. This raises the fundamental question of what is next? Today the most exciting new frontiers of information technology are non-von Neumann computing and quantum computing. This talk will give an overview of our research activities in the field of extending the core technology roadmaps and in the new paradigms of cognitive hardware technologies and quantum computing.

JTu1A.2 Plenary
Chirped Pulse Amplification to ELI and Beyond, Gerard Mourou, École Polytechnique, France. PW laser could be compressed into high-energy single-cycled laser pulse, offering a fundamentally new laser-matter interaction ambit, which could become the fulcrum of novel scientific and societal applications. Among them, we foresee efficient laser electron and ion acceleration, as well as the generation of a single-cycled X-ray pulse leading to Exawatt and zeptosecond science and technology.

09:30–15:00 Science & Industry Showcase Visit page 11 for a complete program schedule.

10:00–11:00
Rapid Fire Oral Presentation I, Science & Industry Theater
Presider: David Busch; Univ. Texas Southwestern Medical Center at Dallas, USA

Participating posters are noted in the list of poster for session JTu2A with the icon **RAPID**. Each presenter will have 3 minutes and the order will be determined by poster number.

JOINT FiO + LS

10:00–12:00
JTu2A • Poster Session I and Dynamic E Posters

JTu2A.1 *E-Poster*
Organic Molecular Beam Deposition and In-Situ Poling of Dense Supramolecular Assemblies for Second Order Nonlinear Optics, Michael Erickson[1], Lauren Dallachiesa[1], Ivan Biaggio[1]; [1]*Lehigh Univ., USA*. We demonstrate that in-situ poling during organic molecular beam deposition of single-component dense supramolecular assemblies can be used to obtain a preferential molecular order and a bulk linear electro-optic effect in the resulting organic films.

JTu2A.2 *E-Poster*
Self-assembling of functionalized micro-optical element driven by pyro-electrohydrodynamic forces, Sara Coppola[1], Giuseppe Nasti[1], Veronica Vespini[1], Pietro Ferraro[1]; [1]*Inst. of Applied Sciences and Intell, Italy.* We present a repeatable and accurate method to pattern fluorescent particles into polymer microlens array and flexible elastomeric membranes. This method uses intense electric field generated by a Periodically Poled Lithium Niobate (PPLN) in order to direct the self-assembly electrophoretic and dielectrophoretic forces.

JTu2A.3 *E-Poster*
3D Fractal Analysis of Optical Images of Retinal Amyloid for Staging in Alzheimer's Disease, Peter A. Neathway[1], Tao Jin[1], Melanie C. Campbell[1,2]; [1]*Physics and Astronomy, Univ. of Waterloo, Canada;* [2]*School of Optometry and Vision Science, Univ. of Waterloo, Canada*. Fractal dimensions of retinal amyloid deposits were calculated using a 3D box counting method. The maximum and average fractal dimensions were significantly correlated to the number of deposits ($p<0.03$ and $p<0.05$, respectively).

JTu2A.4 *E-Poster*
Universal All-Optical Computing Based on Interconnected Lasers, Tuomo von Lerber[2,1], Matti Lassas[1], Quang Trung Le[2], Franko Küppers[2]; [1]*Dept. of Mathematics and Statistics, Univ. of Helsinki, Finland;* [2]*Photonics Lab, Technische Universität Darmstadt, Germany.* We present an all-optical computing scheme based on normalization operations of injection-locked lasers. We show cascaded operations in cellular automaton by an all-optical Conway's Game of Life and simulate 100 generations of gaming.

JTu2A.5 *E-Poster*
Diffraction of Laguerre-Gauss Vortex Beams from Sierpinski Triangles, Sean Nomoto[1], Reeta Vyas[1], Surendra Singh[1]; [1]*Univ. of Arkansas, USA*. Fraunhofer diffraction of Laguerre-Gauss beams from Sierpinski triangle apertures of different iteration orders is studied and its dependence on iteration order, topological charge, and aperture location relative to the beam-waist is investigated.

JTu2A.6 *E-Poster*
Towards the Use of Machine Learning in Setups for OAM Mode Excitation in Optical Fibers, Antonio Astorino[1], Jesper Glückstad[1], Karsten K. Rottwitt[1]; [1]*DTU, Denmark*. Machine Learning algorithms driving spatial light modulators may help achieve higher purity in excited orbital angular momentum modes in fibers. Some preparatory steps are investigated to potentially enable effective Machine Learning in such a configuration.

JTu2A.7 *E-Poster*
Coherent Blue Light Driven by a Diode Laser and a High Repetition Rate Pulse Train, Marco P. Moreno[1], Alexandre A. Almeida[2], Sandra S. Vianna[2]; [1]*Departamento de Física, Universidade Federal de Rondônia, Brazil;* [2]*Departamento de Física, Universidade Federal de Pernambuco, Brazil*. Using a diode laser and a 1 GHz femtosecond pulse train, we investigate the Autler-Townes splitting and the influence of an electromagnetic induced transparency window in the coherent blue light generated in rubidium vapor.

JTu2A.8 *RAPID*
Generating Broadened UV Pulses for Ultrafast Nonlinear Experiments, James D. Gaynor[1], Joel Leger[1], Munira Khalil[1]; [1]*Univ. of Washington, USA*. Broadened UV pulses are generated and used in Fourier transform two-dimensional electronic-vibrational spectroscopy to study vibronic couplings in a solar cell sensitizing dye.

JTu2A.9
Dye-Doped Random Microlasers Fabricated via Two-Photon Polymerization, Nathalia B. Tomazio[1], Lucas F. Sciuti[1], Gustavo F. Almeida[1], Leonardo De Boni[1], Cleber R. Mendonca[1]; [1]*USP Inst de Fisica de Sao Carlos, Brazil*. We demonstrate coherent random lasing in dye-doped microstructures fabricated by two-photon polymerization. Randomly distributed irregularities on the microstructure sidewall surfaces act as back-scattering elements, providing feedback for lasing.

JTu2A.10
Dynamic Ferroelectricity of Trojan Electrons on Multiple Parallel Regular 2-dimensional Lattices, Matt Kalinski[1]; [1]*Utah State Univ., USA*. Dynamic ferroelectric orders are discovered in a volume filled with a parallel layers of various regular 2-dimensional lattices consisting of hydrogen atoms self-consistently supporting Trojan Wave Packet states via the rotating dipole interactions.

JTu2A.11
Study of the generation dynamics in a strict polarization-controlled passively mode-locked Er-fiber laser., Luis Alberto Rodriguez Morales[2], Hector Santiago-Hernandez[2], Baldemar Ibarra-Escamilla[2], Georgina Beltrán Pérez[1], Ivan Armas Rivera[2], Manuel Durán Sanchéz[2], Yazmin Bracamontes[3], Olivier Pottiez[3], Marco V. Hernández-Arriaga[2], Evgeny A. Kuzin[2]; [1]*BUAP, Mexico;* [2]*Optics, INAOE, Mexico;* [3]*Centro de investigaciones en Óptica, Mexico*. We report the relation between the polarization state of the pulses propagating in the cavity and the generation regimes. Rotating the polarization azimuth gets transition from the generation of noise-like pulses to soliton molecules

JTu2A.12
Magnetically Controllable Random Lasers, Yun-Tzu Hsu[1], Yu-Ming Liao[1], Cheng-Yen Tsai[1], Wei-Cheng Liao[1], Wei-Ju Lin[1], Shih-Yao Lin[1], Cheng-Han Chang[1], Golam Haider[1], Tzu-Min Sun[1], Yang-Fang Chen[1]; [1]*National Taiwan Univ., Taiwan*. Controllability is crucial for random lasers. Here, magnetically controllable random lasers (MCRLs) are designed, fabricated. The applied magnetic field can be used to manipulate the distribution of scatterers, which finally determines laser action.

JTu2A.13
Comparison Between InGaAs SPD and Superconducting Nanowire Detector Using a Silicon Photon-pair Source, Woncheol Shin[1], Heedeuk Shin[1], Kyungdeuk Park[1], Young-Wook Choi[2], Yong-Su kim[2]; [1]*Pohang Univ. of Science and Technol, South Korea;* [2]*Center for Quantum Information, Korea Inst. of Science and Technology, South Korea*. Photon-pair generation rate through a silicon photon-pair source is measured by InGaAs SPD and superconducting nanowire detector, showing 240 times higher coincidence count than InGaAs SPD. A high coincidence-to-accidental ratio of 524 is achieved.

JTu2A • Poster Session I and Dynamic E Posters—Continued

JTu2A.14
Withdrawn

JTu2A.15
Independent phase modulation of two polarization states with reflection-type metasurface, Jangwoon Sung[1], Gun-Yeal Lee[1], Chulsoo Choi[1], Byoungho Lee[1]; [1]*Seoul National Univ., South Korea*. Taking the advantage of propagation phase with geometric phase, we designed a novel reflection-type metasurface enabling independent phase control of two polarization states. This method achieves phase control with the high efficiency up to 95%.

JTu2A.16
High Peak Intensity and Tunable Range Bessel Beams Generation and Characterization, A. Srinivasa Rao[1], Goutam K. Samanta[1]; [1]*AMOPH, Physical Research Lab, India*. We report on a novel method to generate high peak intensity, segmented, smooth, zero-order Bessel beams with tunable range peak position using axicon with hollow Gaussian beam (HGB) as pump mode.

JTu2A.17
Optical Simulations of Wavefront Aberrations of Interpenetrating Polymer Network Hydrogel's Artificial Cornea, Chung-Tsung Hsieh[1], Jia-Han Li[1]; [1]*National Taiwan Univ., Taiwan*. The various structure parameters and materials are chosen for artificial cornea. Our simulation results show that increasing the complexity of structures and choosing high refractive index material are important to properties of artificial cornea.

JTu2A.18
Multimode supercontinuum generation in As_2S_3 chalcogenide photonic crystal fiber, Amani Ben Khalifa[1], Rim Cherif[1], Amine Ben Salem[1]; [1]*Univ. of carthage, Tunisia*. The mid-infrared supercontinuum generation spanning 2 to 4 μm at -40 dB for mode HE_{11} is obtained in multimode As_2S_3 photonic crystal fiber. Energy transfer occurs only with long pulses between modes with comparable geometries.

JTu2A.19
Reflective Liquid Crystal Lenses with Electrically Anisotropic Wavefront Modulation, Yu-Jen Wang[1], Jun-Lin Chen[1], Yi-Hsin Lin[1]; [1]*Dept. of Photonics, National Chiao Tung Univ., Taiwan*. Reflective lenses are important in optical design and applications. We investigate reflective liquid crystal lenses with anisotropic wavefront modulation. The impact of this study is to design electrically tunable devices for adaptive optics.

JTu2A.20
Revealing of Axial Separation between Diffusers through Lateral Speckle Correlation, Gokul G. Nair[1], Dinesh N. Naik[1], Michael L. Jakobsen[2], Steen G. Hanson[2], Rakesh K. Singh[1]; [1]*IIST Trivandrum, India;* [2]*Dept. of Photonics Engineering, Technical Univ. of Denmark, Denmark*. We experimentally demonstrate that the intensity correlation of speckled speckles before and after the lateral displacement of the concealed scatterer discloses the axial separation though speckle size, decorrelation length and speckle gearing.

JTu2A.21
Single shot vectorial shearing interferometry technique for wavefront reconstruction and aberration calculation, Pramod Panchal[1], Surya Gautam[1], Dinesh N Naik[1], C. S. Narayanamurthy[1]; [1]*Physics, IIST, India*. We propose a vectorial sheared interferometry technique based on two sagnac interferometer to calculate gradient information along two orthogonal directions. We present an approach to reconstruct the wavefront and calculation of wavefront aberration.

JTu2A.22
Optimized Growth of Titanium Nitride Films using Plasma Enhanced Atomic Layer Depostion, Dhruv Fomra[1], Ray R. Secondo[1], Vitaliy Avrutin[1], Natalia Izyumskaya[1], Ümit Özgür[1], Nathaniel Kinsey[1]; [1]*Virginia Commonwealth Univ., USA*. We investigate and find that the quality of titanium nitride grown at 350°C and 375°C using atomic layer deposition on silicon and sapphire substrates respectively are approaching the metallicity of sputtered films.

JTu2A.23
Automatic Surface Defect Detection using Autoregressive Modeling based Fringe Analysis, Dr. Rishikesh Kulkarni[2], Earu Banoth[1], Dr. Parama Pal[1]; [1]*TCS Research and Innovation, Tata Consultancy Services, India;* [2]*Dept. of Electronics and Electrical Engineering, Indian Inst. of technology Guwahati, India*. We propose a novel fringe analysis technique based on an autoregressive (AR) modeling of fringe signals for detecting surface defects. Defects are localized by studying variations in fringe frequencies computed using estimated AR coefficients.

JTu2A.24
KW-level Triple-Cladding Laser Fiber, Shuang Liu[1,2], Huan Zhan[1], Kun Peng[1], Xiaolong Wang[1], Li Ni[1], Juan Yu[1], Jianjun Wang[1], Feng Jing[1], Rihong Zhu[2], Aoxiang Lin[1]; [1]*Laser Fusion Research Center, China;* [2]*Nanjing Univ. of Science and Technology, China*. We fabricated a kW-level triple-cladding Yb-doped aluminophosphosilicate fiber with an added low-refractive-index fluorine-doped silica cladding. 1.36kW laser output was obtained at 1079.6nm with 82.3% slope efficiency and without nonlinear effects.

JTu2A.25
Development of Multi-modal Bacterial Rapid Detection Instrument, Iyll-joon Doh[1], Huisung Kim[1], Jennifer Sturgis[2], Valery Patsekin[2], J. Paul Robinson[2,3], Euiwon Bae[1]; [1]*Mechanical Engineering, Purdue Univ., USA;* [2]*Basic Medical Sciences, College of Veterinary Medicine, Purdue Univ., USA;* [3]*Weldon School of Biomedical Engineering, Purdue Univ., USA*. An instrument providing simultaneous optical measurement modalities is presented. Integrating custom confocal module, three laser diodes, and sensors into an upright microscope allows measuring multiple optical characteristics of a bacterial colony.

JTu2A.26
Resolution Enhancement for AR/VR Displays Based on LC Sub-pixel Frame Shift, Kyookeun Lee[1], Nikolay Muravyev[2], Dmitry Piskunov[2], Jaeyeol Ryu[2], Kyusub Kwak[1], Myongjo Choi[1], James D. Kim[1]; [1]*Samsung Research, South Korea;* [2]*Samsung R&D Inst. Russia, Russia*. We propose a resolution enhancement method for AR/VR displays based on sub-pixel frame shift using a LC deflector. Experimental results using Samsung Gear VR and Galaxy S8 show that the resolution is doubled and the screen door effect is reduced.

JTu2A.27
Effect of Temperature on the Efficiency of Thin-Film Amorphous Silicon Tandem Heterojunction Solar Cells with AFORS-HET, Muhammad Riaz[1], Ahmad S. Azzahrani[1,2], Ahmed C. Kadhim[1]; [1]*Florida Inst. of Technology, USA;* [2]*Northern Borders Univ., Saudi Arabia*. : Simulation and design of a-SiC/a-Si(i)/a-Si:H/ and a-SiC/a-Si(i)/a-SiGe:H solar cells are investigated and optimized. The maximum efficiency is achieved by changing temperature up to 400K.

JTu2A.28
Localized Electromagnetic Field Enhancement with Patterned Hyperbolic Metamaterials, Jongwoo Hong[1], Chulsoo Choi[1], Byoungho Lee[1]; [1]*Seoul National Univ., South Korea*. The electromagnetic field enhancement is a key factor in efficient light-matter interaction due to small mode volume and loss. We propose hyperbolic metamaterial cavity for field enhancement by patterning funneled aperture on metal-dielectric layers.

JTu2A.29
Extended Propagation Distances For Diffraction-Free Space-Time Light-Sheets, Basanta Bhaduri[1], Murat Yessenov[1], Ayman Abouraddy[1]; [1]*Univ. of Central Florida, CREOL, USA*. We synthesize propagation-invariant space-time wave packets in the form of a pulsed light-sheet of transverse spatial width ~200 mm and spectral bandwidth of ~2 nm, and observe its diffraction-free propagation for a record ~6 meters.

JTu2A.30
Dynamic Footprint Differentiation from Machine Acceleration Effect, Guoyu Yu[1], Christina Reynolds[1], Oliver Faehnle[2], David Walker[1]; [1]*OpTIC Centre, Univ. of Huddersfield, UK;* [2]*QA/QES & Continuous Improvement, FISBA AG, Switzerland*. This paper investigates the differentiation between machine's static and dynamic footprint (FP). Results have shown progressing footprint variation related to tool's tilt angle. Tilt angle compensation has been applied to offset this effect.

JTu2A.31
Linear and nonlinear hyperspectral imaging of nano- and bio- materials in photo-induced force microscopy, Eun S. Lee[1]; [1]*Korea Research Inst of Standards & Sci, South Korea*. Linear and nonlinear optical responses of nano materials are measured through force detection in photo-induced optical microscopy. The measurement results of Raman vibrational signal and excited state absorption of molecular clusters are presented.

JTu2A.32
An opposite approach to steam generation using solar power: cooler for more, Lyu Zhou[1], Haomin Song[1], Youhai Liu[1], Matthew Singer[1], Dengxin Ji[1], Nan Zhang[1], Xie Zeng[1], Zongmin Bei[1], Zongfu Yu[2], Qiaoqiang Gan[1]; [1]*State Univ. of New York at Buffalo, USA;* [2]*Electrical and Computer Engineering, Univ. of Wisconsin Madison, USA*. We proposed a cold vapor generation beyond the input solar energy limit. The vapor was produced at a temperature below that of ambient, resulting in ~2.2 kg m^{-2} h^{-1} generation rate under one sun.

JTu2A.33
Actively mode-locked Yb-doped fiber laser via pump modulation, Zihao Zhao[1], Sze Set[1], Shinji Yamashita[1]; [1]*Univ. of Tokyo, Japan*. An active mode-locked Yb-doped fiber laser via pump modulation is demonstrated. The mode-locked all-normal-dispersion fiber laser operates in dissipative soliton regime without any spectral filter.

JTu2A.34
Pulse Shaping and its Influence on Contrast Enhancement in Nonlinear Optical Imaging, George O. Dwapanyin[1], Gurthwin Bosman[1], Pieter Neethling[1], Erich Rohwer[1]; [1]*Laser Research Inst., Dept. of Physics, Stellenbosch Univ., South Africa*. The influence of temporal phase control of ultra-broadband femtosecond laser pulses on contrast enhancement in nonlinear imaging and its application in a custom built multimodal microscope, is presented in this study.

JTu2A • Poster Session I and Dynamic E Posters—Continued

JTu2A.35
Extreme nonlinear optics under vortex lasers, Chengpu Liu[1]; [1]*Shanghai Inst. of Optics and Fine Mechanics, CAS, China.* As for the interaction of few-cycle vortex laser with matter, many novel phenomena beyond those occurred in traditional nonlinear optics are disclosed, such as nonliear vortex precusors, THz necklace beam, and so on.

JTu2A.36
Modulation of Third Harmonic Generation Achieved through Ground State Depletion, Szu-Yu Chen[1], Hao-Hao Wu[1], Jui-Ting Hung[1], Jian-Ling Chen[1]; [1]*National Central Univ., Taiwan.* Third harmonic generation (THG) is known being able to be enhanced though real-state absorption. Suppressing absorption through ground-state depletion, the THG intensity can be modulated for the purpose of resolution improvement of THG microscopy.

JTu2A.37
Beam Riders and Sailcraft Based on Diffractive Light Sails, Grover A. Swartzlander[1], Ying-Ju Lucy Chu[1], Prateek R. Srivastava[1]; [1]*Rochester Inst. of Technology, USA.* Both solar and laser driven sailcraft are described whereby diffraction, rather than reflection, is used to impart momentum to a sailcraft for in-space propulpsion.

JTu2A.38
Laguerre-Gauss Beams with Polarization-OAM Entanglement in a Graded-Index Medium, Nikolai I. Petrov[1]; [1]*Scientific and Technological Center of Unique Instrumentation of the Russian Academy of Sciences, Russia.* Propagation of linearly and circularly polarized vortex light beams in cylindrical graded-index waveguide taking into account spin-orbit and nonparaxial effects is investigated. Effects of collapse and long-term revival of wave packets are examined.

JTu2A.39
Collective Three-Photon Blockade In A Cavity QED System, Chengjie Zhu[1], Yaping Yang[1], Girish Agarwal[2]; [1]*Tongji Univ., China;* [2]*Texas A&M Univ., USA.* We present a theoretical proposal to realize three-photon blockade in a coherently-driven, two-qubits cavity QED system. We show that the three-photon blockade with two-photon bunching can be achieved when two qubits couple the cavity asymmetrically.

JTu2A.40
Opticaly tunable conductivity of carbon nanotubes in terahertz frequency range, Daniel Gomon[1], Sviatoslav Gusev[1], Petr Demchenko[1], Ilya Anoshkin[2], Dmitry Lyubchenko[2], Mikhail Khodzitsky[1]; [1]*ITMO Univ., Russia;* [2]*KTH Royal Inst. of Technology, Sweden.* Impact of infrared radiation illumination (980 nm) on the properties of carbon nanotubes (CNT), such as complex conductivity and permittivity, with different geometric parameters in the frequency range of 0.2-1.0 THz was studied.

JTu2A.41
Theoretical Approach to Resolution Limit Calculations in Optical Microscopy with the use of Feynman Diagrams, Naoki Fukutake[1]; [1]*Nikon Corporation, Japan.* By means of double-sided Feynman diagrams describing optical processes, we formulate the calculation rules of the resolution limits for all types of optical microscopy that employ linear, nonlinear, coherent, and incoherent optical processes.

JTu2A.42
Stimulated Supercontinuum Generation in CW-pumped Regime, Chao Huang[1], H. Y. Fu[2], Qian Li[1]; [1]*Peking Univ., China;* [2]*Tsinghua Univ., China.* We numerically demonstrate the significant improvement in spectral bandwidth and coherence of CW pumped supercontinuum generation stimulated by a weak CW seed.

JTu2A.43
Energetic ultrafast self-similar fiber laser tunable in 1030-1100 nm wavelength range, Chunyang Ma[1], Ankita Khanolkar[2], Andy Chong[2]; [1]*JILIN UNIV., China;* [2]*Univ. of Dayton, USA.* We report a tunable Yb-doped self-similar fiber laser for 1030-1100 nm by tuning center wavelength of a narrow spectral filter. The result shows the self-similar operation is suitable for tunable lasers with short pulse durations.

JTu2A.44
Generalized Laguerre-Gauss vortex beams, Alfonso I. Jaimes-Nájera[1], Jesús Gómez-Correa[2,3], Sabino Chávez-Cerda[1]; [1]*INAOE, Mexico;* [2]*Facultad de Ingeniería Mecánica y Eléctrica, UANL, Mexico;* [3]*Unidad Monterrey, CICESE, Mexico.* We present new families of vortex beams with orbital angular momentum establishing a generalization of the Laguerre-Gauss beams in its standard and elegant formulation. Their closed analytical free-space propagation formula is obtained.

JTu2A.45
Nonuniform Dynamic Bragg Gratings for Laser Pulses Manipulation, Andrey ILJIN[1], Svitlana Bugaychuk[1], Vycheslav Pinchuk[1]; [1]*Inst. of Physics, NAS of Ukraine, Ukraine.* Nonlinear Schrödinger equation describes effects of wave self-diffraction in an extended dynamic nonlocal medium. The resulting dynamic grating has a soliton-like envelope of modulation depth and provides energy exchange and laser pulse amplification.

JTu2A.46
The Micromaser in a Cross Cavity: A Fidelity Perspective, Julio C. Garcia-Melgarejo[1], Nestor Lozano-Crisóstomo[1], Ariel Dominguez-Pachecano[1], J. Sanchez Mondragon[2]; [1]*Universidad Autonoma de Coahuila, Mexico;* [2]*INAOE, Mexico.* We discuss the generation of a Fock state photon distribution in a perfect cross-cavity. We verify such generation through the numerical computation of the fidelity in two important cases.

JTu2A.47
Analysis of the Twin-soliton Bound States in Passive Microresonator, Maitrayee Saha[1], Samudra Roy[1], Shailendra Varshney[1]; [1]*IIT-KGP, India.* We numerically study spectral characteristics of frequency comb in presence of two solitons separated by a delay much greater than their characteristic width. Nature of interaction potential and energy signify the stability of bound state.

JTu2A.48 ***RAPID***
Superdiffusive charge screening for phase singularities in isotropic random waves, Lorenzo De Angelis[1], L. Kuipers[1]; [1]*Kavli Inst. of Nanoscience, Delft Univ. of Technology, Netherlands.* We present a quantitative study on the screening among phase singularities in random waves. We prove that the fluctuation of the total topological charge Q contained in an area R^2 satisfies $\langle \Delta Q^2 \rangle \sim R \log R$ rather than the ordinary diffusive $\langle \Delta Q^2 \rangle \sim R$.

JTu2A.49 ***RAPID***
Femtosecond Pulse-Splitting Effect in Second Harmonic Generation in the Laue Diffraction Scheme From 1D Photonic Crystals, Vladimir B. Novikov[1], Boris I. Mantsyzov[1], Tatiana V. Murzina[1]; [1]*M. V. Lomonosov Moscow State Univ., Russia.* Phase-matched second harmonic generation at temporal laser pulse-splitting effect in one-dimensional photonic crystals under the Bragg diffraction in the Laue geometry is studied experimentally and theoretically involving supercomputer resources.

JTu2A.50 ***RAPID***
Plasma Formed by Dual-Filament Interaction, Danielle Reyes[1], Jessica Pena[1], Matthieu Baudelet[1], Shermineh R. Fairchild[1], Martin C. Richardson[1]; [1]*Univ. of Central Florida, USA.* The filament plasma resulting from the interaction between two co-propagating beams, separated by 180 and 280 μm, was characterized for different energy distributions – two subcritical beams, one subcritical beam with one filament, and two filaments.

JTu2A.51
Surface Enhanced Raman Scattering Efficiency of Metal Coatings on Photochemically Roughened Silicon Surfaces, Tuba Önder[1]; [1]*Middle East Technical Univ., Turkey.* The aim is obtaining optimal surface to enhance Raman scattering by applying different parameters (power, duration). Laser assisted wet etching technique was used to roughened surface of Si surfaces and they were analyzed to measure enhancement factors.

JTu2A.52
High harmonic generation in diamond driven by intense femtosecond near infrared laser pulse, Boyan Obreshkov[1]; [1]*INRNE-BAS, Bulgaria.* We present theoretical results on photoionization high-harmonic generation in bulk diamond induced by intense laser pulse of photon energy 1.55 eV, having a time duration of 15 fs.

JTu2A.53 ***RAPID***
Two-qudit deterministic optical quantum logic in a single photon, Poolad Imany[1], Jose A. Jaramillo-Villegas[1], Joseph M. Lukens[2], Ogaga D. Odele[1], Daniel E. Leaird[1], Minghao Qi[1], Andrew M. Weiner[1]; [1]*Purdue Univ., USA;* [2]*Oak Ridge National Lab, USA.* We demonstrate deterministic two-qudit gates using the time and frequency degrees of freedom of a single photon, showing the potential of our scheme for deterministic quantum computing in high-dimensional Hilbert spaces.

JTu2A.54 ***RAPID***
Quantum-Limited Electro-Optic Modulator Based on Thermal Rydberg Atoms, Kevin C. Cox[1], David H. Meyer[2,1], Zachary A. Castillo[2,1], Paul D. Kunz[1]; [1]*US Army Research Lab, USA;* [2]*Physics, Univ. of Maryland, College Park, USA.* We discuss the standard quantum limit for electro-optic conversion using a quantum sensor and experimentally demonstrate quantum-limited operation using electromagnetically-induced-transparency with thermal Rydberg atoms.

JTu2A.55 ***RAPID***
The Quest for Nonclassicality using Number-Resolving Single-Photon Detectors, Raphael A. Abrahao[1,2], Farid Shahandeh[2], Geoff Gillett[1,2], Martin Ringbauer[1,2], Till Weinhold[1,2], Marcelo P. Almeida[1,2], Timothy C. Ralph[2], Andrew G. White[1,2]; [1]*Centre for Engineered Quantum Systems, School of Mathematics and Physics, Univ. of Queensland, Australia;* [2]*Centre for Quantum Computation and Communication Technology, School of Mathematics and Physics, Univ. of Queensland, Australia.* The quest for nonclassicality is the search for the border between classical and quantum physics. Our work aims to show that nonclassical correlations can be observed even in the absence of entanglement and quantum discord.

JTu2A.56 ***RAPID***
Enhancing the number of bi-photon orbital angular momentum modes using asymmetric vortex beam, Jabir M. V.[1], Goutam K. Samanta[1], Ali Anwar[1]; [1]*Physical Research Lab, India.* We report on controlling the bi-photon OAM eigenmodes in down-conversion process by simply adjusting the asymmetry of the pump vortex beam. Calculation of the Schmidt number shows the increase in the number of OAM eigenmodes.

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JTu2A.57
First-Principles Study of the Optical Properties of AA-Stacked Bilayer Graphene, Jun-Fu Zhang[1], Min-Hsueh Chiu[1], Chang-Tsung Hsieh[1], Tony Wen-Hann Sheu[1], Jia-Han Li[1]; [1]*National Taiwan Univ., Taiwan.* The density functional theory is used to study optical properties in AA-stacked bilayer graphene. The band gap increases as the interlayer distance gets smaller. The anisotropic permittivity of AA-stacked bilayer graphene is demonstrated.

JTu2A.58
Conductive Gap-Plasmon Nanocavity, Seied Ali Safiabadi Tali[1], Wei Zhou[1]; [1]*Virginia Tech, USA.* We can design and create conductive gap-plasmon nanocavity structures using vertically stacked nanodisks made of metals or conductive oxides, which can simultaneously serve as nanoelectrodes and nanoantennas for hybrid electrical-optical interface.

JTu2A.59
A Comparative Analysis of TM Guided Modes in Silicon on Insulator (SOI) based Rectangular Optical Waveguide, Dhananjoy De[1], Ritu Raj Singh[1], Vishnu Priye[1]; [1]*Indian Insttitute of Technology, Dhanbad, India.* In this paper, TM guided modes of SOI based rectangular optical waveguide of different widths have been investigated. Conditions for first and higher order modes are analyzed mathematically and justified with the FEM simulation.

JTu2A.60
Example of Guessing Probability on Secret Key by Known-Plaintext Attack on Y00 Quantum Stream Cipher, Takehisa Iwakoshi[1]; [1]*Tamagawa Univ., Japan.* While Quantum-Key-Distribution is regarded as promising secure communication, security of Y00 protocol H. P. Yuen proposed for the affinity to conventional optical communication is not well-understood yet. This study gives some insights.

JTu2A.61
Influence of multiple scattering on self-focusing in nematic liquid crystals, Alessandro Alberucci[1], Chandroth P. Jisha[2], Serena Bolis[3,4], Jeroen Beeckman[4], Stefan Nolte[1,5]; [1]*Friedrich-Schiller-Universitat Jena, Germany;* [2]*Universidade do Porto, Portugal;* [3]*Universite libre de Bruxelles, Belgium;* [4]*Ghent Univ., Belgium;* [5]*Fraunhofer Inst. of Applied Optics and Precision Engineering, Germany.* We study the interplay between multiple scattering and self-focusing in Nematic Liquid Crystals (NLCs). At low powers self-focusing increases the coherence, but for large powers a continuous temporal oscillation is observed.

JTu2A.62
Thermal Decoherence of the Carrier-Envelope-Offset Frequency in a Kerr-Microresonator Comb, Tara E. Drake[1], Jordan Stone[1,2], Travis C. Briles[1,2], Daryl Spencer[1], Scott B. Papp[1,2]; [1]*Time and Frequency Division, NIST, USA;* [2]*Physics, Univ. of Colorado, Boulder, USA.* We present measurements of the carrier-envelope-offset frequency noise spectrum of a silicon nitride Kerr-microresonator comb. Our preliminary observations suggest that thermal decoherence is an important contribution.

JTu2A.63
Withdrawn

JTu2A.64
Pump-probe Quantum State Tomography and Photon Statistics in Semiconductor Quantum Dots, Fabian Boehm[1], Nicolai B. Grosse[1], Mirco Kolarczik[1], Bastian Herzog[1], Nina Owschimikow[1], Ulrike K. Woggon[1]; [1]*Technische Universität Berlin, Germany.* Quantum state tomography is applied to InGaAs quantum dot-semiconductor optical amplifiers to reconstruct the Wigner function and photon statistics for a coherent state interacting with QDs with high time-resolution and in the few-emitter limit.

JTu2A.65
Quantum holography with twin photons of large spatial dimensionality, Fabrice. Devaux[1], Alexis Mosset[2], Florent Bassignot[3], Eric Lantz[1]; [1]*Universite de Franche-Comte, France;* [2]*FEMTO-ST, France;* [3]*FEMTO Engineering, France.* We report results of quantum holography where spatial information stored in phase hologram is restored by measuring spatial coincidences between two images formed by spatially entangled twin photons of high-dimensionality transmitted by the hologram.

JTu2A.66
Experimental Implementation of Directionally-Unbiased Linear-Optical Multiport, Shuto Osawa[1], David S. Simon[1,2], Alexander V. Sergienko[1]; [1]*Boston Univ., USA;* [2]*Stonehill College, USA.* A directionally-unbiased optical multiport allows a photon to reverse direction inside and exit at any port, including the input port. This multiport could be used as a quantum gate and for efficiently implementing quantum walks.

JTu2A.67
Multiphoton discrete fractional Fourier operations in waveguide beam splitters, Armando P. Leija[1,2], Konrad Tschernig[2], Roberto D. Leon Montiel[3], Omar Magana Loaiza[4], Alexander Szameit[5], Kurt Busch[1,2]; [1]*Max Born Inst., Germany;* [2]*Inst. of Physics, Humboldt Univ., Germany;* [3]*ICN, UNAM, Mexico;* [4]*NIST, USA;* [5]*Inst. of Physics, Univ. of Rostock, Germany.* We show that exciting a waveguide beam-splitter with N indistinguishable photons, give rise to lattice-like structures in the photon number space that are formally equivalent to coupled systems that perform discrete fractional Fourier transforms.

JTu2A.68
Experimental Implementation of One-Qubit Logic Gates and Verification Via Quantum State Tomography, Christian D. Torres Quelal[1], Carlos A. Melo[1], John H. Reina[1]; [1]*Physics, Universidad del Valle, Colombia.* We implemented one-qubit quantum gates testing through the production of the polarization set of states, with |Hi as input. Complementary, we reconstructed the state for each output via the quantum-tomography protocol with fidelities over 95%.

JTu2A.69
Link between Debye Temperature, Bang Gap Energy, and Fine Structure Constant, Haowen Xi[2], Bruno Ullrich[1], Mithun Bhowmick[3]; [1]*Ullrich Photonics LLC, USA;* [2]*Dept. of Physics and Astronomy, Bowling Green State Univ., USA;* [3]*School of Chemical Sciences, Univ. of Illinois at Urbana-Champaign, USA.* The link between the fine structure constant, energy band gap, and Debye temperature of semiconductors is reported. The revealed relation has the potential to be highly influential for the design of optoelectronic and photonic devices.

JTu2A.70
Phase Noise Based Quantum Random Number Generator Suppressing Classical Noise, Ziyang Chen[1], Zhengyu Li[1], Yichen Zhang[2], Hong Guo[1]; [1]*State Key Lab of Advanced Optical Communication Systems and Networks, School of Electronics Engineering and Computer Science, Center for Quantum Information Technology, Peking Univ., China;* [2]*State Key Lab of Information Photonics and Optical Communications, Beijing Univ. of Posts and Telecommunications, China.* We present a phase-noise-based random number generation scheme with a rate of 600Mbps without using optical delay line, which can remove the classical noise induced by fiber jitter.

JTu2A.71
Stochastic Runge-Kutta Algorithm and Parameter Optimization in Optical Simulations Using MATLAB, John R. Thompson[1], Hongbo Zhang[1]; [1]*Virginia Military Inst., USA.* An algorithm and MATLAB code for solving nonlinear stochastic rate equations are presented and applied to the problem of parameter optimization using high performance computing.

JTu2A.72
Spatial solitons as fixed points of Fox-Lee integral equation, Alex Okulov[1]; [1]*Russian Academy of Sciences, Russia.* The exactly solvable model of nonlinear eigenmodes of laser cavities in Fox-Lee integral equations form includes correctly boundary conditions. Bright soliton solutions and their instability increments are obtained explicitly.

JTu2A.73
Quantum Fractional Fourier Transform, Yesid A. Madrid Carrillo[2,1], Martha Molina[2], Rafael Torres[3]; [1]*Grupo de Ciencias Computacionales, Universidad de Pamplona, Colombia;* [2]*Grupo de Óptica Moderna, Física, Universidad de Pamplona, Colombia;* [3]*Grupo de Óptica y Tratamiento de Señales, Escuela de Física, Universidad Industrial de Santander, Colombia.* Our propose consist in show a new quantum gate that can perform the Fractional Fourier Transform defined by Namias as a tool to solve the differential equation of the quantum mechanical oscillator, which it can satisfy the condition of to be unitary.

JTu2A.74 *RAPID*
Characterization of Fiber Bragg Gratings in Multicore Fibers Using Quantitative Phase Imaging, Yijun Bao[1], Thomas K. Gaylord[1]; [1]*Georgia Inst. of Technology, USA.* A quantitative phase imaging method is applied to characterize fiber Bragg gratings in multicore fibers. Digital image processing techniques are developed to overcome the difficulties arising from the short period of the fiber Bragg gratings.

JTu2A.75
Mode-Transition Bragg Gratings with Increased Group Index for On-Chip Optical Delay Lines, Lingjun Jiang[1], Zhaoran R. Huang[1]; [1]*Electrical, computer and systems engineering, Rensselaer Polytechnic Inst., USA.* We proposed and demonstrated mode-transition Bragg gratings for optical delay line applications. It shows a stronger slow light effect than conventional apodized Bragg gratings, and a maximum group index of 15.8 has been achieved.

JTu2A.76
Scintillation Index Analysis for a Downlink Satellite Communication Based on the Three-layer Altitude Model for Moderate-to-strong Turbulence, Xin Shan[1,2], Yong Ai[1], Curtis Menyuk[2]; [1]*Electronic Information School, Wuhan Univ., China;* [2]*Computer Science and Electrical Engineering Dept., Univ. of Maryland Baltimore County, USA.* Scintillation is analyzed by adopting different wave-structure functions in the three-layer model. Results show that weak-fluctuation theory is limited to smaller zenith angles, and the scintillation index has a larger peak in the focusing regime.

JTu2A • Poster Session I and Dynamic E Posters—Continued

JTu2A.77
Mode-locking Pulse Generation Based on In-fiber Acousto-optic Tunable Bandpass Modulator, Andrés Camarillo-Avilés[1,2], Erika N. Hernandez[1,2], Miguel Bello-Jiménez[1,2], Manuel Durán-Sánchez[3], Baldemar Ibarra-Escamilla[3], Olivier Pottiez[4], Evgeny A. Kuzin[3]; [1]*Universidad Autonoma de San Luis Potosí, Mexico;* [2]*Instituto de Investigación en Comunicación Óptica, Mexico;* [3]*Óptica, Instituto Nacional de Astrofísica, Óptica y Electrónica, Mexico;* [4]*Centro de Investigaciones en Óptica, Mexico.* An all-fiber acousto-optic tunable bandpass modulator and its application to perform mode-locking operation is reported. Experimental results demonstrate efficient spectral filtering to support high intense and ultrashort pulse generation.

JTu2A.78
Fast Quasiadiabatic 2×2 Broadband 3-dB Couplers on SOI Strip Waveguides, Zhong-Ying Li[1], Tung-Ke Huang[1], Hung-Ching Chung[1], Shuo-Yen Tseng[1]; [1]*National Cheng Kung Univ., Taiwan.* We propose a short and broadband 2×2 silicon 3-dB coupler optimized by the fast quasiadiabatic approach. The designed device is 67.6 μm long and has a bandwidth of 280 nm for 3±1 dB splitting ratio.

JTu2A.79
Experimental Supercontinuum Generetion with Combination of Different Types of Optical Fibers, Daniel Torres González[1], Juan Manuel Sierra Hernández[1], Daniel Jáuregui Vázquez[1], Julian Moises Estudillo Ayala[1], Juan Carlos Hernández García[1], Roberto Rojas-Laguna[1]; [1]*Universidad de Guanajuato, Mexico.* Supercontinuum generation was achieved with numerous setups of optical fibers which include SMF-28, high-Numerical Aperture and dispersion-shifted fiber. Supercontinuum flatness was studied by modifying the configurations and inducing fiber losses.

JTu2A.80
Micro-Ring Resonator based Digital Photonic Half Adder Demonstration, F. K. Law[1], Mohammad Rakib Uddin[1], Nur Musyiirah Masir[1]; [1]*Univeristi Teknologi Brunei, Brunei Darussalam.* This paper presents the design and simulation of a digital photonic half adder with two silicon micro-ring resonators as its base element. Simulation result with timing diagrams have been shown to justify the adder function.

JTu2A.81
Design of Interaction Gate for high performance computing structures, Santosh Kumar[2], Amna Bedi[1], Nan-Kuang Chen[2]; [1]*DIT Univ., India, India;* [2]*School of Physics Sciences and Information Technology, Liaocheng Univ., China.* The present work provides a reversible optical computation universal signal interaction gate using lithium-niobate based Mach-Zehnder interferometer for high performance computing structures. The results are verified using beam propagation method.

JTu2A.82
Accurate Optical Vortex Identification in the Presence of Distortions Using a Shack-Hartmann Sensor, Jaime A. Anguita[1], Jaime E. Cisternas[1], Gustavo L. Funes[1]; [1]*Universidad de los Andes - Chile, Chile.* We present and evaluate a robust method to identify orbital angular momentum states with a SH sensor for possible use in free-space optical communication links. Experimental verification using a 200m-range test bed is presented.

JTu2A.83
Analysis and Optimization of Edge-Filter Interrogation Scheme for FBG Sensors, SAI R. EAGALA[1], Abhinav Gautam[1], Ritu Raj Singh[1], Amitesh Kumar[1], Vishnu Priye[1]; [1]*Indian Inst. of Technology (ISM), India.* A technique to interrogate an FBG based on edge-filter detection is proposed and demonstrated. The interrogation is performed along the slope of a filter. The filters used are Trapezoidal, Gaussian, Bessel and Butterworth filter.

JTu2A.84
Simulation of the Brillouin Effect in an Optical Feedback, Leidy J. Quintero Rodríguez[1], Min Won Lee[2], Ana G. Correa Mena[1], Ignacio E. Zaldívar Huerta[1]; [1]*INAOE, Mexico;* [2]*Laboratoire de Physique des Lasers, Université Paris 13, France.* Simulations of the dynamical behavior of a semiconductor laser subjected to stimulated Brillouin scattering and conventional optical feedback are presented. It is corroborated that the laser parameters are changed and the BFS is at 11.12GHz.

JTu2A.85
Temperature Sensor Based on Fiber-Optic Fabry-Perot Interferometer, Sigifredo Marrujo[1], Sofia Flores[1], Miguel Torres-Cisneros[1], Daniel López[2], David Monzón[3], Daniel May[2], Iván Hernández[1]; [1]*Guanajuato Univ., Mexico;* [2]*Centro de Investigaciones en Óptica, Mexico;* [3]*Centro de Investigaciones en Óptica, Mexico.* A fiber optic Fabry-Perot interferometer was fabricated. It was constructed by splicing a single mode fiber and a hollow core fiber, cleaving the last one to a length of 16 μm and filling it with polydimethylsiloxane. The sensitivity was 0.61 nm/°C.

JTu2A.86 *RAPID*
Correlating Macroscopic and Microscopic Vibrations in Silicon Carbide (SiC) Micromechanical Resonators, Yanan Wang[1], Jaesung Lee[1], Vivian Zhou[1], Caleb Main[1], Christian Zorman[1], Qiang Lin[2], Philip Feng[1]; [1]*Electrical Engineering, Case Western Reserve Univ., USA;* [2]*Electrical Engineering, Univ. of Rochester, USA.* Device and lattice vibrations in SiC resonators have been comprehensively studied by laser interferometry and Raman spectroscopy. Bridging macroscopic and microscopic objects via strain mediation or phonon coupling will open up opportunities toward quantum applications.

JTu2A.87 *RAPID*
Efficient second-harmonic generation in sub-micron PPLN waveguides, Jiayang Chen[1], Yong Meng Sua[1], Zhaohui Ma[1], Chao Tang[1], Zhan Li[1], Yu-Ping Huang[1]; [1]*Stevens Inst. of Technology, USA.* Efficient second-harmonic generation (SHG) is demonstrated in sub-micron periodically poled lithium niobate waveguides with normalized conversion efficiencies over 440% $W^{-1}cm^{-2.}$

JTu2A.88 *RAPID*
Excitation of hybrid epsilon-near-zero/plasmonic modes in ALD-AZO coated nanoantennae, Subhajit Bej[1], Sudip Gurung[1], Aleksei Anopchenko[1], Brian Ko[1], Howard Lee[1]; [1]*Baylor Univ., USA.* We study optical properties of nanoantennae conformally coated with epsilon-near-zero (ENZ) Al-doped zinc oxide thin films. Results show splitting of nanoantenna resonance due to coupling between plasmonic and ENZ modes.

JTu2A.89 *RAPID*
Entanglement Enhancement in Multimode Integrated Circuits, Zacharie M. Léger[1], Aharon Brodutch[3,2], Amr Helmy[1,3]; [1]*The Edward S. Rogers Sr. Dept. of Electrical & Computer Engineering, Univ. of Toronto, Canada;* [2]*Dept. of Physics, Univ. of Toronto, Canada;* [3]*Center for Quantum Information and Quantum Control, Univ. of Toronto, Canada.* Entanglement enhancement through photon subtraction is studied in the multimode scenario. Optimal gain regions were identified for bipartite and multipartite measures; positive gains in entanglement were found after losses of 80% for specific bipartite splittings.

JTu2A.90 *RAPID*
Broadband and Gate-Tunable Conducting Oxide Epsilon- Near-Zero Perfect Absorber, Long Tao[3], Aleksei Anopchenko[3], Sudip Gurung[3], Catherine Arndt[3], Jason Myers[2], Howard Lee[3,1]; [1]*The Inst. for Quantum Science and Engineering, Texas A&M Univ., USA;* [2]*US Naval Research Lab, USA;* [3]*Dept. of Physics, Baylor Univ., USA.* We demonstrate broadband and gate-tunable conducting oxide epsilon-near-zero perfect absorbers grown by atomic layer deposition. Absorption bandwidth (> 90%) of 214 nm for Berreman mode in NIR region is realized.

JTu2A.91 *RAPID*
Random Lasers based on Polymer Membranes with Silver Nanoflowers, Junhua Tong[1], Tianrui Zhai[1]; [1]*College of Applied Sciences, Beijing Univ. of Technology, China.* Low-threshold random lasing was achieved in a polymer membrane with silver nanoflowers. The random laser was fabricated by attaching the polymer membrane on the silver nanoflowers.

JTu2A.92
Demonstration of a High Q-factor Microring Resonator Fully Suspended by a Subwavelength Sidewall Grating, Soha E. Yousuf[1], Anatol Khilo[2], Marcus S. Dahlem[1]; [1]*Khalifa Univ. of Science and Technology, United Arab Emirates;* [2]*Boston Univ. , USA.* A microring resonator fully suspended by a subwavelength sidewall grating is demonstrated, with measured quality factor of 125k around 1550 nm. The structure is promising for sensing applications, with predicted sensitivities up to 1250 nm/RIU.

JTu2A.93
Mid-Infrared Supercontinuum Generation with a Weak CW Trigger, Rongle Huang[1], Renlai Zhou[2], Qian Li[1]; [1]*Peking Univ., China;* [2]*Naval Univ. of Engineering, China.* We numerically demonstrate picosecond pulse pumped mid-infrared supercontinuum generation in chalcogenide photonic crystal fibers with a weak CW trigger. An untra-stable and bright supercontinuum with greatly enhanced coherence is achieved.

JTu2A.94
Small-Period Titanium-Diffused Periodically Poled Lithium Niobate Waveguides for Strongly Nondegenerate Quantum Frequency Conversion, John W. Snyder[1], Alexander V. Sergienko[1,2]; [1]*Electrical and Computer Engineering, Boston Univ., USA;* [2]*Physics, Boston Universiry, USA.* A Ti-diffused periodically poled Lithium Niobate device with ultra-short poling periods has been developed for strongly nondegenerate quantum nonlinear optics. Quantum frequency conversion from 369.5nm to 1550nm with a 485nm pump laser is targeted.

JTu2A.95
A Novel Photonic Stampfli Quasicrystal Fiber Based D-Glucose Microbiosensor, Aruna Gandhi M S[1], Xuanyi Liu[1], Qian Li[1]; [1]*Shenzhen Graduate School, Peking University, China.* The proposed photonic Stampfli quasicrystal fiber-based D-glucose Microbiosensor achieves a maximum sensitivity of 20000 nm/RIU and a resolution of 5×10^{-8} RIU in the different concentrations from 50% to 60% of the D-glucose solution.

JTu2A.96
Tunable Electromagnetically Induced Transparency in $Ge_2Sb_2Te_5$-Based Infrared Metasurfaces, Riad Yahiaoui[1], Joshua Burrow[2], Jay Mathews[2], Andrew Sarangan[2], Imad Agha[2], Thomas A. Searles[1]; [1]*Howard Univ., USA;* [2]*Dayton Univ., USA.* We report the investigation of an all-dielectric metasurface (ADM) based on an array of $Ge_2Sb_2Te_5$ (GST) meta-molecules exhibiting a tunable electromagnetically induced transparency (EIT) effect in the infrared frequency regime.

JTu2A • Poster Session I and Dynamic E Posters—Continued

JTu2A.97
Novel refractive index sensor based on hybrid long range plasmon in H-shaped optical fiber, Nelson Gomez-Cardona[2,1], Erick Reyes[2,1], Rodrigo Acuña[2], Pedro Torres[2]; *[1]Departamento de Electrónica y Telecomunicaciones, Instituto Tecnológico Metropolitano, Colombia; [2]Escuela de Física, Universidad Nacional de Colombia, Sede Medellin, Colombia.* We propose a novel design for a refractive index (RI) sensor based on hybrid long-range plasmon in H-shaped microstructured optical fiber. Good sensitivity, as high as $6.1*10^3$ nm/RIU, can be achieved in the proposed structure.

JTu2A.98
Highly confined light guiding in a dielectric-nanowire-loaded hybrid Bloch-surface-polariton waveguide, Weijing Kong[1], Yu Sun[2], Haiyang Zhang[1], Yu Sun[1], Shuang Wang[1], Wenhui Zhao[1]; *[1]School of Electronic Engineering, Tianjin Univ. of Technology and Education, China; [2]School of Information Science and Technology, Beijing Forestry Univ., China.* A hybrid dielectric-nanowire loaded Bloch-surface-polariton waveguide is presented and investigated. The results reveal the hybrid configuration enables significantly improved mode confinement combined with low propagation loss.

JTu2A.99
Topologically-protected Edge Modes in Thue-Morse Photonic Crystals, Mukesh K. Shukla[1], Ritwick Das[1]; *[1]National Institute of Science Education & Research, India.* We report topologically-protected optical edge modes in Thue-Morse (TM) sequence based distributed-reflector (DR) with exceptionally high quality-factor. Topological features are explored through the phase and surface-polaritons in TM-DR lattice.

JTu2A.100
Carbon-dots Embedded Glass Based Inverse Micropillar Structures by Two-photon Polymerization Process, Pratyusha Das[1], Meher Wan[1], Subhrajit Mukherjee[1], Samit K. Ray[1,2], Shivakiran Bhaktha B N[1]; *[1]Indian Inst. of Technology Kharagpur, India; [2]S N Bose National Centre for Basic Sciences, India.* A simple fabrication of 2D photonic crystal with hexagonal lattice system of air-column in a high-dielectric medium based on 3D photolithography technique and interaction of quantum emitters embedded in a microcavity is presented.

JTu2A.101
Inverse Design of Long-range Intensity Correlations in Scattering Media, Milan Koirala[1], Raktim Sarma[2], Hui Cao[2], Alexey G. Yamilov[1]; *[1]Missouri Univ of Science & Technology, USA; [2]Applield Physics, Yale University, USA.* We obtain analytical expression for the long-range spatial intensity correlation in a disordered waveguide of an arbitrary shape. Inverting this relationship allows a possibility to manipulate wave transport complimentary to the wavefront shaping.

JTu2A.102
Mid Infra-red Directional Coupler Optical Switch Based on Phase Change Material Embedded in Partially Etched SOI Waveguide, Nadir Ali[1], Rajesh Kumar[1]; *[1]Indian Inst. of Technology Roorkee, India.* An ultra-compact 1x2 optical coupler switch at wavelength 2.1 μm is designed and simulated using $Ge_2Sb_2Te_5$ embedded in silicon waveguide. The phase alteration of $Ge_2Sb_2Te_5$ results in coupling ratio change from >90% to < 2%.

JTu2A.103
Sub-wavelength focusing in air using semiconductor based Hyperbolic Metamaterial for infrared imaging, Norhan Salama[1], Mai Desouky[1], Mohamed M. Swillam[1]; *[1]Physics, American Univ. in Cairo, Egypt.* We theoretically demonstrate sub-wavelength focusing in air using doped InAs/intrinsic InAs hyperbolic metamaterial (HMM). Sub-wavelength focusing in air is achieved in the near field at wavelength of 9.31μm with focusing distance of 1μm with resolution down to 0.13λ.

JTu2A.104
Honeycomb photonic crystal as a zero index metamaterial, Nishant Shankhwar[1], Yogita Kalra[1], Ravindra K. Sinha[1]; *[1]Delhi Technological Univ., India.* In this article zero index behaviour of honeycomb photonic crystal has been demonstrated. The zero index behaviour arises due to the dirac-like dispersion induced by degeneracy of modes at the dirac point.

JTu2A.105
Design and Analysis of Broadband Square Spiral Shaped Nanoantenna, Ritika Ranga[1], Nishant Shankhwar[1], Yogita Kalra[1]; *[1]Delhi Technological Univ., India.* In this paper, a broad band square spiral shaped nanoantenna is proposed and analysed by finite element method via COMSOL Multiphysics software. Electric field is enhanced in the gap of nanoantenna.

JTu2A.106
Disordered coupled photonic crystal slab cavities: effects on the coupling strength, Juan P. Vasco[1], Vincenzo Savona[1]; *[1]Physics, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland.* We study the effects of disorder on the coupling strength of coupled photonic crystal slab cavities and establish upper bounds for the quantity of disorder in order to the system work into the coupling regime.

JTu2A.107
Leaky-mode Band Dynamics of Photonic Crystal Slabs, Sun-Goo Lee[1], Robert Magnusson[1]; *[1]Univ. of Texas at Arlington, USA.* We present analytical and numerical results on the formation of the second (leaky) stop band of photonic crystal slabs. We show that Bragg processes generated by spatial Fourier harmonics control the band transition dynamics.

JTu2A.108
Super-Absorbing Metamaterials Using Epsilon-Near-Zero Plasma Resonance, Jinnan Chen[1], Justin W. Cleary[2], Joshua R. Hendrickson[2], Evan M. Smith[2,3], Junpeng Guo[1]; *[1]Univ. of Alabama in Huntsville, USA; [2]Air Force Research Lab, USA; [3]KBRwyle, USA.* Metamaterials of epsilon-near-zero (ENZ) and dielectric layer structures are investigated for wideband light absorption in the wavelength range from 1 to 2 micron. Increasing the number of ENZ-dielectric layers results in wider absorption band.

JTu2A.109
Design of microring resonator sensor for liquid chemical sensing applications, Amna Bedi[1], Sonika Singh[1], Santosh Kumar[2], Nan-Kuang Chen[2]; *[1]Dept. of Electrical and Electronics & Communication Engineering, DIT Univ., India, India; [2]School of Physics Sciences and Information Technology, Liaocheng Univ., China.* A microring resonator sensor for liquid chemical sensing applications is proposed, which is based on the change in optical signal intensity with refractive index of analytes. The input and output intensity inside sensor is measured.

JTu2A.110
Design and Characterization of Nanocavity Photonic Crystal Lasers, Binte M. Muminur[1], Muhammad M. Rahman[1]; *[1]Physics, Jahangirnagar Univ., Bangladesh.* Photonic laser sources have great potential in communication applications. We explore the design, fabrication and characterization of lasers based on photonic crystal nanocavities. We demonstrate CW and ultrashort pulse response of photonic lasers.

JTu2A.111
Standoff microparticles characterization with digital holographic Raman spectroscopy, Nava R. Subedi[1], Gombojav O. Ariunbold[1], Prakash Adhikari[1], Matthew J. Berg[2]; *[1]Mississippi State Univeristy, USA; [2]Physics, Kansas State Univ., USA.* A detail standoff interrogation of microparticles irradiated with a coherent light source will be discussed. The results suggest that the methodology could be applied to characterize airborne respirable-sized particles in free-flowing aerosol form.

JTu2A.112
Optically induced pure frequency modulation based on a mid-infrared quantum cascade laser, Hai J. Zhou[1], Chen Peng[2], Tao Chen[2], Biao Wei[1]; *[1]ChongqQing Univ., China; [2]China Academy of Engineer Physics, China.* Purified frequency modulation is demonstrated in a middle-infrared quantum cascade laser by illuminating its front facet with two optimized near infrared lasers. It is beneficial in improving signal fidelity for free space optical communication.

JTu2A.113
Near Field Enhancement in a Hollow Flower Shaped Nanoantenna, Parul Goyal[1], Nishant Shankhwar[1], Yogita Kalra[1]; *[1]Delhi Technological Univ., India.* In this paper, a metallic hollow flower shaped nanoantenna has been designed to obtain a near field enhancement in the feed gap of nanoantenna in the visible vision. The modeling of the nanoantenna has been done using COMSOL Multiphysics software.

JTu2A.114
Optical Biosensor Based on Guided Mode Grating Coupler, Rukmani Singh[1], Ritu Raj Singh[1], Vishnu Priye[1]; *[1]Indian Institute of Technology, Dhanbad, India.* Demonstration of highly sensitive optical biosensor based on interaction of analyte with guided mode light in silicon-on-insulator waveguide through grating coupler is proposed. The presented device is compact and high sensitive (422nm/RIU).

JTu2A.115
Dual-Functional Integrated Modulator-Detector for Optical Communication On-Chip, Shuai Sun[1], Ruoyu Zhang[1], Jiaxin Peng[1], Hamed Dalir[2], Tarek El-Ghazawi[1], Volker J. Sorger[1]; *[1]George Washington Univ., USA; [2]Omega Optics, Inc., USA.* Here we show a novel integrated broadband hybrid photonic-plasmonic device termed MODetector featuring dual light modulation and detection, with 10 dB extinction ratio, 0.8 dB insertion loss, and 0.7 A/W responsivity.

JTu2A.116
Ultrafast sources for optical virtual skin biopsy: a fiber-based solution to pulses at 1250 nm, Hsiang-Yu Chung[1,2], Wei Liu[1,2], Rüdiger Greinert[3], Franz Kärtner[1,2], Guoqing Chang[1,4]; *[1]DESY, Germany; [2]Physics, Universität Hamburg, Germany; [3]Skin Cancer Center Buxtehude, Germany; [4]The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Germany.* We demonstrate a fiber-based ultrafast source generating 450-mW, sub-100-fs pulses centered at 1250 nm by implementing self-phase modulation enabled spectral selection. This source is ideal for harmonic generation microscopy in human skin.

JTu2A • Poster Session I and Dynamic E Posters—Continued

JTu2A.117
Fast Hyperspectral Detection of the Frequency Response of Highly Scattering Tissue using a Femtosecond Pulse with Light Labeling, Patrick A. Stockton[1], Randy Bartels[1], Mohammad Torabzadeh[2], Bruce J. Tromberg[2]; [1]*Colorado State University, USA;* [2]*Biomedical Engineering, Univ. of California, USA.* We introduce a new diffuse optical spectroscopy measuring technique for fast acquisition of optical properties. We utilize a broad bandwidth femtosecond illumination to simultaneously probe the spectral and frequency response of a scattering tissue.

JTu2A.118
Silicon photonics with hybrid integrated 2D MoO3: plasmonic pH driven sensing and reconfigurability, Guanghui Ren[1], Baoyue Zhang[1], Markus Knoerzer[1], Arnan Mitchell[1], Jianzhen Ou[1]; [1]*Royal Melbourne Inst. of Technology, Australia.* A new plasmonic label-free optical pH sensing platform is realized by integrating two-dimensional H^+ doped molybdenum oxide on a silicon micro-ring resonator.

JTu2A.119
Quantitative Second-harmonic Generation Imaging of Tissue Damage from Environmental-scanning Electron Microscopy, Woowon Lee[1], Kimani C. Toussaint, Jr.[1]; [1]*Univ. of Illinois, USA.* We quantitatively evaluate changes of collagenous tissue due to beam exposure in an environmental-scanning electron microscope. Quantitative second-harmonic generation microscopy is used to image and assess selected regions before and after exposure.

JTu2A.120
Development of Medical Diagnostic System using a Non-labeled Extraordinary Optical Transmission Biosensor, Yeji Lee[1], Hyerin Song[1], Heesang Ahn[1], Kyujung kim[1]; [1]*Pusan National Univ., South Korea.* Extraordinary optical transmission sensor with sensitivity of 458.33 nm/RIU was designed and distinguished the hypoalbuminemia group with a probability of over 98 %.

JTu2A.121
1.7-μm gain-switched thulium-doped fiber laser with electrically tuning and its application to spectroscopic photoacoustic imaging, Can Li[1], Jiawei Shi[1], Cihang Kong[1], Xiaojing Gong[2], Liang Song[2], Kenneth K. Wong[1]; [1]*Univ. of Hong Kong, Hong Kong;* [2]*Inst. of Biomedical and Health Engineering, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China.* We demonstrate a gain-switched thulium-doped fiber laser with electrically wavelength tuning in the 1.7-μm band. The achieved stable laser pulses with an energy of 1.6 μJ are exploited to implement spectroscopic photoacoustic microscopy of lipid.

JTu2A.122
Single-shot multiple-color holography of single neuron using spatial frequency multiplexing, Behnam Tayebi[1], Yeonwoo Jeong[1], Jae-Ho Han[1]; [1]*Korea Univ., South Korea.* Here, we present a single-shot triple-wavelength holographic microscopy technique for high-resolution color imaging of the neuronal cells using a monochromatic camera. The feasibility of the technique is demonstrated by imaging of neuronal cells.

JTu2A.123
A Report on ISCOSA sponsored 1st International Day of Light Event 2018 – Light Enchantment, Sumit Ghosh[1,2]; [1]*School of Optics-ISCOSA, India;* [2]*Physics, Andhra Vidyalaya-Osmania Univ., India.* Indian Student Chapter of Optical Society of America celebrated the 1st International Day of Light 2018 by organizing an optics-based event 'Light Enchantment' for the under-privileged students. A brief report is being presented.

JTu2A.124
Optimal Plasmonic Nanopillars Array for Light Confinement of Fluorescence Imaging, Soojung Kim[1], Hyerin Song[1], Tae Young Kang[1], Heesang Ahn[1], Kyujung Kim[1]; [1]*Pusan National Univ., South Korea.* Vertical SiO2 nanopillars array terminated with Au nanofilms for light localization. Reducing light scattering to enable light localization in the vicinity of metals. As a result, we could confirm reducing light scattering.

JTu2A.125
Development of Four Channel Based Linear Stokes-Mueller Polarization Microscope For Tissue Characterization, Spandana K. U[1], Krishna K. Mahato[1], Nirmal Mazumder[1]; [1]*Manipal Academy of Higher Education, India.* We have developed Stokes-Mueller based polarization imaging technique to extract the quantitative microstructural information of biological sample.

JTu2A.126
High Speed, High-Resolution First Surface Defect Detection for Virtual and Augmented Reality Optics, Timothy A. Potts[1]; [1]*Dark Field Technologies, USA.* First surface inspection of uncoated and coated optics is critical for high volume production of Virtual and Augmented Reality headsets and eyeware. Solid State Laser Reflection (SSLR) technology delivers high-speed first surface inspection.

JTu2A.127
Vibrational Spectroscopic Preliminary Study of Blood and Its Components in Mice, Ariunbold Gombojav[1], Supriya Nagpal[1], Prakash Adhikari[1], Enkhsaikhan Purevjav[2], Lu Lu[3]; [1]*Mississippi State Univ., USA;* [2]*Pediatrics, Univ. of Tennessee Health Science Center, USA;* [3]*Genetics, Genomics and Informatics, Univ. of Tennessee Health Science Center, USA.* Spectroscopic study of blood and serum of the mice strains produced from progenitors C57BL/6J and DBA/2J for identifying biomarkers is underway. A preliminary study shows that multivariate spectral analyses discriminate the mice with their ages.

JTu2A.128 *RAPID*
Imaging Brain Pathology in Alzheimer's Disease by Contrast-Enhanced Optical Coherence Tomography, Bernhard Baumann[1], Antonia Lichtenegger[1], Pablo Eugui[1], Martina Muck[1], Marco Augustin[1], Thomas Roetzer[1], Danielle J. Harper[1], Adelheid Woehrer[1], Christoph Hitzenberger[1]; [1]*Medizinische Universität Wien, Austria.* We present three approaches for using optical coherence tomography (OCT) to visualize neuritic plaques in Alzheimer's disease based on intrinsic optical properties, namely their birefringence, spectroscopic characteristics and scattering profile.

JTu2A.129 *RAPID*
Spatial resolution of compressive-sensing-based ghost imaging can approach theoretical upper bound, Xieyu Du[1], Junhui Li[1], Guohua Wu[1], Bin Luo[1], Dongyue Yang[1], Longfei Yin[1], Hong Guo[2]; [1]*Beijing University of Posts & Telecom, China;* [2]*Peking Univ., China.* We present a method for the spatial resolution of ghost imaging to approach its theoretical upper limit based on parameter optimization of compressive sensing. This method shows robustness against additive noise in bucket detector.

JTu2A.130 *RAPID*
Pixel-based Engineering for Suppression of Higher Orders of Diffraction, Joanna Starobrat[1], Jan Bolek[1], Michal Makowski[1]; [1]*Faculty of Physics, Warsaw Univ. of Technology, Poland.* For the reduction of higher diffraction orders in computer hologram reconstructions, pixel engineering methods are proposed: pixel apodization (phase and amplitude) and their randomization. The results of simulations and experiments are discussed.

JTu2A.131 *RAPID*
Numerical Modeling of Unit Cell and Field Stop Effects in Apodized Pupil Lyot Coronagraphs, Scott Will[1], James R. Fienup[1]; [1]*Univ. of Rochester, USA.* We show that the field diffracted from the apodizing mask of an apodized pupil Lyot coronagraph can be computed exactly, and analyze the effect on instrument performance as a function of field stop diameter

JTu2A.132
Sparsity-based One-dimensional Phase Retrieval of Continuous Non-negative Pulse Trains, Qianqian Su[1], Jianfei Hua[1]; [1]*Tsinghua Univ., China.* Represented by discrete-time signals, continuous non-negative pulse trains have been successfully reconstructed from under-sampled measurements of their Fourier amplitude based on assumptions of sparsity and finite support.

JTu2A.133
Contour-based depth-of-field extension in multi-focus integral imaging system, Miao Zhang[1], Yongri Piao[1], Chuanzhen Wei[1], Rui Xu[1]; [1]*Dalian Univ. of Technology, China.* To solve the limited DoF of integral imaging, the contour-based object extraction and minimum bounding box based size correction are developed. Finally, all-in-focus EIs are obtained by the block-based image fusion method.

JTu2A.134
Programmable Multiwavelength Achromatic Focusing Through Scattering Media, Jiannan Wang[1], Wei Li[1], Jietao Liu[1], Xueying Sun[1], Guo Chengfei[1], Xiaopeng Shao[1]; [1]*XiDian Univ. of China, China.* We demonstrate with numerical simulations that multiple scattering can be controlled via serial optical transmission matrix and parallel optical transmission matrix to obtain achromatic 3D focusing at arbitrary position by wavefront shaping.

JTu2A.135
Surface Normals Correction by Removing Specular Reflection for 3D Polarization Imaging, Shengzhi Huang[1], Fei Liu[1], Pingli Han[1], Xuan Li[1], Xiaopeng Shao[1]; [1]*XiDian Univ., China.* 3D polarization imaging is challenged by surface distortion caused by the specular reflection. We used the dichromatic reflection model to remove the specular reflection and correct surface normals to obtain accurate 3D image.

JTu2A.136
Bit-length vs. dimension: Image formation of ghost imaging, Meijing Ke[1], Junhui Li[1], Guohua Wu[1], Bin Luo[1], Dongyue Yang[1], Longfei Yin[1], Hong Guo[2]; [1]*Beijing Univ of Posts & Telecom, China;* [2]*Peking Univ., China.* Length-variant pooling according to conducted sample number excludes endeavor to expand image dimension from image formation process of ghost imaging, leaving bit-length growth alone.

JTu2A.137
Structural contrast function improves image alignment precision of ghost imaging, Dongchu Han[1], Junhui Li[1], Guohua Wu[1], Bin Luo[1], Dongyue Yang[1], Longfei Yin[1], Hong Guo[2]; [1]*Beijing University of Posts & Telecom, China;* [2]*Peking Univ., China.* Structural contrast function prevails cross-correlation and mutual information on image alignment of ghost imaging, both accuracy (pixel shift) and robustness (error curve kurtosis), especially in under-sampling condition.

JTu2A • Poster Session I and Dynamic E Posters—Continued

JTu2A.138
Open Source Computational Photonics Toolbox, Alec Hammond[1], Ryan M. Camacho[1]; [1]*Electrical & Computer Engineering, Brigham Young Univ., USA.* We present an open source and collaborative integrated photonics simulation environment capable of accurately modeling individual components using traditional vectorial methods and large circuits using linear system theory and deep learning.

JTu2A.139
3D Multiple Sclerosis Image Analysis Based on Probabilistic Methods for a 4F Array, Eduardo Perez[1]; [1]*DICIS, Mexico.* This work presents a detection of multiple sclerosis (MS) knowing is a challenging process, which usually requires several analysis of the imaging over time. All of this to be implemented in a 4F array.

JTu2A.140
Raman Spectroscopy as a Tool for Characterisation of Liquid Phase Devices, Benjamin T. Hogan[1]; [1]*Univ. of Exeter, UK.* In this paper, we demonstrate how Raman spectroscopy can be an effective tool for the elucidation of the properties of liquid phase devices, looking at signal enhancement through to beam profiling.

JTu2A.141
Stationary Fourier Transform Spectrometer, Erez N. Ribak[1]; [1]*Technion Israel Inst. of Technology, Israel.* We developed a non-scanning and extremely stable Fourier Transform Infra-red Spectrometer, for detection of narrow atmospheric lines. We intend to use it to identify and measure molecules in our own atmosphere or in remote planets.

10:00–15:00 Science & Industry Showcase Visit page 11 for a complete program schedule.

13:00–14:00
Rapid Fire Oral Presentation II, Science & Industry Theater
Presider: David Busch; Univ. Texas Southwestern Medical Center at Dallas, USA

Participating posters are noted in the list of poster for session JTu3A with the icon **RAPID**. Each presenter will have 3 minutes and the order will be determined by poster number.

JOINT FiO + LS

13:00–15:00
JTu3A • Poster Session II and Dynamic E Posters

JTu3A.1 *E-Poster*
Polarization-Filtering Negative Curvature Fibers, Chengli Wei[1], Curtis Menyuk[2], Jonathan Hu[1]; [1]*Baylor Univ., USA;* [2]*Univ. of Maryland Baltimore County, USA.* We design a polarization-filtering negative curvature fiber. The loss ratio between the two polarizations is more than 100. This simple design will be useful in hollow-core fiber devices that are sensitive to polarization effects.

JTu3A.2 *E-Poster*
Simulation Retrieval of Frequency-Resolved Optical Gating Traces Using Neural Network, Zhe Guang[1,2]; [1]*School of Physics, Georgia Inst. of Technology, USA;* [2]*School of Computer Science, Georgia Inst. of Technology, USA.* We present a FROG pulse retrieval approach using neural network and Hermite-Gaussian decomposition. It shows retrieval error an order of magnitude better than before. Hermite-Gaussian modes also provide the privilege to retrieve non-Gaussian pulses.

JTu3A.3 *E-Poster*
Biomolecule Detection Based on a Liquid Crystal Film Coated on a Single Substrate, Wei Liang Hsu[1], Chao-Ping Pai[1], Po-Chang Wu[1], Mon-Juan Lee[2], Wei Lee[1]; [1]*Inst. of Imaging and Biomedical Photonics, National Chiao Tung Univ., Taiwan;* [2]*Dept. of Bioscience Technology, Chang Jung Christian Univ., Taiwan.* In comparison with the conventional approach entailing sandwiched cells for LC-based biosensing, here we demonstrate a simpler label-free platform—a unique single-substrate technique capable of rapid screening and bioassay of DNA hybridization.

JTu3A.4 *E-Poster*
Non-linear vertical coupling for III-V/SOI interconnects, Ruth Rubio Noriega[1]; [1]*National Inst. for Research and Training in Telecommunications, Peru.* Hybrid III-V/Si devices have been recently exploited for optical interconnects applications. In this work, a 0.2dB loss for the S, C and L bands, process tolerant, vertical evanescent coupling structure is presented.

JTu3A.5 *E-Poster*
Mode-Selective Image Upconversion, Santosh Kumar[1], He Zhang[1], Stephanie Maruca[1], Yu-Ping Huang[1]; [1]*Dept. of Physics, Stevens Inst. of Technology, USA.* We experimentally demonstrate selective frequency up-conversion of complex spatial modes through a nonlinear crystal, with potential applications in areas of quantum communications and pattern recognition.

JTu3A.6 *E-Poster*
Rotation of dielectric microspheres trapped near an ultrathin optical fiber, Cindy Liza C. Esporlas[1], Georgiy Tkachenko[1], Aili Maimaiti[1], Viet Giang Truong[1], Síle Nic Chormaic[1]; [1]*Okinawa Inst. of Science & Technology, Japan.* We experimentally investigate the rotational motion arising from laser light scattering of dielectric particles trapped near the evanescent field of a water-clad ultrathin optical fiber with a guided quasi-circularly polarized fundamental mode.

JTu3A.7 *E-Poster*
Ultra-Fast Relaxation and Singlet-Triplet Conversion Quantum Yield of Ir Complexes, Salimeh Tofighi[1]; [1]*Univ. of Central Florida, CREOL, USA.* The nonlinear-optical properties of Iridium complexes including triplet yield and excited-state cross-sections was studied by steady-state time-resolved measurements using picosecond and femtosecond excitation at multiple wavelengths.

JTu3A.8 *RAPID*
Noise tolerant LIDAR via mode selective up-conversion detection, Yong Meng Sua[1], Amin Shahverdi[1], Ivan Dickson[1], Malvika Garikapati[1], Yu-Ping Huang[1]; [1]*Stevens Inst. of Technology, USA.* We study mode selective up-conversion detection to improve SNR for LIDAR applications. We demonstrate a 41-dB increase in the SNR for single-photon counting compared to that of direct detection using a InGaAs single-photon detector.

JTu3A.9 *RAPID*
Enhanced Light Absorption in Silicon Nanocones for Solar Applications, Sara Al Menabawy[1], Joumana El-Rifai[1], Mohamed M. Swillam[1]; [1]*American Univ. in Cairo, Egypt.* In this work, we report a one-step fabrication of silicon nanocones from amorphous silicon substrates using excimer laser by melting and re-solidifying the deposited material. They show broadband absorption enhancement at multiple angles.

JTu3A.10 *RAPID*
Coherence Resonances and Bandgaps in Plasmonic Hole Arrays, Matt Smith[1], Gregory J. Gbur[1]; [1]*Univ. of North Carolina at Charlotte, USA.* We theoretically demonstrate the existence of optical coherence bandgaps by simulating plasmonic interaction with a partially coherent field on a subwavelength-thickness gold plate perforated by a linear array of circular holes.

JTu3A.11
Development of an *In-situ* Metrology Technique for Freeform Optics, Daliramu Burada[1], Kamal Pant[1,2], Vinod Mishra[1,3], Bichra Mohamed[4], Gufran Khan[1], Stefan Sinzinger[4], Chandra Shakher[1]; [1]*Indian Inst. of Technology Delhi, India;* [2]*DRDO, IRDE, India;* [3]*CSIR, CSIO, India;* [4]*Fachgebiet Technische Optik, Technische Universität Ilmenau, Germany.* The paper presents the development of Shack-Hartmann sensor as *in-situ* metrology technique that can be integrated to the machining platforms and helps in the development process of aspheric and freeform optics within the required tolerances.

JTu3A.12
High-Efficiency Beam Deflection of Visible Light Based on Dielectric Metasurfaces, Rifat Ahmmed Aoni[1], Mohsen Rahmani[1], Lei Xu[2], Khosro Kamali[1], Andrei Komar[1], Jingshi Yan[1], Dragomir Neshev[1], Andrey Miroshnichenko[2]; [1]*Nonlinear Physics Centre, Research School of Physics and Engineering, The Australian National Univ., Australia;* [2]*School of Engineering and Information Technology, Univ. of New South Wales, Australia.* We experimentally demonstrate a dielectric metasurface for beam-deflection with off-resonance near-unity transmittance in the visible wavelength. By reducing the supercell length, the beam deflection can switch efficiently and achieved 16.50°.

JTu3A.13
Superbunching Effect of Light with Digitally Designed Wavefront, Lu Zhang[1], Yiping Lu[1], Liming Li[1], Guoquan Zhang[1]; [1]*Nankai Univ., China.* Superposition of multiple two-photon paths is introduced with digital wavefront encoding technique, resulting in superbunching effect. Experimentally, we measured a bunching peak of 4.18±0.05 with the digitally designed wavefront of classical light.

JTu3A.14
A Metasurface-inspired Focusing Collector for Concentrated Solar Power Applications, Qing Ding[1], Shama Barna[1], Kyle Jacobs[1], Aakash Choubal[1], Glennys Mensing[1], Zhong Zhang[2], Kaito Yamada[2], Robert Tirawat[3], Nicholas Kincaid[3], Guangdong Zhu[3], Tim Wendelin[4], L. Jay Guo[2], Placid Ferreira[1], Kimani C. Toussaint, Jr.[1]; [1]*Univ of Illinois at Urbana-Champaign, USA;* [2]*Univ. of Michigan, Ann Arbor, USA;* [3]*National Renewable Energy Lab, USA;* [4]*Solar Dynamics, USA.* We present a metasurface-inspired planar focusing collector for concentrated solar power. Fabrication is achieved using two-photon lithography and subsequent nanoimprint lithography test for scalability. Optical characterization results are reported.

JTu3A.15
Thin Film High Efficiency Epitaxial Lift-Off Solar Cells, Drew Cardwell[1], Alex Kirk[1], Martin Drees[1], Christopher Stender[1], Ray Chan[1], Andree Wibowo[1], Chris Youtsey[1], Glen Hillier[1], Mark Osowski[1], Noren Pan[1]; [1]*MicroLink Devices Inc., USA.* MicroLink Devices has developed flexible, lightweight, high efficiency III-V inverted metamorphic multi-junction epitaxial lift-off solar cells that are attractive for mobile, terrestrial, airborne, and space applications.

JTu3A.16
Femtosecond Written Silica Waveguides for High Extinction Polarization Filtering, Timothy Lee[1], Qi Sun[1], Rand Ismaeel[1], Marta Castro-Lopez[2], Bocheng Cao[3], Martynas Beresna[1], Gilberto Brambilla[1]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK;* [2]*Huawei Technologies Duesseldorf GmbH, Germany;* [3]*Huawei Technologies Japan KK, Japan.* Silica waveguides with polarization-selective transmission were written by femtosecond laser inscription using linear and circular polarization. By tailoring writing parameters, polarization-dependent losses from 0.5 to 24dB at 1310nm were achieved.

JTu3A.17
Polarization-Holographic-Element-Based-Method for Determining the Complex Birefringence Distribution, Barbara N. Kilosanidze[1], George Kakauridze[1], Irina Kobulashvili[1], Yuri Mshvenieradze[1]; [1]*Lab of Holographic Recording and Processing of Information, Georgian Technical Univ., Georgia.* A new method is presented for determining the distribution of complex birefringence in different materials based on the polarization-holographic element when circularly polarized light beam transmitted through the sample diffracts on the element

JTu3A.18
Image rotation with three skew lenses, Jakub Belin[1], Gergely Ferenczi[2]; [1]*Univ. of Glasgow, UK;* [2]*Univ. of Strathclyde, UK.* We present an image-rotating arrangement of skew lenses. We demonstrate the image-rotating property using ray-tracing simulations.

JTu3A.19
Design and Fabrication of Microring Resonator Array for mid-IR Filter Applications, Rajat K. Sinha[1], Meher Wan[1], Saawan Kumar Bag[1], Shailendra Varshney[1]; [1]*Indian Inst. of Technology Kharagpur, India.* Mid-IR bandpass filter based on microring resonators 2D array is designed and fabricated. The structure is analyzed using transfer matrix-method and simulated using FDTD. The design is fabricated with IP-Dip using two-photon polymerization process.

JTu3A • Poster Session II and Dynamic E Posters—Continued

JTu3A.20
Classification of Propagation-Invariant Space-Time Wave Packets in Free-Space, Basanta Bhaduri[1], Murat Yessenov[1], Hasan E. Kondakci[1], Ayman Abouraddy[1]; *[1]Univ. of Central Florida, CREOL, USA.* We classify all propagation-invariant pulsed beams with respect to their group velocity, direction of propagation, and spatial-frequency content. We identify 10 unique classes that we synthesize experimentally using a single optical arrangement.

JTu3A.21
Comparative Characteristics of the Properties of Photoanisotropic Materials Composed with Covalent Bond and Electrostatic Interactions, Irakli Chaganava[1,2], Sakinah M. Alauddin[4], Nurul F. Aripin[4], Alfonso M. Felipe[3], Irine Kobulashvili[1]; *[1]Lab of Holographic Recording and Processing of Information, Inst. of Cybernetics of Georgian Technical Univ., Georgia; [2]Georgian State Teaching Univ. of Physical Education and Sport, Georgia; [3]Chemical and Materials Engineering Research Group, Univ. of Aberdeen, King's College, UK; [4]Faculty of Chemical Engineering, Univ. of Technology MARA, Malaysia.* The paper presents the study of the polarization-sensitive materials developed by us. It is demonstrated the advantages of these light-recording organic media composed both via covalent bindings and through electrostatic interactions.

JTu3A.22
Reflection By and Transmission Through an ENZ Interface, Zhangjin Xu[1], Henk F. Arnoldus[1]; *[1]Dept. of Physics and Astronomy, Mississippi State Univ., USA.* Reflection and transmission of radiation by an ENZ interface is studied. For *s* polarization, the transmitted magnetic field is circularly polarized. For *p* polarization, the electric field is circularly polarized and the magnetic field vanishes.

JTu3A.23
High-Resolution, In-Situ Defect Detection, Timothy A. Potts[1]; *[1]Dark Field Technologies, USA.* Defect detection of optical glass, during vacuum deposition, has been a long-standing industry need. A special Solid State Laser Reflection (SSLR) technology has been developed which is easily installed and delivers 100% inspection during deposition.

JTu3A.24
Ion Assisted E-beam Deposition of Silicon dioxide Thin films with Graded Refractive Index, Vemuri Srs Praveen Kumar[1,2], Mukesh Kumar[1], Neelam Kumari[1,2], Vinod Karar[1], Amit L. Sharma[1,2]; *[1]Central Scientific Instruments Organisation, India; [2]Optical Devices and Systems, Academy of Scientific and Innovative Research, India.* We report the design and fabrication of SiO_2 films using the GLAD technique with different incidence angles from 10° to 80° by Ion-Assisted E-beam deposition resulting in the decrease of effective film refractive index from 1.46 to 1.38.

JTu3A.25
Phasing a Segmented Space Telescope, Erez N. Ribak[1], Martin Levine[1]; *[1]Technion – Israel Inst. of Technology, Israel.* We wish to phase a segmented and sparse telescope in space, employing only wide-band light from an extended object. A stochastic search for the sharpest image lasts up to one day, for a four-segment telescope.

JTu3A.26
Measurement of remote sound based on laser feedback interferometry, Zongren Dai[1], Kaiyi Zhu[1], Yidong Tan[1]; *[1]Tsinghua Univ., China.* An optical sound measurement technology is developed based on microchip Nd:YVO_4 laser feedback interferometry. The system can recover the sound signal by measuring the vibration of non-cooperative target, which is located in the sound field.

JTu3A.27
Variation of Refractive indices from twisted dielectric media, Dipan Sinha[1], Dipti Banerjee[2]; *[1]Dept. of Physics, Univ. Of Calcutta, India; [2]Dept. of Physics, Vidyasagar College for Women, India.* The properties of twisted dielectric matrix has been studied for symmetric and anti-symmetric part. Variation of refractive index with the internal and external birefringence is also been studied.

JTu3A.28
Polarization and Coherence in the Hanbury Brown-Twiss Effect, Taco D. Visser[1], Ari Friberg[2], David Kuebel[3]; *[1]Vrije Universiteit Amsterdam, Netherlands; [2]Univ. of Eastern Finland, Finland; [3]Univ. of Rochester, USA.* We study the correlation of intensity fluctuations in random electromagnetic beams, the Hanbury Brown-Twiss effect. Not just the state of coherence of the source, but also its state of polarization has a strong influence.

JTu3A.29
Turbulence Mitigation using Chaos-modulated Image Propagation along a Slanted Path under Gamma-Gamma Atmospheric Turbulence, Monish R. Chatterjee[1], Ali A P. Mohamed[1]; *[1]Univ. of Dayton, USA.* Mitigation of distortion under gamma-gamma turbulence is examined for propagation along a low-altitude slanted path using acousto-optic chaos and the Huffnagel-Valley model. System performance is measured using bit error rates and compared with non-chaotic propagation.

JTu3A.30 *RAPID*
Quantum Random Number Generator with Programmable Probability Distributions, Lac Nguyen[1], Yu-Ping Huang[2], Yong Meng Sua[2], Patrick Rehain[2]; *[1]Physics, Stevens Inst. of Technology, USA; [2]Physics, Stevens Inst. of Technology, USA.* We present a method of generating quantum random numbers with arbitrarily defined probability distributions featuring high dimensionality and post-processing free, for significantly improved Monte-Carlo simulations and data analyses.

JTu3A.31
Withdrawn

JTu3A.32
Demonstration of Ultra-High Time-Bandwidth Product in a Non-Reciprocal Fiber-Optic System, Davide Grassani[1], Ivan Cardea[1], Simon Fabbri[1], Jeremy Upham[2], Robert Boyd[2], Hatice Altug[1], Sebastian Schulz[3], Kosmas Tsakmakidis[1], Camille-Sophie Bres[1]; *[1]Ecole Polytechnique Federale de Lausanne, Switzerland; [2]Dept. of Physics, Univ. of Ottawa, Canada; [3]School of Physics and Astronomy, Univ. of St Andrews, UK.* We demonstrate that a non-reciprocal, time-variant fiber cavity can operate above the "fundamental" time-bandwidth limit (TBL) of reciprocal structures by more than two orders of magnitude.

JTu3A.33
Mid-Wave Infrared Nonlinear Optics in Polycrystalline Zinc Selenide and Zinc Sulfide, Kevin Werner[2], Noah Talisa[2], Brian Wilmer[3], Laura Vanderhoef[4], Aaron Schweinsberg[1], Christopher Wolfe[4], Anthony Valenzuela[4], Chowdhury Enam[2]; *[1]ORISE, USA; [2]The Ohio State Univ., USA; [3]SURVICE Engineering, USA; [4]U.S. Army Research Lab, USA.* We investigate the nonlinear optical properties of ZnSe and ZnS using ultrashort mid-wave infrared laser pulses. Multiple harmonic generation in both materials was observed, as well as significant spectral modification of the fundamental pulse.

JTu3A.34
High-repetition-rate Femtosecond-laser Inscription of Low-loss Thermally Stable Waveguides in Lithium Niobate, Teerawat Piromjitpong[2,1], Mykhaylo Dubov[3], Sonia Boscolo[2,1]; *[1]School of Engineering and Applied Science, Aston Univ., UK; [2]Aston Inst. of Photonic Technologies, UK; [3]Optoscribe Ltd., UK.* Optical-lattice-like WGs were fabricated in z-cut $LiNbO_3$ by HRR pulse laser. Low propagation loss was observed in both orthogonal polarizations in the visible and near-IR spectrum. Single-mode guiding was maintained after high-temperature annealing.

JTu3A.35
Large Scale Optical Comb Frequencies Stabilization by Using An Intro-cavity Electro-optic Polarization Modulator, Yanyan Zhang[1,2], Pan Zhang[1], Lulu Yan[1,2], Bingjie Rao[1], Xiaofei Zhang[1,2], Wenge Guo[1], Shougang Zhang[1,2], Haifeng Jiang[1,2]; *[1]National Time Sevice Center (China), China; [2]School of Astronomy and Space Science, Univ. of Chinese Academy of Sciences, China.* We demonstrate a frequency control approach of a nonlinear-polarization-rotation mode-locked Er:fiber laser by rotating polarization state with an intro-cavity electro-optic modulator, enabling a large scale high bandwidth frequency control.

JTu3A.36
Partially Coherent Vortex Beams in the Atmosphere, Gregory J. Gbur[1], Charlotte Stahl[1]; *[1]Univ of North Carolina at Charlotte, USA.* We investigate, through simulations, the robustness of vortices in partially coherent beams propagating through atmospheric turbulence. Several classes of partially coherent vortex beams are considered.

JTu3A.37
Withdrawn

JTu3A.38
Measurements of the Nonlinear Refractive Index (n_2) for Indium Fluoride (InF_3) Bulk Glass and Fiber, Anthony M. Johnson[1], Isaac Basaldua[1], Robinson Kuis[1], Paul Burkins[1], Zack Jiang[2]; *[1]Univ. of Maryland Baltimore County, USA; [2]Thorlabs, USA.* We measured the n_2 of InF_3 bulk glass and fiber using the Z-scan and the induced grating autocorrelation (IGA), respectively. The n_2 value measured for the InF_3 fiber is 1.5X that for ZBLAN fiber.

JTu3A.39
Photonically Tunable MIR Epsilon-Near Zero Modes in CdO Thin Films, Elizabeth Radue[1], Evan Runnerstrom[2], Kyle Kelley[3], J. P. Maria[2], Patrick Hopkins[1,4]; *[1]Mechanical and Aerospace Engineering, Univ. of Virginia, USA; [2]Materials Science, Penn State Univ., USA; [3]Materials Science, North Carolina State Univ., USA; [4]Materials Science and Engineering, Univ. of Virginia, USA.* We propose a novel way of tuning plasmonic absorption of light. By photoexciting electrons from platinum to a CdO film, we are able to control of the ENZ resonance frequency of the film.

JTu3A.40
Experimental Research on the KrF Laser Driven quasi-insentropic compression, Zhao Wang[1], Pinliang Zhang[2], Bao-xian Tian[1], Zhi-xing Gao[1], Jing Li[1], Feng-Ming Hu[1]; *[1]China Inst. of Atomic Energy, China; [2]Beijing Inst. of Spacecraft Environment Engineering, China.* The HEAVEN I laser is used to direct drive quasi-isentropic compression up to 18 GPa in samples of aluminum without temporal pulse shaped. The monotonically increasing loading with rise time is over 16 ns.

JTu3A.41
Withdrawn

JTu3A • Poster Session II and Dynamic E Posters—Continued

JTu3A.42
Quadratic Bright Soliton and Cnoidal Wave Frequency Combs in Microresonators by Second Harmonic Generation, Zhen Qi[1]; *[1]Univ. of Maryland Baltimore County, USA*. We study bright solitons and cnoidal waves in microresonators with quadratic nonlinearity. In the case of both fundamental frequency and second harmonic in the same dispersion regime, we obtain stable bright solitons and cnoidal waves.

JTu3A.43
Implementation of an Alternative Method for the Detection and Temporal Correlation of Spontaneous Parametric Down Converted Photons with Single Photon Counters, Francisco Sierra[1]; *[1]Universidad del Valle, Colombia*. We propose an alternative method for the detection of SPDC photons and their temporal correlations. All this doing mainly by photon counters, a BBO crystal type II, a PBS and taking counts on fundamental points (Control points).

JTu3A.44
Progress On Supercontinuum Generation of Highly Nonlinear Fibers at NTSC, Songtao Fan[1,2], Pan Zhang[1], Yanyan Zhang[1,2], Lulu Yan[1,2], Wenge Guo[1], Xiaofei Zhang[1,2], Shougang Zhang[1,2], Haifeng Jiang[1,2]; *[1]National time service center, China; [2]Univ. of Chinese Academy of Sciences, China*. We report on supercontinuum generation in four types of highly-nonlinear-fibers (HNLFs) pumped by 1.56-μm laser solitons. Experimental results provide guidelines for choosing and using HNLFs for erbium-fiber-based optical frequency combs.

JTu3A.45
Spectron and Dispersive Fourier Transformation: Phase Aspect, Narek Karapetyan[1,2], Minas Sukiasyan[1,2], Hrach Toneyan[1,2], Aghavni Kutuzyan[1], Levon Mouradian[1,2]; *[1]Dept. of Optics, Yerevan State Univ., Armenia; [2]CANDLE Synchrotron Research Inst., Armenia*. The phase behavior of spectron pulses, shaped in the far zone of dispersion, is discussed in view of dispersive Fourier transformation, on the basis of our analytical, numerical and experimental studies.

JTu3A.46 *RAPID*
Synthesis and Analysis of Ultrafast Waveform Generation using Coherent Raman Sidebands, Aysan Bahari[1], Alexandra A. Zhdanova[1], Mariia Shutova[1], Alexei Sokolov[1]; *[1]Texas A&M Univ., USA*. We combine four coherent Raman sidebands generated inside diamond with an OPA-generated beam to create an ultrashort pulse. By using frequency-resolved optical gating (FROG) and interferometric techniques, we characterize the resultant pulse.

JTu3A.47
Mode-Locked Fiber Laser Pulse Repetition Rate Adjustment with Piezoelectric Transducer and Thermoelectric Cooler, Alexander I. Donodin[1], Vasilii S. Voropaev[1], Vladimir A. Lazarev[1], Mikhail Tarabrin[1,2], Valeriy Karasik[1]; *[1]Bauman Moscow State Technical Univ., Russia; [2]P. N. Lebedev Physical Inst. of the Russian Academy of Sciences, Russia*. We demonstrate an adjustment of the all-fiber ring femtosecond erbium laser pulse repetition rate using piezoelectric transducer and thermoelectric cooler. The experimental values are verified with theoretical results.

JTu3A.48
Withdrawn

JTu3A.49
Endurance of photon indistinguishability in noisy quantum networks, Armando P. Leija[1], Diego Guzman-Silva[2], Roberto Leon-Montiel[3], Markus Graefe[4], Matthias Heinrich[5], Hector-Cessa[6], Alexander Szameit[2], Kurt Busch[1]; *[1]Max Born Inst., Germany; [2]Physics, Univ. of Rostock, Germany; [3]ICN, UNAM, Mexico; [4]Physics, Univ. of Jena, Germany; [5]Physics, Rostock Univ., Germany; [6]Optics, INAOE, Mexico*. We show that when indistinguishable photons copropagate through quantum networks affected by nondissipative noise, the system always evolves into a steady state in which coherences accounting for particle indistinguishabilty perpetually prevail.

JTu3A.50
Four-wave mixing of 10 μm radiation in quadratic nonlinear crystals, Jeremy Pigeon[2], Sergei Tochitsky[1], Eric Welch[1], Ilan Ben-Zvi[2], Chan Joshi[1]; *[1]Univ. of California - Los Angeles, USA; [2]Physics and Astronomy, Stony Brook Univ., USA*. We report measurements of the effective nonlinear refractive index of quadratic nonlinear crystals using four-wave mixing of a dual-frequency CO_2 laser pulse. The contribution of second-order processes to the four-wave mixing efficiency is discussed.

JTu3A.51
Application of Machine Learning Techniques to Quantum Optical Problems, Anesan A. Reddy[1], Ilya Sinayskiy[1], Francesco Petruccione[1,2]; *[1]Chemistry and Physics, Centre for Quantum Technology UKZN, South Africa; [2]National Inst. of Theoretical Physics, South Africa*. Researchers have begun applying Machine Learning Techniques (MLT) to difficult problems in physics. E.g., Convolutional Neural Networks can detect phase transitions in Ising and Bose-Hubbard models. I will report on MLT applied in Quantum Optics.

JTu3A.52
Computational Modeling of InGaAs/InP Single Photon Detector for High Sensitive Applications, Ahmed C. Kadhim[1], Ahmad Alalyani[1], Ahmad S. Azzahrani[1], Saud Alanzi[1]; *[1]Florida Inst. of Technology, USA*. An approached to define output current of single photon avalanche photodiode (SPAD) is introduced using a mathematical formula. The mathematical steps and derivations are shown that the dependency of SPAD on gating signals.

JTu3A.53
Multi-resonant Optical Nanocavities by Out-of-plane Magnetic Plasmon Hybridization, Seied Ali Safiabadi Tali[1], Wei Zhou[1]; *[1]Virginia Tech, USA*. In vertically-stacked double-cavity metal-insulator-metal nanostructures, the strong optical interaction between magnetic plasmon modes in each of the nanocavities leads to new hybridized modes with individually tunable energy levels.

JTu3A.54
SHG from Nanoparticles of Noncentrosymmetric Geometry, Raksha Singla[1], Wolf L. Mochan[1]; *[1]Instituto de Ciencias Físicas, UNAM, Mexico*. The effect in the SHG from an almost-centrosymmetric nanoparticle is studied analytically. We obtain its bulk and surface contributions, discuss their multipolar character and their spectral resonances, and compare them to numerical calculations.

JTu3A.55 *RAPID*
Experimental Demonstration of CNOT Gate for Frequency-Encoded Qubits, Hsuan-Hao Lu[1], Joseph M. Lukens[2], Poolad Imany[1], Nicholas A. Peters[2], Brian P. Williams[2], Andrew M. Weiner[1], Pavel Lougovski[2]; *[1]School of Electrical and Computer Engineering, Purdue Univ., USA; [2]Quantum Information Science Group, Oak Ridge National Lab, USA*. We demonstrate the first two-photon gate for frequency-bin qubits, using optical pulse shaping and electro-optic phase modulation. Our coincidence-basis CNOT has a fidelity of 0.9947±0.0008 and shows controlled qubit flips in the computational basis.

JTu3A.56 *RAPID*
A Single-Pass Quantum Source of Multimode Squeezed States of Light, Luca La Volpe[1], Syamsundar De[1], Tiphaine Kouadou[1], Valentina Parigi[1], Claude Fabre[1], Nicolas Treps[1]; *[1]Laboratoire Kastler Brossel, France*. We present a parametric down-conversion based source generating broadband squeezed light in multiple spectral modes. The source will be used to create large-scale cluster states, and to perform space-time positioning measurements beyond classical limit.

JTu3A.57
Withdrawn

JTu3A.58
8×8 Programmable Quantum Photonic Processor Based on Silicon Nitride Waveguides, Caterina Taballione[1], Tom A. Wolterink[2], Jasleen Lugani[2], Andreas Eckstein[2], Bryn A. Bell[2], Robert Grootjans[3], Ilka Visscher[3], Jelmer J. Renema[4], Dimitri Geskus[3], Chris G. Roeloffzen[3], Ian A. Walmsley[2], Pepijn W. Pinkse[4], Klaus-J. Boller[1]; *[1]Laser Physics and Nonlinear Optics, Univ. of Twente, Netherlands; [2]Ultrafast Quantum Optics and Optical Metrology, Univ. of Oxford, UK; [3]LioniX International, Netherlands; [4]Complex Photonic Systems, Univ. of Twente, Netherlands*. Integrated universal linear optical networks are essential for the development of quantum information processing (QIP). We demonstrate a universal, reconfigurable, 8×8 photonic processor based on Si_3N_4 waveguides showing a variety of QIP primitives.

JTu3A.59
Highly Efficient Nonlinear Integrated Photonics in Ultracompact Periodically-Poled Lithium Niobate on Silicon, Ashutosh Rao[1], Kamal Abdelsalam[1], Tracy Sjaardema[1], Guillermo Camacho-González[1], Amirmahdi Honardoost[1], Sasan Fathpour[1]; *[1]Univ. of Central Florida, CREOL, USA*. We present second-harmonic generation, pumped in the telecom wavelengths, with strong nonlinear conversion efficiencies up to 1230 $\%W^{-1}cm^{-2}$ using ultracompact periodically-poled thin-film lithium niobate waveguides on a silicon chip.

JTu3A.60
Experimental Statistical Signature of Many-body Quantum Interference, Taira Giordani[1], Fulvio Flamini[1], Matteo Pompili[1], Niko Viggianiello[1], Nicolò Spagnolo[1], Andrea Crespi[2,3], Roberto Osellame[2,3], Nathan Wiebe[4], Mattia Walschaers[5,6], Andreas Buchleitner[6], Fabio Sciarrino[1]; *[1]Fisica, Sapienza Università di Roma, Italy; [2]Istituto di Fotonica e Nanotecnologie, Consiglio Nazionale delle Ricerche, Italy; [3]Fisica, Politecnico di Milano, Italy; [4]Station Q Quantum Architectures and Computation Group, Microsoft Research, USA; [5]Laboratoire Kastler Brossel, UPMC-Sorbonne Universités, CNRS, ENS-PSL Research Univ., Collège de France, CNRS, France; [6]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Germany*. Quantum interference is a fundamental ingredient for technologies that can provide a quantum advantage. In this work we investigate a clear signature of its presence in a BosonSampling experiment.

JTu3A • Poster Session II and Dynamic E Posters—Continued

JTu3A.61
Local filtering of polarization entangled photon pairs by the components of a telecom network, Brian T. Kirby[1], Dan Jones[1], Michael Brodsky[1]; [1]*The US Army Research Lab, USA*. By treating the polarization dependent loss of fiber-optic quantum channels as a local filtering operation, we show both theoretically and experimentally how entanglement can be distilled by properly orienting local filters.

JTu3A.62
Towards Extending Super-conducting Nanowire Single-photon Detectors into the Infrared Wavelength Range, Paulina S. Kuo[1], Brian G. Alberding[1]; [1]*NIST, USA*. We characterize the long-wavelength transmission of coiled and uncoiled SMF-28 and SM2000 fibers, which is important for extending the range of super-conducting nanowire single-photon detectors (SNSPDs) to infrared wavelengths beyond 1550 nm.

JTu3A.63
Self-referenced continuous-variable quantum key for distribution over longer optical fiber links, Ming Li[1], Milorad Cvijetic[1]; [1]*Univ. of Arizona , USA*. We have evaluated the impact of phase noise in self-referenced continuous-variable quantum key distribution protocol and confirmed its application over longer optical fiber links.

JTu3A.64
Quantum Phase Transitions in Finite Atomic Ensemble under the EIT Configuration, Raúl A. Robles[1]; [1]*IPT Tsing Hua, Taiwan*. We study the ground states of finite ensembles of Λ-type three-level atoms interacting with two electromagnetic fields in the EIT approximation. Critical couplings are revealed for the existence of QPT.

JTu3A.65
Squeezed photons from a single quantum-dot with tuneable central frequency, Parvendra Kumar[1], Agnikumar G. Vedeshwar[2]; [1]*Dept. of Physics and Astrophysics, Univ. of Delhi, India*. We theoretically demonstrate the generation of quadrature squeezed photons from a single quantum-dot with tuneable central frequency. The effects of exciton-phonon coupling on quadrature squeezing are also investigated.

JTu3A.66
Design of Switch gate using Mach-Zehnder interferometer for quantum communications, Santosh Kumar[2], Amna Bedi[1], Nan-Kuang Chen[2]; [1]*Dept. of EECE, DIT Univ., India;* [2]*School of Physics Sciences and Information Technology, Liaocheng Univ., China*. In this paper, a design of reversible switch gate using lithium-niobate based Mach-Zehnder interferometer for quantum communication is proposed. The results are verified using beam propagation method.

JTu3A.67
A dynamical approach to low-cost shortcut to adiabaticity, Hamidreza Ramezani[1], Fatemeh Mostafavi[1]; [1]*Univ. of Texas, Rio Grande Valley, USA*. By introducing a class of non-Hermitian Hamiltonians we propose an approach to low-cost shortcut to adiabaticity. Our approach focuses on dynamical properties of the system and has application in STIRAP, tunable mode filtering.

JTu3A.68
Design and Analysis of a Cross V-shaped Nanoantenna for Visible Region, Shanu Kumar[1], Pooja Chauhan[1], Ajeet Kumar[1]; [1]*Delhi Technological Univ., India*. A cross V-shaped nanonoantenna is designed using gold with gap of 10 nm. The scattering cross-section and the Electric field at the centre is obtained with optical resonant wavelength of 530 nm in visible range.

JTu3A.69 *RAPID*
Polarization diversity phase modulator for measuring frequency-bin entanglement of biphoton frequency combs in in a depolarized channel, Oscar Sandoval[1], Navin B. Lingaraju[1], Poolad Imany[1], Daniel E. Leaird[1], Michael Brodsky[2], Andrew M. Weiner[1]; [1]*Purdue Univ., USA;* [2]*U.S. Army Research Lab, USA*. We report frequency-bin entanglement measurements of arbitrarily polarized photon pairs using a polarization diversity phase modulator, thereby extending this technique to depolarized channels such as in a practical quantum networking environment.

JTu3A.70 *RAPID*
Direct extrusion of suspended-core polymer optical fibers from 3D printers, Wanvisa Talataisong[1], Rand Ismaeel[1], Martynas Beresna[1], Gilberto Brambilla[1]; [1]*Optoelectronics Research Centre, UK*. We demonstrate the single-step manufacturing of a microstructured polymer optical fiber (MPOF) by extruding and directly drawing the polymer from a structured 3D printer nozzle.

JTu3A.71 *RAPID*
Open Cavity Raman-Erbium Hybrid Random Fiber Laser with Single Arm Pumping Scheme, Nadiah Zainol Abidin[2], Muhammad Hafiz Abu Bakar[2], Nizam Tamchek[1], Mohd Adzir Mahdi[2]; [1]*Dept. of Physics, Faculty of Science, Universiti Putra Malaysia, Malaysia;* [2]*Wireless and Photonics Networks Research Centre, Faculty of Engineering, Universiti Putra Malaysia, Malaysia*. This paper analyzes forward and backward spectral outputs of 80 km Raman-erbium hybrid random fiber laser employing single arm pumping. Stable laser generation at the output is achieved without resonance within the entire cavity.

JTu3A.72
Propagation of a supercontinuum light source in a novel tellurite hollow core optical fiber, Hoang Tuan Tong[1], Nobuhiko Nishiharaguchi[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Toyota Technological Inst., Japan*. We experimentally demonstrated the fabrication of a novel tellurite hollow core optical fiber and managed to propagate a supercontinuum light from 500 to more than 1550 nm in the fiber core by the fundamental mode.

JTu3A.73
ITO-based Mach Zehnder Modulator, Rubab Amin[1], Rishi Maiti[1], Caitlin Carfano[1], Volker J. Sorger[1]; [1]*The George Washington Univ., USA*. We report the first experimental Mach Zehnder modulator on SOI-platform with ITO as the active phase-shifting material. Our results show a low $V_\pi L$ of 0.52 V-mm with 6 dB insertion loss.

JTu3A.74
Ultra-flat Optical Frequency Comb Generation Based on an Electroabsorption Modulated Laser and Adaptive Pulse Shaping, Linnan Li[1], Juanjuan Yan[1], Jing Chen[1]; [1]*BeiHang Univ., China*. A scheme for the generation of ultra-flat optical frequency comb (OFC) is proposed by using an Electroabsorption Modulated Laser and adaptive pulse shaping. An OFC with a 0.5-dB bandwidth of 4nm containing 50 spectral lines is achieved.

JTu3A.75
Analysis and Elimination of Shrinkage Phenomenon of Photonic Crystal Fiber during Fusion Splicing, Chunxiao Wu[1], Ningfang Song[1], Jingming Song[1], Jiaqi Liu[1], Haowei Li[1]; [1]*Beihang Univ., China*. The impact of shrinkage phenomenon of photonic crystal fiber during fusion splicing is analyzed. A method based on temperature distribution analysis is proposed to eliminate the detrimental phenomenon. The splice loss and strength are improved.

JTu3A.76
Multi-wavelength Fiber Laser Temperature Sensor Based on Modal Fiber Interferometer, Yanelis Lopez Dieguez[1], Julian Moises Estudillo Ayala[1], Daniel Jauregui[1], Luis A. Herrera Piad[1], Juan M. Sierra Hernandez[1], Diego Garcia-Mina[2], Juan C. Hernandez-Garcia[1], Abraham Gatelum Barrios[3], Roberto Rojas-Laguna[1]; [1]*Universidad de Guanajuato, Mexico;* [2]*Universidad del Centro Ocidente, Colombia;* [3]*Universidad Autónoma de Queretaro, Mexico*. A fiber optic laser arrangement for temperature sensing applications is presented. The multi-wavelength spectrum has a SMSR of 40dB and moreover, the temperature generated tunable multi-wavelength effect, here, a sensitivity of 20pm/°C is achieved.

JTu3A.77
Vehicular FSO Communication Systems Applying Real-time Recognition and Tracking, JIANAN ZHANG[1], Wentao Xia[1], Tim Kane[1]; [1]*PENN STATE UNIV., USA*. As the field-of-view of an optical receiver decreases, the receiver gain increases. By applying real-time recognition and tracking, the demonstration of a vehicular free-space optical communication system which has a small field-of-view is presented.

JTu3A.78
Numerical Study of Spatio-Temporal Evolution of Chaotic Effects in the Generation of Broad Spectra, Jose Ramon Martinez Angulo[1], Juan C. Hernandez-Garcia[1,2], Jesus P. Lauterio-Cruz[1], Julian M. Estudillo-Ayala[1], Olivier Pottiez[3], Jose D. Filoteo-Razo[1], Carlos M. Carrillo-Delgado[1], Daniel Jauregui-Vazquez[1], Juan M. Sierra-Hernandez[1], Roberto Rojas-Laguna[1]; [1]*Universidad de Guanajuato, Mexico;* [2]*Catedratico CONACYT, Consejo Nacional de Ciencia y Tecnologia, Mexico;* [3]*Centro de Investigaciones en Optica (CIO), Mexico*. We report the implementation of the RK4IP method for studying the propagation of a hyperbolic secant pulse into 10 km of standard fiber. The results describe the appearance of chaotic phenomena in the spectral broadening.

JTu3A.79
Extreme power fluctuations in optical communications, Stanislav Derevyanko[1], Alexey Redyuk[2,3], Sergey Vergeles[4,5], Sergei Turitsyn[6,2]; [1]*Ben Gurion Univ. of the Negev, Israel;* [2]*Novosibirsk State Univ., Russia;* [3]*Inst. of Computational Technologies, Russia;* [4]*Landau Inst. for Theoretical Physics, Russia;* [5]*Moscow Inst. of Physics and Technology, Russia;* [6]*Aston Inst. of Photonic Technologies, Aston Univ., UK*. We present an analysis of dangerous symbol sequences in CO-OFDM optical transmission systems leading to appearance of extreme power fluctuations and study their influence on system performance in dispersion uncompensated long haul fiber links.

JTu3A.80
One-step waveguide endface dicing approach for Silica-on-Silicon PIC chip, Xu Liu[1], Zhekai Zhang[1], Xiaohan Sun[1]; [1]*Southeast Univ. (China), China*. The IL of 0.055dB/facet at 1550nm wavelength is achieved for Silica-on-Silicon waveguide using Disco ZH05-SD3500-N1-70FF/01 blade with spindle revolution speed, workpiece feed speed and cooling water flow velocity of 30000*r/min*, 1*mm/s* and 1.2*L/min*.

JTu3A.81 *RAPID*
Optomechanics Outside the Lab: Prototyping and Field-testing a Whispering Gallery Mode Accelerometer, Ying Lia Li[1], Peter F. Barker[1]; [1]*UCL, UK*. The dispersive and dissipative optomechanical coupling between a whispering gallery mode (WGM) resonance and the motion of the WGM cavity is used to measure acceleration. We describe the prototype assembly and the results from outdoor field-trials.

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JTu3A.82 *RAPID*
Superhydrophobic SERS Substrates based on Plasmonic Hierarchical Micro-nanostructures, Junyeob Song[1], Weifeng Cheng[2], Jiangtao Cheng[2], Wei Zhou[1]; *[1]Electrical Engineering, Virginia Tech, USA; [2]Mechanical Engineering, Virginia Tech, USA*. Integration of multilayered plasmonic nanostructures with hierarchical micro-nanopillar arrays can result in a superhydrophobic surface with high-performance Surface Enhanced Raman Spectroscopy (SERS) functionality.

JTu3A.83 *RAPID*
Gallium Indium Phosphide Nanostructures with Suppressed Photoluminescence for Applications in Nonlinear Optics, Eleonora De Luca[1], Dennis Visser[1], Srinivasan Anand[1], Marcin Swillo[1]; *[1]KTH Royal Inst. of Technology, Sweden*. Nanostructured GaInP shows remarkable nonlinear properties. By measuring the SHG before and after stimulating photobleaching, we observed suppressed photoluminescence and unchanged nonlinear properties, making it suitable for low-noise applications.

JTu3A.84 *RAPID*
Multifocal Optical Meta-Lenses, Nantakan Wongkasem[1], Patricia Briea[2]; *[1]Univ. of Texas Rio Grande Valley, USA; [2]MetaSolver, USA*. Multifocal optical and flat meta-lenses are investigated towards designing an improved multifocal meta-lens with ultra-thin multilayers and flat shape overcoming the background noise occurring from the physical restriction of multiple focus regions.

JTu3A.85
Double-sided guided-mode resonance metamaterials, Hafez Hemmati[1], Robert Magnusson[1]; *[1]Univ. of Texas at Arlington, USA*. We fabricate resonant metamaterial membranes with subwavelength gratings on both sides employing nanoimprint lithography methods. Measured spectral response of the resonance membranes is in good agreement with numerical results.

JTu3A.86
GaN Distributed Bragg Reflector Cavity for Sensing Applications, Simeng Jia[1], Emmanuel L. Boulbar[3], Krishna C. Balram[1], Jon Pugh[1], Tao Wang[2], Duncan Allsopp[3], Philip Shields[3], Martin Cryan[1]; *[1]Univ. of Bristol, UK; [2]Univ. of Sheffield, UK; [3]Univ. of Bath, UK*. GaN grating couplers and a distributed Bragg reflector cavity are fabricated using displacement Talbot lithography on GaN-on-sapphire. Cavity resonances are simulated and measured for two devices with Q factors of ~200.

JTu3A.87
A Narrowband Photothermoelectric Detector Using Guided-Mode Resonance Filter, Hosein Monshat[1], Longju Liu[1], Meng Lu[1]; *[1]Iowa State Univ., USA*. A narrowband photothermoelectric detector, integrating a guided-mode resonance (GMR) structure and a metal thermocouple, is demonstrated. The detector utilizes the GMR effect to selectively absorb light and generate thermoelectric voltage outputs.

JTu3A.88
Implementation and Optimization of a Cost-Effective 2D Haar Transform Network for Image Compression, Catia Pinho[1,2], Tiago Morgado[1], Berta Neto[1,2], Mario Lima[1,2], António Teixeira[1,2]; *[1]Instituto de Telecomunicações (IT), UA, Portugal; [2]Dept. of Electronics, Telecommunications and Informatics (DETI), Univ. of Aveiro, Portugal*. A new cost-effective 2D Haar transform network for data compression composed by three 2×2 MMI magic-T disposed in a two level signal decomposition architecture is implemented and tested. A model for design optimization is proposed.

JTu3A.89
Novel Mid-Infrared Metamaterial Thermal Emitters for Optical Gas Sensing, Yongkang Gong[2], Sang Soon Oh[2], Diana L Huffaker[2], Nigel Copner[1]; *[1]Univ. of South Wales, UK; [2]School of Physics and Astronomy, Cardiff Univ., UK*. We demonstrated that metamaterial technology enables us to tailor infrared thermal emission and provides a promising strategy towards novel, cost-effective and highly efficient mid-infrared source for optical gas sensing.

JTu3A.90
Withdrawn

JTu3A.91
Metamaterial Tunable Notch Filters Operating in Longwave Infrared, Neelam Gupta[1], Mark S. Mirotznik[2]; *[1]US Army Research Lab, USA; [2]Dept. of Electrical and Computer Engineering, Univ. of Delaware, USA*. We describe the design of metamaterial tunable notch filter operating from 8 to 12 μm based on the guided-mode resonance phenomenon using dielectric materials germanium and zinc selenide and their characterization using quantum cascade lasers.

JTu3A.92
Size dependent optical performance of light trapping metallic electrodes, Mengdi Sun[1], Pieter G. Kik[1,2]; *[1]CREOL, Univ. of Central Florida, USA; [2]Physics Dept., Univ. of Central Florida, USA*. The optical performance of light-trapping embedded metal electrodes with widths varying from 100-1000nm was investigated. Up to 90% of visible light incident on the metal wire can be trapped, limited by diffraction and plasmon-mediated absorption.

JTu3A.93
Optimized Ultrabroadband Absorbing Multilayer Thin Film Structure, Corey T. Matyas[1], Chenglong You[1], Yin Huang[2], Jonathan P. Dowling[1], Georgios Veronis[1]; *[1]Louisiana State Univ., USA; [2]Central South Univ., China*. We design an optimized aperiodic multilayer thin film structure with ultrabroadband absorption over a broad angular range. Using a hybrid optimization algorithm, we achieve an average 97.9% absorption from 400 nm to 2500 nm.

JTu3A.94
Design and Fabrication of Embedded Nanofences in Racetrack Microring Resonator for Single Gold Nanoparticle Detection, Saawan Kumar Bag[1], Rajat K. Sinha[1], Meher Wan[1], Shailendra Varshney[1]; *[1]Indian Inst. of Technology Kharagpur, India*. Photonic nanofence assisted racetrack microring resonator is proposed, numerically analyzed and fabricated. Numerical results shows the device ability to detect single gold nanoparticle which can be a potential platform for biosensing applications.

JTu3A.95
Fano Resonances Based on Aperture-coupled Square Plasmonic System and its Application in Nanosensor, Yilin Wang[1], Li Yu[1]; *[1]Beijing Univ. of Posts and Telecommunications, China*. A novel refractive index plasmonic nanosensor was proposed with high properties based on groove and aperture-coupled square resonator. This nanosensor with sharp Fano profiles yield an ultra-high sensitivity of ~1300nm/RIU and a FOM of ~9400.

JTu3A.96
Absolute Optimization Method of a Vertical Grating Coupler, Anat Demeter[1]; *[1]Tel-Aviv Univ., Israel*. Based on S-matrix formalism a method for analyzing and designing vertical grating couplers is presented. Optimal efficiency values and corresponding design parameters are provided, including a theoretical return loss limit better than 56dB.

JTu3A.97
Mid IR absorption using Hyperbolic Silicon tubes, Mai desouky[1], Ahmed Mahmoud[1,2], Mohamed M. Swillam[1]; *[1]Physics, American Univ. in Cairo, Egypt; [2]electrical, American Univ. in Cairo, Egypt*. Doped semiconductors have been extensively investigated for mid IR metamaterials. We theoretically demonstrate mid IR absorber using Doped Si/Si hyperbolic tubes with broad band absorption reaching 0.95 across the mid-IR range.

JTu3A.98
On Red, Stop. Simple Speed and Stop Control for Traffic Automation, Forrest F. Jesse[1]; *[1]Beijing Xixuan Lab, China*. A simple design for local signaling in an intelligent transportation network which endows vehicles with awareness of sub-meter local transportation conditions, and which allows speed control and stop control of vehicles is discussed.

JTu3A.99
Single Spot Focusing with Dielectric based Plasmonic Phase Manipulation, Mayur S. Darak[2], Rakesh G. Mote[1], Shobha Shukla[3]; *[1]Dept. of Mechanical Engineering, Indian Inst. of Technology, Bombay, India; [2]Centre for Research in Nanotechnology and Science (CRNTS), Indian Inst. of Technology, Bombay, India; [3]Dept. of Metallurgical Engineering and Materials Science (MEMS), Indian Inst. of Technology, Bombay, India*. A slit type dielectric based phase manipulative plasmonic lens for in-plane focusing of linearly polarized light to a single spot is proposed. Focal spot with full-width at half-maximum of $0.28\lambda_0$ is obtained to beat the diffraction limit.

JTu3A.100
Naturally phase matched waveguides and microrings on lithium niobate-on-insulator (LNOI), Jiayang Chen[1], Yong Meng Sua[1], Heng Fan[1], Yu-Ping Huang[1]; *[1]Stevens Inst. of Technology, USA*. We demonstrate naturally phase matched waveguides and microrings on chip for second-harmonic generation (SHG) with submicron transverse mode confinement.

JTu3A.101 *RAPID*
Generation of shaped THz beams by nonlinear metasurfaces, Shay Keren-Zur[1,3], Daniel Mittleman[2], Tal Ellenbogen[1,3]; *[1]School of Electrical Engineering, Tel Aviv Univ., Israel; [2]School of Engineering, Brown Univ., USA; [3]Center for Light-Matter Interaction, Tel Aviv Univ., Israel*. We present functional nonlinear plasmonic metasurfaces for generation of shaped broadband THz beams. The spatial phase of the emitted THz wavefront is tailored by the distribution of the meta-atoms orientation to control the generation process.

JTu3A.102
Multilayer plasmonic structures for ultrasensitive protein probing, Ildar Salakhutdinov[1], Bo Shrewsbury[1], Nolan Johnston[1], Ertan Salik[1]; *[1]Physics and Astronomy, California State Polytechnic Univ., USA*. Multilayer plasmonic structures consisting of alternating layers of metal and dielectric create a new type of guiding modes with very high effective refractive index. We chose a biomedical sensing including protein detection as the main application.

JTu3A.103
Modulation of Electromagnetically Induced Transparency in Toriodal Resonance Terahetz Metasurface, Sirak M. Mekonen[1], Riad Yahiaoui[1], Joshua Burrow[2], Andrew Sarangan[2], Imad Agha[3], Jay Mathews[2], Thomas A. Searles[1]; *[1]Howard Univ., USA; [2]Electro-Optics and Photonics, Univ. of Dayton, USA; [3]Physics, Univ. of Dayton, USA*. We report modulation of electromagnetically induced transparency in toroidal planar terahertz metamaterials. By breaking symmetry, we demonstrate tunability of EIT while exciting multiple Fano-like resonances with high Q-factor.

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JTu3A.104
High Sensitivity Vibrational Mode Detection with Doppler Raman Spectroscopy, David Smith[3], Jeffrey J. Field[3], David Winters[1], Scott Domingue[1], Jesse Wilson[3], Daniel Kane[2], Randy Bartels[3]; *[1]KM Labs, USA; [2]Mesa Photonics, USA; [3]Colorado State Univ., USA*. We present Doppler Raman, a novel detection technique for coherent Raman scattering that offers improved sensitivity and readily detects low frequency modes from 10cm^{-1} to 1500cm^{-1} for use in studying biological systems.

JTu3A.105
Spectroscopic Imaging of DDS Nano-particle by Polarization Interferometric Nonlinear Confocal Microscopy, Chikara Egami[1], Shota Kawasaki[1]; *[1]Shizuoka Univ., Japan. In this study, we propose a polarization-interferometric nonlinear confocal microscope targeted on Drug Delivery System (DDS) spectroscopic imaging. The microscope successfully measured microscopic optical anisotropy in a single DDS nano-particle.*

JTu3A.106
Optical coherence propagation in biological tissues with significant scattering by Green's functions, Jose Luis Ganoza-Quintana[1], Felix Fanjul-Velez[1], Jose L. Arce-Diego[1]; *[1]Universidad de Cantabria, Spain*. Diagnostic optical techniques employ usually intensity measurements, disregarding coherence. Scattering greatly influences propagation. Analyzing coherence propagation in scattering media by Green's functions could provide additional contrast.

JTu3A.107
Extracting Fluorescence Efficiency and Emission Spectra of Cervical Tissue, Shih Cheng Tu[1], Tsan-Hsueh Huang[1], Ting-Wen Yu[1], Ming-Hwa Hong[1], Ling-Hong Wei[2], Chi-Hau Chen[2], KUNG-BIN SUNG[1]; *[1]National Taiwan Univ., Taiwan; [2]National Taiwan Univ. Hospital, Taiwan.* This study aims to extract layer-resolved fluorescence efficiency and emission spectral shape of in-vivo cervical mucosa tissue by a two-layered fluorescence Monte Carlo model.

JTu3A.108
Single Element Detection Phase Contrast Spatial Frequency Modulation Imaging, Nathan G. Worts[1], Jeff Field[2], Randy Bartels[2], Jason Jones[3], Jeff Broderick[4], Jeff Squier[1]; *[1]Colorado School of Mines, USA; [2]Electrical and Computer Engineering, Colorado State Univ., USA; [3]Moog Inc., USA; [4]Epilog Laser, USA.* For the first time, dynamic phase contrast imaging is demonstrated using single element detection, spatial frequency modulated imaging (SPIFI). Sub-micron axial resolution is shown.

JTu3A.109
The Influence of Melanopsin Activation on the Cone-mediated Photopic White Noise Electroretinogram (wnERG) in Humans, Prakash Adhikari[1], Andrew J. Zele[1], Dingcai Cao[3], Jan Kremers[4], Beatrix Feigl[2,5]; *[1]School of Optometry and Vision Science & Inst. of Health and Biomedical Innovation, Queensland Univ. of Technology (QUT), Australia; [2]School of Biomedical Sciences & Inst. of Health and Biomedical Innovation, Queensland Univ. of Technology (QUT), Australia; [3]Dept. of Ophthalmology and Visual Sciences, Univ. of Illinois at Chicago, USA; [4]Dept. of Ophthalmology, Univ. Hospital Erlangen, Germany; [5]Queensland Eye Inst., Australia.* The white noise ERG (wnERG) measurements using silent-substitution methods show melanopsin activation supresses the human cone wnERG, potentially mediated via retrograde signalling from melanopsin cells to cones through dopaminergic amacrine cells.

JTu3A.110
Modeling of SPAD Response of Absorbed Near-Infrared Light in a Biological Tissue to Improve Diffuse Optical Tomography Resolution, Ahmed C. Kadhim[1], Ahmad Alalyani[1], Ahmad S. Azzahrani[1], Muhammad Riaz[1]; *[1]Florida Inst. of Technology, USA*. This paper introduces a new mathematical model to determine the single photon avalanche photodiodes response and the dark count rate that occupied with the detector output when the photon is absorbed by the biological tissue.

JTu3A.111
Application of heat-sensitive fluorescent dyes to determine the spatial and temporal temperature distribution in liquid media, Mykyta O. Redkin[1], Yakunov V. Andrii[2], Gaiduk Natalia[1]; *[1]Minor Academy of Science, Ukraine; [2]Optics, KNU , Ukraine*. For many technological processes,a non-contact measurement of the local temperature is necessary. A pyrometric method doesn't provide the necessary spatial resolution and accuracy. There we used the phenomenon of fluorescence dependence on temperature.

JTu3A.112
Sensitivity Improvement for a Smartphone-Based Lateral Flow Immunoassay Reader, Lalita Saisina[1], Ratthasart Amarit[2], Armote Somboonkaew[2], Oraprapai Gajanandana[3], Orawan Himananto[3], Boonsong Sutapun[1]; *[1]Suranaree Univ. of Technology, Thailand; [2]National Electronics and Computer Technology Center, Thailand; [3]National Center for Genetic Engineering and Biotechnology, Thailand.* We show that manually adjusting the camera's exposure time of a smartphone lateral flow reader to the highest slope of the nonlinear transfer function can significantly improve the sensitivity of the reader.

JTu3A.113
An Accessible Implementation for Synthetic Optical Holography (SOH), Arturo Canales[1,2], Martin Schnell[3], Raul I. Hernandez-Aranda[2], P. Scott Carney[1]; *[1]The Inst. of Optics, Univ. of Rochester, USA; [2]Photonics and Mathematical Optics Group, Tecnológico de Monterrey, Mexico; [3]CIC nanoGUNE, Spain*. We propose an accessible implementation for synthetic optical holography (SOH) in confocal microscopes by using an interferometry objective, and a nano-positioning z-stage, thus providing quantitative phase imaging capabilities.

JTu3A.114
Optical Parametric Amplification of Gated Confocal Reflectance Microscopy Signals in Scattering Media, Yi Sun[1], Haohua Tu[1], Sixian You[1], Stephen Boppart[1]; *[1]Univ. of Illinois , USA.* We apply optical parametric amplification to amplify weak ballistic photons and suppress the multiple-scattering background. The reflectance imaging signal are amplified with over 50 dB gain. Improvements in imaging depth are demonstrated.

JTu3A.115
Feasibility Study of Spectral Fusing GD-OCM using FPGA Acquisition Device, Panomsak Meemon[1], Yutana Lenaphet[1], Joewono Widjaja[1]; *[1]Suranaree Univ. of Technology, Thailand.* Gabor-domain optical coherence microscopy (GD-OCM) overcomes depth-of-focus limitation by combining multiple images acquired at different focus positions. Here, an implementation of FPGA-based Gabor fusion to improve processing speed was studied.

JTu3A.116
Laguerre-Gaussian Vortex Beam Transmission through Mouse Brain Tissue, Sandra Mamani[1]; *[1]IUSL at City College, USA.* Abstract: Light transmission of Laguerre-Gaussian (LG) vortex beams in different local regions in mouse brain tissue is investigated. Transmittance is measured in ballistic region with various polarizations states and orbital angular momentums (OAM).

JTu3A.117
Blue and Red Light Emitting Diode (LED) Variation on Soybean (Glycine Max) Growth, Selvy U. Hepriyadi[1], Wilda Prihasty[1], Intan D. Kurniawati[1], Achmad S. Hidayat[1], Iman R. Rosohadi[1], Detak Y. Pratama[1]; *[1]Institut Teknologi Sepuluh Nopember, Indonesia.* Soybeans were grown in uniform boxes and obtained that most optimum soybean plant is using the lighting ratio of the red LEDs 75% and blue 25% as the reference of modern artificial light for soybean.

JTu3A.118 *RAPID*
Assessment of basal cell carcinoma from normal human skin tissues using Resonance Raman spectroscopy, Lin Zhang Chen[1], Cheng-hui Liu[1], Binlin Wu[2]; *[1]The City College of New York, USA; [2]Southern Connecticut State Univ., USA.* VRR spectroscopy was used for BCC and normal skin tissues with 532nm excitation. The spectra showed significant changes in collagen, carotenoids and lipids. These enhanced fingerprints demonstrate a potential use as label-free pathology method.

JTu3A.119 *RAPID*
Photonic Resonator Outcoupler Microscopy (PROM) for Quantitative Monitoring of Stem Cell Focal Adhesion Area, Yue Zhuo[1], Ji Sun Choi[1], Thibault Marin[2], Hojeong Yu[1], Brendan A. Harley[1], Brian Cunningham[1]; *[1]Univ of Illinois at Urbana-Champaign, USA; [2]Univ. of Illinois Research Park, USA.* We developed a novel label-free imaging approach, named Photonic Resonator Outcoupler Microscopy (PROM) utilizing the reduction of the peak-resonance intensity reflected from a photonic crystal surface. PROM can monitor the variation of focal adhesion areas in live cells dynamically and quantitatively for extended time.

JTu3A.120
Polarization Splitter with TE Homogeneous Media and TM Inhomogeneous Media, Poliane A. Teixeira[1], Daniely G. Silva[1], Lucas H. Gabrielli[2], Danilo Spadoti[1], Mateus Junqueira[1]; *[1]Federal Univ. of Itajubá, Brazil; [2]School of Electrical and Computer Engineering, Univ. of Campinas, Brazil.* QCTO is employed to develop reflectionless non-magnetic polarization splitter with uniaxial properties, where the transformation is applied only in the TM mode. A low insertion loss and high extinction rate within a broadband are achieved.

JTu3A.121
Passive Underwater Polarization Imaging in Neritic Area, Yi Wei[1], Pingli Han[1], Fei Liu[1], Kui Yang[1], Xinhua Wang[2], Xiaopeng Shao[1]; *[1]XiDian Univ., China; [2]Changchun Inst. of Optics, China.* A passive underwater polarization imaging method is proposed to address color cast and degradation of image contrast in neritic area imaging. Results demonstrate its contribution to object information restoration in underwater target detection.

JTu3A.122
Effective pipeline to suppress coherent noise in digital holograms recorded under visible and infrared laser light, Vittorio Bianco[1], Pasquale Memmolo[1], Melania Paturzo[1], Pietro Ferraro[1]; *[1]Consiglio Nazionale delle Ricerche-ISASI, Italy.* We introduce an effective pipeline to reconstruct denoised digital holograms from multiple or single shot recordings. This is based on the simulation of noise diversity and a sparsity promoting filtering scheme.

JTu3A • Poster Session II and Dynamic E Posters—Continued

JTu3A.123
Parallel GPU Computing in Light Scattering Metrology of Ultrafast Surface Dynamics, Larry Theran[1], Armando Rúa[1], Felix Fernández[1], Sergiy Lysenko[1]; *[1]Univ. of Puerto Rico, USA.* Phase-retrieval algorithms are developed for parallel computing of surface autocorrelation function (ACF) and for solving the inverse problem of light scattering. A real-time visualization of ACF was achieved for transient spectroscopy of materials.

JTu3A.124
Snow Cover Monitoring Algorithm in Northeast China Using FY-2G Satellite Data, Tong Wu[1], Lingjia Gu[1], Ruizhi Ren[1], Haoyang Fu[1]; *[1]College of Electronic Science and Engineering, Jilin Univ., China.* The multi-temporal geostationary satellite FY-2G was used to reduce the cloud interference. The BRDF models were used in angular correction. An improved snow monitoring algorithm combined with geostationary satellite and BRDF model was proposed.

JTu3A.125
General Theoretical Analysis of Noise in Single-pixel Imaging, Robby Stokoe[1], Patrick Stockton[1], Ali Pezeshki[1], Randy Bartels[1]; *[1]Colorado State Univ., USA.* In single-pixel imaging, every reconstructed pixel includes noise from the entire object. We derive a general expression for the noise associated with any single-pixel imaging technique, enabling development of techniques that account for noise.

JTu3A.126
Withdrawn

JTu3A.127
Classification of Saline-alkaline Soil Using Multispectral Remote Sensing Data, Haoyang Fu[1], Chenglin Sun[1], Lingjia Gu[1]; *[1]Jilin Univ., China.* This paper analyzes the relationship between soil salinity and spectral characteristics. And LANDSAT 5 TM multispectral data is used to classify saline-alkaline soil into three degrees according to salinization ratings.

JTu3A.128
Speckle Reduction in Computer-Generated Holography with Multi-level Amplitude Encoding, Hang Feng[1], Weiping Wan[1], Qihuang Gong[1,2], Yan Li[1,2]; *[1]Peking Univ., China; [2]Shanxi Univ., China.* Speckles often occur in the reconstructed image of a phase-only computer-generated hologram. Here we present the speckle reduction by encoding hologram with both the phase and multi-level amplitude, which can be realized by a dielectric metasurface.

JTu3A.129
Image Focus Analysis using Gaussian Windows applied to Fourier Transform Frecuency, Eduardo Perez[1]; *[1]DICIS, Mexico.* Different analysis techniques have been developed to help understand and characterize image analysis with focal errors, in this paper we present an implementation using Gaussian windows applied to Fourier analysis.

JTu3A.130
Multi-resolution Based Cone-beam Computed Tomography High Precision Point Cloud Acquisition, Jia Zheng[1], Dinghua Zhang[1], Kuidong Huang[1], Yuanxi Sun[1]; *[1]Northwestern Polytechnical Univ., China.* We improve disconnections in sub-pixels of cone-beam computed tomography (CBCT) slice images. The proposed method, which is based on the multi-resolution, can acquire more connective sub-pixels and point cloud with higher precision.

JTu3A.131
Graphene and the Control of Liquid Crystal Alignment, Benjamin T. Hogan[1]; *[1]Univ. of Exeter, UK.* Here, we present results on using graphene as electrodes for controlling the orientation of liquid crystal molecules. We examine how graphene can pre-align the molecules as well as be used to apply electric field.

JTu3A.132 *RAPID*
Reconstruction of conditions of rays in space using a light-field display combined with Retro-Reflector, Toru Iwane[1], Hirotsugu Yamamoto[2]; *[1]Nikon Corporation, Japan; [2]Dept. of Optical Engineering, Utsunomiya Univ., Japan.* With reversing a light-field camera system combined with retro-reflector which can be regarded as a time reversing device for light, 3D scene can be reconstructed from light-field data acquired by light-field camera.

JTu3A.133
Novel 1066nm Nd:GdYTaO$_4$ laser under indirect and direct pumping, Xudong Li[1], Guichuan Xu[1]; *[1]National Key Lab of Tunable Laser Technology, Harbin Inst. of Technology, China.* CW and acousto-optically Q-switched operations with a novel Nd:$Gd_{0.69}Y_{0.3}TaO_4$ mixed crystal were demonstrated for the first time under indirect and direct pumping.

JTu3A.134
Surface Plasmon Polariton Generation in a Single-Walled Carbon Nanotube, Sergey G. Moiseev[1,2], Igor Zolotovskii[1,3], Yuliya Dadoenkova[1], Aleksei Kadochkin[1]; *[1]Ulyanovsk State Univ., Russia; [2]Kotelnikov Inst. of Radio Engineering and Electronics of the Russian Academy of Sciences, Russia; [3]Institute of Nanotechnologies of Microelectronics of the Russian Academy of Sciences, Russia.* Show that high quality of carbon nanotube in surface plasmon polariton generator as a resonator is achieved due to modulation of the phase velocity of the surface plasmon polariton wave along the nanotube.

JTu3A.135 *RAPID*
Time Resolved Study of Optical Properties and Microscopic Dynamics During the Drying of TiO2 Films by Spectral Diffusing Wave Spectroscopy, Luis F. Rojas-Ochoa[1], Damián Jacinto-Méndez[1], Angel A. Duran-Ledezma[1]; *[1]Cinvestav-IPN, Mexico.* We present a combined experimental, theoretical and numerical study of photon transport and microscopic dynamics in rigid and drying turbid thin TiO_2 films during the full drying process.

JTu3A.136
Study of dual-wavelength quasi-mode-locked regimes in a strict polarization-controlled Er-fiber ring laser, Luis Alberto Rodriguez Morales[1], Hector Santiago-Hernandez[1], Baldemar Ibarra-Escamilla[1], Manuel Durán Sanchéz[1], Marco V. Hernández-Arriaga[1], Evgeny A. Kuzin[1]; *[1]Optics, INAOE, Mexico.* We report a dual-wavelength quasi mode-locked (DWQML) operation of a strict polarization-controlled passively mode-locked Er-Fiber laser. The DWQML properties are studied by a birefringent Fiber optical loop mirror (FOLM).

JTu3A.137
Acousto-Optic Filter with Ultra-Narrow Bandwidth, Nikolai I. Petrov[1], Vladislav I. Pustovoit[1]; *[1]Scientific and Technological Center of Unique Instrumentation of Russian Academy of Sciences, Russia.* Significant increase in spectral resolution of acoustooptic filter due to spatial variation of refractive index of medium is shown. Influence of light absorption and random variation of dielectric constant on the filter spectrum is investigated.

JTu3A.138
Multiphoton processing technologies applied in laser-based 3D printing, Bogdan S. Calin[1], Marian Zamfirescu[1], Irina Paun[1], Catalin Luculescu[1], Florin Jipa[1], Stefana Iosub[1], Emanuel Axente[1], Felix Sima[1]; *[1]INFLPR, Romania.* Micrometer scale 3D printing using various materials, either through additive or subtractive manufacturing, offers a clean, precise and reproducible method of fabricating various passive devices for biomedical applications.

JTu3A.139
Organic Microlasers with Tunable Output, Yongli Yan[1]; *[1]Chinese Academy of Sciences, China.* A supermolecular inclusion strategy to construct wavelength-tunable microlasers was developed. Both β-cyclodextrin and metal-organic framework materials have been successfully adopted as matrix to encapsulate various dyes for lasing.

JTu3A.140
Relativistic Laser-Plasma Diagnostics with the Third Harmonic, Matthew Edwards[1], Alec R. Griffith[1], Tim Bennett[1], Julia Mikhailova[1]; *[1]Princeton Univ., USA.* We experimentally demonstrate the efficient generation of second and third harmonic light from a solid-density plasma for relativistic laser intensities and compare the emission characteristics to simulation and theory.

JTu3A.141
Cr:ZnSe laser generation in two longitudinal modes regime with intracavity monoblock Fabry-Perot interferometer for methane saturation spectroscopy, Mikhail Tarabrin[1,2], Sergey Tomilov[1,2], Vladimir Lazarev[1], Valeriy Karasik[1], Alexey Kireev[2], Alexander Shelkovnikov[2], Dmitry Tyurikov[2], Mikhail Gubin[2,3]; *[1]Bauman Moscow State Technical Univ., Russia; [2]P. N. Lebedev Physical Inst. of the Russian Academy of Sciences, Russia; [3]National Research Nuclear Univ. MEPhI, Russia.* We reported on the Cr:ZnSe single crystal laser with intracavity monoblock Fabry-Perot interferometer and two Lyot filters for methane saturation spectroscopy at 2.36 μm.

NOTES

15:00–16:30
FTu4A • Applied Nanoplasmonics: Solar – Sensing – Communication
Presider: Ortwin Hess; Imperial University, UK

FTu4A.1 • 15:00 Invited
Title to be Determined, Harry Atwater[1]; [1]*California Institute of Technology, USA*. No abstract available.

FTu4A.2 • 15:00 Invited
Solving the Resistive Loss Problem in Optical Antennas, Eli Yablonovitch[1], Sean Hooten[1]; [1]*University of California, USA*. One of the greatest problems in metal optics (of which plasmonics is a subset), is loss and dissipation in the metal. The basis of all radio is that antennas can concentrate electromagnetic energy within an extremely small volume, <10-15(l)3. Resistive loss limits every application of metals in optics, particularly in the new concept of "optical antennas". Such antennas produce sub-wavelength concentration of optical energy, enabling the antenna-LED (Light Emitting Diode), which can be faster than lasers. The tiny optical antenna vertices experience locally concentrated optical currents which severely increase Ohmic losses. When the concentrated optical region is smaller than the electron mean-free-path in the metal, surfaces collisions lead to even further dissipation. On the other hand, dielectric antennas have little dissipation, but they do not concentrate electromagnetic energy nearly as well as metallic antennas. If the metallic optical antenna is supplemented by 10nm dielectric tips at the vertices, they suffer only 2x larger concentration volume, but the Ohmic loss problem becomes solved.

15:00–16:30
FTu4B • Short Pulse Lasers
Presider: Junho Cho; Nokia Bell Labs, USA

FTu4B.1 • 15:00 Invited
Spatiotemporal Mode-Locking in Multimode Fiber Lasers, Frank W. Wise[1]; [1]*Cornell Univ., USA*. Existing mode-locked lasers operate in a single transverse mode. Locking of multiple transverse and longitudinal modes in a laser was recently demonstrated. Implications for laser science and high-power sources will be discussed.

FTu4B.2 • 15:30
Patterned Graphene on SiN Waveguides with NPR for Fiber Laser Mode-Locking, Goran Kovacevic[1], Takuma Shirahata[1], Bingchang Wu[1], Ting-Hui Xiao[2], Lei Jin[1], Taiki Inoue[3], Shigeo Maruyama[3], Zhenzhou Cheng[2], Sze Set[1], Shinji Yamashita[1]; [1]*RCAST, Univ. of Tokyo, Japan;* [2]*Dept. of Chemistry, Univ. of Tokyo, Japan;* [3]*Dept. of Mechanical Engineering, Univ. of Tokyo, Japan*. We passively mode locked a fiber laser using SiN waveguides covered with graphene of different lengths, and observed two types of solitons, with single and multiple pulses. Grating couplers induce NPR, but graphene triggers mode-locking.

FTu4B.3 • 15:45
Hybrid mode-locked erbium fiber laser with a 40 GHz phase modulator and graphene saturable absorber, Eduardo J. Aiub[1], Eunezio Thoroh de Souza[1], Lucia Saito[1]; [1]*Universidade Presbiteriana Mackenzie, Brazil*. We report a hybrid mode-locked erbium fiber laser operating at 40 GHz using CVD monolayer graphene on a D-shaped fiber as saturable absorber. As result, we obtain ultrashort pulses with temporal width of 1 ps.

FTu4B.4 • 16:00
Pre-chirp Managed Amplification Using Chirped Mirrors for Pulse Compression, Huang Hangdong[1,2], Yang Xie[1], Hao Teng[2], Shaobo Fang[2], Hainian Han[2], Guoqing Chang[2], Zhiyi Wei[2]; [1]*Xi Dian Univ., China;* [2]*Chinese Academy of Sciences, China*. We employ high-dispersion chirped mirrors as the pulse compressor and demonstrate an Yb-fiber pre-chirp managed amplification laser system, which produces 55 fs pulses with 43 W average power.

FTu4B.5 • 16:15
Passive Q-switching Tm-Doped Fiber Laser by Using an Alcohol-Based Saturable Absorber, Manuel Duran-Sanchez[1], Berenice Posada-Ramirez[1], Ricardo Iván Alvarez-Tamayo[2], Baldemar Ibarra-Escamilla[1], Jared Alaniz-Baylón[1], Miguel Bello-Jiménez[3], Patricia Prieto-Cortes[2], Evgeny A. Kuzin[1]; [1]*INAOE, Mexico;* [2]*Universidad Autonoma de Nuevo Leon, Mexico;* [3]*IICO, UASLP, Mexico*. With the maximum pump power of 1.42 W are obtained Q-switched pulses with minimum pulse duration of ~1.46 μs and maximum repetition rate of 66.71 kHz, peak power of 634 mW and pulse energy of 0.93 μJ.

15:00–16:30
FTu4C • Terahertz Science
Jelena Vuckovic; Stanford University, USA

FTu4C.1 • 15:00 Invited
Topological Insulator Lasers, Miguel A. Bandres[1], Steffen Wittek[2], Gal Harari[1], Midya Parto[2], Jinhan Ren[2], Demetrios N. Christodoulides[2], Mordechai Segev[1], Mercedeh Khajavikhan[2]; [1]*Technion, Israel;* [2]*CREOL, USA*. We demonstrate a topological insulator laser exhibiting topologically-protected transport. The topological properties give rise to single mode lasing, robustness against defects, and higher slope efficiencies compared to its trivial counterpart.

FTu4C.2 • 15:30
Withdrawn

FTu4C.3 • 15:45
Effect of Pulse Duration on the Performance of Sub-Terawatt Laser Wakefield Acceleration, Chia-Ying Hsieh[1], Shih-Hung Chen[1], Ming-Wei Lin[2]; [1]*Dept. of Physics, National Central Univ., Taiwan;* [2]*Inst. of Nuclear Engineering and Science, National Tsing Hua Univ., Taiwan*. A 3-D particle-in-cell (PIC) model is developed to investigate the effect of pulse duration when 1030-nm lasers are applied to drive the sub-terawatt laser wakefield acceleration.

FTu4C.4 • 16:00
Multiple Acceleration of High-velocity Flyer Driven By Long-pulse KrF Laser, Bao-xian Tian[1], Zhao Wang[1], Pinliang Zhang[2], Zhixing Gao[1], Jing Li[1], Fengming Hu[1]; [1]*Dept. of Nuclear Physics, China Inst. of Atomic Energy, China;* [2]*Beijing Inst. of Spacecraft Environment Engineering, China*. Planar aluminum flyers are accelerated to more than 10 km/s driven by long-pulse laser. Multiple acceleration processes were observed by VISAR. However, the flyer is easily broken up for four or more acceleration because of 2-D effects.

FTu4C.5 • 16:15
EuPRAXIA - a Compact, Cost-Efficient XFEL Source, Maria Katharina Weikum[1], Paul A. Walker[1], Ralph Assmann[1]; [1]*Deutsches Elektronensynchrotron DESY, Germany.* The EuPRAXIA design study aims to develop a first large-scale accelerator and Free-Electron-Laser facility based on plasma acceleration technology. We present an overview over the status of the project as well as possible user applications.

15:00–16:30
FTu4D • Optical Technologies for Autonomy in Realistic Weather

The general understanding that sensors "work" often neglects real world conditions outside of laboratories or sunny streets. Most tests and demonstrations focus on controlled or favorable conditions, leaving out the harsher realities of real-world operation. Rain, snow, fog, pollen, dust, and numerous other common obscurants can negatively affect a variety of sensing modalities. Sensor failure can take a variety of forms: graceful degradation with built-in warnings, unknown blind-spots, low signal-to-noise ratios (known or unknown), etc. In this session we address failure modalities, how improved sensor design can improve autonomy estimations, and the optical technologies needed to address common weather conditions.

Panelists:
Chris DeBrunner, *Lockheed Martin, USA*
Paolo Masini, *Raytheon Vision Systems, USA*
Joseph Minor, *U.S. Army, USA*
Colin Reese, *U.S. Army Research Laboratory, USA*

15:00–16:30
FTu4E • Integrated Nanophotonic Devices
Presider: Mohammad Hafezi, University of Maryland Joint Quantum Institute, USA

FTu4E.1 • 15:00
Free-space Communication Links with Transmitting and Receiving Integrated Optical Phased Arrays, Matthew Byrd[1], Christopher V. Poulton[1], Murshed Khandaker[1], Erman Timurdogan[1], Diedrik Vermeulen[1], Michael R. Watts[1]; [1]*Analog Photonics, USA.* A lens-free chip-to-chip free space optical communication link showing data transmission from a single transmitter to multiple receivers is demonstrated using steerable integrated silicon photonic optical phased arrays at a data rate of 1Gbps.

FTu4E.2 • 15:15
Highly-efficient second-harmonic generation in semi-nonlinear nanophotonic waveguides, Rui Luo[1], Yang He[1], Hanxiao Liang[1], Mingxiao Li[1], Qiang Lin[1]; [1]*Univ. of Rochester, USA.* We report second-harmonic generation in semi-nonlinear nanophotonic waveguides composed of titanium oxide and lithium niobate, with a theoretical normalized conversion efficiency of 2900 $W^{-1}cm^{-2}$, and an experimental efficiency of 650 $W^{-1}cm^{-2}$.

FTu4E.3 • 15:30
Probing finite-size effects and disorder in extended slow light photonic crystal coupled-cavity waveguides, Mohamed S. Mohamed[1], Yiming Lai[2], Momchil Minkov[3], Vincenzo Savona[1], Antonio Badolato[4], Romuald Houdré[1]; [1]*Inst. of Physics, École Polytechnique Fédérale de Lausanne, Switzerland;* [2]*The Inst. of Optics, Univ. of Rochester, USA;* [3]*Ginzton Lab, Stanford Univ., USA;* [4]*Dept. of Physics, Univ. of Ottawa, Canada.* Slow light properties of Si photonic crystal coupled-cavity waveguides comprising up to 800 cavities are experimentally investigated using Fourier-space imaging. The influence of cavity chain length and disorder on slow light transport is elucidated.

FTu4E.4 • 15:45
High-quality two-dimensional lithium niobate photonic crystal slab nanoresonators, Mingxiao Li[1], Hanxiao Liang[1], Rui Luo[1], Yang He[1], Qiang Lin[1]; [1]*Univ. of Rochester, USA.* We report a 2D LN PhC slab nanoresonators with high optical Q over 3 hundred thousand. Such a high quality enables us to probe the intriguing anisotropy of nonlinear optical phenomena of LN never reported previously.

FTu4E.5 • 16:00 Invited
Superconducting Nanowire Single-photon Detector Integrated with a Nanophotonic Cavity, Julian Münzberg[2], Andreas Vetter[2], Wladislaw Hartmann[1], Fabian Beutel[1], Carsten Rockstuhl[2], Wolfram Pernice[1]; [1]*University of Munster, Germany;* [2]*Karlsruhe Institute of Technology, Germany.* We present the design and the characterization of a new generation of on-chip single-photon detectors, integrated with a double heterostructure photonic crystal cavity to combine high detection efficiency in the near-infrared and sub-ns recovery time.

15:00–16:30
LTu4F • Extreme Laser Science I
Presider: David Reis; Stanford University, USA

LTu4F.1 • 15:00 Invited
Boiling the Quantum Vacuum with Extremely Intense Laser Light, Sebastian Meuren[1]; [1]*Princeton Univ., USA.* According to our current understanding of quantum electrodynamics (QED) the properties of matter change qualitatively in the presence of ultra-strong electromagnetic fields. The scale at which novel quantum effects are predicted to occur is called the QED critical or Schwinger field. By colliding highly energetic gamma photons with ultra-intense optical laser pulses the strong-field quantum regime of light-matter interaction is explorable with existing technology. In particular, nontrivial properties of the quantum vacuum (vacuum birefringence and dichroism, anomalous dispersion), the production of matter from pure light, and laser-induced electron-positron recollision processes are now within experimental reach. After a general introduction into strong-field QED recent results related to those phenomena are discussed and conceptual similarities to analogous phenomena in atomic physics are pointed out.

LTu4F.2 • 15:30 Invited
Extreme Conditions from Ultra-Intense Femtosecond Laser Pulses Interacting with Aligned Nanostructures, Jorge J. Rocca[1], Reed J. Hollinger[1], V. N. Shlyaptsev[1], Maria Capeluto[1], Alden H. Curtis[1], Chase Calvi[1], Stephen Kasdorf[1], Vural Kaymak[2], Alexander Pukhov[2], Yong Wang[1], Shoujun Wang[1], Alex Rockwood[1]; [1]*Colorado State Univ., USA;* [2]*Heinrich-Heine-Universität, Germany.* Irradiation of ordered nanowire arrays with highly relativistic pulses is demonstrated to volumetrically heat solid density matter to extreme temperatures, resulting in record conversion into keV photons, high energy ions, & ultrafast neutron bursts.

LTu4F.3 • 16:00
A high-energy mid-infrared to THz laser, Yuxi Fu[1], Katsumi Midorikawa[1], Eiji J. Takahashi[1]; [1]*RIKEN, Japan.* Employing a dual-chirped difference frequency generation (DC-DFG) method, we generate a source tunable from mid-infrared (3 μm) to THz (15 THz). DC-DFG, which is an energy scalable approach, enables us to generate few-mJ THz pulses.

LTu4F.4 • 16:15
Jitter-Induced Max-of-N Fluence Distribution at National Ignition Facility, Zhi M. Liao[1], C W. Carr[1], Paul Wegner[1]; [1]*Lawrence Livermore National Lab, USA.* Measured pointing jitter from NIF is used to simulate the effect of Max-of-N accumulated fluence distribution. The simulate result was able to reproduce the measured Max-of-N effect for different energy and wavelength operations.

16:45–18:15
FTu5A • Quantum and Near-Field Nanoplasmonics
Presider: Ortwin Hess; Imperial University, UK

FTu5A.1 • 16:45 Invited
Strong Coupling of a Single Quantum Dot to a Plasmonic Nanoresonator at Ambient Conditions, Bert Hecht[1]; [1]*Inst. of Physics, Univ. Of Würzburg, Germany.* We exploit the ultrasmall modal volume of plasmonic slit resonators to achieve broadband strong coupling to quantum dots at ambient conditions. The slit resonantor is positioned by means of scanning probe technology with respect to the quantum dot.

FTu5A.2 • 17:15 Invited
Giant Nonlinear Response at a Plasmonic Nanofocus Drives Efficient Four-wave Mixing Over Micron Length Scales, Rupert Oulton[1], Michael P. Nielsen[1], Xingyuan Shi[1], Paul Dichtl[1], Stefan A. Maier[1]; [1]*1Imperial College London, UK*. We report efficient four-wave mixing (FWM) over micron-scale interaction lengths at telecommunications wavelengths on silicon. This was achieved by creating a giant nonlinear response within an integrated plasmonic gap waveguide incorporating a nonlinear polymer. The technique introduces the possibility of compact, broadband, and efficient frequency mixing integrated with silicon photonics.

FTu5A.3 • 17:45 Invited
Plasmonics with Quantum States of Light Towards Quantum Applications, Sahin Ozdemir[1]; [1]*Department of Engineering Science and Mechanics, Pennsylvania State University, USA.* Plasmonics promise novel properties to integrated quantum photonics, such as nanoscale footprint and strong light-matter interactions. In this talk, I will discuss our studies on probing plasmonic structures using single and entangled photons and realizing quantum applications such as random number generation and entanglement distillation in plasmonic structures.

16:45–18:15
FTu5B • Semiconductor Lasers and SDM
Presider: Bob Jopson; Nokia Bell Labs, USA

FTu5B.1 • 16:45 Invited
Quantum-Inspired Redesign of the Semiconductor Laser for High Coherence , Amnon Yariv[1]; [1]*Caltech, USA.* The semiconductor laser (sl) basic architecture reflects the historical need for high gain needed to achieve CW operation. This design is antithetical to high coherence i.e. to small Schawlow-Townes (ST) linewidth.Our new design starts with a drastic lowering of the optical modal losses which is a prerequisite to the reduction of the noisy coherence -lowering spontaneous emission into the laser mode. New lasers fabricated in our group will be described and relevant data shown which include ST linewidths in the single Hz regime Semiconductor lasers with sub hertz ST linewidths are extrapolated.

FTu5B.2 • 17:15
Influence of the upper nonlasing state on the route to chaos of InAs/GaAs quantum dot lasers, Heming Huang[3], Dejan Arsenijević[1], Dieter Bimberg[1,2], Frederic Grillot[3,4]; [1]*Institut für Festkörperphysik, Technische Universität Berlin, Germany;* [2]*"Bimberg Chinese-German Center of Green Photonics" of Chinese Academy of Science at CIOMP, China;* [3]*COMELEC, LTCI, Télécom ParisTech, Université Paris-Saclay, 46 rue Barrault, France;* [4]*Center for High Technology Materials, Univ. of New-Mexico, 1313 Goddard SE, USA.* This paper investigates the route to chaos of a quantum dot laser emitting exclusively on a single lasing state. Results reveal that amplified spontaneous emission from the upper non-lasing state drastically accelerates the destabilization process.

FTu5B.3 • 17:30 Invited
Laguerre-Gaussian Spatial Mode Sorter, Joel A. Carpenter[1]; [1]*Queensland Univ., Australia*. Abstract not available.

FTu5B.4 • 18:00
Mode-Group Selective Air-Clad Photonic Lantern, Neethu Mariam Mathew[1], Lars Grüner-Nielsen[2], Mario A. Castaneda[1], Michael Galili[1], Karsten K. Rottwitt[1]; [1]*DTU, Denmark;* [2]*Danish Optical Fiber Innovation, Denmark.* A new method for fabrication of mode group selective photonic lanterns is experimentally demonstrated. The design is very simple, using only a tapered fiber bundle and an air-cladding. Good mode group selectivity is demonstrated.

16:45–18:00
FTu5C • Novel Lasers and Applications
Presider: Kaoru Minoshima; University of Electro-Communications, Japan

FTu5C.1 • 16:45 Invited
Random Lasers for Sensing, Judith M. Dawes[1], Wan Zakiah Wan Ismail[1,2], Charlotte Hurot[1,3], Corentin Huard[1,3], Nonthanan Sitpathom[1,4]; [1]*MQ Photonics, Dept of Physics and Astronomy, Macquarie Univ., Australia;* [2]*Universiti Sains Islam Malaysia, Malaysia;* [3]*Ecole Centrale de Lyon, France;* [4]*Mahidol Univ., Thailand.* We sensitively detect biomolecules by their effect on gold nanoparticle aggregates in a random laser. The aggregation affects the scattering properties of the laser, enabling us to quantitatively measure dopamine to nanomolar concentrations.

FTu5C.2 • 17:15
Enhanced THz Emission from Two-Color Femtosecond Laser Filamentation at Low Pressures, Dogeun Jang[1], Yungjun Yoo[1,2], Ki-Yong Kim[1]; [1]*Univ. of Maryland at College Park, USA;* [2]*Thorlabs Imaging Systems, USA.* We report enhanced terahertz (THz) emission from elongated, two-color-laser filamentation at low gas pressures. This counterintuitive pressure dependence is investigated with experimental and numerical studies.

FTu5C.3 • 17:30
Coherent Extreme-Ultraviolet Source Applied to Atom Probe Tomography, Luis Miaja Avila[1], Ann N. Chiaramonti[1], Paul T. Blanchard[1], Norman A. Sanford[1], Henry C. Kapteyn[2], Margaret M. Murnane[2], David R. Diercks[3], Brian P. Gorman[3]; [1]*NIST, USA;* [2]*JILA, Univ. of Colorado, USA;* [3]*Colorado School of Mines, USA.* We have adapted an atom probe tomograph (APT) with an extreme ultraviolet (EUV) source. The observations suggest that the photoionization pathway provided by the EUV light is superior to the thermal mechanism in conventional APT.

FTu5C.4 • 17:45
Measurement of the nonlinear refractive index of air constituents from λ=2.5 μm to λ=10.6 μm, Sina Zahedpour Anaraki[1], Scott W. Hancock[1], Fatholah Salehi[1], Jared K. Wahlstrand[2], Howard Milchberg[1]; [1]*Univ. of Maryland at College Park, USA;* [2]*National Inst. of Standards and Technology, USA.* We measure the nonlinear refractive indices of major air constituents in the wavelength range of λ=2.5μm-10.6μm extending the range of prior measurements [1]. These results are important for the study of intense laser propagation in the atmosphere.

18:30–20:30 Conference Reception, *International Ballroom*

16:45–18:15
FTu5D • Optical Technologies for Autonomy in Unstructured Environments

Typical discussions of autonomy revolve around self-driving cars on the streets of major metropolitan areas. These highly structured environments offer standard visual cues, commonly accepted behavioral protocols, and obstacles occurring within a standard plane and region. Throughout large parts of the world, it is not unusual to find the local road is dirt track which may have limited variation from the surrounding landscape. Moreover, operation off-road is regularly required by the military, rescue personnel, and aid organizations. For an autonomous system to operate in complex, unstructured environments, the sensors must be able to observe the environment in a new way. This session will address the difficulties facing optical sensors in environments ranging from featureless snow fields to dense jungles.

Panelists:
Brendan Byrne, *Argo AI, USA*
Marcus Chevitarese, *Raytheon, USA*
Deva Ramanan, *Carnegie Mellon University, USA*
Robert Sadowski, *U.S. Army TARDEC, USA*

16:45–18:15
FTu5E • Topological Photonics
Presider: Simone Ferrari, University of Münster, Germany

FTu5E.1 • 16:45 Invited
Non-Hermitian Photonics: Lasers and Sensors, Mercedeh Khajavikhan[1]; [1]*Univ. of Central Florida, CREOL, USA.* Abstract not available.

FTu5E.2 • 17:15 Invited
Towards Quantum Topological Photonics, Mohammad Hafezi[1]; [1]*Joint Quantum Inst., USA.* I discuss two recent application of topological photonics in the quantum regime: (1) strong light-matter interaction in topological photonic crystals (2) topological quantum source of light in silicon ring resonators.

FTu5E.3 • 17:45
Parity-Time (PT) symmetric photonic system based on Parametric Gain, Tong Lin[1], Avik Dutt[1], Xingchen Ji[1], Utsav Dave[1], Alexander Gaeta[1], Michal Lipson[1]; [1]*Columbia Univ., USA.* We report the first demonstration of PT symmetry based on parametric gain, in a single Si_3N_4 microring. We observe the typical merging of eigenvalue branches as the gain/loss contrast between counterpropagating modes is increased.

FTu5E.4 • 18:00
Topological Photonics with Bichromatic Photonic Crystals, Filippo Alpeggiani[1], L. Kuipers[1]; [1]*TU Delft, Netherlands.* We investigate the spectrum of *bichromatic photonic crystals*, a novel class of nanostructures which represent a photonic analog of topological insulators. Nontrivial topology is illustrated by the formation of topologically protected boundary states.

16:45–18:15
LTu5F • Extreme Laser Science II
Presider: Jorge Rocca; Colorado State University, USA

LTu5F.1 • 16:45 Invited
Title to be Determined, Agostino Marinelli[1]; [1]*SLAC National Accelerator Lab, USA.* Abstract not available.

LTu5F.2 • 17:15
An intense soft X-ray harmonic super-continuum generated by a three-channel optical waveform synthesizer, Bing Xue[1], Yuxi Fu[1], Kotaro Nishimura[1,2], Oliver Mucke[3], Akira Suda[2], Katsumi Midorikawa[1], Eiji J. Takahashi[1]; [1]*RIKEN, Japan;* [2]*Tokyo Univ. of Science, Japan;* [3]*Center for Free-Electron Laser Science, DESY, Germany.* We report a soft X-ray super-continuum supporting 200 as isolated attosecond pulses at 60 eV generated using a TW-scale three-channel optical waveform synthesizer. The continuum soft X-ray pulse energy is beyond 0.2 μJ at the exit of the argon gas.

LTu5F.3 • 17:30 Invited
Probing Photoionization Dynamics by High-spectral-resolution Attosecond Spectroscopy, Shiyang Zhong[1], Marcus Isinger[1], Richard Squibb[2], David Busto[1], Anne Harth[1], David Kroon[1], Saikat Nandi[1], Cord Arnold[1], Miguel Miranda[1], J. M. Dahlström[1,3], Eva Lindroth[3], Raimund Feifel[2], Mathieu Gisselbrecht[1], Anne L'Huillier[1]; [1]*Dept. of Physics, Lund Univ., Sweden;* [2]*Dept. of Physics, Gothenburg Univ., Sweden;* [3]*Dept. of Physics, Stockholm Univ., Sweden.* Photoionization time delays are measured with two-color (XUV+IR) interferometric technique. The combination of attosecond temporal resolution and high spectral resolution from narrowband harmonics allows the study of ultrafast dynamics in both time and frequency domain.

LTu5F.4 • 18:00
Dissipative Soliton Resonance in a Figure-Eight Thulium-Doped Fiber Laser, Manuel Duran-Sanchez[1], Berenice Posada-Ramirez[1], Baldemar Ibarra-Escamilla[1], Hector Santiago-Hernandez[1], Ricardo Iván Alvarez-Tamayo[3], Miguel Bello-Jiménez[2], Evgeny A. Kuzin[1]; [1]*INAOE, Mexico;* [2]*IICO, UASLP, Mexico;* [3]*Universidad Autonoma de Nuevo Leon, Mexico.* We reported dissipative soliton resonance effects passively mode-locked figure-eight thulium doped fiber laser. At maximum pump power was achieved 85.18 ns pulse duration, a pulse energy of 206 nJ, a repetition rate of 1.19 MHz.

18:30–20:30 Conference Reception, *International Ballroom*

08:00–09:00
FW1A • The Coming of Age for Smart Glasses, AR and VR
Presider: Bernard Kress; Microsoft, USA

Introduction to the AR/VR themed days at FIO 2018, Bernard Kress; *Microsoft, USA.*

FW1A.1 • 08:10 Invited
User-centered Design of Head Worn Displays, Thad Starner[1]; [1]*School of Interactive Computing, Georgia Inst. of Technology, USA.* Fashion and head weight are more important than field-of-view for on-the-go AR displays, and displays centered in line-of-sight may be rejected by on-the-go users due to safety perceptions. What other surprises might user-centered design reveal?

FW1A.2 • 08:35 Invited
Head-Mounted Displays for High Stress Occupations, James E. Melzer[1]; [1]*Thales Visionix, Inc., USA.* Pilots, warfighters, first responders and medical personnel must maintain their situation awareness in times of high stress or risk harm to themselves, team members or those in their care. While we can't necessarily make them better at their job, perhaps we can give them a head-mounted (*or helmet-mounted)* display that can provide cognitively "pre-digested" information in a hands-free and timely manner that will reduce their workload? What are the requirements for maintaining situation awareness and reducing workload for these important occupations? How do these requirements translate into performance specifications for the head-mounted display?

08:00–09:00
FW1B • Novel Lasers and Photodetectors
Presider: Alexey Turukhin; TE SubCom, USA

FW1B.1 • 08:00
High-Speed Waveguide Integrated Si Photodetector on SiN-SOI Platform for Short Reach Optical Interconnect, Avijit Chatterjee[1], Saumitra S[1], Sujit K. Sikdar[1], Shankar K. Selvaraja[1]; [1]*Indian Inst. of Science Bangalore, India.* We demonstrate high-speed Silicon pin photodetector integrated with SiN waveguide. Optimized waveguide-photodetector coupling yields maximum responsivity of 0.44A/W and highest ever bandwidth of 15.5GHz for waveguide integrated Silicon photodetector.

FW1B.2 • 08:15
10-Gb/s Floor-Free Transmission of a Hybrid III-V on Silicon Distributed Feedback Laser with Optical Feedback, Sandra Gomez[1], Heming Huang[1], Bewindin Sawadogo[1], Frederic Grillot[1,2]; [1]*Telecom ParisTech, France;* [2]*Univ. of New Mexico, USA.* A 10 Gb/s transmission by direct modulation of a distributed feedback semiconductor laser heterogeneously integrated onto silicon is studied with optical feedback. Its impact on the bit error rate and power penalty degradation is analyzed.

FW1B.3 • 08:30 Invited
III-V Membrane Buried Heterostructure Lasers on SiO2/Si Substrate, Tomonari Sato[1]; [1]*NTT Device Technology Labs, Japan.* A membrane buried heterostructure with a lateral p-i-n junction on SiO2/Si substrate enables tight confinement of carriers and photons simultaneously, which enables us to achieve energy-efficient lasers.

08:00–09:00
FW1C • Nanophotonics I
Presider: Katarzyna Matczyszyn; Wroclaw University of Science and Techn., Poland

FW1C.1 • 08:00 Invited
Enabling Next-Generation Optical Microsystems, Gordon A. Keeler[1]; [1]*DARPA, USA.* Integrated photonics promises revolutionary solutions for communications, sensing, and metrology. This talk describes DARPA efforts to develop technology through investments in components and materials, and highlights programs driving innovation.

FW1C.2 • 08:30
Multiplexing Soliton-Combs in Optical Microresonators, Erwan Lucas[1], Grigory Lihachev[2,3], Romain Bouchand[1], Nikolay Pavlov[2], Arslan S. Raja[1], Maxim Karpov[1], Michael Gorodetsky[2,3], Tobias Kippenberg[1]; [1]*Ecole Polytechnique Fédérale de Lausanne, Switzerland;* [2]*Russian Quantum Center, Russia;* [3]*Moscow State Univ., Russia.* We simultaneously create stable solitons in up to 3 distinct mode families of a single crystalline MgF_2 microresonator. The resulting Kerr combs have distinct repetition rates, are mutually coherent allowing dual or future triple comb applications.

FW1C.3 • 08:45
In-situ Backpropagation in Photonic Neural Networks, Momchil Minkov[1], Tyler W. Hughes[1], Yu J. Shi[1], Ian Williamson[1], Shanhui Fan[1]; [1]*Stanford Univ., USA.* Using the adjoint variable method, we derive an in-situ backpropagation procedure for training of photonic neural networks. Our method may also be of interest for experimental sensitivity analysis and optimization of reconfigurable optics platforms.

09:15–10:00
FW2A • Visionary: Mark Bolas

FW2A.1 • 09:15 VISIONARY
Bending Light to Bend Reality, Mark Bolas[1]; [1]*Microsoft Corp, USA.* As we dive head-first into the new medium of mixed reality, we find that the ability to bend light is central to the palette of mixed reality systems and content designers as they bend the reality that is ultimately formed in the user's mind. This talk will look backwards and forward in time to explore just how messy that process has been, and how much messier it will become.

08:00–09:00
FW1D • Quantum Sensing for Industry and Fundamental Physics I
Presider: To be Determined

FW1D.1 • 08:00 Invited

Enabling Technologies for Cold-Matter Based Quantum Systems, Evan A. Salim[1]; [1]*ColdQuanta Inc., USA.* Quantum technologies exploit properties of matter to manage information, and to measure phenomena in ways that greatly exceed existing capabilities. We present on key technologies to enable quantum information science, sensing, and timekeeping.

FW1D.2 • 08:30 Invited

Quantum Enhanced Metrology with Trapped Ions, Dietrich Leibfried[1]; [1]*National Inst. of Standards and Technology, USA.* Laser cooling and quantum logic allows us to prepare atomic and molecular ions into nearly pure quantum states of their internal degrees of freedom and external motion and subsequently interrogate them with high metrological precision.

08:00–09:00
FW1E • Nanophotonic Sensing and Optomechanics
Presider: Roel G. F. Baets; Ghent University INTEC, Belgium

FW1E.1 • 08:00

Robust non-Hermitian sensors, Qi Zhong[1], Mohammad Hosain Teimourpour[1], Ramy El-Ganainy[1]; [1]*Michigan Technological Univ., USA.* We introduce a new design concept for non-Hermitian photonic that combine robustness with sensitivity and demonstrate its utility for sensing applications.

FW1E.2 • 08:15

Quantum metrology for high-accuracy measurement of refractive index difference in original optical fibers, Florent Mazeas[1,2], Romain Dauliat[3,4], Djeylan Aktas[5], Mattis Reisner[1,2], Panagiotis Vergyris[1,2], Philippe Roy[3,4], Raphael Jamier[3,4], Florian Kaiser[6,7], Laurent Labonté[1,2], Sébastien Tanzilli[1,2]; [1]*Université Côte d'Azur, CNRS, France;* [2]*Institut de Physique de Nice, France;* [3]*Université de Limoges , France;* [4]*XLIM, France;* [5]*Univ. of Bristol, UK;* [6]*Univ. of Stuttgart, Germany;* [7]*3rd Inst. of Physics, Germany.* We report on a quantum-based measurement of index difference in original fibers. With an interferometric setup and a peculiar optical fiber structure, we demonstrate index difference measurements with a precision reaching the 10-5 - 10-6 level.

FW1E.3 • 08:30

Arrays of High Reflectivity SiN Photonic Crystal Membranes for Cavity Optomechanics, João Moura[1], Claus Gärtner[1,2], Wouter Haaxman[1], Richard A. Norte[1], Simon Gröblacher[1]; [1]*Kavli Inst. of Nanoscience, Delft Univ. of Technology, Netherlands;* [2]*Vienna Center for Quantum Science and Technology (VCQ), Univ. of Vienna, Austria.* We fabricate photonic crystal SiN membranes with reflectivity > 99.9% at 1550 nm. These form a platform for studying arrays of mechanical oscillators inside optical cavities, which can potentially reach strong single-photon optomechanical coupling.

FW1E.4 • 08:45

Demonstration of a Phonon Laser With a Nanosphere Levitated in an Optical Tweezer, Robert Pettit[1], Wenchao Ge[2], Pardeep Kumar[2], Danika Luntz-Martin[1], Justin Schultz[1], Levi Neukirch[3], Mishkat Bhattacharya[2], Anthony N. Vamivakas[1]; [1]*Univ. of Rochester, USA;* [2]*Rochester Inst. of Technology, USA;* [3]*Los Alamos National Lab, USA.* A phonon laser based on the center-of-mass oscillations of a silica nanosphere, levitated in an optical tweezer under vacuum, is proposed and developed. The observed dynamics are shown to result from stimulated emission of phonons.

08:00–09:00
LW1F • Novel Lasers, Plasmonics, Nanophotonics I
Presider: Maiken Mikkelsen; University of California Berkeley, USA

LW1F.1 • 08:00 Invited

High Performance Flat Optics, Federico Capasso[1], Wei-Ting Chen[1]; [1]*Harvard Univ., USA.* The talk will focus on metasurface optics including broadband achromatic and tunable metalenses, ultracompact spectrometers and polarimeters that match the performance of state-of-the-art ones and novel endoscopes for lung cancer detection.

LW1F.2 • 08:30 Invited

Nonreciprocal Photonics, Andrea Alu[1]; [1]*Photonics Initative, CUNY Advanced Science Research Center, USA.* We discuss opportunities to break reciprocity in photonics using mechanical motion, spatio-temporal modulation, and/or nonlinearities, and their impact in the context of integrated photonics, slow-light devices, and photonic topological insulators.

09:15–10:00
LW2B • Visionary: Mark Brongersma
Presider: Pieter G. Kik; University of Central Florida, USA

LW2B.1 • 09:15 VISIONARY

Activities Shaping the Wavefront of Nanophotonics, Mark Brongersma[1]; [1]*Stanford Univ., USA.* In the field of nanophotonics we aim to manipulate the flow of light using optically resonant nanostructures. I will share my personal perspective on a number of exciting recent developments in the field that are transforming the way we create new optical materials and devices.

10:15-11:15
Rapid Fire Oral Presentation III, Science & Industry Theater
Presider: Wei Lee; National Chiao Tung University, Taiwan

Participating posters are noted in the list of poster for session JW3A with the icon **RAPID**. Each presenter will have 3 minutes and the order will be determined by poster number.

JOINT FiO + LS

10:00–12:00
JW3A • Poster Session III and Dynamic E Posters

JW3A.1 *E-Poster*
Fabrication of active microdisc resonators using solvent immersion imprint lithography, Priyanka Choubey[1], Shailendra Varshney[1], Shivakiran Bhaktha B. N.[1]; *[1]Indian Inst. of Technology Kharagpur, India.* We present fabrication of active microdisc resonators for sensing platform based on whispering-gallery modes. The arrays of microdisc are fabricated from DCM laser dye-doped PVA using solvent immersion imprint lithography (SIIL).

JW3A.2 *E-Poster*
Polarization Rotation Utilizing Berry's Phase in Asymmetric Silicon Waveguides, Ryan Patton[1], Ronald M. Reano[1]; *[1]Ohio State Univ., USA.* We present a method to achieve polarization rotation in asymmetric silicon waveguides using Berry's phase. By exploiting periodic in-plane and out-of-plane sections, we achieve 90° polarization rotation in the presence of linear birefringence.

JW3A.3
Withdrawn

JW3A.4 *E-Poster*
Single-pixel three-dimensional profiling with a dual-comb fiber laser, Yihong Li[1], Xin Zhao[1], Qian Li[1], Jie Chen[1], Zheng Zheng[1,2]; *[1]School of Electronic and Information Engineering, Beihang Univ., China; [2]Beijing Advanced Innovation Center for Big Date-based Precision Medicine, Beihang Univ., China.* Using a single-cavity, dual-comb fiber laser, single-pixel 3D profiling is demonstrated with a simple and compact setup. Sub-millimeter resolution achievable with the dual-comb ranging scheme can be attractive to many applications.

JW3A.5 *E-Poster*
Quasi-monoenergetic Electron Beams from Mid-IR Laser Wakefield Acceleration in the Bubble Regime, Anastasia Korolov[1], Daniel C. Woodbury[1], Robert Schwartz[1], Howard Milchberg[1]; *[1]Institute for Research in Electronics & Applied Physics, USA.* We present simulation results of laser plasma wakefield acceleration in the bubble regime driven by ultrashort mid-infrared laser pulses (30fs, λ=3.9μm, $3x10^{17}$ W/cm^2). We observe a quasi-monoenergetic accelerated electron bunch at ~20MeV.

JW3A.6 *E-Poster*
Enhanced resolution in remote sensing using UV filaments with long pulses, Ladan Arissian[1,2], Jean Claude Diels[1], Ali Rastegari[1], Brian Kamer[1]; *[1]CHTM, Univ. of New Mexico, USA; [2]Univ. of Ottawa, Canada.* We present high resolution spectroscopy of solid samples from 200ps UV filaments. The temperature gradient on the expanding plume results into self-absorption of the hot plasma by the surrounding colder regions improving the resolution.

JW3A.7 *E-Poster*
Signatures of Coherent Photon Transport in Nanowire Waveguides with Coupled Quantum Dots, Chelsea L. Carlson[1], Dan Dalacu[2], Robin L. Williams[2], Phillip J. Poole[2], Stephen Hughes[1]; *[1]Queen's Univ., Canada; [2]National Research Council of Canada, Canada.* We present theory and experiments of coupled quantum dots (QDs) in semiconductor nanowire waveguides. Depending upon the two QD spatial separation, we demonstrate pronounced spectral shifts, as well as strongly coupled super/sub-radiant states.

JW3A.8 *RAPID*
Amplitude Shifting Holography, Surya Gautam[1], Pramod Panchal[1], Dinesh N. Naik[1], C. S. Narayanamurthy[1], Rakesh K. Singh[1]; *[1]Physics, Indian Institute of Space Science & Technology, India.* Amplitude Shifting Holography method for imaging complex value objects is based on the consideration that one point can be taken from the object as a reference and by shifting its amplitude to record the digital hologram.

JW3A.9 *RAPID*
Fabrication of Black Silicon using Laser Annealing, Sara Al Menabawy[1], Joumana El-Rifai[1], Mohamed M. Swillam[1]; *[1]American Univ. in Cairo, Egypt.* A novel fabrication technique of Silicon nanowires using excimer laser is developed in this work. Using one-step and easily scalable method, array of nanowires with broadband absorption enhancement are formed without etching the deposited material.

JW3A.10 *RAPID*
High Efficiency Photon Sieves by Laser Direct Writing, Matthew Julian[1], David MacDonnell[2], Mool Gupta[1]; *[1]Univ. of Virginia, USA; [2]NASA Langley Research Center, USA.* We show that photon sieve focusing efficiencies can be increased 7-fold. Such sieves can be fabricated via standard laser direct writing techniques. By optimizing laser parameters, near diffraction limited performance is demonstrated.

JW3A.11
Mode-locking Fiber Laser Using SMS Fiber Structure as a Saturable Absorber, Yunxiu Ma[1,2], Xiushan Zhu[1], Luyun Yang[2], Jing Zhang[3], Wei Shi[4], Nasser Peyghambarian[1]; *[1]College of Optical Sciences, Univ. of Arizona, USA; [2]Wuhan National Lab for Optoelectronics, Huazhong Univ. of Science and Technology, China; [3]School of Science, Changchun Univ. of Science and Technology, China; [4]College of Precision Instrument and Optoelectronics Engineering, Tianjin Univ., China.* Mode-locking fiber laser by nonlinear Kerr effect of a single-mode-multimode-single-mode (SMS) fiber structure as saturable absorber was demonstrated. A 13.01 MHz mode-locking Tm^{3+}-doped fiber laser operating at 1941.37 nm was obtained.

JW3A.12
Diffractive Fresnel Lens Fabrication with Femtosecond Bessel Beam Writing in Silica, Qi Sun[1], Timothy Lee[1], Ziqian Ding[2], Martynas Beresna[1], Gilberto Brambilla[1]; *[1]Optoelectronics Research Centre, Univ. of Southampton, UK; [2]Huawei Technologies Co., Ltd., China.* A 3-layer Fresnel lens with 52% diffraction efficiency was inscribed with a femtosecond Bessel beam in silica, with each layer being ~80 μm. An anomalous dispersion property was characterized with an RGB LED source.

JW3A.13
Material Selection for Generalized Achromatic Lenses Including Conventional, Gradient Index, and Diffractive Components, Guy Beadie[1], Joseph N. Mait[2]; *[1]US Naval Research Lab, USA; [2]US Army Research Lab, USA.* Optimum material selection is discussed for unconventional achromatic lenses, including gradient index and diffractive optical elements. The approach is based on defining a figure of merit, and finding material combinations that maximize its value.

JW3A.14
Scintillation of Gaussian-, multi-Gaussian-, and non-uniformly-correlated beams, Milo W. Hyde[1], Svetlana Avramov-Zamurovic[2], Charles Nelson[2]; *[1]Air Force Inst. of Technology, USA; [2]USA Naval Academy, USA.* We compute the mean intensities and scintillation indices for Gaussian-, multi-Gaussian-, and nonuniformly-correlated sources. Under the simulated conditions, we find no significant scintillation improvement over the Gaussian-correlated source.

JW3A.15
Symmetry Aspects of the Cesium D_2 Double Resonance Spectrum, Thomas Marty[1]; *[1]Thomas Marty (private), Switzerland.* Dark resonance spectra were recorded with a σ^+-polarized beam from a laser diode. Longitudinal magnetic fields reveal seven double resonances. In orthogonal magnetic fields fifteen double resonances appear. This indicates strong angular dependence.

JW3A.16
Multi-Plane, Learning Algorithm for Focal Volume Beam Shaping, Harry Burton[1], Ashish Bachavala[1], Christopher Debardelaben[1], Wafa Amir[1], Thomas A. Planchon[1]; *[1]Delaware State Univ., USA.* A Multi-Plane Genetic Algorithm is developed to optimize the focal volume of a laser instead of its focal plane. Using a Spatial Light Modulator, non-diffracting beams are generated to demonstrate the validity of the approach.

JW3A.17
Simple Circular Beam Lattices via Phase Modulated Bessel Beams, Mariia Shutova[1], Aleksandr Goltsov[1,2], Anatoli Morozov[3], Alexei Sokolov[1,2]; *[1]Inst. for Quantum Science and Engineering, Dept. of Physics and Astronomy, Texas A&M Univ., USA; [2]Baylor Univ., USA; [3]Princeton Univ., USA.* We tailor Bessel beams generated by an axicon employing phase modulation. Resultant non-diffracting circular lattices create stable intensity channels, which, if modified according to experimental needs, offer an ideal instrument for plasma guiding.

JW3A.18
Linearly Polarized Generalized-Gaussian Laser Beams, Jessica P. Conry[1]; *[1]Arkansas Tech Univ., USA.* Dominant and cross-polarization intensity profiles of Generalized Gaussian beams are produced of several orders and angle parameter using a spatial light modulator. The experimental and theoretical profiles are in agreement.

JW3A.19
Performance Evaluation of Infrared Thermographic Fever Screening Systems, Pejhman Ghassemi[1], Joshua Pfefer[1], Jon Casamento[1], Quanzeng Wang[1]; *[1]Food and Drug Administration, USA.* Methods to test stability and uniformity of infrared thermographs were evaluated and improvements were suggested. The study has provided significant insights toward the design of least burdensome standardized test methods.

JW3A.20
A Full-field Heterodyne Interferometer using for Modal Identification, Zong H. Chen[1], Wen Xiao[1], Feng Pan[1]; *[1]Beihang Univ., China.* In this paper, a full-field heterodyne interferometer, is proposed for modal identification. The experiment results show a great agreement with data obtained from theoretical calculation and LDV.

JW3A • Poster Session III and Dynamic E Posters—Continued

JW3A.21
Measurement of Centering Errors of Glass Molds and Casted Lenses for Production of Ophthalmic Lenses, Saharat Kaew-aram[1], Boonsong Sutapun[1]; [1]*Suranaree Univ. of Technology, Thailand.* In this work, we discuss the instrument design challenges and preliminary results for the development of an apparatus for measurement of centering error of the assembled glass molds used for manufacturing of plastic ophthalmic lenses.

JW3A.22
Non-uniformly correlated partially coherent lasers, Jixiong Pu[1], Chengcheng Chang[1], Xudong Chen[1], Ziyang Chen[1]; [1]*Huaqiao Univ., China.* We demonstrate a new kind of laser, called as a partially coherent digital laser, producing non-uniformly correlated partially coherent light (NUC-PCL) beams by "playing a video" inside the cavity directly.

JW3A.23
Low-loss BSO photonic waveguides, Florent Behague[1], Nadege Courjal[1], Florent Bassignot[1], Ludovic Gauthier-Manuel[1], Alexis Caspar[1], Venancio Calero Vila[1], Fadi Baida[1]; [1]*femto-st, France.* We report for the first time the fabrication of low loss ridge-waveguides in Bismuth-Silicon-oxide by optical grade-dicing. This approach promises to be powerful for compact and highly sensitive E-field sensors, scintillators and laser applications.

JW3A.24
Design and Fabrication of Germanium-Zinc Sulfide Mid-IR Photonic Devices, Daniel Carney[1], Robert Magnusson[1]; [1]*Univ. of Texas at Arlington, USA.* The mid-IR from 3 to 13 µm is an established region for scientific and industrial applications and may benefit from the introduction of photonic devices. Methods for the design and fabrication mid-IR devices are demonstrated.

JW3A.25
The Absorbed Energy of Essential Amino Acids by Geometric Phase, Dipti Banerjee[1,2]; [1]*Vidyasagar College for Women, India;* [2]*ICTP, Italy.* Optical activity of essential amino acids is studied experimentally. Rotation of plane polarization results in the change of helicity & energy. Variation of absorbed intensity with the geometric phase has been studied for different concentrations.

JW3A.26
2D Material Liquid Crystal Nanocomposites for Optoelectronic and Photonic Devices, Benjamin T. Hogan[1]; [1]*Univ. of Exeter, UK.* We synthesise, characterise and move toward application of 2D material liquid crystalline nanocomposites for optoelectronic and photonic devices, focussing on those produced using graphene oxide, tungsten disulfide and boron nitride.

JW3A.27
Optical 3D µ-Printing of Polymer Whispering-Gallery-Mode Microcavity Lasers, Xia Ouyang[1], Jijun He[1], A. Ping Zhang[1], Hwa-Yaw Tam[1]; [1]*Electrical Engineering, The Hong Kong Polytechnic Univ., Hong Kong.* A new optical printing technology for the fabrication of polymer whispering-gallery-mode microcavity lasers is presented. Polymer mushroom-like optical microresonators capped with a layer of dye-based gain film were shown for WGM laser applications.

JW3A.28
Spectroscopy Analysis for Real Time Application in Oil and Gas Instrumentation, Eduardo Perez[1]; [1]*DICIS, Mexico.* Spectroscopy applied to technical innovation continues with the spectrometer, whose provides excellent optical design for sharper images and spectra for dramatically improved resolution and signal-to-noise ratio.

JW3A.29
Remote Detection of Radioactive Material using Optically Induced Air Breakdown Ionization, Joshua J. Isaacs[1], Phillip Sprangle[1]; [1]*Univ. of Maryland, USA.* We model irradiated air to estimate the density of negative ions and use a set of coupled rate equations to simulate the subsequent laser-induced avalanche ionization for detection of radioactive materials remotely.

JW3A.30
Modeling the Formation of Nanometer-Scale High-Density Electron Bunches in Relativistic Laser-Solid Interaction: Effects of Numerical Resolution, Nicholas M. Fasano[1], Matthew Edwards[1], Julia Mikhailova[1]; [1]*Princeton Univ., USA.* With numerical simulations we demonstrate that laser-driven electrons near solid targets bunch together and travel along a synchrotron-like trajectories. The effect of numerical resolution on the formation of these nanoscale bunches is studied.

JW3A.31 *RAPID*
Frequency Shifting Whispering Gallery Modes With Planar Dielectric Substrates, Patrick A. Devane[1], Madhuri Kumari[1], Luke Trainor[1], Harald G. Schwefel[1]; [1]*Univ. of Otago, New Zealand.* We assess a proposed method of dielectric tuning for whispering gallery mode resonators using a set up that allows dielectric substrates to move into close proximity with a lithium niobate resonator and analyse the resulting frequency shifts.

JW3A.32 *RAPID*
Stationary Beam Synthesis From its Coherent Modes, Xi Chen[1], Jia Li[1], Mohammad Hashemi Rafsanjani[1], Olga. Korotkova[1]; [1]*Univ. of Miami, USA.* We introduce a technique for synthesis of stationary beams via superposition of coherent modes. Some stationary beams are generated from randomized sequences of ten Laguerre-Gaussian modes and analyzed on propagation in vacuum and atmosphere.

JW3A.33 *RAPID*
Modulated Photoluminescence of Germanium *via* Intense Terahertz Pulse Electric Fields, Mary Alvean B. Narreto[1], Chenxi Huang[1], David N. Purschke[1], Frank Hegmann[1]; [1]*Univ. of Alberta, Canada.* We show a nonlinear effect of intense terahertz pulse electric fields (>200 kV/cm) on the photoluminescence of bulk germanium. Terahertz-pulse-induced direct-gap photoluminescence quenching is observed.

JW3A.34 *RAPID*
Lorenz-Mie Scattering in Terms of Complex Focus Fields, Rodrigo Gutiérrez-Cuevas[1], Nicole J. Moore[2], Miguel A. Alonso[1,3]; [1]*Univ. of Rochester, USA;* [2]*Gonzaga Univ., USA;* [3]*Aix Marseille Universite, Centrale Marseille, Institut Fresnel, France.* An analytic approach to the Mie scattering of highly focused fields is presented. By describing the incident field in terms of complex focus fields we can model the scattering and trapping properties of fields with many properties of interest.

JW3A.35
Withdrawn

JW3A.36 *RAPID*
Angle Dependent THz Absorption in Aligned RGO/Fe3O4 Nanocomposite, Nikita Porwal[1], Shivam V. Raval[1], Tridib Sinha[1], Samit K. Ray[1,2], Prasanta Kumar Datta[1]; [1]*IIT Kharagpur, India;* [2]*SN Bose National Centre for Basic Sciences, India.* We report a polarizing nature in aligned Fe3O4\RGO Nanocomposite of 10 nm size. The DOP of the nanocomposite varies from 0.51-0.04 for 0.4-1.6 THz, suggesting a good polarization effect for future polarizer applications.

JW3A.37
Diffusion of External Magnetic Field into Laser-produced Plasma Plume, Narayan Behera[1], Rajesh K. Singh[1], Ajai Kumar[1]; [1] *Inst. for Plasma Research, HBNI, India.* The diffusive term of the generalized Ohm's law is calculated to understand how magnetic field diffuses into laser-produced plasma as it is useful to understand confinement and acceleration of the plasma plume and its dynamics.

JW3A.38
Single mode fibers for two stage higher-order soliton compression at 2 µm, Fumin Wang[1], Zihao Cheng[1], Qian Li[1]; [1]*PKU Shenzhen graduate school, China.* We demonstrate design of single mode fibers for two-stage higher-order soliton compression at 2 µm. A compression factor of 79.9 has been achieved and the pedestal energy is only 51.54%.

JW3A.39
Avoiding Parametric Instability in Advanced LIGO, Terra C. Hardwick[1,2]; [1]*LIGO, USA;* [2]*Physics, Louisiana State Univ., USA.* Parametric instability is a three mode optical-mechanical interaction that, if not controlled, can cause the high power LIGO arm cavities to lose resonance. We discuss theory, observation, mitigation and applications of parametric gain.

JW3A.40 *RAPID*
Coherent Anti-Stokes Raman Scattering Enhanced by MoS_2 Nanoparticles, Anton D. Shutov[1], Zhenhuan Yi[1], Jizhou Wang[1], Alexander M. Sinyukov[1], Zhe He[1], Chenwei Tang[1,2], Jiahao Chen[1,2], Zhedong Zhang[1], Esther J. Ocola[3], Jaan Laane[3], Alexei V. Sokolov[1,4], Dmitri V. Voronine[5], Marlan O. Scully[1,4]; [1]*Inst. for Quantum Science and Engineering, Texas A&M Univ., USA;* [2]*School of Science, Xi'an Jiaotong Univ., China;* [3]*Dept. of Chemistry, Texas A&M Univ., USA;* [4]*Baylor Research Innovative Center, Baylor Univ., USA;* [5]*Univ. of South Florida, Dept. of Physics, USA.* We demonstrate the surface enhancement of coherent anti-Stokes Raman scattering (CARS) on pyridine-ethanol solution by MoS_2 nanoparticles. The time resolved CARS measurements reveal increased dephasing rates of pyridine vibrational modes.

JW3A.41 *RAPID*
Continuous-Wave, Singly-Resonant Optical Parametric Oscillator Source of Vortex Beams Tunable in the Ultraviolet, Varun Sharma[1], Goutam K. Samanta[1], R.P. Singh[1], S. C. Kumar[2], M. Ebrahim-Zadeh[2,3]; [1]*PRL Ahmedabad, India;* [2]*ICFO-Institut de Ciencies Fotoniques, Mediterranean Technology Park, 08860 Castelldefels, Barcelona, Spain, Spain;* [3]*Institucio Catalana de Recerca i Estudis Avancats (ICREA), Spain.* We report a continuous-wave source of ultraviolet radiation in vortex spatial intensity profile tunable across 332-344 nm based on a green-pumped optical parametric oscillator.

JW3A.42
Coherent Mid-infrared Supercontinuum Generation Using All Solid Hybrid Micro-structured Tellurite Fibers, Hoa P. Nguyen[1], Hoang Tuan Tong[1], Than Singh Saini[1], Luo Xing[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Toyota Technological Inst., Japan.* We simulate supercontinuum generation using all solid hybrid micro-structured tellurite fibers. By controlling carefully the chromatic dispersion, a highly coherent and broad SC spectrum (0.78 µm – 4.8 µm) is obtained using a laser pumping at 2 µm.

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JW3A.43
Near-perfect terahertz wave amplitude modulation enabled by impedance matching in VO_2 thin films, Jiang Li[1]; [1]*Inst. of Fluid Physics, CAEP, China*. A terahertz amplitude modulation method with near perfect E-field amplitude modulation depths of 97.6% that is based on impedance matching in VO_2 thin films during the thermally induced insulator-metal transition.

JW3A.44
Crumple Nanostructured Graphene for Mechanically Reconfigurable Plasmonic Resonances, Pilgyu Kang[3], Kyoung-Ho Kim[1], Hong-Gyu Park[1], SungWoo Nam[2]; [1]*Dept. of Physics, Korea Univ., South Korea;* [2]*Dept. of Mechanical Science and Engineering, Univ. of Illinois at Urbana-Champaign (UIUC), USA;* [3]*Dept. of Mechanical Engineering, George Mason Univ., USA*. We present an innovative approach to achieve mechanically reconfigurable, strong plasmonic resonances via crumple nanostructured graphene. The mechanical reconfiguration of crumpled graphene enables broadband tunability from mid- to near-infrared.

JW3A.45
Effects of Spatial Confinement on Plasmon Modulated Photoluminescence, Robert D. Lemasters[1], Hayk Harutyunyan[1]; [1]*Emory Univ., USA*. Investigating the effects of spatial confinement of plasmon gap-modes on PL in nanometrically precise plasmonic nanostructures. Results show a linearly increasing nonlinear power law for pulsed laser excitation and linear power law for CW excitation.

JW3A.46
Laser Cooling of Crystalline Yb: YAG and Yb: KYW, Long Cheng[1], Laura Andre[1], Stephen C. Rand[1,2]; [1]*EECS, Univ. of Michigan, USA;* [2]*Physics, Univ. of Michigan, USA*. Laser cooling of a 3%Yb:YAG crystal by 4K is achieved under ambient temperature and pressure conditions in an open lab environment and laser cooling of 1%Yb:KYW is reported for the first time.

JW3A.47
Ultrafast Carrier Dynamics in Self-Assembled $La_{1-x}Sr_xMnO_3/SrTiO_3$ Heterostructures, Joel E. Taylor[1], Rami A. Khoury[2], Kun Zhao[1], Mohammad Saghayezhian[1], Louis Haber[2], Ward Plummer[1]; [1]*Dept. of Physics & Astronomy, Louisiana State Univ., USA;* [2]*Dept. of Chemistry, Louisiana State Univ., USA*. Optically excited carrier dynamics are observed for self-assembled $La_{1-x}Sr_xMnO_3/SrTiO_3$ heterostructures using pump-probe reflectivity.

JW3A.48
Efficient Polarization Modulation by a Phase Change Material on Metal, Alain Hache[1], Tran Vinh Son[1], Truong Vo-Van[2], Phuong Ahn Do[1]; [1]*Universite de Moncton, Canada;* [2]*Physics, Concordia Univ., Canada*. The polarization state of light interacting with a layer of vanadium dioxide on metals undergoing phase transition is observed to change due to large variations in the material's refractive index.

JW3A.49
Second Harmonic Generation in $CH_3NH_3PbI_3$ Thin Films, Anna A. Popkova[1], Vladimir O. Bessonov[1], Irina V. Soboleva[1], Mehedhi Hasan[2], Dmitry Lyashenko[2], Alex Zakhidov[2,3], Andrey A. Fedyanin[1]; [1]*Lomonosov Moscow State Univ., Russia;* [2]*MSEC, Texas State Univ., USA;* [3]*Dept. of Physics, Texas State Univ., USA*. Second-harmonic generation in $CH_3NH_3PbI_3$ perovskite multidomain film is experimentally studied. The MAPI nonlinear second-order susceptibility is estimated. Polarization of MAPI SHG signal is observed and hyper-Rayleigh scattering angle is estimated.

JW3A.50
Image Transmission across a Nonchiral/chiral Boundary Based on Dispersive Fresnel Coefficients, Monish R. Chatterjee[1], Rajab Ataai[1]; [1]*Univ. of Dayton, USA*. Fresnel coefficients for LCP/RCP modes are computed for *s*-polarized wave transmission across an achiral/chiral interface. 2D image transmission and recovery is examined using dispersive dielectric parameters, PCM encoding and discrete sideband analysis.

JW3A.51
Complex Mirror Symmetry in Optics, Li Ge[1]; [1]*College of Staten Island, CUNY, USA*. We first show the existence of a novel non-Hermitian symmetry, i.e., complex mirror symmetry. We then demonstrate a recursive process that generates high-order non-Hermitian degeneracies based on this new symmetry, which can potentially increase the spontaneous emission rate and sensing sensitivity of optical devices by orders of magnitude.

JW3A.52
Broadband THz Spectral Characterization with THz Bandpass Filters, Yungjun Yoo[1,2], Dogeun Jang[1], Malik Kimbrue[1], Ki-Yong Kim[1]; [1]*Univ. of Maryland at College Park, USA;* [2]*Thorlabs Imaging Systems, USA*. Metal-mesh bandpass THz filters often exhibit undesired transmission at their block-band frequencies. By solving an inverse matrix problem with regularization, we overcome this limitation and correctly characterize THz radiation from 1 to 30 THz.

JW3A.53
Design of Photonic Quasicrystal Mirrors Using Adjoint Shape Optimization, Behrooz Semnani[1,2]; [1]*Univ. of Waterloo, Canada;* [2]*Inst. for quantum computing, Canada*. This work presents application of the adjoint optimization for inverse construction of qua-sicrystal slab-mirrors. The topology of the structure is obtained based on band analysis and is adjusted for high performance operation.

JW3A.54
Frustrated Tunnel Ionization with Few-cycle Pulses, Rohan Glover[2], Dashavir Chetty[2], Bruno A. deHarak[2,1], Adam J. Palmer[2], Milad A. Dakka[3], John L. Holdsworth[4], Igor Litvinyuk[2], Andre N. Luiten[3], Philip S. Light[3], Robert T. Sang[2]; [1]*Physics Dept., Illinois Wesleyan Univ., USA;* [2]*Centre for Quantum Dynamics, Griffith Univ., Australia;* [3]*Inst. for Photonics and Advanced Sensing and School of Physical Sciences, The Univ. of Adelaide, Australia;* [4]*School of Mathematical and Physical Sciences, Univ. of Newcastle , Australia*. We experimentally investigate frustrated tunnel ionization with few-cycle pulses. Our results indicate that frustrated tunnel ionization is more prevalent with few-cycle pulses and shows qualitative agreement with modelling.

JW3A.55
Non-Destructive Heterodyne Measurement of Number of Atoms in Cesium-Potassium Mixture, Jakub Dobosz[1]; [1]*Univ. of Warsaw, Poland*. We present a setup of a heterodyne interferometer for measuring phase shift of light passing through atomic cloud mixture of cesium and potassium, to derive the number of atoms in the cloud with atom losses.

JW3A.56
Influence of an acoustic wave on particle trapped in optical tweezers in the air, Gabriela Mach[1], Lukasz Golacki[2], Jan Masajada[1]; [1]*Optics and Photonics, Wroclaw Univ. of Science and Technology, Poland;* [2]*Experimental Physics, Wroclaw Univ. of Science and Technology, Poland*. The phenomena of optical tweezers which causes the trapping is called photophoresis, which occurs to uniform distribution of temperature over the particle surface irradiated by a laser beam.

JW3A.57
Radiative interaction with arbitrary material bodies, Yu-Lin Xu[1]; [1]*Univ. of Texas at El Paso/JETS, USA*. This work introduces an effective way to study radiative responses of bulk materials, in which a material body is regarded as an array of microscopic particles. Practical examples include the comparison between theory and experiment.

JW3A.58
Withdrawn

JW3A.59
Towards Sub-shot-noise Imaging using Squeezed Light from Four-Wave Mixing in Rubidium, Rory W. Speirs[1], Nicholas Brewer[1], Meng-Chang Wu[1,2], Paul Lett[1,3]; [1]*Joint Quantum Inst., Univ. of Maryland, USA;* [2]*Inst. for Physical Science and Technology, Univ. of Maryland, USA;* [3]*National Inst. of Standards and Technology, USA*. We present progress towards the generation of sub-shot-noise images using two-mode intensity difference squeezed light beams produced by four wave mixing in rubidium vapour.

JW3A.60
Quantum Frequency Conversion of Ba^+ Photons, John M. Hannegan[1,2], James Siverns[2,1], Qudsia Quraishi[3,2]; [1]*Physics, Univ. of Maryland, College Park, USA;* [2]*Joint Quantum Inst., USA;* [3]*Army Research Lab, USA*. Hybrid quantum networks consisting of disparate memories require identical photons for entanglement distribution. Using frequency conversion of either single photons from Ba^+ or resonant laser light, we generate 780 nm and 1260 nm light respectively.

JW3A.61
Photon-Phonon Pair Correlations in Sapphire, Kai B. Shinbrough[1], Bin Fang[1], Yanting Teng[1], Offir Cohen[1], Virginia O. Lorenz[1]; [1]*Univ. of Illinois Urbana-Champaign, USA*. We measure the quantum-state purity of Stokes photons from sapphire, achieving a purity of 1.00±0.03 and quantitative agreement with a new theoretical model of photon-phonon correlations that includes dispersion and finite excitation lifetime.

JW3A.62
Withdrawn

JW3A.63 *RAPID*
Engineering a Noiseless and Broadband Raman Quantum Memory for Temporal Mode Manipulation, Thomas M. Hird[1,2], Sarah Thomas[1,4], Joseph Munns[1,4], Oscar Lazo Arjona[1], Shaobo Gao[1], Joshua Nunn[3], Benjamin Brecht[1], Dylan Saunders[1], Patrick Ledingham[1], Ian A. Walmsley[1]; [1]*Univ. of Oxford, UK;* [2]*Dept. of Physics and Astronomy, Univ. College London, UK;* [3]*Dept. of Physics, Univ. of Bath, UK;* [4]*Blackett Lab, Imperial College London, UK*. The Raman quantum memory can manipulate temporal modes of light - a promising high-dimensional basis for quantum information processing. We demonstrate both temporal mode manipulation and a novel suppression scheme for four-wave mixing noise.

JW3A.64 *RAPID*
Twin-beam Intensity-difference Squeezing below 10 Hz from Dual-seeded Four-wave Mixing, Meng-Chang Wu[1], Bonnie Schmittberger[1], Nicholas Brewer[1], Rory W. Speirs[1], Paul Lett[1]; [1]*Univ. of Maryland, College Park, USA*. We have obtained bright-beam intensity-difference squeezing below 10 Hz via four-wave mixing in a rubidium vapor. This was accomplished by increasing phase matching angle and using two seed beams to balance the power.

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JW3A.65 *RAPID*
Active Light Emission Control via Tunable Hybrid Epsilon-Near-Zero and Surface-Plasmon-Polariton Mode, Aleksei Anopchenko[1], Long Tao[1], Norbert Danz[2], Girish Agarwal[3,4], Howard Lee[1,3]; *[1]Baylor Univ., USA; [2]Fraunhofer Inst. for Applied Optics and Precision Engineering IOF, Germany; [3]Inst. for Quantum Science and Engineering, Texas A&M Univ., USA; [4]Biological and Agricultural Engineering, Texas A&M Univ., USA.* Field-effect tuning of strongly coupled epsilon-near-zero and surface-plasmon-polariton modes in ITO/oxide/Au heterostructure is shown. The tuning enables active control of emissive properties of quantum emitters coupled to the hybrid polariton mode.

JW3A.66 *RAPID*
Mutually unbiased bases for time-bin qudits, Joseph M. Lukens[1], Nurul T. Islam[2], Charles C. Lim[3], Daniel J. Gauthier[2]; *[1]Oak Ridge National Lab, USA; [2]The Ohio State Univ., USA; [3]National Univ. of Singapore, Singapore.* We introduce a method for generation and detection of mutually unbiased bases for time-bin qudits employing electro-optic phase modulator -- coded fiber Bragg grating pairs. Our approach uses one spatial mode and can switch rapidly between bases.

JW3A.67
Towards Room-Temperature Single-Photon LEDs by FRET from Metal Nanoparticles to Exfoliated 2D Crystal Overlayers, Robin Puchert[1], Florian Steiner[1], Gerd Plechinger[1], Felix Hofmann[1], Philipp Nagler[1], Alexey Chernikov[1], Christian Schüller[1], Tobias Korn[1], Jan Vogelsang[1], Sebastian Bange[1], John Lupton[1]; *[1]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Germany.* Localized surface-plasmon resonances enable efficient coupling to proximal resonant dipole transitions. By exploiting energy transfer from metal nanoparticles to monolayers of 2D crystals we point a way to generate single photons at room temperature.

JW3A.68
Two-mode intensity squeezing using OAM-carrying pump and probe beams, Nikunj Prajapati[1], Nathan Super[1], Irina Novikova[1]; *[1]Physics, College of William & Mary, USA.* We investigate the transfer of optical angular momentum (OAM) and two-mode intensity squeezing in the four-wave-mixing process. We could control the OAM of the generated stokes field in a wide range maintaining similar squeezing levels.

JW3A.69
What are the physical processes behind the evolution of spatial coherence out of incoherent light and particle beams? Chandra Roychoudhuri[1]; *[1]Univ. of Connecticut, USA.* This paper raises the fundamental questions to explore the possible physical models behind the evolution of spatial coherence during the propagation of an incoherent EM wave beam or a particle beam.

JW3A.70
Room-Temperature Photon-Number-Resolved Detection Using A Two-Mode Squeezer, Elisha Siddiqui[1], Deepti Deepti Vaidyanathan[2], Kenji W. Arai[4], Ryan T. Glasser[3], Hwang Lee[1], Jonathan P. Dowling[1]; *[1]Physics and Astronomy, Louisiana State Univ., USA; [2]Baton Rouge Magnet High School, USA; [3]Dept. of Physics and Engineering Physics, Tulane Univ., New Orleans, LA 70118, USA; [4]Reed College, USA.* Intensity-intensity correlations signal (⟨C⟩) at the output of a two-mode squeezing device with N-photon state and coherent light as inputs is studied. Photon-number is resolved from the jumps in ⟨C⟩ vs. *N*.

JW3A.71
Bowtie Plasmonic Nanoantennas with Nanocrystals: Photon Antibunching, Polarization Selectivity and Tunability, Svetlana G. Lukishova[1], Jeremy Staffa[1], Huiqing Zhu[1], Kevin Kuyk[1], Andreas Liapis[3], Robert Boyd[1,2]; *[1]Univ. of Rochester, USA; [2]Univ. of Ottawa, Canada; [3]Harvard Medical School, USA.* Photon antibunching was observed from NV-nanodiamonds and nanocrystal quantum dots within bowtie plasmonic nanoantennas. We also showed polarization selectivity of these nanoantennas. Numerical modeling was carried out for air and liquid crystals.

JW3A.72
Quantum State Engineering Using One-dimensional Discrete-time Quantum Walks, Luca Innocenti[1], Helena Majury[1], Taira Giordani[2], Nicolò Spagnolo[2], Fabio Sciarrino[2,3], Mauro Paternostro[1,4], Alessandro Ferraro[1]; *[1]Centre for Theoretical Atomic, Molecular, and Optical, School of Mathematics and Physics, Queen's Univ. Belfast, UK; [2]Dipartimento di Fisica, Sapienza Università di Roma, Italy; [3]Consiglio Nazionale delle Ricerche, Istituto dei sistemi Complessi (CNR-ISC), Italy; [4]Laboratoire Kastler Brossel, ENS-PSL Research Univ., France.* The capability of generating arbitrary quantum states is a fundamental task in many quantum information areas. Here we propose a scheme for quantum state engineering that exploits discrete-time quantum walk in the angular momentum of single-photons.

JW3A.73
Fluctuations Statistics in an Erbium Random Fiber Laser, Bismarck C. Lima[1], Pablo I. Pincheira[1], André L. Moura[2], Anderson S. Gomes[1], Leonardo d. Menezes[1], Ernesto P. Raposo[3], Cid B. Araújo[1], Raman Kashyap[4]; *[1]Departamento de Física, Universidade Federal de Pernambuco, Brazil; [2]Grupo de Física da Matéria Condensada, NCEx, Campus Arapiraca, Universidade Federal de Alagoas, Brazil; [3]Laboratório de Física Teórica e Computacional, Departamento de Física, Universidade Federal de Pernambuco, Brazil; [4]Fabulas Lab, Dept. of Engineering Physics, Dept. of Electrical Engineering, Polytechnique Montreal, Canada.* The mixed statistical regime of a Random Fiber Laser is experimentally and theoretically studied with the framework of the generalized extreme value and alpha stable distribution statistics.

JW3A.74
High Dimensional Quantum Key Distribution Based on Coherence Modulation and Orbital Angular Momentum, Paula A. López Higuera[2,3], Yezid Torres Moreno[2], William T. Rhodes[1]; *[1]Dept. of Computer & Electrical Engineering and Computer Science, Florida Atlantic Univ., USA; [2]Grupo de Óptica y Tratamiento de Señales GOTS, Escuela de Física, Universidad Industrial de Santander, Colombia; [3]Escuela de Ingenierías Eléctrica, Electrónica y de Telecomunicaciones, Universidad Industrial de Santander, Colombia.* A QKD scheme based on coherence modulation of OAM beams, with an orthonormal basis of delays τ_n and charge l is proposed. The mutually unbiased set uses linear combination of wave trains of OAM beams.

JW3A.75
Radiation-reaction electromagnetic fields in metasurfaces, Michele Merano[1]; *[1]Universita degli Studi di Padova, Italy.* I derive the optical response of a metasurface starting from the microscopic description. Surprisingly the advanced potential solutions of the inhomogeneous Maxwell's equations are necessary to compute the macroscopic fields.

JW3A.76
Slow Light Generation in Decagonal Liquid Core Photonic Crystal Fiber, Rahul Kumar[1], Pooja Chauhan[1], Ajeet Kumar[1]; *[1]Delhi Technological Univ., India.* Liquid Core PCF has been designed using carbon-disulphide as core and silica as cladding. Confinement loss has been plotted and a time delay of 166.70ns is calculated for maximum power of 102 mW at 1.55μm.

JW3A.77
100-Gb/s Doubly Differential QPSK System with Improved Receiver Sensitivity Using Polarization Switching, Tingting Zhang[1], Christian Sanchez[1], Andrew Ellis[1]; *[1]Aston Univ., UK.* 0.7-dB receiver sensitivity improvement at 7% HD-FEC threshold is numerically demonstrated using polarization switching in 100-Gb/s doubly differential QPSK 80-km SSMF transmission system with simplified receiver-side DSP.

JW3A.78
Spectra of Raman scattering in Few Mode Fibers, Zhenzhen Zhang[1], Cheng Guo[1], Liang Cui[1], Ming Xu[1], Ylchi Zhang[2], Xiaoying Li[1]; *[1]Tianjin Univ., China; [2]Fiberhome Telecommunication Technologies Co Ltd, China.* We measure Raman scattering (RS) in polarization maintained few mode fiber (FMF) and common FMF, respectively, and show vector mode coupling of the degenerate modes affect the dependence of RS on polarization and spatial mode.

JW3A.79
Entanglement Concentration Service for the Quantum Internet, Laszlo Gyongyosi[2,1], Sandor Imre[1]; *[1]Budapest Univ of Techolology & Economic, Hungary; [2]Univ. of Southampton, UK.* A fundamental concept of the quantum Internet is quantum entanglement. The aim of our entanglement concentration service is to provide reliable, high-quality entanglement for a dedicated set of quantum nodes in the quantum Internet.

JW3A.80
Unequally Spaced Channel Allocation Algorithm in Hybrid DWDM System for Reduction of FWM, Yugnanda Malhotra[1], Ashutosh Singhal[1], Nisha Nisha[1]; *[1]Electronics and Communication Engineering, Bharati Vidyapeeth College of Engineering, India.* We propose an Unequally Spaced Channel Allocation Algorithm in a 0.2nm, mixed bit rates, DWDM system, for FWM reduction. Overall performance in terms of covered optical bandwidth, reduced FWM products and received output power is reported.

JW3A.81
Femtosecond Pulse Propagation through Large Mode Area Tapered Fiber at 1.06 μm Wavelength, Mohd Rehan[1], Gyanendra Kumar[1], Vipul Rastogi[1], Rajesh Kumar[1]; *[1]IIT ROORKEE, India.* We demonstrate femtosecond pulse propagation through large mode area tapered fiber at 1.06 μm wavelength. We obtain compression, soliton like propagation and dispersion of ultra-short pulses which can be utilized in medical applications.

JW3A.82
Flatness Optimization of Optical Frequency Combs Using an Adapted Differential Evolution Algorithm, Guilherme F. Pendiuk[1], Paulo D. Neves[1], Alexandre D. Pohl[1]; *[1]CPGEI, Universidade Tecnológica Federal do Paraná, Brazil.* A Differential Evolution based algorithm is used to identify input driving parameters of a Dual-Parallel Mach-Zehnder Modulator to generate flat Optical Frequency Combs. Combs with 7 lines showing flatness of 0.03 dB can be obtained.

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JW3A.83 *RAPID*

Properties of the Effective Noise for the Nonlinear Fourier Transform-Based Transmission, Maryna Pankratova[1], Anastasiia Vasylchenkova[1], Jaroslaw E. Prilepsky[1], Stanislav Derevyanko[2]; [1]*Aston Univ., UK;* [2]*Dept. of Electrical and Computer Engineering, Ben-Gurion Univ. of the Negev, Israel.* We investigate the correlation properties of optical noise in nonlinear Fourier domain for communication systems using the nonlinear Fourier transform. Effective covariance functions are obtained numerically and compared with theoretical predictions.

JW3A.84

Analysis of the evolution of the polarization states of a pumping source on an Erbium doped fiber, Karla E. Contreras-Vallejo[1], Julian Moises Estudillo Ayala[1], Roberto Rojas-Laguna[1], Daniel Jauregui-Vazquez[1], Juan C. Hernandez-Garcia[1], Juan M. Sierra-Hernandez[1], Jose D. Filoteo-Razo[1], Manuel Toledano-Ayala[2], Ramon Martinez-Angulo[1]; [1]*Universidad de Guanajuato, Mexico;* [2]*División de Investigación y Posgrado, Facultad de Ingeniería, Universidad Autónoma de Querétaro, Mexico.* An analysis of the effects of the evolution of the polarization states on an Erbium doped fiber is presented; this it to optimize the development tunable fiber laser systems.

JW3A.85

Experimental Implementation of High-speed Balanced Homodyne Detector, Xiaoxiong Zhang[1], Yichen Zhang[1], Bingjie Xu[2], Song Yu[1], Hong Guo[3]; [1]*Beijing Univ. of Posts and Telecommunications, China;* [2]*Inst. of Southwestern Communication, China;* [3]*Peking Univ., China.* We present a high-speed balanced homodyne detector whose bandwidth is above 900 MHz and quantum to classical noise ratio reaches 12 dB respectively, which could be applied to the high-speed continuous variable quantum information.

JW3A.86

Simplified PAM4 optical signals combined with spatially multiplexed communication systems, Syed H. Murshid[1], Han Wang[1], Gregory Lovell[1], Abhijit Charavarty[1], Ce Su[1], Bilas Chowdhury[1]; [1]*Florida Inst. of Technology, USA.* Experimental eye diagram of a four-level simplified pulse amplitude modulation scheme is presented along with simulated results. The output is then used with two channel SDM system to generate PAM16 efficiency per fiber.

JW3A.87

The All Optical Magnetic Recording Head with Near-Infrared Enhancement, Zhihao Zeng[1], Haiwei Wang[1], Sicong Wang[2], Hongyun Li[1], Yuhao Zou[1], Lanlan Huang[1], Yao Xiao[1], Changsheng Xie[1]; [1]*Huazhong Univ of Science and Technology, China;* [2]*Jinan Univ., China.* We present a fabricated nanograting structured magnetic write head featuring near-infrared optical enhancement and low angle sensitivity, suitable for ultrafast magnetic switching, ultrahigh-density magnetic recording.

JW3A.88

Acoustical Response Characteristics of an Optomechanical Accelerometer, Ramgopal Madugani[1], Feng Zhou[1], Randall P. Wagner[1], Yiliang Bao[1], Jason J. Gorman[1], Thomas W. LeBrun[1]; [1]*National Inst. of Standards and Technology, USA.* A Fabry-Perot microcavity-based accelerometer was tested in an anechoic chamber to measure the limiting noise for the device operating in air at room temperature. The acoustic response illustrates the design requirement for an optical microphone.

JW3A.89

Single Photon Optical Memory With Cavityless Levitated Optomechanics, Pardeep Kumar[1], Mishkat Bhattacharya[1]; [1]*Rochester Inst. of Technology, USA.* We investigate a protocol to upload, store and retrieve a single photon quantum state from a mechanical mode in cavityless levitated optomechanics. A high fidelity in our results indicates efficient photon-phonon-photon transfer.

JW3A.90

The Super absorbing Ag-Au Metasurfaces for Surface-Enhanced Raman Spectroscopy Sensing of Drugs and Chemicals, Lyu Zhou[1], Nan Zhang[1], Dengxin Ji[1], Haomin Song[1], Youhai Liu[1], Qiaoqiang Gan[1]; [1]*State Univ. of New York at Buffalo, USA.* We proposed a super absorbing metasurfaces with hybrid Ag-Au nanostructures, which enables efficient light trapping and result in enhanced SERS sensing performance.

JW3A.91

Fluorescence Enhancement and Quenching in Tip-Enhanced Fluorescence Spectroscopy, Justin Isaac[1], Huizhong Xu[1]; [1]*San Francisco State Univ., USA.* Fluorescence enhancement and quenching is studied for a fluorophore near a metal tip above a glass substrate. Resonant behavior is observed as a function of tip-substrate distance and displays a strong dependence on tip dimensions.

JW3A.92

Linear Localization of Non-Hermitian Photonic Zero Modes, Bingkun Qi[1,2], Li Ge[1,2]; [1]*College of Staten Island, CUNY, USA;* [2]*Graduate Center, CUNY, USA.* A non-Hermitian photonic zero mode can exhibit an unusual behavior at the transition between extended and localized regimes: it displays a linearly decreasing amplitude spatially in a weakly coupled non-Hermitian reservoir.

JW3A.93

High-speed pulse control and optimization of quantum cascade laser using all-optical modulation, Chen Peng[1], Haijun Zhou[2], Tao Chen[1], Biao Wei[2], Zeren Li[1]; [1]*Inst. of Fluid Physics, China Academ, China;* [2]*Chongqing Univ., China.* Pulse control and optimization are demonstrated in a middle-infrared quantum cascade laser via an all optical approach. It has the potential for application in free space optical communication and high speed frequency modulation spectroscopy.

JW3A.94

Octave-spanning Supercontinuum Generation in Nanoscale Lithium Niobate Waveguides, Juanjuan Lu[1], Yuntao Xu[1], Joshua Surya[1], Hong Tang[1]; [1]*Yale Univ., USA.* We demonstrate an octave-spanning supercontinuum (SC) generation in nanoscale lithium niobate (LN) waveguides with anomalous dispersion by a turn-key pulsed laser at 1560nm, which enables a simple and integrable SC source in LN nanophotonic platform.

JW3A.95

Dynamic Plasmonic Pixels, Nicholas J. Greybush[1], Kristin M. Charipar[2], Nicholas Charipar[2], Jeffrey A. Geldmeier[3], Jawad Naciri[2], Jake Fontana[2]; [1]*National Research Council (NRC) Postdoctoral Research Associate, U.S. Naval Research Lab, USA;* [2]*U.S. Naval Research Lab, USA;* [3]*American Society for Engineering Education (ASEE) Postdoctoral Fellow, U.S. Naval Research Lab, USA.* We demonstrate spectral, spatial, and temporal control of plasmonically generated color through alignment of Au nanorods by an applied electric field. Tailoring the nanorod aspect ratio enables operation across the visible and near-infrared spectrum.

JW3A.96

VO_2 / ITO Hybrid Plasmonic High Performance Electro-Optical Modulator, Aya Amer[1], Mohamed Badr[1], Mohamed M. Swillam[1]; [1]*American Univ. in Cairo, Egypt.* A hybrid plasmonic slot waveguide electro-optical modulator using VO_2 and ITO is proposed. An extinction ratio (ER) of 6.36 dB and an insertion loss (IL) of 1.13 dB are achieved at 1.55 μm wavelength.

JW3A.97

Graphene-based Slot Waveguide Photodetectors for Optical Communications, Kazuya Kikunaga[1,2], Zhizhen Ma[1], Rishi Maiti[1], Volker J. Sorger[1]; [1]*George Washington Univ., USA;* [2]*National Inst. of Advanced Industrial Science and Technology, Japan.* Here we report on a novel graphene-based plasmonic slot waveguide photodetector. The ultra-narrow 15 nm slot waveguide enables short carrier transitions times resulting in a gain-bandwidth product $5.3x10^{15}$ at l = 1.5 μm.

JW3A.98

Investigation of Si_3N_4 Microring Resonator for Bio-Chemical Sensing Applications, Subrata Das[1], Sarath C. Samudrala[1], Kyu Lee[1], Brett R. Wenner[3], Jeffery W. Allen[2], Monica S. Allen[2], Robert Magnusson[1], Michael Vasilyev[1]; [1]*Univ. of Texas at Arlington, USA;* [2]*Air Force Research Lab Munitions Directorate, USA;* [3]*Air Force Research Lab Sensors Directorate, USA.* We design and fabricate Si_3N_4 microring resonator for measuring refractive index change in aqueous environment. The experimentally observed sensitivity >72 nm/RIU indicates its suitability for biochemical sensing applications.

JW3A.99

Equilibrium Temperature of Wideband Perfect Light Absorbers Under Direct Solar Illumination, Jinnan Chen[1], Junpeng Guo[1]; [1]*Univ. of Alabama in Huntsville, USA.* A new method is introduced to calculate equilibrium temperature by using dipole antenna model. It is found that the single dielectric layer absorbing structure gives the highest equilibrium temperature of 979 K.

JW3A.100

Optical Coupling in Dielectric Resonator Nanoantenna, Gilliard N. Malheiros-Silveira[2], Hugo E. Hernandez-Figueroa[1]; [1]*Univ. of Campinas, Brazil;* [2]*São Paulo State Univ. (Unesp), Brazil.* A theoretical study regarding to coupling efficiency between a dielectric resonator nanoantenna (DRNA) integrated to a metal-dielectric-metal-dielectric nanostrip waveguide (NW), and free space is evaluated.

JW3A.101

Plasmonic Blazing of a Wire-Grid Polarizer: How It Improves the Polarimetric Performance, Changhun Lee[1], Eunji Sim[2], Donghyun Kim[1]; [1]*Electrical and Electronic Engineering, Yonsei Univ., South Korea;* [2]*Chemistry, Yonsei Univ., South Korea.* We investigate the polarimetric performance of surface plasmon-enhanced blazed wire-grid polarizer (WGP) compared with conventional WGP. Highest extinction ratio was found to be 15,740 at 800 nm period which allows easier fabrication of WGPs.

JW3A.102

Topology of High-k States in Quartic Metamaterials, Maxim Durach[1], Thomas Mulkey[1], Jimmy Dillies[1]; [1]*Georgia Southern Univ., USA.* We study the short-wavelength waves in quartic metamaterials. The quartic k-surfaces feature from 0 to 4 cones, longitudinal polarization and perpendicular to k-vectors group velocities, which leads to negative refraction in quartic metamaterials.

JW3A • Poster Session III and Dynamic E Posters—Continued

JW3A.103
Damage Detection in Bridge-Weigh-In-Motion Structures using Fiber Bragg Grating Sensors, Sravanthi Alamandala[1], Saiprasad R L N[1], Rathish Kumar P[2], Ravi Kumar M[1]; [1]*Dept. of Physics, National Inst. of Technology Warangal, India;* [2]*Dept. of Civil Engineering, National Inst. of Technology, India.* Fiber Bragg Grating (FBG) based Weigh-In-Motion system is proposed for the study of the health condition of structures. Artificial damage is created in the system, and the results were compared with those of undamaged.

JW3A.104
A 3D Nanostructure based SPR Sensor for Enhancement of Sensing Ability, Heesang Ahn[1], Hyerin Song[1], Kyujung kim[1], Taeyeon Kim[1], Yeji Lee[1]; [1]*Pusan National Univ., South Korea.* We investigated localized surface plasmon resonance sensors based on 3D nanostructures array patterns. The enhancement of the near-field distribution on the 3D nanostructure is confirmed with calculation and experimental results.

JW3A.105
The Method and Mechanism of Tuning LSPR on The Biased Metallic Nanosphere, Lihui Gong[1], Xianyang Lyu[1]; [1]*Research Lab, School of Transportation, Nantong Univ., China.* We propose a method for creating tunable localized surface plasmon resonance (LSPR) by applying a variable bias to metallic nanospheres. This method base on a different extinction equation and has been supported by experiments.

JW3A.106
Hybrid Vanadium Dioxide Plasmonic Electro-Optical Modulator based on Race-Track shaped Resonator, Mohamed Abdelatty[1,2], Mahmoud M. Elgarf[1], Mohamed M. Swillam[1]; [1]*Physics, American Univ. in Cairo, Egypt;* [2]*Engineering / Basic sciences, The British Univ. in Egypt, Egypt.* An optical modulator based race-track shaped resonator utilizing the phase change properties of Vanadium dioxide. An extinction ratio of 8.45 dB and an insertion loss of 1.85 dB is achieved at the telecommunications wavelength (1.55 μm).

JW3A.107
Radius Optimization of SOI based Rectangular Waveguide Ring Resonator Filter, Ritu Raj Singh[1], Soumya Kumari[1], Abhinav Gautam[1], Vishnu Priye[1]; [1]*Indian Institute of Technology, Dhanbad, India.* The SOI ring resonator as a notch filter is analyzed by varying ring radius and performance parameters such as FSR, FWHM, finesse and Q-factor has been optimized for 220nm silicon height technology at C-band wavelengths.

JW3A.108
Scalable SERS by Activating "Passive" Hotspots in Multigap Nanoplasmonic Systems, Junyeob Song[1], Wonil Nam[1], Wei Zhou[1]; [1]*Electrical Engineering, Virginia Tech, USA.* A partial removal of dielectric materials in nanogaps can activate "passive" hotspots in multigap nanoplasmonic systems for scalable high-performance Surface Enhanced Raman Spectroscopy (SERS) applications.

JW3A.109 ***RAPID***
Boosting Local Field Enhancement by Synergistic Nanoantenna-Microcavity Coupling, Qinglan Huang[1], Jui-Nung Liu[1], Keng-Ku Liu[2], Srikanth Singamaneni[2], Brian Cunningham[1]; [1]*Dept. of Electrical and Computer Engineering, Dept. of Bioengineering, Univ. of Illinois at Urbana-Champaign, USA;* [2]*Dept. of Mechanical Engineering and Materials Science, Inst. of Materials Science and Engineering, Washington Univ. in St. Louis, USA.* We theoretically and experimentally studied a photonic-plasmonic hybrid system integrating the dielectric photonic crystal slab (as a photonic microcavity) and gold nanorod (as a plasmonic nanoantenna) for highly cooperative near-field enhancement.

JW3A.110 ***RAPID***
Calibration and imaging in acoustophoresis platforms by Digital Holography, Teresa Cacace[1,2], Pasquale Memmolo[1], Vittorio Bianco[1], Melania Paturzo[1], Massimo Vassalli[3], Pietro Ferraro[1]; [1]*CNR-ISASI, Italy;* [2]*Univ. of Campania "L.Vanvitelli", Italy;* [3]*Istituto di Biofisica-CNR, Italy.* We demonstrate that ultrasound field calibration and imaging are achievable in a vertical resonator using digital holography, showing that it is a flexible tool to assist the diffusion of acoustophoresis microfluidic devices.

JW3A.111
Imaging of cochlear cells through scattering bone, Marilisa Romito[1], Konstantina M. Stankovic[2], Demetri Psaltis[1]; [1]*Optics, Ecole Polytechnique Federale de Lausanne, Switzerland;* [2]*Otolaryngology, Harvard Medical School, USA.* Intracochlear imaging will be important for the assessment of hearing disorders. Currently, cochlear small size and encasement in bone prevent visualization of intracochlear microanatomy. We report a technique for imaging cochlear cells through bone.

JW3A.112
Imaging-Aided Temperature Measurements with a Single Optical Fiber for In-vivo Sensing Applications, Erik P. Schartner[1], Jiawen Li[1], Stefan Musolino[1], Bryden Quirk[1], Rodney Kirk[1], Robert McLaughlin[1], Heike Ebendorff-Heidepriem[1]; [1]*Univ. of Adelaide, Australia.* We present a combined imaging and physical sensing probe based on optical coherence tomography and up-conversion fluorescence respectively, integrated into a single optical fiber enabling precise locating of the probe for in-vivo sensing applications.

JW3A.113
Combination digital breast tomosynthesis and diffuse optical tomography, Duchang Heo[1], Kee-Hyun Kim[1], Young-Min Bae[1], Young-Wook Choi[1], Sohail Sabir[2], Seungryong Cho[2], Hak Hee Kim[3]; [1]*Korea Electrotechnology Research Inst., South Korea;* [2]*Korea Advanced Inst. of Science and Technology, South Korea;* [3]*Asan Medical Centerv, South Korea.* We report a frequency domain DOT system with high-speed data acquisition to improve the diagnostic accuracy of DBT. We test the basic performance of the DOT system with optical phantom and can obtain DBT/DOT images using blood vessel mimic phantom.

JW3A.114
Withdrawn

JW3A.115
Large-scale Volumetric Imaging of Insects with Natural Color, Ming Lei[1]; [1]*Xi'an Inst. of Optics and Precision Mech, China.* We present a structured illumination-based approach to get large-scale 3D images with full natural color, and high spatiotemporal resolution. With this approach, full-color volumetric images and morphological data of insect samples can be obtained.

JW3A.116
Tomographic phase microscopy for label-free imaging in biomedicine, Pietro Ferraro[1], Francesco Merola[1], Pasquale Memmolo[1], Lisa Miccio[1], Martina Mugnano[1], Massimiliano Villone[2], Pier Luca Maffettone[2]; [1]*ISASI-CNR, Italy;* [2]*DICMAPI, Federico II Univ., Italy.* Full-tomography in phase contrast modality of both sick and healthy cells flowing in microchannels is demonstrated. The proposed method can open the way for real-world biomedical diagnosis by quantitative coherent imaging. Results on Red Blood Cells (RBC), diatoms and tumor cells are reported.

JW3A.117
Characterization and *In Vivo* Application of Mobile Phones for Near-Infrared Fluorescence Imaging of Tumors, Nitin Suresh[1], Qinggong Tang[1], Yi Liu[1], Joshua Pfefer[2], Yu Chen[1]; [1]*Fischell Dept. of Bioengineering, Univ. of Maryland - College Park, USA;* [2]*Center for Devices and Radiological Health, U.S. Food and Drug Administration, USA.* To elucidate the performance of near-infrared fluorescence imagers for cancer detection and localization, we performed imaging of phantoms and a rodent tumor model. Results provide insights into differences between mobile phone and CCD-based systems.

JW3A.118
Biomimetic Microvascular Tissue Phantoms Fabricated with Two-Photon 3D Printing, Hannah Horng[1], Yi Liu[1], Nitin Suresh[1], Pejhman Ghassemi[2], Joshua Pfefer[2], Yu Chen[1]; [1]*Fischell Dept. of Bioengineering, Univ. of Maryland at College Park, USA;* [2]*Center for Devices and Radiological Health, Food and Drug Administration, USA.* Phantoms that simulate tissue microvasculature may provide tools to facilitate development and assessment of biophotonic devices. We evaluate the use of two-photon polymerization-based 3D printing to fabricate phantoms with biomimetic micro-channels.

JW3A.119
Flexible and Highly EffectiveTrapping Particles of Optical Tweezers in Nonlinear Optical Imaging, Qin Wu[1], Hang S. Chang[1], Feng X. Huang[1]; [1]*School of Science, Hangzhou Dianzi Univ., China.* We demonstrate flexible and highly-effective single beam trapping particles by optical tweezers in nonlinear optical imaging system, achieve a diverse manipulation of the particles, increase the imaging depth and contrast of the particles.

JW3A.120
Withdrawn

JW3A.121
Improved Inverse Two- Layered Monte Carlo Fitting of In-vivo Skin Diffuse Reflectance Spectra, Chiao-Yi Wang[1], Ting-Xuan Lin[1], Kung-Bin Sung[1]; [1]*National Taiwan Univ., Taiwan.* The objective of this study is to improve the inverse Monte Carlo fitting method to make the extraction of optical coefficients more reliable and precise. Some non-invasive in-vivo human skin measurements were done to validate the proposed approach.

JW3A.122
Time-resolved diffusion technique to probe protein-drug interaction, Masahide Terazima[1]; [1]*Kyoto Univ., Japan.* A time-resolved diffusion method was applied to detections of the protein-protein interaction, protein-DNA interaction, and protein-small molecule. A number of examples show that this method is powerful to explore the protein-drug interaction.

JW3A.123
Photonic Neural Network Nonlinear Activation Functions by Electrooptic Absorption Modulators, Jonathan K. George[1], Armin Mehrabian[1], Rubab Amin[1], Tarek El-Ghazawi[1], Paul R. Prucnal[2], Volker J. Sorger[1]; [1]*George Washington Univ., USA;* [2]*Dept. of Electrical Engineering, Princeton Univ., USA.* We report on using the transfer function of electrooptic absorption modulators as nonlinear activation functions of photonic neurons and show 95% accuracy of MNIST classification inference on an AlexNet in optical artificial neural networks.

JW3A • Poster Session III and Dynamic E Posters—Continued

JW3A.124
Achieving Invisibility in the Far Field with a 3D Carpet Cloak Design for Visible Light, Daniely G. Silva[1], Poliane A. Teixeira[1], Lucas H. Gabrielli[2], Mateus A. Junqueira[1], Danilo Spadoti[1]; *[1]Federal Univ. of Itajubá, Brazil; [2]Univ. of Campinas, Brazil.* This work presents new results for a 3D carpet cloak designed with transformation optics and quasi-conformal mapping. Simulations confirm the successful operation at optical frequencies for arbitrary propagation directions, and in far field region.

JW3A.125 *RAPID*
Differential Digital Holography of Distant Objects with the Use of Fiber Optics, Maciek Neneman[1], Michal Dolinski[1], Agnieszka Siemion[1], Michal Makowski[1]; *[1]Warsaw Univ. of Technology, Poland.* A lensless setup capable of recording differential holograms over large distance is presented. Reference beam is propagated in optical fiber, allowing compact setup. Advantages of proposed solution allow detailed surface imaging in orbital devices.

JW3A.126
Optical simulation of curved 2D and 3D spaces, Jakub Belin[1], Dimitris Georgantzis Garcia[1], Gregory Chaplain[2], Tomas Tyc[3], Christoph Englert[1], Johannes K. Courtial[1]; *[1]Univ. of Glasgow, UK; [2]Dept. of Mathematics, Imperial college of London, UK; [3]Dept. of Theoretical Physics and Astrophysics, Masaryk Univ., Czechia.* A method for the optical simulation of curved spaces using so-called space-cancelling wedges is presented. We model, theoretically, devices for optical simulation of two- and three-dimensional curved manifolds.

JW3A.127
Improving the quality of ghost imaging system based on Wiener Filtering, Dongyue Yang[1], Junhui Li[2], Chen Chang[1], Guohua Wu[1], Bin Luo[2], Longfei Yin[1], Hong Guo[3]; *[1]School of Electronic Engineering, Beijing Univ. of Posts and Telecommunications, China; [2]State Key Lab of Advanced Optical Communication Systems and Networks, Beijing Univ. of Posts and Telecommunications, China; [3]State Key Lab of Advanced Optical Communication Systems and Networks, Peking Univ., China.* In ghost imaging with pseudo-thermal light, Wiener filter improves reconstructed image quality with the estimation of point spread function and a noise factor, which is well-fitted as proportional relation to noise amplitude in image.

JW3A.128
Optical System for Capturing 3D Images, Nikolai I. Petrov[1], Angela Storozheva[1], Maxim Khromov[1], Yuri Sokolov[1]; *[1]Scientific and Technological Center of Unique Instrumentation of Russian Academy of Sciences, Russia.* An optical system for capturing 3D images and a method for capturing 3D images, in particular, for capturing 3D objects in real-time for video-conference and 3D image display using integral imaging technology are proposed.

JW3A.129
Polarization Imaging Through Highly turbid Water, Fei Liu[1,2], Pingli Han[1], Yi Wei[1], Guang Zhang[2], Dayu Li[2], Xiaopeng Shao[1]; *[1]Xidian Univ., China; [2]Changchun Inst. of Optics, China.* We present a polarization imaging method to image through highly turbid water based on the dependence of light scattering and the optical correlation theory. Experiments demonstrate its contribution to make "can't see" into "can see".

JW3A.130
High-energy 50-attosecond 'water window' X-ray driven by a high-energy infrared waveform synthesizer, Yuxi Fu[1], Hua Yuan[2], Pengfei Lan[2], Katsumi Midorikawa[1], Eiji J. Takahashi[1]; *[1]RIKEN, Japan; [2]Huazhong Univ. of Science and Technology, China.* Combining high-energy infrared laser, which are generated by a dual-chirped optical parametric amplification (DC-OPA) method, and an optical waveform synthesizer, strong 'water window' soft X-rays with 50-attosecond pulse duration can be obtained.

JW3A.131
Extraction of Laser Pulses from the Rejection Port of an All-PM Figure-eight Femtosecond Er-doped Fiber Laser, Jin-long Peng[1]; *[1]Industrial Technology Research Inst., Taiwan.* An all-PM figure-eight femtosecond Er-fiber laser with a rejection port is demonstrated to deliver output power of 23 mW. This is the highest output power ever reported in all-PM Er-fiber lasers based on NOLM/NALM technique.

JW3A.132
Theoretical Analysis of High Efficiency Laser-diode-pumped Continuous-Wave Hemispherical Short Cavity Laser, Fumihiro Sugiki[1], Ryo Kobayashi[1], Tomoki Kanetake[1], Naoya Nakajima[1], Shunji Kataoka[1], Yuu Aoyagi[2], Kohei Tomizawa[2], Masashi Shibata[2], Shunya Maeda[2], Hiroki Yamakawa[2], Sakae Kawato[3,4]; *[1]Graduate School of Engineering, Univ. of Fukui, Japan; [2]School of Engineering, Univ. of Fukui, Japan; [3]Faculty of Engineering, Univ. of Fukui, Japan; [4]Life Science innovation Center, Univ. of Fukui, Japan.* We theoretically analyzed a optical-to-optical conversion efficiencyiy of a CW hemispherical cavity Yb:YAG laser which pump source is a single-emitter-laser-diode. As a result, the maximum efficiency of 78.6% was obtained by high intensity pumping.

JW3A.133
PQ:DMNA/PMMA, a new material for recording volume Bragg grating for laser spectrum narrowing, Te-Yuan Chung[1], Yu-Hua Hsieh[1], Yu-Che Hsiao[1]; *[1]National Central Univ., Taiwan.* PQ:DMNA/PMMA is a photopolymer sensitive to red light exposure. Volume Bragg gratings are successfully recorded in PQ:DMNA/PMMA and serve as external mirror of a 638 nm diode laser to achieve single longitudinal mode.

JW3A.134 *RAPID*
Radiation Balanced Ytterbium-doped Silica Double-Clad Fiber Amplifier, Esmaeil Mobini[1], Mostafa Peysokhan[1], Behnam Abaie[1], Arash Mafi[1]; *[1]Univ. of New Mexico, USA.* Heat mitigation by radiative cooling is investigated in a fiber amplifier, where the amplifier temperature does not change substantially from the ambient, while amplifying 0.1 W of input signal power to 7.6 W.

JW3A.135
Effective Medium Model of Biochar - Iron Ore - Binder Powders Mixture for Enhanced Reduction of Iron, Leonid Butko[1], Anton Anzulevich[1], Igor Bychkov[1], Svetlana Anzulevich[1], Zhiwei Peng[2]; *[1]Chelyabinsk State Univ., Russia; [2]Central South Univ., China.* A model of biochar-iron ore-binder powders mixture was studied at microwaves. The effective medium Bruggeman expression was expanded for three types of particles. Wave impedance dependency on concentration of iron ore was calculated.

JW3A.136
Power improvement in a CW THz polariton laser, Yameng Zheng[1], Andrew Lee[1], Helen Pask[1]; *[1]Macquarie Univ., Australia.* An enhancement in the performance of an intracavity CW THz polariton laser is reported. THz output power of up to 23.1 μW was detected at 1.66 THz, frequency tunability across 1.30 - 2.51 THz was achieved.

JW3A.137
Prepulse-Induced Three-Halves-Harmonic Generation as a Probe for Relativistic-Laser-Driven High-Density Plasmas, Alec R. Griffith[1], Matthew Edwards[2], Tim Bennett[2], Julia Mikhailova[2]; *[1]Astrophysical Sciences, Princeton Univ., USA; [2]Mechanical and Aerospace Engineering, Princeton Univ., USA.* We examine three-halves-harmonic generation for femtosecond laser pulses under varying pulse intensity and contrast. Strong variation in the shape and relative magnitude of the three-halves harmonic is observed.

JW3A.138
A non-destructive method for measuring the absorption coefficient of a Yb-doped fiber, Mostafa Peysokhan[1], Esmaeil Mobini[1], Behnam Abaie[1], Arash Mafi[1]; *[1]Univ. of New Mexico, USA.* A non-destructive method for measuring the absorption coefficient of the doped optical fiber is presented that is based on tuning the pump wavelength and measuring the spontaneous emission at two different locations along the fiber.

10:15–15:00 Science & Industry Showcase Theater Programming. See page 11 for a complete list of programs.

13:00–14:00
Rapid Fire Oral Presentation IV, Science & Industry Theater
Presider: Wei Lee; National Chiao Tung University, Taiwan

Participating posters are noted in the list of poster for session JW4A with the icon **RAPID**. Each presenter will have 3 minutes and the order will be determined by poster number.

JOINT FiO + LS

13:00–15:00
JW4A • Poster Session IV and Dynamic E Posters

JW4A.1 *E-Poster*
THz Detection with Structured Plasmonic Channel, Kiana Montazeri[1], Pouya Dianat[1], Zhihuan Wang[1], Bahram Nabet[1]; *[1]Drexel Univ., USA*. We are proposing a novel semiconductor based terahertz detector, using the plasma wave propagation in a structured 2DEG by electrically measuring the voltage across the channel in room temperature.

JW4A.2 *E-Poster*
All-Dielectric Polarization-Independent Metasurface Using Cross-Shaped Unit cell, Mostafa Abdelsalam[1], Ahmed Mahmoud[2], Mohamed M. Swillam[1]; *[1]Dept. of Physics, American Univ. in Cairo, Egypt; [2]Electronics and Communication Engineering Dept., The American Univ. in Cairo, Egypt*. Metasurfaces depend on introducing a phase gradient across the interface. In this paper we show a novel polarization-independent all-dielectric metasurface, that is CMOS-compatible, showing beam steering capabilities with efficiency of 89%.

JW4A.3 *E-Poster*
Diagnosis of glioma brain cancer using visible resonance Raman spectroscopy, Yan Zhou[2], Binlin Wu[1], Cheng-hui Liu[3], Xinguang Yu[2], Gangge Cheng[2], Kai Wang[4], Chunyuan Zhang[3], Lingyan Shi[5], Robert Alfano[3]; *[1]Southern Connecticut State Univ., USA; [2]Air Force General Hospital, PLA, China; [3]City College of New York, USA; [4]Jilin Univ., China; [5]Dept. of Chemistry, Columbia Univ., USA*. Resonance Raman spectroscopy using 532nm excitation was used to distinguish normal brain tissue from different grades of glioma tissues. Principal component analysis was used to analyze the spectral data and achieved high accuracy.

JW4A.4 *E-Poster*
Non-Adiabatic Tapered Fibers for the Operation of a Switchable Multi-Wavelength Thulium-Doped Fiber Laser, Baldemar Ibarra-Escamilla[1], Marco V. Hernández-Arriaga[1], Manuel Durán-Sánchez[2], Hector Santiago-Hernandez[1], Evgeny A. Kuzin[1]; *[1]INAOE, Mexico; [2]INAOE, CONACyT, Mexico*. A switchable multi-wavelength thulium-doped fiber laser based on non-adiabatic tapered fibers is experimentally demonstrated. The laser is switched from single to multi-wavelength by curving the tapers showing high stability output near 2 μm region.

JW4A.5 *E-Poster*
Continuous Wave Laser Induced Damage Threshold of $Ge_{28}Sb_{12}Se_{60}$ at 1.07 microns, John E. McElhenny[1]; *[1]US Army Research Lab, USA*. The continuous wave laser-induced damage threshold of chalcogenide glass, $Ge_{28}Sb_{12}Se_{60}$, is measured for a 5s exposure of 1.07 μm light focused to a spot size with $1/e^2$ diameter of 830 μm, following the ISO standards.

JW4A.6 *E-Poster*
Engineering the Wavelength and Topological Charge of Non-diffracting Beams along their Axis of Propagation, Ahmed Dorrah[1], Michel Zamboni-Rached[2], Mo Mojahedi[1]; *[1]Dept. of Electrical and Computer Engineering, Univ. of Toronto, Canada; [2]School of Electrical Engineering, Univ. of Campinas, Brazil*. We report on class of non-diffracting beams where the wavelength and topological charge (orbital angular momentum) can be controlled along the beam's axis, thus addressing challenges in imaging, materials processing, and dense data communications.

JW4A.7 *RAPID*
Incoherent Propagation-Invariant Space-Time Light Sheets Produced from a Broadband Light Emitting Diode, Murat Yessenov[1], Hasan E. Kondakci[1], Monjurul F. Meem[2], Rajesh Menon[2], Ayman Abouraddy[1]; *[1]CREOL, Univ. of Central Florida, USA; [2]Dept. of Electrical and Computer Engineering, Univ. of Utah, USA*. We demonstrate the experimental synthesis of incoherent broadband diffraction-free space-time beams in the form of light sheets from an LED by introducing judicious spatio-temporal spectral correlations.

JW4A.8 *RAPID*
Experimental Ray Tracing – from simulation to reality, Tobias Binkele[1], David Hilbig[1], Ufuk Ceyhan[2], Gustavo Gutierrez[3], Mahmoud Essameldin[1], Thomas Henning[1], Friedrich Fleischmann[1]; *[1]Univ. of Applied Sciences Bremen, Germany; [2]BLF Optik Teknoloji Sanayi A.S., Turkey; [3]Cofem S.A., Spain*. Ray tracing is mostly known from simulation. However, Häusler et al. also proposed an experimental implementation of ray tracing. We have taken the proposal to real life and covered a lot of applications with it.

JW4A.9 *RAPID*
Improved Subaperture Stitching for the Measurement of Freeform Wavefront, kamal pant[1,2], Daliramu Burada[1], Amitava Ghosh[2], Gufran Khan[1], Chandra Shakher[1]; *[1]IDDC, IIT, India; [2]IRDE, India*. This paper presents an improved stitching technique for freeform metrology. The lateral misalignments are minimized using modified iterative closest point based registration. The method is applied to freeform measurement using Shack-Hartmann Sensor.

JW4A.10 *RAPID*
Extremely Compact and Broadband Polarization Beam Splitter Enabled by Customized Port Angles, Yannick D'Mello[1], Eslam El-Fiky[1], James Skoric[1], Yun Wang[1], Amar Kumar[1], David Patel[1], David V. Plant[1]; *[1]McGill Univ., Canada*. We demonstrate a compact yet fabrication tolerant polarization beam splitter. Customized angles at each port facilitate a broadband response over 100 nm, including 3 dB insertion loss and 11.2 dB extinction ratio in the C-band.

JW4A.11 *RAPID*
A Tunable Low-pass Filter for Femtosecond Lasers Based on a Passive Cavity, Xiao Xiang[1], Feiyan Hou[1], Dongdong Jiao[1], Tao Liu[1], Shougang Zhang[1], Ruifang Dong[1]; *[1]National Time Service Center, CAS, China*. We report a tunable optical low-pass filter for femtosecond lasers based on a passive cavity. The cutoff frequency can be tuned by stabilizing the cavity length to different secondary resonance peaks.

JW4A.12
Nonregular Three-Dimensional Polarization States, Jose J. Gil[2], Andreas Norrman[3], Tero Setälä[1], Ari Tapio Friberg[1]; *[1]Univ. of Eastern Finland, Finland; [2]Univ. of Zaragoza, Spain; [3]Max Planck Inst. for the Science of Light, Germany*. General three-dimensional (3D) states of polarization may be classified as regular and nonregular. We consider the concept of nonregularity and assess its characterization and consequences with applications to evanescent electromagnetic waves.

JW4A.13
Laser Temperature Sensor Based on a Core-offset Aluminum Coated Mach-Zehnder Interferometer, Javier A. Martin Vela[1], Eloísa Gallegos Arellano[1], Juan M. Sierra Hernandez[1], Daniel Jauregui Vazquez[1], Juan C. Hernandez-Garcia[1], Julian M. Estudillo-Ayala[1], Erika Silva Alvarado[1], Roberto Rojas-Laguna[1]; *[1]Education, Mexico*. A laser temperature sensor based on a core-offset aluminum coated Mach-Zehnder interferometer is presented. The experimental results shown a temperature sensitivity of 28 pm/°C and a signal to noise ratio of 45 dB.

JW4A.14
A Simple and Robust Technique For Full Spatiotemporal Measurement of Ultrafast Laser Pulses, Daniel Adams[1], Henry C. Kapteyn[1], Seth L. Cousin[2]; *[1]Physics, Univ. of Colorado, Boulder, USA; [2]KMLabs, USA*. We present a straightforward tool for routine evaluation of the spatiotemporal field of ultrafast pulses. We combine white light interferometry with reference-free wave-front-sensing and pulse-measurement in a single-scan to obtain 3D pulse profiles.

JW4A.15
Suppression of Back-Side Reflections with Broadband Elastomeric Light Trap, David Miller[1], Robert R. McLeod[1]; *[1]Univ. of Colorado at Boulder, USA*. Using elastomeric material and a broadband absorber, we detail a method for broadband suppression of Fresnel reflections from the backside of transparent substrates. Applications include spectroscopic ellipsometry, holography, and lithography.

JW4A.16
LDLS Powered High Throughput Tunable Light Source, Xiaohua Ye[1], Alex Cutler[1], Qingsong Wang[1], Tseten Lungjangwa[1], Ron Collins[1], Matt Besen[1], Huiling Zhu[1]; *[1]Energetiq Inc., USA*. High throughput tunable light sources (TLS) using an ultrahigh-brightness Laser-Driven Light Source (LDLS™) are developed for photonic applications. Measurement results of in-band fluxes and FWHM bandwidths, between 400nm and 1100nm, are presented.

JW4A.17
Tunable Stacks of Wedged Interferometers for Optical Communications and Spectroscopy, Marin Nenchev[2], Elena Stoykova[1], Margarita Deneva[2]; *[1]Bulgarian Academy of Sciences, Bulgaria; [2]Technical Univ. - Plovdiv Branch, Bulgaria*. We propose a stack of two Fizeau interferometers for selection of a single continuously tunable within 10-50 nm resonance with a linewidth of 0.01 nm or less and utilization of such stacks for wavelength-division multiplexing.

JW4A.18
Anti-Reflecting Surfaces Using Two-layer Motheye Structures for Spinel Ceramic Windows, Chaoran Tu[1], Curtis Menyuk[1]; *[1]Univ. of Maryland Baltimore County, USA*. We design and optimize a two-layer pyramid motheye structures for long wavelength $MgAl_2O_4$ spinel ceramic windows. We show that a two-layer pyramid motheye structure can achieve average transmission of 98.96% from 0.5 μm to 5 μm.

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JW4A.19
Photodarkening of kW-level Yb-doped Aluminosilicate (Al_2O_3-SiO_2) Fiber, Jiacheng Wu[1], Tianhong Qian[1], Kaijun Shu[1]; [1]*Anhui Univ. of Chinese Medicine, China.* We reported on laser performance of a kW-level 20/400 Yb-doped aluminosilicate fiber. Laser running of 120 minutes at 1.2kW showed power degradation of 10.6% and slope efficiency degradation of 116%, directly justifying serious photodarkening effect.

JW4A.20
Camera and Inverse Camera System for Free-Space Optical Communications, Sajad Saghaye Polkoo[1,2], Christopher K. Renshaw[1,2]; [1]*Univ. of Central Florida, CREOL, USA;* [2]*Physics, Univ. of Central Florida, USA.* We introduce an imaging-based transceiver for FSOC that enables precision beam steering over a wide field-of-regard using low-cost components with no moving parts. Passive beam steering provides dynamic beam-shaping and multiplexable communication.

JW4A.21
A Fabrication of Nanostructures with a Transmission Light and a Plasmonic Field at Different Z-axis Position, Taeyeon Kim[1], Heesang Ahn[1], Hyerin Song[1], Jong-ryul Choi[2], Kyujung Kim[1,3]; [1]*Dept. of Cogno-mechatronics Engineering, Pusan National Univ., South Korea;* [2]*Medical Device Development Center, Dagu-Gyeongbuk Medical Innovation Foundation (DGMIF), South Korea;* [3]*Dept. of Optics and Mechatronics Engineering, Pusan National Univ., South Korea.* We fabricated two hole-array pattern masks and observed the differences between conventional photolithography and plasmonic lithography by controlling the gap distance between the mask and the photoresist.

JW4A.22
Non-scanning three-dimensional measurements using a chirped frequency comb interferometry with a multi-mode fiber bundle, Megumi Uchida[1,2], Takashi Kato[1,2], Yurina Tanaka[1,2], Kaoru Minoshima[1,2]; [1]*The Univ. of Electro-Communications (UEC), Japan;* [2]*Japan Science and Technology Agency (JST), ERATO MINOSHIMA Intelligent Optical Synthesizer (IOS) Project, Japan.* We developed a non-scanning three-dimensional measurement method using multi-mode fiber bundle. Based on ultrafast space-time-frequency conversion with the optical frequency comb, non-scanning 3D imaging with high power efficiency is demonstrated.

JW4A.23
Slit-Width Effects in a Double-Slit Experiment with a Partially-Coherent Source, Brett J. Pearson[1], Natalie Ferris[1], Ruthie Strauss[1], Hongyi Li[1], David P. Jackson[1]; [1]*Dickinson College, USA.* We perform a Young's double-slit experiment using a partially-coherent light source. As compared to the standard theory, the data agree much more favorably with a calculation that fully accounts for the width of the slits.

JW4A.24
Fabrication of $YAlO_3$:Gd^{3+} Thin Films for Nanoimaging, Mykyta Kolchiba[1], Wataru Inami[2], Yoshimasa Kawata[2]; [1]*Graduate School of Science and Technology, Shizuoka Univ., Japan;* [2]*Research Inst. of Electronics, Shizuoka Univ., Japan.* We have fabricated $YAlO_3$:Gd^{3+} perovskite thin films by RF magnetron sputtering as free-standing membranes for optical nanoimaging systems. Homogeneous, robust and bright scintillators emerge a perfect candidate in high-resolution imaging.

JW4A.25 *RAPID*
Two-Dimensional Reconstruction of The Fly *Drosophila Melanogaster* By Holographic Interferometry, Luis A. Marín[1], Evelyn A. Granizo[1]; [1]*Optics Lab, ESPOCH, Ecuador.* Using the Matlab software, images obtained from the fly Drosophila melanogaster are shown in a holographic simulator designed with the objective of processing and reconstructing binary holograms. An unconventional system of teaching science.

JW4A.26
High-Resolution, High Speed Defect Detection of Curved Optics, Timothy A. Potts[1]; [1]*Dark Field Technologies, USA.* Automated inspection of curved optics is a large industry need. Conventional laser/camera systems cannot deliver reliable inspection of curved surfaces. Solid State Laser Reflection (SSLR) technology solves the problem of curved optics inspection.

JW4A.27
Multimodal imaging Mueller polarimetric microscope on geometrical analysis of spherical microparticles, Thomas Sang Hyuk Yoo[1], Andrea Fernández[2], Fernando Moreno[2], Jose Maria Saiz[2], Razvigor Ossikovski[1], Enric Garcia-Caurel[1]; [1]*LPICM, Ecole Polytechnique, France;* [2]*Dpto. de Física Aplicada, Universidad de Cantabria, Spain.* We developed a multimodal imaging polarimetric microscope which images both in Fourier (back-focal) and real planes. We propose an application to study spherical microparticles showing size and shape dependent polarimetric properties.

JW4A.28
Toward Training a Deep Neural Network to Optimize Lens Designs, Geoffroi Côté[1], Jean-François Lalonde[1], Simon Thibault[1]; [1]*Université Laval, Canada.* A deep neural network (DNN) is trained in an unsupervised manner, using RMS spot size, to output optimized lens designs from provided specifications.

JW4A.29
Synchronized Microphone Array for Single-shot Axial Profiles of Femtosecond Filaments, Ilia Larkin[1], Aaron Schweinsberg[2], Anthony Valenzuela[3], Howard Milchberg[1]; [1]*IREAP, Univ. of Maryland, USA;* [2]*Oak Ridge Inst. for Science and Education, USA;* [3]*US Army Research Lab, Aberdeen Proving Grounds, USA.* A synchronized array of microphones maps, in a single shot, the axial energy deposition profile from a femtosecond laser filament as a function of perturbations in input laser energy, pulse duration, and focusing geometry.

JW4A.30
High-sensitive Absorption Measurement in Silica and Quartz Crystal with Time-resolved Photo-thermal Common-path Interferometry, Ksenia V. Vlasova[1], Alexandre Makarov[1], Nikolai Andreev[1]; [1]*Inst. of Applied Physics RAS, Russia.* The results of measurements of ultra-low (~$10^{-7}$$cm^{-1}$) absorption of optical radiation (λ=1.07 μm) in synthetic crystalline quartz and in fused quartz by time-resolved modification of a Photo-thermal common interferometry are presented.

JW4A.31
Coherent ultra-broadband wave-breaking radiation in a laser plasma accelerator, Bo Miao[1], Linus Feder[1], Howard Milchberg[1]; [1]*Univ. of Maryland at College Park, USA.* Abstract: Electron self-injection in a laser plasma accelerator generates an ultra-broadband coherent radiation flash. We show that the flash spectrum reveals information on the plasma density and the electron injection process.

JW4A.32
Temporal and Polarization Symmetry Breaking in Ring Resonators, Francois Copie[1], Michael T. Woodley[1], Leonardo Del Bino[1], Jonathan M. Silver[1], Shuangyou Zhang[1], Pascal Del'Haye[1]; [1]*National Physical Lab, UK, UK.* We study the occurrence of two symmetry breaking processes in ring resonators pumped by short pulses. Different scenarios are predicted depending on the input characteristics, including a complex dynamical interplay between the two mechanisms.

JW4A.33
Brillouin Comb Generation in a Highly Nonlinear Tellurite Single Mode Fiber, Luo Xing[1], Hoang Tuan Tong[1], Than Singh Saini[1], Hoa P. Nguyen[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Research Center for Advanced Photon Technology, Toyota Technological Inst., Japan.* Brillouin comb generation in a ring cavity composed of a piece of tellurite single mode fiber was demonstrated. Cascaded stimulated Brillouin Stokes and anti-Stokes lines resulted in multi-wavelength Brillouin comb generation bi-directionally.

JW4A.34
Surface Modification of Additively Manufactured Titanium Components via Femtosecond Laser Micromachining, Nathan G. Worts[1], Jason Jones[2], Jeff Squier[1]; [1]*Colorado School of Mines, USA;* [2]*Moog Inc., USA.* Novel capabilities including surface roughness modification, nanogratings, and micro-cones are achieved through post-processing of additively manufactured parts by an amplified femtosecond laser. Applications of these surface features are discussed.

JW4A.35
Radiation detection with mid-IR laser breakdown of air, Daniel C. Woodbury[1], Robert Schwartz[1], Joshua Isaacs[1], Phillip Sprangle[1], Howard Milchberg[1]; [1]*Univ. of Maryland at College Park, USA.* We demonstrate standoff detection of radioactive material based on avalanche breakdown of irradiated air with mid-IR laser pulses. With radiation present, breakdowns experience a temporal shift in their evolution, and can exhibit on-off sensitivity.

JW4A.36
Coherent Excitation of Phonon Polaritons in $BaGa_4Se_7$ by Terahertz Pulses, Bo Wang[1], Yiwen E[1], Jiyong Yao[2], Li Wang[1]; [1]*Beijing National Lab for Condensed Matter Physics, Inst. of Physics, Univ. of Chinese Academy of Sciences, Chinese Academy of Sciences, China;* [2]*Key Lab of Functional Crystals and Laser Technology, Technical Inst. of Physics and Chemistry, Univ. of Chinese Academy of Sciences, Chinese Academy of Sciences, China.* Phonon polaritons are generated in $BaGa_4Se_7$ by linear excitation of terahertz pulses, and probed using 800 nm femtosecond laser pulses. The observed phonon polaritons can be perfectly reproduced by a damped harmonic oscillator model.

JW4A.37
Third-Order Nonlinear Optical Properties of ALD Grown TiO_2 Films by Thermally Managed Z-scan Method, Isaac Basaldua[1], Paul Burkins[1], Robinson Kuis[1], Jaron Kropp[1], Theodosia Gougousi[1], Anthony M. Johnson[1]; [1]*Univ. of Maryland Baltimore County, USA.* Thermally managed Z-scan performed on ALD grown TiO_2 films demonstrated n_2 values of $1.7x10^{-11}$ and $1.94 x10^{-10}$$cm^2$/W for films grown at 100°C and 250°C, respectively – greater than 1000X that of other growth methods.

JW4A.38
Polarization and Entanglement in Mixed Classical States, Asma Al-Qasimi[1], Joseph H. Eberly[1]; [1]*Univ. of Rochester, USA.* The relationship between polarization and entanglement [1] implies classical entanglement places limits on observable coherence properties. Here we study how the coherences affect each other in the case of mixed classical states.

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JW4A.39
Design and Modeling of a Chalcogenide Taper Fiber for High Average Power Supercontinuum Generation, Than Singh Saini[1], Hoa P. Nguyen[1], Hoang Tuan Tong[1], Luo Xing[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; *[1]Toyota Technological Inst., Japan.* Chalcogenide taper-fiber structure is reported for high-power broadband supercontinuum spectrum covering from 1.5–14 μm. The taper fiber was pumped with femtosecond laser pulse of an average power of 200 mW at 3.5 μm.

JW4A.40
Optical Switching and Thermal Recovery of Vanadium Dioxide, Marc Currie[1], Virginia Wheeler[1], Mario Ancona[1], Tatyana Feygelson[1], Karl Hobart[1]; *[1]US Naval Research Lab, USA.* Vanadium dioxide films were grown on sapphire substrates as well as thin diamond membranes. Optical pump-probe experiments show large optical modulation in response to moderate optical excitation and follow a pure thermal model.

JW4A.41
Linear Localization of non-Hermitian Photonic Zero Modes, Li Ge[1], Bingkun Qi[1]; *[1]College of Staten Island, CUNY, USA.* A non-Hermitian photonic zero mode can exhibit an unusual behavior at the transition between extended and localized regimes: it displays a linearly decreasing amplitude in space inside a weakly coupled non-Hermitian reservoir.

JW4A.42
Dark Soliton and Cnoidal Wave Frequency Combs in Microresonators by Second Harmonic Generation, Zhen Qi[1]; *[1]Univ. of Maryland Baltimore County, USA.* We study dark solitons and cnoidal waves frequency combs generated by second harmonic generation in microresonators. We obtain stable dark solitons and cnoidal waves when fundamental frequency and second harmonic in oppositely dispersive regimes.

JW4A.43
THz Region Elastic Scattering from a Silica Microsphere, Suat Kurt[1], Nurperi Yavuz[1], Syed Sultan Shah Bukhari[1], Ali Serpengüzel[1]; *[1]Koc Univ., Turkey.* Using GLMT, we investigated 0° transmission and 90° elastic scattering from a silica microsphere. The numerically observed mode spacing agrees well with the theoretically estimated value. Silica microspheres show promise for novel THz applications.

JW4A.44
Imaging with Thick Lenses using ABCD Matrices and under First-Order Material Dispersion, Monish R. Chatterjee[1], Salaheddeen Bugoffa[1]; *[1]Univ. of Dayton, USA.* ABCD matrices for a thick lens are applied for imaging a colored 2D object under first-order material dispersion. Frequency-dependent dispersion of permittivity is incorporated in the analysis and results are compared with the non-dispersive problem.

JW4A.45
Warped Space-Time Optics, William B. Webb[1]; *[1]Energy Control Engineering, USA.* Atoms are structured from Loopons; a variety of Photons. Loopon Electrons warp. Their speed-of-light is warped, producing a transparent material's Index of Refraction. Photons obliquely entering or leaving bend and change speeds outside the material.

JW4A.46 *RAPID*
Spatio-temporal observation of the Fermi-Pasta-Ulam recurrence in optical fibers, Corentin Naveau[1], Pascal Szriftgiser[1], Alexandre Kudlinski[1], Matteo Conforti[1], Stefano Trillo[2], Arnaud Mussot[1]; *[1]Université de Lille, France; [2]Univ. of Ferrara, Italy.* We report the spatio-temporal observation of the Fermi-Pasta-Ulam recurrence via non-destructive distributed measurements in phase and intensity of main frequency components of the frequency comb.

JW4A.47 *RAPID*
Development of high-precision mode decomposition devices for optical vortices, Keisaku Yamane[1], Yuho Watanabe[1], Isamu Wakisaka[1], Kazuhiko Oka[2], Yasunori Toda[1], Ryuji Morita[1]; *[1]Hokkaido Univ., Japan; [2]Hirosaki Univ., Japan.* New mode decomposition devices for optical vortices were developed. Their performances were experimentally verified and in good agreement with the corresponding simulations, showing precise spatial-phase control based on Pancharatnam-Berry phase.

JW4A.48 *RAPID*
Photokinetic effects in vector Bessel beams, Aaron Yevick[1], David G. Grier[1]; *[1]New York Univ., USA.* Vector Bessel Beams are a conical superposition of polarized plane waves. The angular spectrum including polarizations is useful for identifying relationships among different polarization states, and understanding forces on small objects.

JW4A.49 *RAPID*
Ultrafast magnetization dynamics in nanoscale two-dimensional Permalloy annular antidot lattices, Nikita Porwal[1], Sucheta Mondal[2], Samiran Choudhury[2], Anulekha De[2], Jaivardhan Sinha[2], Anjan Barman[2], Prasanta Kumar Datta[1]; *[1]Indian Inst. of Technology Kharagpur, India; [2]2Dept. of Condensed Matter Physics and Material Sciences, S. N. Bose National Centre for Basic Sciences, Block JD, Sector III, Kolkata , India.* The static and dynamic response of 2-D $Ni_{80}Fe_{20}$ annular antidot lattices has been investigated with varying bias magnetic field using TR-MOKE microscopy. Multiple frequency modes observed in experiment are verified by micromagnetic simulations.

JW4A.50 *RAPID*
Vector vortex beam from doubly-resonant nanosecond optical parametric oscillator, Varun Sharma[1], Goutam K. Samanta[1], S. C. Kumar[2], A Aadhi[1], H. Ye[2], M. Ebrahim-Zadeh[2,3]; *[1]PRL Ahmedabad, India; [2]ICFO-Institut de Ciencies Fotoniques, The Barcelona Inst. of Science and Technology, Spain; [3]Institucio Catalana de Recerca i Estudis Avancats (ICREA), Spain.* We demonstrate a novel experimental scheme to generate tunable vector vortex beam directly from an optical parametric oscillator (OPO). Using a nanosecond doubly-resonant OPO, we produce vector vortex beam tunable across 964-990 nm.

JW4A.51
Propagation of Vortex Pulsed Beams in Free Space, Nikolai I. Petrov[1]; *[1]Scientific and Technological Center of Unique Instrumentation of Russian Academy of Sciences, Russia.* Propagation of spatiotemporal pulses in free-space taking into account nonparaxial effects is investigated. Non-invariance of the velocity of spatially localized vortex pulsed beams in vacuum is shown by rigorous calculation of the wave equation.

JW4A.52
Ultrafast Laser Micro-stressing for Correction of Thin Fused Silica Optics for Future X-Ray Space Telescopes, Heng Zuo[1,2], Brandon Chalifoux[2], Ralf Heilmann[2], Mark Schattenburg[2]; *[1]Dept. of Aeronautics and Astronautics, MIT, USA; [2]MIT Kavli Inst. for Astrophysics Research, USA.* We present a novel application of ultrafast laser micromachining for figure correction of future light-weight high-resolution X-ray mirrors. Preliminary results of local deformation and stress changes in flat fused silica substrates are demonstrated.

JW4A.53
Interaction of Laser Beam with Plasmonic Nanoparticles, Avesh Kumar[1,2]; *[1]Bhim Rao Ambedkar Univ., India; [2]AMOPH, Physical Research Lab, India.* Interaction of input laser beams with colloidal suspensions of plasmonic nanoparticles is studied. It results in different types of structures after propagation through a suspension.

JW4A.54
Probing Vibration-Cavity Polariton Dynamics via Ultrafast Infrared Spectroscopy, Andrea B. Grafton[2,1], Adam Dunkelberger[1], Kenan Fears[1], Roderick Davidson[2,1], Blake Simpkins[1], Jeffrey Owrutsky[1]; *[1]U.S. Naval Research Lab, USA; [2]National Research Council, USA.* Time resolved IR pump-probe spectroscopy was used to measure the vibrational dynamics of strong chromophores in optical cavities. A fast component in the lifetime of $W(CO)_6$ in hexane was observed, but not in the other systems.

JW4A.55
Self-Compression of Ultrashort Pulses in Hollow Waveguide for High Harmonic Generation, Qiandong Ran[1], Lifeng Wang[2], Lu Li[2], Hao Li[2], Ying Zhang[2]; *[1]Nanyang Technological Univ., Singapore; [2]Singapore Inst. of Manufacturing Technology, Singapore.* Self-compression of pulses was observed in gas-filled waveguide. This can be used to enhance High Harmonic Generation (HHG). Here, 2cm hollow waveguide with inner diameter 150μm was used. Bright HHG in water window was produced.

JW4A.56 *RAPID*
Probing Light-Metal Interaction with the Photon-Drag Effect, Jared Strait[2], Glenn Holland[2,1], B. Robert Ilic[2], Amit Agrawal[2,1], Domenico Pacifici[2,3], Henri Lezec[2]; *[1]Maryland NanoCenter, Univ. of Maryland, USA; [2]Center for Nanoscale Science and Technology, NIST, USA; [3]School of Engineering and Dept. of Physics, Brown Univ., USA.* We demonstrate that the sign of the photon-drag effect in smooth metal films conflicts with the prevailing intuitive model of direct momentum transfer to free electrons, establishing the need for a new microscopic model of radiation pressure.

JW4A.57 *RAPID*
Multiplexing a Cavity-Enhanced Quantum Memory, Paul D. Kunz[1], Kevin Cox[1], David Meyer[2,1], Zachary A. Castillo[2,1]; *[1]Army Research Labs, USA; [2]Physics, Univ. of Maryland, USA.* We present ongoing work on a multiplexed atom-cavity quantum memory with the goal of achieving fast entanglement generation - one of the primary remaining hurdles to a functional quantum repeater.

JW4A.58 *RAPID*
Entanglement between Topological and Trivial Modes, Andrea Blanco-Redondo[1], Bryn A. Bell[1], Dikla Oren[2], Benjamin J. Eggleton[1], Mordechai Segev[2]; *[1]Univ. of Sydney, Australia; [2]Technion, Israel.* We report the experimental observation of biphoton entanglement between topologically and trivially localized modes in a nanophotonic lattice of coupled silicon waveguides.

JW4A.59 *RAPID*
Sensitivity-bandwidth Enhancement of Gravitational Wave Detector Without Using Dispersive Medium, Minchuan Zhou[1], Zifan Zhou[1], Selim M. Shahriar[1]; *[1]Northwestern Univ., USA.* We show that via small changes in the parameters of the existing signal-recycled interferometric gravitational wave detector, it is possible to achieve an enhancement on the order of 10 in the sensitivity-bandwidth product.

JW4A.60
Generation and Storage of Entanglement between Two All-Optical Quantum Memories, Fumiya Okamoto[1], Yosuke Hashimoto[1], Jun-ichi Yoshikawa[1], Rei Sakakibara[1], Peter v. Loock[2], Akira Furusawa[1]; *[1]The Univ. Of Tokyo, Japan; [2]Johannes Gutenberg Univ. Mainz, Germany.* We experimentally demonstrate generation and storage of entanglement between two concatenated cavity memories. The logarithmic negativity is 0.150±0.006 even at 400 ns storage time.

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JW4A.61
Optimized Cooling of Atoms in Optical Lattice for High Rate Quantum Memory Operation, Michal J. Piotrowicz[2], Thomas G. Akin[3], John Reintjes[2], Alex Kuzmich[4], Adam T. Black[1], Mark Bashkansky[1]; *[1]Optical Sciences Division, U.S. Naval Research Lab, USA; [2]KeyW Corporation, USA; [3]NRC Postdoctoral Research Associate, USA; [4]Dept. of Physics, Univ. of Michigan, USA.* We present an optimized cooling sequence for Rb atoms in a 1D optical lattice for quantum memory experiments. We show an increase in number of memory write and read events per one lattice load.

JW4A.62
Dual-Seeded Four-Wave Mixing in Portable Quantum Light Source, Nicholas Brewer[1], Meng-Chang Wu[1], Rory W. Speirs[1], Paul Lett[2]; *[1]Univ. of Maryland, USA; [2]National Inst. of Standards and Technology, USA.* The noise spectrum of intensity-difference squeezed light exhibits excess noise at high frequencies when a tapered amplifier is used as a pump beam. Our dual-seed technique corrects this noise.

JW4A.63
Complete characterization of optical multi-temporal-mode quantum states, Kan Takase[1], Masanori Okada[1], Takahiro Serikawa[1], Shuntaro Takeda[1,2], Jun-ichi Yoshikawa[1], Akira Furusawa[1]; *[1]applied physics, the Univ. of Tokyo, Japan; [2]JST, PRESTO, Japan.* We propose and demonstrate a method useful to characterize optical multi-temporal-mode Fock states typified by quantum error correction code states using a simple experimental setup and data analysis procedure.

JW4A.64
Two Opto-Atomic Devices for Classical and Quantum Communication, David H. Meyer[1], Kevin C. Cox[2], Zachary A. Castillo[1], Paul D. Kunz[2]; *[1]Dept. of Physics, Univ. of Maryland at College Park, USA; [2]U.S. Army Research Lab, USA.* We present ongoing developments of two atomic devices to improve optical communication rates in the classical and quantum regimes: a Rydberg atomic receiver for classical data and a ring-cavity atomic memory for long distance quantum communication.

JW4A.65
Carrier Dynamics in Monolayer WS_2 via Time-Resolved Terahertz Spectroscopy, Jon K. Gustafson[1], Michael Hayden[1]; *[1]Physics, UMBC, USA.* We investigate the ultrafast dynamics of photogenerated charge carriers in the two-dimensional material WS_2 via time-resolved terahertz spectroscopy. We report on the behavior of excitons, trions, and unbound electrons/holes in this material.

JW4A.66
Reduced Decoherence of Macroscopic States Using Squeezing and Anti-Squeezing, Richard A. Brewster[1], James Franson[1]; *[1]Univ. of Maryland, Baltimore County, USA.* The decoherence of macroscopic quantum states due to loss can be reduced by squeezing before transmission, followed by amplification and anti-squeezing to restore the original amplitude. This approach does not decrease the data transmission rate.

JW4A.67
Picosecond Pulse Pumped Supercontinuum Generation in Silicon-on-insulator Waveguide with a Weak Continuous Wave Trigger, Guangkuo Li[1], Qian Li[1]; *[1]Peking Univ., China.* We investigate the effect of a weak continuous-wave trigger on picosecond pulse pumped supercontinuum generation in silicon-on-insulator waveguide. A spectrally broadened and highly coherent supercontinuum is achieved.

JW4A.68
Correlation Properties of Polarization Dynamics in Quantum Dot Lasers with Optical Feedback, Chen Yang[1], Salim Ourari[1], Hong Lin[1]; *[1]Bates College, USA.* Dynamics of polarized states are examined for a quantum dot laser subject to polarization-rotated feedback. Correlations of different polarizations are studied by evaluating cross correlation functions.

JW4A.69
Rectangular Core Dispersion Engineered Photonic Crystal Fiber for Supercontinuum Generation, Pooja Chauhan[1], Ajeet Kumar[1], Yogita Kalra[1], Than Singh Saini[2]; *[1]Delhi Technological Univ., India; [2]Toyota Technological Inst., Japan.* Design of a rectangular core photonic crystal fiber in $Ge_{20}Sb_{15}Se_{64}$ chalcogenide glass is presented for mid-IR. Our simulation results include the study of dispersion, nonlinearity and fundamental effective mode area.

JW4A.70
Blu-ray DVD as SERS substrate for reliable detection and quantification of urea, Nabadweep Chamuah[1], Ankita Saikia[1], Pabitra Nath[1]; *[1]Tezpur Univ., India.* Herein development SERS substrate using blu-ray DVD and subsequent use for detection of urea is demonstrated. The substrate yields reproducibility with RSD value of 14.33%. Urea concentration of 0.06μg/dL can be detected reliably with this substrate.

JW4A.71
Anderson Localization in Subwavelength Plasmonic Structures, Ali Ghoreyshi[1], R. H. Victora[1]; *[1]Univ. of Minnesota, USA.* We used the FDTD simulation to study photon propagation in arrays of plasmonic particles. In such systems, structural randomness can lead to localization of light in the deep subwavelength regime, similar to Anderson localization of electrons.

JW4A.72
Free-Space Daylight Quantum Key Distribution without Source Side Channel Effects, Heasin Ko[1], Chun Ju Youn[1]; *[1]Electronics and Telecommunications Research Inst., South Korea.* We study the performance of a free-space quantum key distribution system operated at the clock rate of 400MHz in daylight without source side channel effects. Noise photons from sunlight were effectively eliminated with filtering techniques.

JW4A.73
Strong-Coupling Model for Pulsed Light Propagation and Quantum Kinetics of Electron-Hole Plasmas in Quantum Wire Arrays, Jeremy R. Gulley[1], Danhong Huang[2]; *[1]Dept. of Physics, Kennesaw State Univ., USA; [2]Space Vehicles Directorate, Air Force Research Lab, USA.* A quantum-kinetic model is proposed for ultrafast carrier-scattering dynamics in quantum wires coupled to resonant scattering of ultrashort light pulses. The model includes effects from transverse, longitudinal, and applied DC fields on the wires.

JW4A.74
Probing Dynamics In Quantum Magnetism With Ultracold Atoms, Araceli Venegas Gomez[1], Andrew J. Daley[1], Wolfgang Ketterle[2]; *[1]Univ. of Strathclyde, UK; [2]MIT, USA.* The macroscopic control over cold atoms in optical lattices offers an excellent platform to study the out-of-equilibrium behaviour of strongly correlated systems, such as spin models, which are usually motivated by solid state physics.

JW4A.75
Tunable Stub Plasmonic Structures for Terahertz Detectors and Sources, Michael Shur[1,2], Gregory Aizin[3], John Mikalopas[3]; *[1]Rensselaer Polytechnic Inst., USA; [2]Electronics of the Future, Inc., USA; [3]Kingsborough College, USA.* Plasmonic boom terahertz devices could increase the generated power and detection sensitivity by orders of magnitude. They require tuning conditions at heterodimensional interfaces and slow plasmons. These requirements are met using plasmonic stubs.

JW4A.76
Effective photonic potential for TM waves, Alessandro Alberucci[1], Chandroth P. Jisha[2], Stefan Nolte[1,3]; *[1]Friedrich-Schiller-Universitat Jena, Germany; [2]Universidade do Porto, Portugal; [3]Fraunhofer Inst. of Applied Optics and Precision Engineering, Germany.* We use an effective photonic potential to describe light confinement of TM waves in sub-wavelength structures, such as GRIN and slot waveguides. The predictions of the model are confirmed by FDTD simulations.

JW4A.77
Aluminum Gallium Arsenide as a High-Reflectivity Coating Material for Interferometric Gravitational-wave Detectors, Gregory M. Harry[1], Steve Penn[2], Garrett Cole[3], GariLynn Billingsley[4], Matthew Evans[5], Geoffrey Lovelace[6]; *[1]American Univ., USA; [2]Hobart and William Smith Colleges, USA; [3]Crystalline Mirror Solutions, USA; [4]LIGO Lab, California Inst. of Technology, USA; [5]LIGO Lab, MIT, USA; [6]Physics, California State Univ. Fullerton, USA.* Substrate-transferred single-crystal semiconductor heterostructures are effective as low-thermal-noise optical coatings for small beams. We discuss progress in developing GaAs/AlGaAs coatings at a size for gravitational wave detectors such as LIGO.

JW4A.78
Solitary wave solutions in nonlinear media with quartic and quadratic dispersion—implications for high-power lasers, Kevin K. Tam[1], Tristram J. Alexander[1], Andrea Blanco-Redondo[1], C. Martijn de Sterke[1]; *[1]Univ. of Sydney, Australia.* We consider solutions to the nonlinear Schrödinger equation with quadratic and quartic dispersion, and discover a temporal soliton family that includes recently discovered pure quartic solitons and solitons with only quadratic dispersion.

JW4A.79
Electro-Optic Temporal Optical Systems for Spectral Shaping of Quantum Light, Filip Sosnicki[1], Maciej Galka[1,2], Michal Mikolajczyk[1], Alex O. Davis[3], Valérian Thiel[3], Brian J. Smith[3,4], Michal Karpinski[1,3]; *[1]Uniwersytet Warszawski, Poland; [2]Cavendish Lab, Univ. of Cambridge, UK; [3]Clarendon Lab, Univ. of Oxford, UK; [4]Dept. of Physics and Oregon Center for Optical, Molecular, and Quantum Science, Univ. of Oregon, USA.* We experimentally show spectral-temporal (ST) modification of single-photon pulses by a system of two electrooptic time lenses. Our work enables ST shaping of quantum light for mode matching in quantum networks and for quantum information processing.

JW4A.80
An Effective Suppression of Relative Intensity Noise for Fiber-Optic Gyroscopes with Harmonics Demodulation, Yulin Li[1], Fang Ben[1], Rongya Luo[1], Sheng Deng[1], Fangyuan Chen[1], Dong He[1], Chao Peng[1], Zhengbin Li[1]; *[1]State Key Lab of Advanced Optical Communication Systems and Networks, Peking Univ., China.* A relative intensity noise suppression method is demonstrated for interferometric fiber-optic gyroscopes with harmonics demodulation by processing the interference and reference signals electronically, which decreases the angular random walk by 40%.

JW4A • Poster Session IV and Dynamic E Posters—Continued

JW4A.81
400 Gbps PM-QPSK Transmission for Metro-DCI Applications Employing 20 Gbaud Transmitter, Lakshmi Narayanan Venkatasubramani[1], Aneesh Sobhanan[1], Deepa Venkitesh[1]; [1]*INDIAN INST. OF TECHNOLOGY, MADRAS, India*. A PM-QPSK superchannel transmission is experimentally demonstrated for 400-Gbps data center interconnects, based on 20-GBd transmitter and coherent receiver technology, yielding a spectral efficiency of 4-b/s/Hz.

JW4A.82
Impact of Dispersion on the Relative Cross-Talk of WDM Channels in Multicore Fiber Systems., Monica Lopez-Coyote[1], Ramon Gutierrez-Castrejon[1], Daniel E. Ceballos-Herrera[1]; [1]*Inst. of Engineering, Universidad Nacional Autónoma de México UNAM, Mexico*. We report a numerical analysis of the group velocity dispersion impact on the relative inter-core cross-talk among WDM channels in a two-core fiber transmission system by considering simultaneously Four-Wave Mixing and Stimulated Raman Scattering.

JW4A.83
Method for High-Speed Optical Modulator Characterization Using Only DC Measurements, Iam Bui[1]; [1]*School of Engineering and Technology, Central Queensland Univ., Australia*. A novel technique to obtain the frequency response of high-speed optical modulators is presented. The proposed technique uses only DC measurements which greatly simplify the setup and reduce the time and cost of device characterization.

JW4A.84
Modal Analysis of Dielectric Chiral Optical Fibers by Immersed Interface Method, Yusheng Cao[1]; [1]*Ningxia Univ., China*. We describe a mode solver for dielectric chiral optical fibers, with the immersed interface method utilized to treat the discontinuity of medium parameters across the core-cladding interface, which produce a second order accuracy.

JW4A.85
FBG Based Optical Surveillance Network for Oil and Gas Pipelines, Abhinav Gautam[1], Ritu Raj Singh[1], Amitesh Kumar[1], Jaisingh Thangaraj[1], Vishnu Priye[1]; [1]*Indian Inst. of Technology (ISM), India*. A FBG based pipeline surveillance architecture is proposed. An array of FBGs, having unique reflection wavelength is used to spot location of any pressure or temperature variation, which is smartly sensed using optical heterodyning technique.

JW4A.86
Observation of Optical Multistability in directional coupler with negative index material channel, Kanagaraj Nithyanandan[2,1]; [1]*Universite de Bourgogne, India;* [2]*Laboratoire Interdisciplinaire de Physique, Universite de Grenoble Alpes, France*. We observe mulistability in directional couplers with negative index material channel. The emergence of multiple stable states is a result of the action of nonlinear saturation and opposite directionality of phase velocity and energy flow in the ODC.

JW4A.87
Tuning of the Free Spectral Range of a Fiber Optic Notch Filter Using a Dispersive Link, Luis A. González Mondragón[1], Ignacio E. Zaldívar Huerta[1], Leidy J. Quintero Rodríguez[1], Ana G. Correa Mena[1], Jorge Rodríguez Asomoza[2], Alejandro García Juárez[3], Ana L. Leal Cruz[3]; [1]*INAOE, Mexico;* [2]*UDLAP, Mexico;* [3]*Universidad de Sonora, Mexico*. Theoretical and experimentally is demonstrated that the free spectral range of a fiber optic notch filter can be tuned by adjusting the length of the optical link. A series of numerical simulations validate this proposal.

JW4A.88
Off-Axis Parabolic Mirrors Based Multiplexer Design for Spatial Domain Multiplexing, Syed H. Murshid[1], Ce Su[1]; [1]*Florida Inst. of Technology, USA*. CAD based model to multiplex the input of MIMO based spatially multiplexed optical communications system is presented. The design uses off the shelf components and allows better coupling effiency and reduces insertion loss.

JW4A.89 *RAPID*
Quantum Measurement of Time Difference in an Unbalanced Fiber Mach-Zehnder Interferometer, Yiwei Zhai[1,2], Runai Quan[1,2], Yue Zhang[1,2], Tao Liu[1,2], Shougang Zhang[1,2], Ruifang Dong[1,2]; [1]*National Time Service Center, China;* [2]*Univ. of Chinese Academy of Sciences, China*. We report a novel way for measuring the time difference in an unbalanced fiber Mach-Zehnder interferometer based on the second-order quantum interference of the frequency entangled light source.

JW4A.90
A Fiber-Pigtailed Hemispherical Fabry-Pérot Microcavity for Accelerometry and Sensing, Feng Zhou[1]; [1]*NIST, USA*. A novel hemispherical Fabry-Pérot microcavity with high finesse, good optical performance and compact packaging is developed for potential applications in optomechanical accelerometry and precision sensing.

JW4A.91
Highly Sensitive Plasmonic Metasensor with Wide Detection Range, Rifat Ahmmed Aoni[1], Mohsen Rahmani[1], Lei Xu[2], Rajib Ahmed[3], Dragomir Neshev[1], Andrey Miroshnichenko[2]; [1]*Nonlinear Physics Centre, Research School of Physics and Engineering, Australian National Univ., Australia;* [2]*School of Engineering and Information Technology, Univ. of New South Wales, Australia;* [3]*Bio-Acoustic MEMS in Medicine (BAMM) Lab, School of Medicine, Stanford Univ., USA*. We propose a highly sensitive plasmonic metasensor for the detection of wide range of analyte refractive index (RI) from 1 to 1.60. The proposed metasensor shows the average sensitivity of 630 nm/RIU with high linearity of 0.9998.

JW4A.92
Non-Reciprocal Transport in Floquet Photonic Resonators: High Frequency Expansion, Huanan Li[1], Boris Shapiro[2], Tsampikos Kottos[1]; [1]*Wesleyan Univ., USA;* [2]*Technion - Israel Inst. of Technology, Israel*. We develop a systematic high-frequency expansion of the scattering matrix of Floquet periodically-driven photonic systems. The method unveils the critical role of micro-motion for non-reciprocal transport in such systems.

JW4A.93
Withdrawn

JW4A.94
Photonic Crystals Band Diagrams Computation by Using Extreme Learning Machine, Adriano da Silva Ferreira[2], Gilliard N. Malheiros-Silveira[1], Hugo E. Hernandez-Figueroa[2]; [1]*São Paulo State Univ. (Unesp), Brazil;* [2]*DECOM, Univ. of Campinas, Brazil*. We modeled Extreme Learning Machine feed-forward Artificial Neural Network for estimating band diagrams of tri-dimensional photonic crystals and demonstrated a simple approach for speedy computations.

JW4A.95
Improved Acetylene-Filled Photonic Bandgap Fiber Cells Fabricated using a Tapering Method, Sajed Hosseini[1], Manasadevi Thirugnanasambandam[1], Kushan Weerasinghe[1], Kristan Corwin[1], Brian Washburn[1]; [1]*Kansas State Univ., USA*. Gas-filled photonic microcells (PMC) have been produced by tapering the end of photonic bandgap fibers. This method improves cell transmission and reduces etalon-like effect. PMC contamination was determined by fitting the measured absorption lines.

JW4A.96
Integration of TMDCs Layer on a Silicon Micro-ring Resonator for Photonic Applications, Rishi Maiti[1], Rohit Hemnani[1], Rubab Amin[1], Volker J. Sorger[1]; [1]*GEORGE WASHINGTON UNIV., USA*. Here we report on the integration of 2D TMDCs materials on Silicon microring to tune the rings resonance as a function of coverage length. This hybrid platform can be used for versatile photonic device applications.

JW4A.97
All-dielectric integrated photonic devices based on multimode intereference of Bloch surface waves, Dmitry N. Gulkin[1], Kirill Safronov[1], Ksenia Abrashitova[1,2], Ilya Antropov[1], Aleksandr Frolov[1], Vladimir O. Bessonov[1], Andrey A. Fedyanin[1]; [1]*Lomonosov Moscow State Univ., Russia;* [2]*mmanuel Kant Baltic Federal Univ., Russia*. The multimode intereference of the Bloch surface wave devices in 1D photonic crystal was experimentally and numerically studied. Photonics devises based on this phenomena were demonstrated.

JW4A.98
Highly Sensitive Nanogap-Based Surface Plasmon Resonance Biosensing through Light-Matter Colocalization, Changhun Lee[1], Eunji Sim[2], Donghyun Kim[1]; [1]*Electrical and Electronic Engineering, Yonsei Univ., South Korea;* [2]*Chemistry, Yonsei Univ., South Korea*. We present characteristics of surface plasmon resonance biosensing with nanogap-based light-matter colocalization. Optical signature was shown to increase by nearly 15 times than conventional detection with high sensitivity at a relatively large gap.

JW4A.99
Residual Intensity Modulation Analysis of Multifunction Integrated Optic Circuit, Jiaqi Liu[1], Chunxi Zhang[1], Jingming Song[1], Dewei Yang[1], Wei Cai[1], Chunxiao Wu[1]; [1]*Beihang Univ., China*. The reasons for residual intensity modulation (RIM) in APE $LiNbO_3$ MIOC are theoretical analyzed. The linear and nonlinear part are evaluated quantitatively. The RIM of a high PER MIOC with spatial filters is tested.

JW4A.100
Withdrawn

JW4A.101 *RAPID*
Fabrication of Nano Arrays on Chromium Coated Optical Fibre Tip, Meher Wan[1], Saawan Kumar Bag[1], Rajat K. Sinha[1], Shailendra Varshney[1], B. Lahiri[1], chacko Jacob[1], Cheruvu S. Kumar[1]; [1]*Indian Inst. of Technology-Kharagpur, India*. We report the creation of chromium-coated optical fiber meta-tip using Focused-Ion-Beam Lithography. A 2D nano array is designed and fabricated on standard optical fiber tip and supports the localized surface plasmon resonance.

JW4A.102
SPR based fiber optic pH sensor using polyaniline as a sensing layer, Vivek Semwal[1], Banshi D. Gupta[1]; [1]*Indian Inst. of Technology, Delhi, India*. In the present work, we report a surface plasmon resonance based fiber optic pH sensor utilizing polyaniline as a sensing layer. The sensor works for the pH range from 3 to 11.

JW4A.103
ULI based single-mode multimode single-mode waveguide structure as a highly sensitive refractive index sensor: Design and simulation, Parvinder Kaur[1], M. R. Shenoy[1]; [1]*Dept. of Physics, Indian Inst. of Technology Delhi, India*. We propose the design of a highly sensitive refractive index sensor based on ULI single-mode multimode single-mode waveguide structure. The VE multimode waveguide sensor has refractive index sensitivity ~ 10^4 nm/RIU.

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JW4A.104
Transmission Control in Photonics Crystal Slab Using Transparent Conductive Oxide, Vishal Vashistha[1], Andriy Serebryannikov[1], Maciej Krawczyk[1]; [1]*Physics, Adam Mickiewicz Univ. in Poznan, Poland.* We proposed to control the propagation of light through PhC slab by imposing a lossy boundary condition from the direction perpendicular to plane of propagation using transparent conducting oxides.

JW4A.105
ITO-Si heterojunction solar cell with nanocrystal line CdTl thin films, Andrii Pocherpailo[1], Sergii Kondratenko[1]; [1]*Taras Shevchenko National Univ., Ukraine.* ITO-Si heterojunction solar cell with nanocrystal line CdTe thin films grown by magnetron sputtering is studied. The electrical and optical properties of these solar cell devices were studied by current–voltage and photovoltage spectroscopy.

JW4A.106
Effects of spectral shift on ultrashort pulse propagation in AZO/ZnO multilayered metamaterials at epsilon-near-zero, Priscilla Kelly[1], Lyuba Kuznetsova[1]; [1]*San Diego State Univ., USA.* Numerical FDTD study of ultrashort (100 fs) pulse propagation shows strong pulse shaping for central frequencies smaller than the epsilon-near-zero (ENZ) point, and soliton-like propagation (up to 500 nm) for central frequencies larger than ENZ.

JW4A.107
Rectangular Waveguide based SOI Toluene Gas Sensor, Anumeha Varma[1], Dhananjoy De[1], Ritu Raj Singh[1], Vishnu Priye[1]; [1]*Indian Insttitute of Technology, Dhanbad, India.* The Silicon on insulator (SOI) rectangular waveguide as a toluene gas sensor is designed. Change in confinement factor and sensitivity of the sensor against the low fraction of toluene is reported at 1550nm operating wavelength.

JW4A.108
Surface Plasmon Resonance as a biosensing technique for possible development of a point of care diagnostic tool., Rudzani Malabi[1,2], sello Manoto[1], Saturnin OmbindaLembourba[1], Patience Mthunzi-Kufa[1]; [1]*CSIR National Laser Centre, South Africa;* [2]*Physics, UNISA , South Africa.* Surface Plasmon Resonance is an optical sensing technique with the ability to monitor molecular binding in real-time for biological and chemical sensing applications.

JW4A.109
Instantaneous Quantum Description of Photonic Wavefronts for Phase-Sensitive Amplification, Andre Vatarescu[1]; [1]*R&D, Fibre-Optic Transmission of Canberra, Australia.* Pure photonic quantum states consist of two consecutive number states, enabling evaluation of instantaneous amplitudes and phases of wavefront distributions of photons Sub-Poissonian distributions are shaped without the need for quasi-probabilities.

JW4A.110
Optical Responses of Asymmetrical Ag Nano-particles in Graphene Environment, Shivani Bhardwaj[1], R.P. Sharma[1]; [1]*Indian Inst. of Technology, Delhi, India.* Scattering and absorption efficiencies of the Oblate and ortho-Oblate Ag nano-particles has been calculated by the numerical experiment named as Discrete Dipole Approximation (DDA) against the quasi-static approximation in Graphene environment.

JW4A.111
Optical Sum Frequency Generation Spectroscopy and Microscopy of Starch in Rice Grain as a Function of Developing Stage, Akira Matsubara[1], Goro Mizutani[1], Khuat Thi Thu Hien[1], Wataru Kouyama[1], Sultana Sharmin[1], Yasunori Nakamura[2]; [1]*Japan Adv. Inst. of Sci. and Tech., Japan;* [2]*Akita Prefectural Univ., Japan.* The change of the molecular structure of sugar chains in rice seeds at different growth stages after flowering using a confocal sum frequency generation microscope. The starch structure in the developing rice endosperm was estimated by SFG spectra.

JW4A.112
Quantitative Analysis of Glucose Concentration Using NIR Spectroscopy, Selvy U. Hepriyadi[1], Iwan C. Setiadi[1], Aulia Nasution[1]; [1]*Engineering Physics, Institut Teknologi Sepuluh Nopember, Indonesia.* The quantitative evaluations were carried out using PLS model. The collected absorbance data was pre-processed before calibration. From the data acquisition, it can be obtained the good model for predicting glucose concentration.

JW4A.113
A Custom Multi-Pixel Photodetector Probe and Partial Least Squares Regression for the Efficient Identification of Optical Tissue Properties, Callie M. Woods[1], Ozlem Senlik[1], Nan M. Jokerst[1]; [1]*Electrical and Computer Engineering, Duke Univ., USA.* Diffuse reflectance spectroscopy performed using a custom photodetector array combined with partial least squares regression increases the accuracy of optical tissue property extraction. Prediction accuracies of 4.15% (u_s), 9.02% (u_a) are reported.

JW4A.114 *RAPID*
Near-real time evaluation of live and dead bacterial concentration using the optrode – a portable fluorimeter, Fang Ou[1], Cushla McGoverin[1], Simon Swift[2], Frédérique Vanholsbeeck[1]; [1]*The Dodd-Walls Centre for Photonic and Quantum Technologies, Dept. of Physics, The Univ. of Auckland, New Zealand;* [2]*School of Medical Sciences, The Univ. of Auckland, New Zealand.* We describe a method to determine live and dead bacterial concentration that take advantage of an inexpensive fibre-based fluorimeter, the optrode, which can measure fluorescence intensity in bacterial solutions in challenging working environments.

JW4A.115
Two-photon fluorescence microscopy and selective laser ablation through multimode fibers, Eirini Kakkava[1], Donald Conkey[1], Damien Loterie[1], Christophe Moser[1], Demetri Psaltis[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland.* Using wavefront shaping, we deliver a focus spot through a multimode fiber (MMF) with a maximum peak power of ~$1x10^{13}$W/cm^2, sufficient to perform two-photon fluorescence (TPF) imaging and laser ablation (LA) of a variety samples.

JW4A.116
Simultaneous Two-layer Two-photon Imaging with Confocal Strategy, Qinglei Hu[1], Pei Li[1], Yu Wang[1], Yumaio Xiong[1], Xiaohua Lv[1], Shaoqun Zeng[1]; [1]*Huazhong Univ. of Science and Technology, China.* To simultaneously record images from two planes at different axial positions, a two-photon imaging method was proposed in which signal demultiplexing is implemented using confocal strategy.

JW4A.117
High-throughput Light Sheet Tomography Platform for Fast Imaging of Whole Mouse Brain, Xiong Yang[1], Qi Zhang[1], Fei Huang[1], Longhui Li[1], Yongsheng Zhang[1], Xiaofeng Cheng[1], Shaoqun Zeng[1], Xiaohua Lv[1]; [1]*Huazhong Univ. of Science and Technology, China.* Here we develop a high-throughput light-sheet tomography platform (HLTP), by which an aligned three-dimensional image dataset of a whole mouse brain can be obtained within 5 hours.

JW4A.118
Enhanced Discrimination of Cervical Cancer by Application of PCA with SVM on Time-Resolved Fluorescence Decay, Gyana Sahoo[1], Asima Pradhan[1,2]; [1]*Physics, Indian Inst. of Technology Kanpur, India;* [2]*CELP, Indian Inst. of Technology Kanpur, India.* Time-resolved fluorescence decay of normal and abnormal cervical tissue is seen to display better discrimination on application of PCA, which captures subtle changes in fluorophore environment and the application of SVM quantifies the discrimination.

JW4A.119
A White Random Laser, Chia-Tse Tai[1], Yu-Ming Liao[1], Shu-Wei Chang[1], Wei-Cheng Liao[1], Shih-Yao Lin[1], Wei-Ju Lin[1], Cheng-Han Chang[1], Hung-I Lin[1], Packiyaraj Perumal[1], Golam Haider[1], Tai-Yuan Lin[1], Yang-Fang Chen[1]; [1]*National Taiwan Univ., Taiwan.* The hope of next-generation illuminants goes on random laser. Random laser is naturally endowed with two key superiorities, namely, laser-level intensity and broad-angular emissions, which are mutually exclusive in common light sources and lasers.

JW4A.120
Lens free microscope with an Arduino monochrome camera module, Camila de Paula D'Almeida[1], Patrick Oliveira Feitosa[1], Sebastião Pratavieira[1]; [1]*Instituto de Física de São Carlos (IFSC), Brazil.* Lens free microscope is an emerging portable and simple image device. In this paper, we present our version of this microscope, which make use of an Arduino camera module.

JW4A.121
Purity Analysis of Adulterated Vegetable Oils by Raman and FTIR Spectroscopy, Shyju Bhaskar[1], Spandana K. U[1], Krishna K. Mahato[1], Nirmal Mazumder[1]; [1]*Manipal Academy of Higher Education, India.* Raman and Fourier transfer infrared (FTIR) spectroscopy have been used to compute the purity and investigate the adulteration in edible oils which are commonly used.

JW4A.122
Dual Pulsed Laser Stimulation to the Auditory Nerve in Vivo, Muqun Yang[1], Tian Guan[1], Yonghong He[1]; [1]*Graduate School at Shenzhen, TSINGHUA UNIV., China.* We demonstrated a system of dual pulsed laser stimulation could successfully induce auditory response. We analyze its characterization and mechanism for future artificial cochlea.

JW4A.123
Displaying 3D Images on Mobile Phones, Nikolai I. Petrov[1], Vladislav G. Nikitin[1], Yuri Sokolov[1], Maxim Khromov[1]; [1]*Scientific and Technological Center of Unique Instrumentation of Russian Academy of Sciences, Russia.* Multiview 3D display system consisting of mobile phone screen and optical screen consisting of microlens array film is designed. 3D image files are created and images are demonstrated on different smartphones with high resolution displays.

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JW4A.124 *RAPID*
Sub-Rayleigh Limit Localization with a Spatial Mode Analyzer, Jeremy Hassett[1], Tanya Malhorta[3], Miguel Alonso[1], Robert Boyd[1,2], Mohammad Hashemi Rafsanjani[1], Anthony N. Vamivakas[1,3]; [1]*Optics, Univ. of Rochester, USA;* [2]*Physics, Univ. of Ottawa, Canada;* [3]*Physics, Univ. of Rochester, USA.* A spatial mode analyzer based on a generalized Michelson interferometer is applied to the estimation of sub-Rayleigh limit incoherent point source separations. Proof-of-principle experimental measurements of a single shifted source are presented.

JW4A.125 *RAPID*
Rapid detection of variability and adulteration of diesel oils, Boniphace E. Kanyathare[1], Buratin Khampirat[2], Kai E. Peiponen[3], Boonsong Sutapun[1]; [1]*Electronic Engineering, Suranaree Univ. of Technology, Thailand;* [2]*School of General Education, Inst. of Social Technology, Suranaree Univ. of Technology, Thailand;* [3]*Physics and Mathematics, Univ. of Eastern Finland, Finland.* Adulteration and smuggling of diesel oils are serious problems. Vis-NIR and PCA were applied to study samples from same oil fields and refinery process. Variability and adulteration were both detected rapidly.

JW4A.126
Weak-measurement-enhanced Metrology in the Presence of CCD Noise and Saturation, Liang Xu[1], Zexuan Liu[1], Lijian Zhang[1]; [1]*Nanjing Univ., China.* We experimentally demonstrate that the measurement using weak value amplification offers metrological advantages over the conventional measurement in the presence of classical noise and detection saturation with a generic scientific CCD.

JW4A.127
Naked-Eye Full-Screen Resolution Stereoscopic Imaging Based on Amplitude-Polarization Imager and Passive Distant Binocular Filter with Complementary Liquid Crystal Layers, Vasily A. Ezhov[1], Peter Ivashkin[1], Alexander Galstian[1]; [1]*GPI RAS, Russia.* The described method of the naked-eye stereoscopic imaging is flicker-free at 60 Hz frame rate due to simultaneous reproducing both full-screen view images. High separation contrast is due to complementarity of LC layers of the imager and the filter.

JW4A.128
Using adaptive window and non-uniform sampling model to improve autofocusing performances, Jie Cao[1], Yuqing Xiao[1], Qun Hao[1], Yang Cheng[1]; [1]*School of Optics and Photonics, Beijing Inst. of Technology, China.* An adaptive autofocusing method based adaptive sampling window and non-uniform sampling model is proposed. Model verification is carried out. The autofocus time under 8× using Laplacian (LAP) autofocus function reduces from 1670ms to 1240ms.

JW4A.129
Large field of view imaging based on compound and human hybrid eye using non-uniform curved microlens array, Yang Cheng[1], Jie Cao[1], Fanghua Zhang[1], Qun Hao[1]; [1]*Beijing Key Lab. for Precision Optoelectronic Measurement Instrument and Technology, School of Optics and Photonics, Beijing Inst. of Technology, China.* A large field of view (FOV) imaging system based on compound and human hybrid eye using non-uniform curved microlens array is proposed. Model verification is carried out. The FOV of this system is up to 96°.

JW4A.130
Automatic snow grain size measurement method based on adaptive minimum circumscribed rectangle, Xintong Fan[1], Lingjia Gu[1], Ruizhi Ren[1], Haoyang Fu[1]; [1]*Jilin Univ., China.* Snow grain size affects the brightness temperature of snow. At present, snow grain size is mainly based on manual measurement. In this paper, a method of automatic snow grain size measurement is proposed.

JW4A.131
Three-Dimensional Digital Reconstruction Methodology Specialized in Human Skulls, Andrés L. González[1], Jaime E. Meneses[1]; [1]*Universidad Industrial de Santander, Colombia.* This paper presents a three-dimensional reconstruction strategy (3DR) specialized in the digital reconstruction of Human Skulls. The strategy is based on the fringe projection technique.

JW4A.132
Shadow Detection and Removal from Buildings in UAV Data, Tingting Zhou[1], Haoyang Fu[1]; [1]*Jilin Univ., China.* Considering the problem that UAV data is susceptible to shadow interference, shadow detection and removal algorithms are used for buildings in UAV data in this paper.

JW4A.133
Low-rank Constrained Image Enhancement For Ghost Imaging., Tiaohua Li[1], Bin Luo[1], Dongchu Han[1], Junhui Li[1], Dongyue Yang[1], Guohua Wu[1], Hong Guo[2]; [1]*Beijing Univ of Posts & Telecom, China;* [2]*Peking Univ., China.* Low-rank constraint improves image quality of ghost imaging, for both correlation and compressive sensing approaches.Image by correlation plus low-rank constraint can even surpass that by compressive sensing when under-sampling.

JW4A.134
Image compression in real-time holographic projection in color, Paula A. Kochanska[1], Michal Makowski[1], Izabela Ducin[1], Karol Kakarenko[1], Jaroslaw Suszek[1], Marcin Bieda[1], Adam Kowalczyk[1]; [1]*Faculty of Physics, Warsaw Univ. of Technology, Poland.* In the paper we present holographic projection system used in holographic real-time transmission in color between Poland and Japan. We discuss visually-lossless data compression of CGH on the fly with client-adjustable compression ratios.

JW4A.135
Imaging Through Scattering Layers with Extention of Memory Effect Range Driven by Prior Information, Wei Li[1], Jiannan Wang[1], Jietao Liu[1], Xueying Sun[1], Guo Chengfei[1], Xiaopeng Shao[1]; [1]*Xidian Univ., China.* We demonstrate numerically and experimentally that by exploiting a known object, or even a point as prior information, the speckle correlation imaging method can be used to observe the extended object exceeding the memory-effect range.

JW4A.136
Imaging through haze utilizing a multi-aperture coaxial polarization imager, Xuan Li[1], Pingli Han[1], Fei Liu[1], Yi Wei[1], Xiaopeng Shao[1]; [1]*Xidian Univ., China.* This study focused on a polarization-based dehazing technology based on the multi-aperture coaxial polarization imager. By solving the image displacement problem accompanied with the imager, instant polarization dehazing is possible.

JW4A.137
Intramolecular Charge Transfer Probed by Femtosecond Stimulated Raman Spectroscopy, Sebok Lee[1], Myungsam Jen[1], Kooknam Jeon[1], Joonwoo Kim[1], Yoonsoo Pang[1]; [1]*Gwangju Inst of Science & Technology, South Korea.* Distinct Raman spectra of the locally excited and charge transferred conformers of DCM were resolved from femtosecond stimulated Raman measurements and a twisted geometry was proposed for the intramolecular charge transfer state.

JW4A.138
Passively Q-switched Laser Performance of $Nd_{0.01}$:$Gd_{0.89}La_{0.1}NbO_4$ Mixed Crystal, Haiyue Sun[1], Yufei Ma[1], Shoujun Ding[2], Zhenfang Peng[1], Ying He[1], Fang Peng[2], Xin Yu[1], Qingli Zhang[2]; [1]*Harbin Inst. of Technology, China;* [2]*Chinese Academy of Sciences, Hefei , China.* Diode-pumped continue-wave and passively Q-switched lasers with novel $Nd_{0.01}$:$Gd_{0.89}La_{0.1}NbO_4$ mixed crystals were demonstrated. The maximum peak power was 1.13 kW with the pulse width of 32 ns and the repetition rate of 24.5 kHz.

JW4A.139
Quantum-Classical Intersection from Perspective of Spatially-Resolved Intensity Interferometry, Piotr F. Wegrzyn[1], Lukasz Zinkiewicz[1], Radek Lapkiewicz[1]; [1]*Faculty of Physics, Univ. of Warsaw, Poland.* We present an extension to the intensity interferometry, which is an example of the intersection of quantum and classical theory. We believe that obtained results would contribute to deeper understanding of correspondence between those theories.

JW4A.140
Dinamic Laser Speckle applied to the determination of the specific surface area of clays, Ruth D. Mojica Sepulveda[1], Mendoza Herrera Luis Joaquin[2], Bertolini Guillermo[3], Cabello Carmen I.[3], Soria Delia B.[1], Trivi Marcelo[2]; [1]*CEQUINOR, Argentina;* [2]*Centro de Investigaciones Ópticas, Argentina;* [3]*Centro De Investigacion Y Desarrollo En Ciencias Aplicadas, Argentina.* Dynamic laser speckle (DLS) is proposed as a complementary technique to determine the specific surface area of natural and chemically modified bentonite. To verify this approach, we compared DLS technique with the standard physicochemical methods.

JW4A.141
Relativistic Single-Cycle Tunable Infrared Pulses Generated from a Tailored Plasma Density Structure, Zan Nie[1], Chih-Hao Pai[1], Jianfei Hua[1], Chaojie Zhang[2], Wei Lu[1], Hsu-Hsin Chu[3], Jyhpyng Wang[3,4], Warren Mori[2], Chan Joshi[2]; [1]*Tsinghua Univ., China;* [2]*Univ. of California Los Angeles, USA;* [3]*National Central Univ., Taiwan;* [4]*Inst. of Atomic and Molecular Sciences, Academia Sinica, Taiwan.* A new scheme capable of generating tunable relativistically intense, single-cycle pulses in the spectral range of 5-14 μm with a 1.7% conversion efficiency through asymmetric self-phase modulation in a tailored plasma density structure is proposed.

15:00–16:30
FW5A • AR and VR Ecosystems Developments
Presider: Jim Melzer; Thales Visionix; USA

FW5A.1 • 15:00 Invited
The Opportunities and Challenges of Creating Artificial Perception Through Augmented and Virtual Reality, Barry Silverstein[1]; [1]*Optics and Display, Facebook Reality Labs., USA*. Researchers are beginning to create and deliver realistic artificial human inputs. These inputs of sight, sound, motion, and touch are being woven together into virtual and augmented reality systems than can emulate convincing human perception.

FW5A.2 • 15:30 Invited
Smart Glasses and AR Headsets for Enterprise and Consumer Markets, John Haddick[1]; [1]*Osterhout Design Group, USA*. Abstract not available.

FW5A.3 • 16:00 Invited
The Age of Light: From an Electronic to a Photonic Society, Tish Shute[1,2]; [1]*Dir. AR/VR, Huawei, USA, USA;* [2]*Co-Founder, Augmented World Expo & Augmented Reality Org, USA*. This talk will look at the transformation from Electronics to Photonics and the important role AR/VR/MR will play in creating a Photonic Society and a better life for all.

15:00–16:30
FW5B • Optical Communications
Presider: Greg Raybon; Nokia Bell Labs, USA

FW5B.1 • 15:00 Invited
Rate-Adaptive Modulation Schemes for High Spectral Efficiency Optical Communications, Junho Cho[1], Sethumadhavan Chandrasekhar[1], Peter J. Winzer[1]; [1]*Nokia Bell Labs, USA*. We review various rate-adaptive modulation schemes for optical communications that maximize the spectral efficiency for any channel condition, and analyze their benefits and weaknesses.

FW5B.2 • 15:30
Ultra-wideband parametric amplification in telecom wavelengths with an optimally mode-matched PPLN waveguide, Yong Meng Sua[1], Jia-Yang Chen[1], Yu-Ping Huang[1]; [1]*Stevens Inst. of Technology, USA*. Ultra-wideband parametric amplification over 14 THz in the telecom band is realized via cascaded nonlinear processes in an optimally mode-matched PPLN waveguide. With a tailored waveguide cross-section, we observe a maximum gain of 38.3 dB.

FW5B.3 • 15:45
Generation of Phase-correlated Parametric Frequency Combs Spaced at 10GHz Based on Injection Locking, Jing Chen[1], Juanjuan Yan[1], Linnan Li[1]; [1]*Beihang Univ., China*. We demonstrate a phase-correlated parametric frequency comb generator using injection locking. A frequency comb spaced at 10GHz is experimentally generated in a span of 3nm.

FW5B.4 • 16:00
Scaling Bandwidths of Optical Frequency Combs Generated in Silicon Modulators through Heterodyne Optical Frequency Locking., Nagarjun KP[1], Vikram B.S.[1], Roopa Prakash[1], Vadivukkarasi Jeyaselvan[1], Shankar K. Selvaraja[1], Supradeepa V.R.[1]; [1]*IISc, Bangalore, India*. We demonstrate bandwidth-scaling of frequency combs in silicon charge-injection modulators by linking two 10GHz combs (8 lines) through heterodyne optical frequency-locking within 6.6MHz resulting in a broadened comb of 13 lines in a 30dB band.

FW5B.5 • 16:15
Free-Space Optical Stealth Communication Based on Wideband Noise, Yang Qi[1], Ben Wu[1]; [1]*Electrical & Computer Engineering, Rowan Univ., USA*. We demonstrate a free-space optical (FSO) stealth communication system to protect the privacy of FSO channels. The signal is hidden in the phase randomness of wideband optical noise generated by spontaneous emission.

15:00–16:30
FW5C • Quantum Systems
Presider: Gordon A. Keeler; DARPA, USA

FW5C.1 • 15:00 Invited
A Dissipative Phase Transition in a Two-photon-driven Array of Kerr Resonators, Vincenzo Savona[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland.* We show that an array of coupled Kerr resonators, with two-photon drive and dissipation, behaves as a quantum simulator of the quantum XY spin model with transverse field. We study the associated quantum phase transition and its universality class.

FW5C.2 • 15:30
Implementing Majorana Fermions in a Cold-Atom Honeycomb Lattice with Textured Pairings, Ruizhi Pan[1], Charles Clark[1]; [1]*Univ. of Maryland, College Park, USA*. We propose a model to create unpaired Majorana fermions at one edge of a pseudospin-state dependent, time-reversal symmetry noninvariant honeycomb lattice by generalizing a topologically nontrivial Haldane model and introducing textured pairings.

FW5C.3 • 15:45
Self-trapping of light via the Pancharatnam-Berry phase, Chandroth P. Jisha[2], Alessandro Alberucci[1], Stefan Nolte[1,3]; [1]*Friedrich-Schiller-Universitat Jena, Germany;* [2]*Universidade do Porto, Portugal;* [3]*Fraunhofer Inst. of Applied Optics and Precision Engineering, Germany.* We discover a new type of light self-trapping based upon the Pancharatnam-Berry phase. These waves need a rotation of the optical axis dependent on the input light intensity, such as liquid crystals.

FW5C.4 • 16:00
Light Superfluidity in Hot Atomic Vapors, Quentin Fontaine[1], Alberto Bramati[1], Quentin Glorieux[1], Tom Bienaimé[1]; [1]*Laboratoire Kastler Brossel, France*. We investigate the dispersion relation of small amplitude density waves propagating on top of a photon fluid. We also present two ongoing experiments to study dispersive shock waves and observe superfluidity of light.

FW5C.5 • 16:15
Goos-Hänchen shift in a two-dimensional atomic crystal, Michele Merano[1]; [1]*Universita degli Studi di Padova, Italy.* It is widely known that the Goos–Hänchen shift in three dimensional materials is proportional to the wavelength of the incident light. In freestanding two-dimensional crystals instead, it is proportional to their surface susceptibility.

15:00–16:30
FW5D • Quantum Sensing for Industry and Fundamental Physics II
Presider: To be Determined

FW5D.1 • 15:00 Invited
Commercialization of Quantum Sensing Technologies, Nils Hempler[1]; [1]*M Squared Lasers, UK.* The presentation will describe M Squared's mission to transfer the demonstrated potential of quantum technologies from lab based demonstrator systems to fully engineered products that will benefit a wide range of industries.

FW5D.2 • 15:30 Invited
Time for Quantum Technologies: Optical Clocks for Users, Stephan Ritter[1]; [1]*TOPTICA Photonics, Germany.* High-precision clocks are one of the first and most prominent examples of quantum technology. Optical clocks employ narrow-band optical transitions in atoms or ions as frequency standards, with applications ranging from synchronization and navigation to the measurement of height differences. As with other quantum technologies, optical clocks have to be brought out of the laboratory and into the hands of users in order to exploit their full application potential. To this end, a consortium of six companies, two universities, one research and one federal institute have teamed up to realize a robust, long-lasting and easy-to-use demonstrator device for an optical single-ion clock. The project, led by TOPTICA Photonics and the Physikalisch-Technische Bundesanstalt (PTB) and partially funded by the German Federal Ministry of Education and Research, will run for three years. It will on the one hand help to transfer scientific research results into industry and on the other hand leverage industrial expertise in project management, engineering, and system integration. In the talk, we will give an overview of the clock system and explain how the necessary development of key technologies will also benefit other quantum technologies. Related developments at TOPTICA will be sketched and we will review how this fits into the broader picture of a primarily quantum-enabling company.

15:00–16:30
FW5E • Plasmonic and Nanophotonic Materials
Presider: Mercedeh Khajavikhan; University of Central Florida, USA

FW5E.1 • 15:00 Invited
The Next Generation of Colloidal Quantum Emitters for Nanophotonics and Plasmonics, David Norris[1]; [1]*ETH Zurich, Switzerland.* New quantum emitters with improved properties for nanophotonics will be discussed. Examples include lanthanide-doped nanocrystals, semiconductor nanoplatelets, and perovskite nanocrystals.

FW5E.2 • 15:30
Purcell Enhancement in 1-D ITO-slot Photonic Crystal Nanobeam Cavity, Rubab Amin[1], Mohammad H. Tahersima[1], Zhizhen Ma[1], Can Suer[1], Ke Liu[1], Rishi Maiti[1], Volker J. Sorger[1]; [1]*The George Washington Univ., USA.* We report Si-slot waveguide with active-ITO layer 1D photonic crystal nanobeam cavity delivering 3.4 nm tuning keeping Q-factor moderately high. The subdiffraction limited mode volume $(0.1(\lambda/2n)^3)$ facilitates a high Purcell factor exceeding 4000.

FW5E.3 • 15:45
Interactions of Hexagonal Boron Nitride with the Insulator-Metal Phase Transition in Vanadium Dioxide, Samuel T. White[1], Alireza Fali[2], Thomas G. Folland[3], Joshua D. Caldwell[3], Yohannes Abate[2], Richard F. Haglund[1]; [1]*Vanderbilt Univ., USA;* [2]*Physics, Univ. of Georgia, USA;* [3]*Mechanical Engineering, Vanderbilt Univ., USA.* Phonon polaritons in hexagonal boron nitride (hBN) reflect and refract at phase domains in underlying vanadium dioxide (VO_2) crystals, a potential reconfigurable metasurface. Also, hBN slows the VO_2 phase transition via thermal or strain effects.

FW5E.4 • 16:00
MIR spin angular momentum detection by a chiral graphene plasmonic nanostructure, Jingyang Peng[1], Benjamin P. Cumming[1], Min Gu[1]; [1]*School of Science, RMIT Univ., Australia.* A graphene-chiral plasmonic nanostructure photodetector that can detect MIR spin angular momentum (SAM) has been designed, modelled and fabricated. We demonstrate circular dichroism of 30% and absorption of 65% at a wavelength of 3.9 μm.

FW5E.5 • 16:15
Active photonic integrated circuits combining Si_3N_4 microresonators with 2D materials for applications in the visible wavelength range, Clément Javerzac-Galy[1], Junqiu Liu[1], Arslan S. Raja[1], Tobias Kippenberg[1], Domenico De Fazio[2], Alisson Cadore[2], Ioannis Paradeisanos[2], Giancarlo Soavi[2], Gang Wang[2], Andrea Ferrari[2]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland;* [2]*Cambridge Graphene Centre, Univ. of Cambridge, UK.* We present air-cladded silicon nitride microresonators at visible wavelengths compatible with 2D material transfer, fabricated using the photonic Damascene reflow process. Quality factors of 1 million have been measured at 765 nm.

15:00–16:30
LW5F • Novel Lasers, Plasmonics, Nanophotonics II
Presider: Federico Capasso; Harvard University, USA

LW5F.1 • 15:00 Invited
Infrared Nanophotonics Based on Phonon Polaritons in Boron Nitride , Rainer Hillenbrand[1]; [1]*Nanogune, Spain.* Thin hexagonal boron nitride layers host ultra-confined and long-lived phonon polaritons, which allow for manipulating mid-infrared light on the nanometer scale. We discuss our recent progress including phonon-enhanced molecular vibrational sensing and hyperbolic metasurfaces.

LW5F.2 • 15:30 Invited
Resolving Multipolar Transitions and Directional Metasurface Light Emission with Momentum-Resolved Spectroscopy, Jon Schuller[1]; [1]*Univ. of California Santa Barbara, USA.* In momentum-resolved spectroscopy, researchers measure or control light's momentum content. Using momentum-resolved spectroscopy, we demonstrate multipolar light emission in layered perovskites and directional light emission in GaN metasurfaces.

LW5F.3 • 16:00 Invited
Plasmonic Metasurfaces: Combinatorial Colors and High-Speed Photodetection, Maiken Mikkelsen[1]; [1]*Duke Univ., USA.* Plasmonic film-coupled nanocubes are used to demonstrate large-area perfect absorbers, pixel arrays and ~10,000 combinatorial colors. By integrating a pyroelectric thin-film, we also demonstrate a high-speed, spectrally-selective thermal photodetector operating at room temperature.

16:45–18:45
FW6A • New Optical Hardware is Key to Next Generation AR and MR
Presider: Patricia Shute; Huawei, USA

FW6A.1 • 16:45 Invited
Recreating Reality: Enabling Immersive VR/AR Experience on Mobile Platforms, Behnam Bastani[1]; [1]*Oculus, USA.* The talk outlines how a full system integration, from content creation, to transmission to display optics play an important role on delivering an immersive experience in head-mounted displays. It highlights the challenges in the industry especially as customer would like to have a more realistic experience on standalone devices.

FW6A.2 • 17:15 Invited
Meta-Resonant Waveguide-Gratings - Monochromatic Diffraction to AR, Guillaume Basset[1]; [1]*Resonant Screens, Switzerland.* Meta-Resonant Waveguide-Gratings can be engineered to have selective and tunable diffraction, while being manufactured with high throughput methods. This enables new optical combiners for AR being affordable, compact and providing a better immersion.

FW6A.3 • 17:45 Invited
Is LCOS the Display of Choice for AR?, Poking Li[1]; [1]*Himax, Taiwan.* Abstract not available.

16:45–18:15
FW6B • Novel Optical Fibers and Modulators
Presider: Lyuba Kuznetsova; San Diego State University; USA

FW6B.1 • 16:45 Invited
High Performance Chalcogenide Photonic Crystal Fibers Pumped in the Short Wave Infrared, Camille-Sophie Bres[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland.* We present recent advances in Chalcogenide photonic crystal fibers for use in the short wave infrared. Results on fiber quality, nonlinear parametric effects and supercontinuum generation are covered.

FW6B.2 • 17:15
Photonic crystal fiber metalensenabled by geometric phase optical metasurfaces, Jingyi Yang[1], Indra Ghimire[1], Pin Chieh Wu[2], Sudip Gurung[1], Catherine Arndt[1], Din Ping Tsai[2], Howard Lee[1,3]; [1]*Dept. of Physics, Baylor Univ., USA;* [2]*Research Center for Applied Sciences, Academia Sinica, Taiwan;* [3]*The Inst. for Quantum Science and Engineering, Texas A&M Univ., USA.* We demonstrate an in-fiber chromatic metalens that can focus light upon exiting the fiber with numerical-aperture of 0.3714 at wavelength of 1550 nm by integrating geometric phase metasurface on the end-facet of photonic crystal fiber.

FW6B.3 • 17:30
Virtual Draw of Tubular Hollow-Core Fibers, Gregory T. Jasion[1], John R. Hayes[1], Natalie V. Wheeler[1], Yong Chen[1], Thomas D. Bradley[1], Reza Sandoghchi[1], Marco Petrovich[1], Francesco Poletti[1], David Richardson[1]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK.* A numerical model that accurately predicts the fabricated geometry of tubular hollow-core fibers is presented and experimentally validated. Such a model can be invaluable in driving design decisions for yield upscaling and loss reduction.

FW6B.4 • 17:45
Composite Material Hollow Core Optical Fiber Electro-Modulation, Adam Lewis[1], Francesco De Lucia[1], Walter Belardi[1], Chung-Che Huang[1], John R. Hayes[1], Francesco Poletti[1], Dan Hewak[1], Pier Sazio[1]; [1]*Univ. of Southampton, UK.* We demonstrate the integration of the Transition Metal Dichalcogenide (TMDC) materials WS_2 and MoS_2 into hollow core anti-resonant fibers. We show the potential to use such structures as all fiber electro-optical modulators.

16:45–18:15
FW6C • Solid State Quantum Optics
Presider: Vincenzo Savona; Ecole Polytechnique Federale de Lausanne, Switzerland

FW6C.1 • 16:45 Invited
Deterministic Coupling of Quantum Emitters in Two-dimensional Materials to Optical Cavities, Stefan Strauf[1]; [1]*Stevens Inst. of Technology, USA.* We review our recent work on deterministic coupling of site controlled quantum emitters in WSe2 to plasmonic nanocavities as well as integration schemes for quantum emitters in boron nitride to metallo dielectric antennas.

FW6C.2 • 17:15
Charge-Tunable Quantum Dots in Monolayer WSe_2, Mauro Brotons-Gisbert[1], Artur Branny[1], Santosh Kumar[1], Raphael Picard[1], Raphael Proux[1], Brian Gerardot[1]; [1]*Heriot-Watt Univ., UK.* We demonstrate Coulomb blockade in monolayer WSe_2 quantum dots. Further, gate tunable hybridization of the localized and continuum of electron states in a Fermi sea is observed due to strong tunnel interaction.

FW6C.3 • 17:30
A Silicon Photonic On-Chip Filter for Quantum Emitters, Shahriar Aghaeimeibodi[1], Je-Hyung Kim[2], Mustafa Atabey Buyukkaya[1], Chang-Min Lee[1], Christopher J. Richardson[3], Richard P. Leavitt[3], Edo Waks[1,4]; [1]*Electrical and Computer Engineeering, Univ. of Maryland, USA;* [2]*Dept. of Physics, Ulsan National Inst. of Science and Technology, South Korea;* [3]*Lab for Physical Sciences, Univ. of Maryland, USA;* [4]*Joint Quantum Inst., Univ. of Maryland, USA.* We demonstrate on chip filtering of single photons using a hybrid integrated device that contains III/V quantum dots and a silicon-on-insulator photonic disk resonator.

FW6C.4 • 17:45
Enhancing Two-Photon Emission From Epitaxially Grown Quantum Dot With Nanoantennas, Andrzej Gajewski[1], Karolina Slowik[1], Jakob Straubel[2], Carsten Rockstuhl[2]; [1]*Nicolaus Copernicus Univ., Poland;* [2]*Karlsruhe Inst. of Technology,, Germany.* We present the result of broad analysis of enhancement and control of emission of an entangled two-photon pair from the epitaxially grown quantum dot (InAs/InP) by the mean of nanoantennas.

16:45–18:15
FW6D • Quantum Computing with Atoms and Photons I
Presider: To be Determined

FW6D.1 • 16:45 Invited

Photonic Integrated Circuits for Scalable Quantum Networks, Dirk Englund[1]; [1]*MIT, USA.* Photonic integrated circuits (PICs) have become increasingly important in classical communications applications over the past decades, including as transmitters and receivers in long-haul, metro and datacenter interconnects. Many of the same attributes that make PICs attractive for these applications — compactness, high bandwidth, and the ability to control large numbers of optical modes with high phase stability — also make them appealing for quantum information processing. The first part of this talk will review our recent progress in adapting one of the leading PIC architectures—silicon photonics—for various quantum secure communications protocols. The second part of the talk will describe how photonic integrated circuits technology can extend the reach of quantum communications through all-optical and memory-based quantum repeater protocols.

FW6D.2 • 17:15 Invited

Quantum Control and Metrology with Trapped Ions, Michael Biercuk[1]; [1]*Univ. of Sydney, Australia.* In this talk we provide an overview of the field of quantum control engineering and the tools we have built to enhance the performance of quantum devices for applications in quantum computing and quantum sensing. We introduce the concept of the filter function, a simple heuristic tool to characterize the decoherence-sensitivity of arbitrary quantum operations performed on single or multi-qubit devices. We perform experiments with trapped ions to validate the predictive power of the filter functions and demonstrate how they can enable quantum control solutions addressing major challenges in both error suppression for quantum computing and narrowband detection for quantum sensing. These concepts form the fundamental tools at the heart of our venture-backed quantum technology startup Q-CTRL.

16:45–18:15
FW6E • Meta- and Nanophotonic Devices for Imaging and Applications
Presider: David Norris; ETH Zurich, Switzerland

FW6E.1 • 16:45 Invited

Medical Device Applications of Silicon Photonics, Roel G. F. Baets[1], Yanlu Li[1]; [1]*Ghent Univ., INTEC and IMEC, Belgium.* Silicon photonics enables compact and cost-effective photonic integrated circuits, based on manufacturing in CMOS fabs. It can serve point-of-care medical device applications. Here we focus on multi-beam laser Doppler vibrometry circuits for cardiovascular disease monitoring.

FW6E.2 • 17:15

Symmetric cladding thin film waveguides – from lossy media to disordered metasurfaces, Karsten Pufahl[1], D. Boyaciyan[2], Jan Heckmann[1], Philipp Franz[1], Nicolai B. Grosse[1], Regine v. Klitzing[2], Ulrike K. Woggon[1]; [1]*Technische Universität Berlin, Germany;* [2]*TU Darmstadt, Germany.* Symmetric cladding thin film waveguides (SCTW) are investigated with respect to nonlinear response and propagation length. Enhancement of both is demonstrated on thin metal films and functionalized metasurfaces (Au nanoparticles in a polymer brush).

FW6E.3 • 17:30

Dynamic Pulse Shaping by Metasurfaces, Shawn Divitt[1,2], Wenqi Zhu[1,2], Cheng Zhang[1,2], Henri Lezec[2], Amit Agrawal[1,2]; [1]*Univ. of Maryland College Park, USA;* [2]*National Inst. of Standards and Technology, USA.* Metasurfaces offer the ability to shape optical pulses with unprecedented resolution. Here, we demonstrate dynamic shaping of <15 femtosecond ultrafast laser pulses using a Taylor series system in conjunction with silicon metasurfaces.

FW6E.4 • 17:45

A Broadband Achromatic Metalens, Yi-Teng Huang[2], Hsin Yu Kuo[1], Pin Chieh Wu[2]; [1]*National Taiwan Univ., Taiwan;* [2]*California Institue of Technology, USA.* Metalens suffers from chromatic aberration issue, which limits its applications on color images. Here we demonstrate the first broadband achromatic metalens in visible wavelength based on the concept of integrated-resonant unit elements (IRUEs).

16:45–18:15
LW6F • Novel Lasers, Plasmonics, Nanophotonics III
Presider: Andrea Alu; University of Texas at Austin, USA

LW6F.1 • 16:45

Active-Cavity Optomechanics: A Self-Cooling Laser, John Lawall[1], Adarsh Ganesan[1], Justin Foley[1], Weijian Yang[2], Christopher Chase[3]; [1]*NIST, USA;* [2]*Electrical and Computer Engineering, Univ. of California at Davis, USA;* [3]*Bandwidth 10, Inc., USA.* We demonstrate interferometrically that a laser with a mechanically compliant output coupler can optically self-cool its fundamental mechanical mode from room temperature to an effective temperature of 30 K.

LW6F.2 • 17:00

Quantum-Well Diode Lasers for Frequency Comb Generation, Mark Dong[1], Herbert G. Winful[1], Steven T. Cundiff[1]; [1]*Univ. of Michigan, USA.* We experimentally demonstrate single-section InGaAsP/InP quantum-well diode lasers for frequency comb generation at 1.5 μm and 1.3 μm wavelengths. Their optical and RF spectra are measured and analyzed.

LW6F.3 • 17:15

Low-Threshold Lasing From Monolithic Nanostructured Porous Silicon Hybrid Microcavities, Giuseppe Barillaro[1]; [1]*Information Engineering, Univ. of Pisa, Italy.* Here we demonstrate low-threshold lasing from fully-transparent nanostructured porous silicon (PSi) monolithic microcavities (MCs) infiltrated with a polyfluorene derivative that supports single-mode blue lasing at 466 nm, with line width of ~1.3 nm and lasing threshold of 5 nJ (i.e. fluence of 15 μJ/cm^2).

LW6F.4 • 17:30

Observed Phase-locking Between a Rubidium Raman Laser and its Pump Laser, Nicholas Condon[1,2], Devin Hileman[1,2], Shih Tseng[1,2], Zifan Zhou[1], Selim M. Shahriar[1]; [1]*Northwestern Univ., USA;* [2]*Digital Optics Technologies, USA.* We have observed that the beat-note between a rubidium Raman ring laser and its gain pump is much narrower than the spectral width of the pump laser itself, indicating that they are mutually phase-locked.

LW6F.5 • 17:45

Novel free space and fiber laser cavities demonstrating extreme sensitivities in Intracavity Phase Interferometry systems, James Hendrie[1], Hanieh Afkhamiardakani[1], Luke Horstman[1], Matthias Lenzner[1], Ladan Arissian[1], Jean Claude Diels[1]; [1]*Univ. of New Mexico, USA.* A method to enhance the sensitivity of sensors based on Intracavity Phase Interferometry by a factor of up to 10,000 is demonstrated in a free space laser. This technique is then implemented in fiber lasers.

FW6A • New Optical Hardware is Key to Next Generation AR and MR—Continued

FW6A.4 • 18:15 Invited

Stereo, Parallax, Wavefronts, and Immersion - Where is the Value?, Joel S. Kollin[1]; [1]*Microsoft, USA.* The dominant display paradigm (smart phones) prioritizes convenience over performance, and wrist- and head-mounted displays have yet to gain traction. How do we ensure that HMD doesn't follow stereoscopic video into niche markets or irrelevance?

FW6B • Novel Optical Fibers and Modulators—Continued

FW6B.5 • 18:00

Integrated Visible-Light Liquid-Crystal Phase Modulator, Milica Notaros[1], Manan Raval[1], Jelena Notaros[1], Michael R. Watts[1]; [1]*MIT, USA.* An integrated liquid-crystal phase modulator for applications within the visible wavelength range is demonstrated. A threshold voltage of ±1.2V is shown and 24π phase shift is achieved within ±2.5V in a 500-μm-long modulator.

FW6C • Solid State Quantum Optics—Continued

FW6C.5 • 18:00

Field Effect Transistors Deploying Anisotropic Two-Dimensional Materials for Light Generation and Detection, Ergun Simsek[1], Mengqing Yuan[3], Qing H. Liu[2]; [1]*Electrical Engineering and Computer Science, Exponent, USA;* [2]*Electrical and Computer Engineering, Duke Univ., USA;* [3]*Wave Computation Technologies, USA.* Photodetector sensitivity and photoluminescence efficiency of ReS2 coated SiO2/Si substrates are studied. For ultra-thin applications, metal nanoparticles embedded in Si yield maximum enhancement.

18:15–19:00 Dinner break on your Own

19:00–21:00 Postdeadline Papers (View Conference Updated Sheet for list of talks and locations.)

FW6D • Quantum Computing with Atoms and Photons—Continued

FW6E • Meta- and Nanophotonic Devices for Imaging and Applications—Continued

FW6E.5 • 18:00
Dynamic Transmission Control Based on All-Dielectric Huygens Metasurfaces, Austin A. Howes[1], Wenyi Wang[1], Ivan Kravchenko[2], Jason Valentine[1]; [1]*Vanderbilt Univ., USA;* [2]*Oak Ridge National Lab, USA.* Dielectric metasurfaces exhibit low-loss modes, but their volumetric field profiles make them difficult to dynamically tune. We overcome this issue by coupling resonators to an epsilon-near-zero mode in a thin film to actively modulate transmittance.

LW6F • Novel Lasers, Plasmonics, Nanophotonics III—Continued

LW6F.6 • 18:00
A Free-space Brillouin Laser Using Diamond, Zhenxu Bai[1], Robert Williams[1], Ondrej Kitzler[1], Soumya Sarang[1], David Spence[1], Richard Mildren[1]; [1]*MQ Photonics Research Centre, Dept. of Physics and Astronomy, Macquarie Univ., Australia.* Continuous-wave lasing in a free-space crystal Brillouin laser is demonstrated using CVD diamond. For a <111> polarized pump a threshold of 125 W is obtained, which corresponds to a gain coefficient of 60 cm/GW.

18:15–19:00 Dinner break on your Own

19:00–21:00 Postdeadline Papers (View Conference Updated Sheet for list of talks and locations.)

08:00–09:00
FTh1A • Vision Comfort as a Key to AR Mass Adoption
Presider: Barry Silverstein; Oculus, USA

FTh1A.1 • 08:00 Invited
Optimizing Head mounted Light Field Displays for Quality and Comfort, Hong Hua[1]; [1]*Univ. of Arizona, USA.* In this presentation, we describe a generalized framework to model the image formation process of light-field display methods and present a systematic method to characterize the retinal image and the accommodation response rendered by a light field display. We further employ this framework to investigate engineering guidelines for designing a 3D light field displays with a balance of quality and view comfort.

FTh1A.2 • 08:30 Invited
Title to be Determined, Edward Tang[1]; [1]*Avegant Corporation, USA.* Abstract not available.

08:00–09:00
FTh1B • Quantum Information
Presider: Momchil Minkov; Stanford University, USA

FTh1B.1 • 08:00 Invited
Silicon Photonics for Generating and Manipulating Entangled Photons, Shayan Mookherjea[1], Chaoxuan Ma[1], Xiaoxi Wang[1]; [1]*Univ. of California San Diego, USA.* Review of recent advances, future challenges and the state-of-the-art in integrated silicon photonics for quantum optical communications and other applications of heralded single and entangled photons.

FTh1B.2 • 08:30
High-precision phase noise estimation for continuous-variable quantum key distribution, Yijia Zhao[1], Yichen Zhang[1], Yundi Huang[1], Song Yu[1], Hong Guo[2]; [1]*Beijing Univ of Posts & Telecom, China;* [2]*Peking Univ., China.* We propose a high-precision phase noise estimation for continuous-variable quantum key distribution to reduce the phase noise caused by inaccurate estimation. The phase noise is reduced below 1/10 by using modified reference data.

FTh1B.3 • 08:45
Unsupervised Machine Learning Control of Quantum Gates in Gate-Model Quantum Computers, Laszlo Gyongyosi[2,1], Sandor Imre[1]; [1]*Budapest Univ of Techolology & Economic, Hungary;* [2]*Univ. of Southampton, UK.* The precise and stable working of quantum gates in quantum computers is essential for any quantum computations. We define a machine learning-based framework for the unsupervised control of entangled quantum gates in gate-model quantum computers.

08:00–09:00
FTh1C • Shaping Light and Design of Quantum Devices
Presider: Greg Gbur; University of North Carolina at Charlotte, USA

FTh1C.1 • 08:00 Invited
Framework for Complex Quantum State Generation and Coherent Control Based on On-Chip Frequency Combs, Piotr Roztocki[1], Christian Reimer[1,3], Stefania Sciara[1,4], Luis Romero Cortés[1], Yanbing Zhang[1], Benjamin Wetzel[1,5], Mehedi Islam[1], Alfonso Cino[4], Sai Chu[6], Brent Little[7], David Moss[8], Lucia Caspani[9], Jose Azaña[1], Michael Kues[1,10], Roberto Morandotti[1,2]; [1]*INRS-Energie Mat & Tele Site Varennes, Canada;* [2]*National Research Univ. of Information Technologies, Mechanics and Optics, Russia;* [3]*Harvard Univ., USA;* [4]*Univ. of Palermo, Italy;* [5]*Univ. of Sussex, UK;* [6]*City Univ. of Hong Kong, China;* [7]*Chinese Academy of Science, China;* [8]*Swinburne Univ. of Technology, Australia;* [9]*Univ. of Strathclyde, UK;* [10]*Univ. of Glasgow, UK.* Integrated frequency combs introduce a scalable framework for the generation and manipulation of complex quantum states (including multi-photon and high-dimensional states), using only standard silicon chip and fiber telecommunications components.

FTh1C.2 • 08:30 Invited
Connecting Quantum Systems through Optimized Photonics, Jelena Vuckovic[1]; [1]*Stanford Univ., USA.* Our inverse design approach offers a powerful tool to implement classical and quantum photonic circuits with superior properties, including robustness to errors in fabrication and temperature, compact footprints, novel functionalities, and high efficiencies. We illustrate this with a number of demonstrated devices in silicon and in diamond.

09:00–09:15 Break

09:15–10:00
FTh2A • Visionary: Sir Peter Knight
Presider: Kartik Srinivasan; National Inst of Standards & Technology, USA

FTh2A.1 • 09:15 VISIONARY
Quantum Technology for a Networked World, Peter L. Knight[1]; [1]*Kavli Royal Society International Ctr, UK.* I will describe the worldwide efforts to develop quantum technology, exploiting coherence and superposition. A second quantum revolution is emerging with electronic and photonic devices that use quantum science, harnessing our ability to interact with atoms, photons and electrons with exquisite level of control and with transformative potential for technology.

10:00–10:30 Coffee Break, *Concourse Foyer*

08:00–09:00
FTh1D • Quantum Computing with Atoms and Photons II
Presider: To be Determined

FTh1D.1 • 08:00 Invited

Quantum computing with Neutral Atoms, David Weiss[1]; [1]*Dept. of Physics, Penn State Univ., USA.* I will describe our approach to neutral atom quantum computing using a 3D optical lattice. We have previously demonstrated perfect filling of 5x5x2 and 4x4x3 arrays and site-addressed single qubit gates with 0.997 fidelity and low cross talk. Most recently, we have achieved lossless state detection with fidelities exceeding 0.999.

FTh1D.2 • 08:30 Invited

Reconfigurable and Programmable Ion Trap Quantum Computer, David Moehring, Jungsang Kim; *IonQ, USA.* Trapped atomic ion qubits present a fundamentally scalable approach to quantum computation. All qubits are identical, and interactions can be faithfully replicated and measured with near-perfect efficiency. Unlike many other approaches to quantum hardware, trapped ion qubits operate effectively at room-temperature, and even allow for reconfigurable quantum circuits. This flexibility will likely allow ion trap quantum computers to express the superset of all known quantum computation operations, and thus efficiently target any type of application that arises.

08:00–09:00
FTh1E • Computational/Transformation Optics and Optics in Computing
Presider: Simon Horsley; Exeter University, United Kingdom

FTh1E.1 • 08:00 Invited

Topology and the optical Dirac equation, S. A. R. Horsley[1]; [1]*Univ. of Exeter, UK.* Maxwell's equations can be written as an effective Dirac equation (the 'optical Dirac equation'), which can be a useful tool to classify electromagnetic materials. This analogy can be provide a new way to relate the integral of the Berry curvature (the Chern number) to the number of interface states. In contrast to the common approach we show that the Chern number can be computed without knowledge of how the material parameters depend on frequency.

FTh1E.2 • 08:30

Optical Convolutional Neural Networks with Optimized Phase Masks for Image Classification, Julie Chang[1], Vincent Sitzmann[1], Gordon Wetzstein[1]; [1]*Electrical Engineering, Stanford Univ., USA.* Convolutional neural networks excel in many computer vision applications but exert high computational demands. We propose a zero-power optical convolutional layer that can be incorporated for increased efficiency and show its potential in simulation.

FTh1E.3 • 08:45

Deep Neural Networks for Information Recovery Through Multimode Fibers, Eirini Kakkava[1], Navid Borhani[1], Christophe Moser[1], Demetri Psaltis[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland.* Image classification and reconstruction from the instensity speckle patterns at the distal end of a multimode fiber (MMF) was demonstrated using Deep Neural Networks (DNNs). Handwritten digits were recovered after propagation in 1km long MMF.

08:00–09:00
LTh1F • Precision Laser Spectroscopy
Presider: Konstantin Vodopyanov; University of Central Florida CREOL, USA

LTh1F.1 • 08:00 Invited

Development of Cryogenic Strontium Optical Lattice Clocks and their Applications, Masao Takamoto[1], Ichiro Ushijima[2,1], Hidetoshi Katori[2,1]; [1]*RIKEN, Japan;* [2]*The Univ. of Tokyo, Japan.* The recent progress of optical lattice clocks has improved the accuracies to 10^{-18}, which outperforms the realization of the SI second. We will present the development of the clocks and their applications in geodetic measurements.

LTh1F.2 • 08:30

Laser system to laser-cool and trap cadmium: towards a cadmium optical lattice clock, Daniel T. Schussheim[1], Kurt Gibble[1]; [1]*The Pennsylvania State Univ., USA.* We use frequency doubling and summing to generate >1 W of 326 nm to laser cool cadmium. Other wavelengths, 361, 468, and 480 nm, are also generated from the high power fiber amplifier. We developed an FPGA controller to automatically lock the system.

LTh1F.3 • 08:45

Optimization of acousto-optic frequency combs for multi-heterodyne spectroscopy, Kanagaraj Nithyanandan[1], Leao Djevarhidjian[1], Vicente Duran[1], Come Schnébelin[1], Samir Kassi[1], Guillaume Mejean[1], Daniele Romanini[1], Guillet de Chatellus Hugues[1]; [1]*CNRS / Université Grenoble Alpes, France.* Acousto-optic frequency combs provide more than 1000 mutually-coherent lines, and are a valuable tool for multi-heterodyne coherent spectroscopy. We present and validate a simple model of acousto-optic frequency combs, and discuss their limitations.

09:00–09:15 Break

09:15–10:00
LTh2B • Visionary: David DeMille
Presider: Nathan Newbury; NIST, USA

LTh2B.1 • 09:15 VISIONARY

Activities Shaping the Wavefront of Nanophotonics, David DeMille[1]; [1]*Yale Univ., USA.* Remarkably, certain ultra-precise spectroscopic measurements are sensitive to the existence of certain new, yet-undiscovered particles whose mass far exceeds that of the recently discovered Higgs boson. This talk will describe ongoing and future examples of such measurements, including the ACME experiment, a search for the electron's electric dipole moment.

10:00–10:30 Coffee Break, *Concourse Foyer*

10:30–12:30
FTh3A • AR/VR Applications for Enterprise and Consumer Markets
Presider: Hong Hua; University of Arizona, USA

FTh3A.1 • 10:30 Invited
Waveguide Manufacturing for AR Displays, Past, Present and Future, Jonathan Waldern[1]; [1]*DigiLens, USA.* Current AR waveguide fabrication processes, including Surface Relief Gratings (SRG), holographic and cascaded mirrors, are reviewed. We present DigiLens's Switchable Bragg Grating (SBG) based process, a manufacturing method based on classical holographic contact copy, which today is used for both large and small AR displays including a range of displays suitable for HUD and XR applications.

FTh3A.2 • 11:00 Invited
Augmented Reality Smart Glasses: Disruption or Distraction?, Kayvan Mirza[1]; [1]*Optinvent, France*. The destiny of mobile AR has been inextricably linked to the success of Smart Glasses. Although there is some traction in the enterprise space, consumer adoption has remained elusive. Will the next generation of Smart Glasses be more successful than their predecessors in bringing AR to the masses?

FTh3A.3 • 11:30 Invited
Use of AR and smart glasses at Erie Insurance, Brett McCorkle[1]; [1]*Erie Insurance, USA*. The insurance industry is rooted in legacy technology and business practices. Introducing technologies like smart glasses and AR is challenging due to change resistance and technical uncertainty. Using human-focused design in your implementation helps you engage users and increase the likelihood of adoption.

10:30–12:30
FTh3B • Quantum Electronics
Presider: Shayan Mookherjea; University of California San Diego, USA

FTh3B.1 • 10:30 Invited
Quantum-state Generation and Frequency-Domain Manipulation using Nanophotonics, Kartik Srinivasan[1]; [1]*NIST, USA*. I will review experiments on the generation and frequency-domain manipulation of photonic quantum states using scalable nanophotonic devices, and discuss their relevance to several applications in photonic quantum information science.

FTh3B.2 • 11:00
On-demand four-wave mixing parametric processes in periodically-tapered waveguides, Mohammed F. Saleh[1]; [1]*Heriot Watt Univ., UK*. I show using Fourier-series analysis how sinusoidally-tapered waveguides can be employed as efficient quasi-phase-matching schemes in third-order nonlinear media for on-demand four-wave mixing parametric processes, such as third-harmonic generation.

FTh3B.3 • 11:15
Complementarity of Vectorial Quantum Light, Andreas Norrman[1], Kasimir Blomstedt[2], Tero Setälä[2], Gerd Leuchs[1,3], Ari Tapio Friberg[2]; [1]*Max Planck Inst. for the Science of Light, Germany;* [2]*Univ. of Eastern Finland, Finland;* [3]*Univ. of Erlangen-Nuremberg, Germany.* We study partial coherence and polarization in double-pinhole interference and establish two general complementarity relations for genuine vectorial quantum-light fields. The framework uncovers new fundamental aspects of photon wave–particle duality.

FTh3B.4 • 11:30
Increasing Sensitivity of an Atom Interferometer to the Heisenberg Limit using *Enhanced* Quantum Noise, Renpeng Fang[1], Resham Sarkar[1], Selim M. Shahriar[1]; [1]*Northwestern Univ., USA*. We show how, by using a Schroedinger Cat state, the sensitivity of an atomic interferometer can be increased, to the Heisenberg limit, while *enhancing* the quantum noise, thereby suppressing strongly the effect of excess noise.

FTh3B.5 • 11:45
Self-similar Pulse Compression in the Tapered Silicon Waveguide, Jiayao Huang[1], Aruna Gandhi M S[1], Qian Li[1]; [1]*Peking Univ., China*. We demonstrate self-similar pulse compression in the tapered silicon waveguide. The initial 1 ps pulse can be compressed to 76.4 fs, and the corresponding peak power is 7.1 times compared to the initial pulse.

10:30–12:30
FTh3C • Optical Comb Metrology
Presider: Judith Dawes; Macquarie University, Australia

FTh3C.1 • 10:30 Invited
Spatio-temporal Manipulation of Light Waves by use of Optical Frequency Combs, Kaoru Minoshima[1,2], Akifumi Asahara[1,2]; [1]*Univ. of Electro-Communications, Japan;* [2] *JST ERATO MINOSHIMA Intelligent Optical Synthesizer (IOS), Japan*. Relative carrier envelope phase control in the dual-comb was utilized to generate an advanced light source for versatile spatiotemporal phase manipulation. Optical vortex comb is experimentally demonstrated with application for optical tweezers.

FTh3C.2 • 11:00
Efficient Non-Linear Optical Spectroscopy with Multiple High-Frequency Modulated Optical Frequency Combs, Ayan Chattopadhyay[1], Alexei Goun[1], Herschel Rabitz[1]; [1]*Princeton Univ., USA*. High signal-to-noise detection of the non-linear polarization is obtained, utilizing multiple high-frequency modulated optical frequency combs that place the observed polarization in the field-free region within comb line structure.

FTh3C.3 • 11:15
Bridging Telecom Wavelengths to Alkali Atomic Transitions with Tunable Kerr Frequency Combs, Su-Peng Yu[1,2], Travis C. Briles[1,2], Gregory T. Moille[3], Xiyuan Lu[3], Scott A. Diddams[1,2], Kartik Srinivasan[3], Scott B. Papp[1,2]; [1]*Time and Frequency Division, NIST Boulder, USA;* [2]*Dept. of Physics, Univ. of Colorado, USA;* [3]*Center for Nanoscale Science and Technology, NIST Gaithersburg, USA*. We report a silicon-nitride microresonator frequency comb platform that provides coverage from the telecom L band to the 780 nm range. Arbitrary design and generation of Kerr-soliton combs enables continuous fine-tuning across the entire bandwidth.

FTh3C.4 • 11:30
Progress Towards a Three-Node Free-Space Clock Network, Paritosh Manurkar[1], Sarah Stevenson[1], Isaac Khader[1], Jean-Daniel Deschenes[2], William Swann[1], Nathan R. Newbury[1], Laura Sinclair[1]; [1]*NIST Boulder, USA;* [2]*Octosig Consulting, Canada*. We report the latest progress towards the development of a three-node free-space clock network. We will demonstrate clock comparison between two optical nodes via coherent time/frequency transfer through a third node.

FTh3C.5 • 11:45
Towards Isolated Attosecond Pulses at 100 kHz for Electron-Ion Coincidence Spectroscopy, Federico J. Furch[1], Tobias Witting[1], Felix Schell[1], Mikhail Osolodkov[1], Claus Peter Schulz[1], Marc J. Vrakking[1]; [1]*Max Born Inst., Germany.* We report on the progress towards isolated attosecond pulses in the extreme ultraviolet at 100 kHz with high photon flux. The system will be used in pump-probe experiments detecting electrons and ions in coincidence

10:30–12:30
FTh3D • Quantum Communications and the Future Quantum Internet
Presider: To be Determined

FTh3D.1 • 10:30 Invited
Quantum Dot Based Devices for Telecom Wavelength Quantum Networks, Joanna Skiba-Szymanska[1], Tina Müller[1], Andrey Krysa[2], Jan Huwer[1], Ginny Shooter[1], Mathew Anderson[1], Martin Felle[1], Ian Farrer[2], Richard Penty[3], Richard M. Stevenson[1], Jon Heffernan[2], David Ritchie[3], Andrew Shields[1]; [1]*Toshiba Research Europe Ltd., UK;* [2]*Univ. of Sheffield, UK;* [3]*Univ. of Cambridge, UK.* Quantum networks rely on robust and secure distribution of quantum states to share entanglement between connected technologies. We demonstrate quantum dot based devices that use photons as flying qubits within existing fibre optics infrastructure.

FTh3D.2 • 11:00 Invited
Quantum Computation and Quantum Information, Ian Walmsley[1]; [1]*Univ. of Oxford, UK.* Hybrid light-matter networks offer the promise for delivering robust quantum information processing technologies, from sensor arrays to quantum simulators. New sources, circuits, detectors and memories illustrate progress towards building a resilient, scalable photonic quantum network.

FTh3D.3 • 11:30 Invited
Quantum Communication Experiments with Telecom-band Photonics Technologies, Hiroki Takesue[1]; [1]*NTT Basic Research Labs, Japan.* We present our effort to realize basic functions for advanced quantum communication systems using telecom-band photonics technologies, including entanglement sources using nano-scale silicon devices and quantum logic gate for time-bin qubits based on electro-optic modulators.

10:30–12:30
FTh3E • Information Processing, Information Display and Optical Device
Presider: Michael Klug; Magic Leap, USA

FTh3E.1 • 10:30 Invited
Optics for Wearable Spatial Computing Systems, Michael Klug[1]; [1]*Magic Leap, USA.* Spatial Computing requires visual system and wearable display compatibility for accurate perception, user comfort, and effective interaction. We present optical approaches that balance these goals with demands for manufacturability and practicality.

FTh3E.2 • 11:00
Digitally designed HOE lens arrays for large size see-through head up displays, Jackin Boaz Jessie[1], Lode Jorissen[2], Ryutaro Oi[1], Koki Wakunami[1], Yasuyuki Ichihashi[1], Philippe Bekaert[2], Kenji Yamamoto[1]; [1]*National Inst of Information & Comm Tech, Japan;* [2]*Expertise Center for Digital Media, Hasselt Univ.-tUL, Belgium.* See-through head-up 3D display which uses a commercial projector and holographic lens array is reported. The display system is significantly simplified and a 3D scene of size 20cm x 10cm x 5 cm (Depth) is successfully reconstructed.

FTh3E.3 • 11:15
Depth-induced Cellular Automata for Light Field Saliency, Yongri Piao[1], Xiao Li[1], Miao Zhang[1]; [1]*Dalian Univ. of Technology, China.* A Depth-induced Cellular Automata (DCA) is proposed to optimize light field saliency maps. DCA is robust to challenging scenes because it considered interactions and complementarities of intrinsic structure among the abundant cues on light field.

FTh3E.4 • 11:30
Iterative Forward-Backward Algorithm for Optical Diffraction Tomography, Shengli Fan[1], Seth D. Smith-Dryden[1], Guifang Li[1], Bahaa Saleh[1]; [1]*Univ. of Central Florida, CREOL, USA.* An iterative forward-backward algorithm for optical diffraction tomography is proposed for imaging phase objects with large refractive index contrast. Numerical results demonstrate accurate and robust reconstructions with sub-wavelength resolution.

FTh3E.5 • 11:45
Deep Neural Network for Low Light Phase Recovery, Alexandre Goy[1], Kwabena Arthur[1], Shuai Li[1], George Barbastathis[1,2]; [1]*Mechanical Engineering, MIT, USA;* [2]*Singapore-MIT Alliance for Research and Technology Centre, Singapore.* Poisson noise severely impacts imaging systems in low light conditions. We demonstrate the use of deep neural networks applied to phase retrieval and show successful phase recovery with only 10 photons per detector pixel.

10:30–12:30
LTh3F • Advances in Molecular Spectroscopy
Presider: Nathan Newbury; National Institute of Standards and Technology, USA

LTh3F.1 • 10:30 Invited
Optical Pulse Shaping, From Nanoseconds to Femtoseconds, And Its Roles in Coherent Molecular Spectroscopy and Medical Imaging, Warren S. Warren[1]; [1]*Duke Univ., USA.* I will discuss the evolution of pulse shaping and pulse train modulation technologies over many different timescales, with modern applications for characterizing materials and diagnosing disease.

LTh3F.2 • 11:00 Invited
Cavity-enhanced Ultrafast Spectroscopy: Enabling Transient Absorption Spectroscopy of Dilute Species in Molecular Beams, Melanie Reber[1], Nicholas Cooper[1], Ramesh Basnet[1], Kayla Warren[1]; [1]*Univ. of Georgia, USA.* Coupling ultrafast frequency combs to external enhancement cavities increases the sensitivity of transient absorption spectroscopy by several orders of magnitude. This enables femtosecond transient absorption of dilute species in molecular beams, such as hydrocarbon radicals.

LTh3F.3 • 11:30 Invited
Massively Parallel Sensing of Trace Molecules with Broadband Mid-Infrared Subharmonic Frequency Combs, Konstantin L. Vodopyanov[1], Andrey Muraviev[1], Viktor O. Smolski[3], Zachary E. Loparo[2]; [1]*CREOL, College of Optics and Photonics, Univ. Cent. Florida, USA;* [2]*Mechanical and Aerospace Engineering, Univ. Cent. Florida, USA;* [3]*Mid-Infrared Lasers, IPG Photonics, USA.* We use a pair of mutually-coherent frequency-divide-by-two OPOs with instantaneous span 3.1-5.5μm to demonstrate fast acquisition of 350,000 mode-resolved spectral data points and perform parallel detection in a mixture of 22 molecular species.

FTh3A • AR/VR Applications for Enterprise and Consumer Markets—Continued

FTh3A.4 • 12:00 Invited

AR UI for Lunar and Martian Energy Operations, Micah TinklePaugh[1]; [1]*EPRI Inst., USA.* Astronauts and utility workers need better visual tools than afforded by static screens and current interfaces. 'Holograms' in remote terrain, space capsules, control rooms, and storm affected environments might make them more effective and efficient.

FTh3B • Quantum Electronics—Continued

FTh3B.6 • 12:00

Simulation of nonlinear photonic crystals by modified finite difference frequency domain method, Tamás Szarvas[1], Zsolt Kis[2]; [1]*BME Dept. of Atomic Physics, Hungary;* [2]*HAS Wigner Research Center for Physics, Hungary.* We have worked out a true vectorial numerical method for the simulation of second harmonic generation by extending the finite difference frequency domain method. As an application we have simulated an array of nonlinear cylinders.

FTh3B.7 • 12:15

Nonlinear optical studies of new bioprobes, Katarzyna Matczyszyn[1]; [1]*Wroclaw Univ. of Science and Techn., Poland.* Two-photon fluorescent dyes and bistable molecular photoswitches are key components in the ongoing quest toward increasingly sophisticated, selective, sensitive, and versatile biological procedures and constitute an ideal mean to manipulate a wide range of bio-events.

FTh3C • Optical Comb Metrology—Continued

FTh3C.6 • 12:00

Gallium Phosphide Microresonator Frequency Combs, Dalziel Wilson[2,1], Simon Hönl[2], Katharina Schneider[2], Miles Anderson[1], Tobias Kippenberg[1], Paul Seidler[2]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland;* [2]*IBM Research, Zurich, Switzerland.* We demonstrate the first microresonator frequency combs in GaP, a III-V semiconductor transparent above 549 nm. High Kerr nonlinearity ($\sim 10^{-17}$ m^2/W) yields THz combs at 1550 nm with a 3-mW power threshold and >100-nm bandwidth.

FTh3C.7 • 12:15

Revealing the quantum nature of a free electron in an attosecond laser pulse, Ori Reinhardt[1], Ido Kaminer[1]; [1]*Technion, Israel.* Free electrons interacting with the frequency comb of an attosecond laser pulse follow intricate quantum dynamics. We present an analytic treatment of the interaction and use it to shape the electron energy spectrum.

FTh3D • Quantum Communications and the Future Quantum Internet—Continued

FTH3D.4 • 12:00 Invited

Quantum Key Distribution: From Technology to Real-World Implementation, Bruno Huttner[1]; [1]*ID Quantique, Switzerland.* The quantum computer is now seen as a credible threat to cybersecurity. Companies world-wide understand that upgrading to quantum-safe security is required. Quantum technologies, and especially quantum key distribution, provide a solution, which can be implemented today, and will contribute to a new cybersecurity infrastructure.

FTh3E • Information Processing, Information Display and Optical Device—Continued

FTh3E.6 • 12:00

Electro-Optical Response of Nonconventional Cholesteric Liquid Crystal with Refined Uniform Lying Helix Alignment, Yueh-Chern Lin[1], Po-Chang Wu[1], Wei Lee[1]; [1]*College of Photonics, National Chiao Tung Univ., Taiwan.* We demonstrate a well-aligned and stable uniform lying helix structure by adding bent-core molecules into a cholesteric liquid crystal. The frequency-dependent electro-optic response is characterized by flexoelectricity-induced dielectric relaxation.

FTh3E.7 • 12:15

Synthesis of Broadband Space-Time Diffraction-Free Wave Packets Using Transmissive Phase Plates, Murat Yessenov[1], Hasan E. Kondakci[1], Monjurul F. Meem[2], Danielle Reyes[1], Daniel Thul[1], Shermineh R. Fairchild[1,3], Martin C. Richardson[1], Rajesh Menon[2], Ayman Abouraddy[1]; [1]*CREOL, Univ. of Central Florida, USA;* [2]*Dept. of Electrical and Computer Engineering, Univ. of Utah, USA;* [3]*Physics and Space Sciences, Florida Inst. of Technology, USA.* We demonstrate the synthesis of broadband diffraction-free space-time pulsed light sheets using transmissive phase plates. We produce propagation-invariant wave packets having a bandwidth of 30~nm from a multi-terawatt femtosecond laser.

LTh3F • Advances in Molecular Spectroscopy—Continued

LTh3F.4 • 12:00 Invited

Probing Soot Formation and Chemical Evolution during Combustion, Hope A. Michelsen[1]; [1]*Combustion Research Facility, Sandia National Labs, USA.* Large gaps in the understanding of soot formation during combustion are predominantly attributable to a limited ability to probe relevant particle parameters during formation. This talk will describe approaches to developing appropriate diagnostics.

Key to Authors and Presiders

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