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Program updates and changes may be found on the Conference Program Update Sheet distributed in the registration bags.

Conference Schedule-at-a-Glance

	Sunday 18 October	Monday 19 October	Tuesday 20 October	Wednesday 21 October	Thursday 22 October
GENERAL & EXHIBITS					
Registration	12:00–18:30	07:00 –18:00	07:00–18:00	07:00–18:00	07:30–17:30
Speaker Ready Room	12:00–18:00	07:00–18:00	07:00–18:00	07:00–18:00	07:30–15:30
Coffee Breaks		10:00–10:30 15:30–16:00	09:30–10:00 14:30–15:00	09:30–10:00 15:30–16:00	10:00–10:30 15:00–15:30
Exhibition			09:30–16:00	09:30–14:00	
Unopposed Exhibition-only Times			09:30–10:30 12:00–13:00 14:30–16:00	09:30–11:00 12:30–13:30	
PROGRAMMING					
Townes Memorial Symposium: Reminiscences – Scientific and Personal	16:30–18:30				
FiO/LS Technical Sessions		08:00–15:30	10:30–18:00	11:00–18:00	08:00–17:30
Symposium on Photoreceptor Analysis and Single-cone-mediated Vision		08:00–10:00			
Laser Science Symposium on Undergraduate Research		10:00 - 16:00			
Symposium on Optics for Global Health and Low Resource Settings		13:30–15:30			
IYL – Science to Solutions		16:00–18:00			
Joint FiO/LS Plenary & Awards Sessions			08:00–09:30	08:00–09:30	
Joint FiO/LS Poster Sessions			14:30–16:00	09:30–11:00	
Symposium Honoring Adolf Lohmann				11:00–18:15	
Symposium on Optical Remote Sensing for the Climate				13:30–15:00	
FiO Postdeadline Paper Sessions				20:00–22:00	
Symposium on Applications of Low Noise Frequency Combs					13:00–17:30
SPECIAL EVENTS					
OSA Student Chapter Leadership Meeting (Invitation only)	07:00–17:00				
Townes Memorial Reception (sponsored by Thorlabs)	18:30–20:00				
OSA Student Member Reception	19:00–22:00				
Frontiers in Photonic Detection Panel Discussion		12:00–13:30			
Nonlinear Optics Technical Group Workshop		12:00–13:30			
OSA Fellow Members Lunch (invitation only)		12:00–13:30			
Meet OSA's Journal Editors		18:00–19:00			
OSA Microscopy and Optical Coherence Tomography Technical Group Poster Session		18:00–19:00			
International Year of Light/OSA President's Reception		18:30–20:30			
Optical Material Studies Technical Group			12:00–13:30		
Better than Fakin' it Good: Multifunctional Bioreplication			12:00–13:30		
OSA Student Chapter Competition			14:30–16:00		
Minorities and Women in OSA (MWOSA) Networking Reception			16:00–17:00		
Exhibitor Appreciation Reception (Sponsored by OSA Industry Development Association)			16:00–17:00		
OSA Annual Business Meeting			17:00–17:45		
DLS Annual Business Meeting			17:00–18:00		
OSA Member Reception			18:30–20:30		
Laser Science Banquet			19:00–22:00		
VIP Industry Leaders Networking Event				12:30–14:00	
Meet the Editors of the APS Journals				13:00–14:30	
OSA Science Educators' Day				17:00–20:00	
Optical Fabrication and Testing Technical Group Networking Event				18:00–20:00	
OIDA Town Hall Forum on Biophotonics Challenges and Opportunities				18:00–20:00	

Note: Dates and Times are subject to change. All times reflect Pacific time zone.

Welcome to Frontiers in Optics 2015

Welcome to San Jose, California—one of the premier centers of optics and photonics research in the USA. We are pleased that you have chosen to join us for the 2015 Frontiers in Optics (FiO) conference, the 99th Annual Meeting of The Optical Society.

This year's conference encompasses the breadth of optical science and engineering and provides an atmosphere that fosters the exchange of information between those working on fundamental research and those looking for solutions to engineering problems. 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 2015.

The technical program features over 700 invited, contributed oral and poster presentations by celebrated members of the community describing some of the most exciting advances in their fields. Special symposia and other major events further highlight major advances in many selected areas.

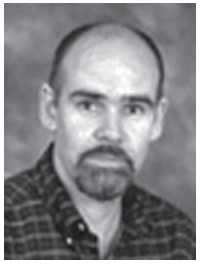
Joss Bland-Hawthorne, University of Sydney, Australia, the FiO plenary speaker, will speak on Astrophotonics: Future Developments in Astrophysics and Instrumentation at the Wednesday Plenary Session. James G. Fujimoto, MIT, USA, winner of the OSA 2015 Frederic Ives Medal/Jarus W. Quinn Prize, will also give an address at the Tuesday Plenary session. They will be joined by the LS plenary speaker David Reitze and the recipient of the APS 2015 Arthur L. Schawlow Prize in Laser Science, Christopher Monroe.

FiO is pleased to feature several special symposia – The Townes Symposium: Reminiscences – Scientific and Personal (Sunday, 18 October, 16:30–18:30); the Symposium on Photoreceptor Analysis and Single-cone-mediated Vision (Monday, 19 October, 08:00–10:00); the Symposium on Optics for Global Health and Low Resource Settings (Monday, 19 October, 13:30–15:00); the Symposium on Optical Remote Sensing for the Climate (Wednesday, 21 October, 13;30–15:30); and the Symposium Honoring Adolf Lohmann (Wednesday, 21 October, 11:00–18:15); the Symposium on Applications of Low Noise Frequency Combs (Thursday, 22 October, 13:00–17:30). Details about all the symposia are listed on the Symposia pages of this program.

This year's meeting is filled with many informational and networking events. Some of the highlights of FiO 2015 include the following:

- The Townes Memorial Symposium will be immediately followed by a reception on Sunday, 19 October, from 18:30–20:00.
- OSA Students will be welcomed at the OSA Student Member reception on Sunday, 19 October from 19:00–22:00.
- The International Year of Light – Science to Solutions Special Session will be held on Monday, 19 October, 16:00–18:00 followed by the International Year of Light/OSA Presidents Reception from 18:30–20:30.
- If you are an OSA member, be sure to join us at the OSA Member Reception on Tuesday, 20 October, from 18:30–20:30.
- Late-breaking advances in optics will be presented on Wednesday, 21 October, in the FiO Postdeadline Paper Sessions, running from 20:00–22:00.
- FiO is pleased to announce the 7th annual Emil Wolf Outstanding Student Paper Competition. One award winner will be selected from each of the seven FiO subcommittees. Selections will be made based on the quality of the submitted technical summary and presentation. Winners will be announced at the end of the conference and in the next issue of *Optics & Photonics News* (OPN).
- Tuesday and Wednesday, while you are enjoying the poster sessions and the coffee breaks in the Exhibit Hall and/or taking breaks from the presentations, please see the latest in scientific and optical instrumentation and information that our exhibitors have on display!
- Science Educators' Day will be held on Wednesday, 22 October, from 17:00–20:00, in the Regency Ballroom I. Hosted by The Optical Society, Science Educator's Day (EDAY) provides middle and high school science teachers with a wide variety of optics-focused lesson plans and classroom demonstration guides. EDAY attendees receive materials that can be used in middle and high school classrooms.

We welcome you to FiO 2015 and encourage you to take full advantage of the benefits of this year's social and networking opportunities, technical sessions, corporate programming, poster sessions and exhibition!



David Hagan
General Chair
Univ. of Central Florida, CREOL, USA

Nikola Alic
General Chair
Univ. of California at San Diego, USA

Nozomi Nishimura
Program Chair
Cornell Univ., USA

Ronald Reano
Program Chair
Ohio State Univ., USA

Welcome to Laser Science 2015

The leadership of the Division of Laser Science (DLS) of the American Physical Society (APS) is pleased to welcome you to our 31st annual meeting, Laser Science (LS) 2015, in San Jose, California, 18–22 October 2015. We are grateful for the help of our colleagues and technical program committee members, Ido Kaminer, Josh Hendrickson, Sangam Chatterjee, Nasser Peyghambarian, Lei Tian, Jesse Wilson, Dylan Yost, and Jeff Field, in organizing a broad range of topics in physics, biology 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, as well as a tutorial by Eli Yablonovitch on "Can Opto-Electronics Provide the Motive Power for Future Vehicles?" We have collaborated with our colleagues in The Optical Society to coordinate schedules to encourage your intellectual wanderings between DLS and OSA sessions.

In addition to an outstanding technical program, there are many exciting special symposia 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 selected undergraduate researchers.

David Reitze, *California Inst. of Technology, USA*, the LS plenary speaker, will speak on LIGO and the Coming Dawn of Gravitational Wave Physics and Astronomy at the Plenary Session and Awards Ceremony, Tuesday, 20 October from 08:00–09:30. Christopher Monroe, *University of Maryland, USA*, winner of the APS 2015 Arthur L. Schawlow Prize in Laser Science, will give his address on Wednesday, 21 October. They will be joined by the FiO plenary speaker and the recipient of the OSA 2015 Frederic Ives Medal/Jarus W. Quinn Prize.

The technical sessions for the Laser Science meeting are organized around several broad themes: Accelerating Beams in Optics and Beyond; Innovative Metallic-Emitter Coupled Systems; Semiconductor Nanooptics; Novel Fiber Lasers; Computational Optical Imaging; Advances in Nonlinear Laser Spectroscopy; and Light Propagation in Scattering Media. Also of special note is an International Year of Light – Science to Solutions Special Session (Monday, 19 October, 16:00–18:00).

Our DLS business meeting will be held Tuesday, 20 October from 17:00 to 18:00 in the Belvedere Room. The Laser Science banquet will be Tuesday evening, following the business meeting at the Gordon Biersch restaurant from 19:00–22:00.

We welcome you to the Laser Science 2015 Meeting and encourage you to take full advantage of this year's technical and poster sessions, symposia, and plenary lectures, as well as an exhibit hall showcasing leading suppliers to the laser science community.

Enjoy!

Galina Khitrova
Conference General Chair
Univ. of Arizona, USA

Randy Bartels
Conference Program Chair
Univ. of California Davis, USA

General Information

Conference Services

Registration
Market Street Foyer

Registration Hours

Sunday, 18 October	12:00–18:30
Monday, 19 October	07:00–18:00
Tuesday, 20 October	07:00–18:00
Wednesday, 21 October	07:00–18:00
Thursday, 22 October	07:30–17:30

Speaker Preparation Room
Paseo

Speakers and presenters are encouraged to stop by the Speaker Preparation Room to test their computers and presentations prior to their session. The room will be equipped with LCD projectors and screens. Computers will be available to test presentations.

Speaker Preparation Hours

Sunday, 18 October	12:00–18:00
Monday, 19 October	07:00–18:00
Tuesday, 20 October	07:00–18:00
Wednesday, 21 October	07:00–18:00
Thursday, 22 October	07:30–15:30

Media Room
Redwood

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 press kits, internet connectivity and printer, quiet work space and conference information.

Media Room Hours

Sunday, 18 October	12:00–16:00
Monday, 19 October	07:30–18:00
Tuesday, 20 October	07:30–18:00
Wednesday, 21 October	07:30–18:00
Thursday, 22 October	07:30–12:00

E-Center
Market Street Foyer

The E-Center, offering free internet connectivity, will be open Sunday through Thursday during registration hours.

Exhibition
Tuesday, 20 October, 09:30–16:00 and
Wednesday, 21 October, 09:30–14:00
Imperial Ballroom

The FiO Exhibit is open to all registered attendees. Visit a diverse group of companies representing every facet of the optics and photonics industries. For more information, see page 23.

FedEx Office (Business Center)
+1 408.299.0424

Access your office when you're away from the office at the FedEx Office Print and Ship Center. With premium printing, copying and binding right on site, you can have all of your materials printed to handle any last-minute surprises. Business Center is available 24 hours a day with guest room key accessibility.

FedEx Office Hours

Monday–Friday	08:00–17:30
Saturday–Sunday	Closed

Lost and Found

For Lost and Found please check first at the conference registration counter in the Market Street Foyer. **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 in order to fully participate in this conference, please contact Conference Management at the registration desk. Your specific needs will be addressed.

WiFi Access Instructions

To access the complimentary wifi services during the FiO/LS Conference, use the following information to log in. If you require more detailed instructions, a step-by-step access guide is available at the FiO registration desk.

SSID: FIO2015
Password: IYL2015

Women in Optics WiO

Women have made great contributions to science, but there have very often been major barriers and obstacles placed in their path. Despite accounting for nearly half of the college-educated workforce, women in 2010 accounted for less than one-third of S&E employment. Although the number of women in S&E jobs has risen significantly in the past two decades, the disparity has narrowed only modestly. In recognition of the women in optics, we have placed a WiO symbol by the abstracts of the many women presenters who are contributing to this year's program.

First Aid and Emergency Information

In the event of an emergency at the Fairmont San Jose hotel, go to the nearest house phone and dial "50", advise the operator of your identity and location so they can better assist you. Please only use 911 in the event of a serious situation.

If you have a Security concerns for yourself or others in your group please contact the operator at "0" and you will be put in touch with the Loss Prevention Department.

Medical Facilities

O'Connor Hospital
2105 Forest Avenue, San Jose, California
+1 408.947.2500
www.oconnorhospital.com

Good Samaritan Hospital
2425 Samaritan Drive, San Jose, California
+1 408.559.2011
www.Goodsamsanjose.com

Sponsoring Society Membership Booths

Market Street Foyer

APS and OSA Society Booths and IYL Booth Hours

Sunday, 18 October	12:00–17:00
Monday, 19 October	08:00–17:00
Tuesday, 20 October	08:00–17:00
Wednesday, 21 October	08:00–17:00
Thursday, 22 October (IYL Booth Only)	08:00–14:00

APS Booth

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 Applied, Physical Review Special Topics, and Physics.* Please stop by our table near Registration to learn more about the prestigious Physical Review collection.

OSA Booth

All FiO attendees are invited to stop by the OSA Booth.

Not a Member? Join on-site and take advantage of a 50 percent dues discount on the Individual Member category. Sign up at the OSA Booth, which is located near Registration.

International Year of Light Booth

How are you celebrating the International Year of Light? Visit the International Year of Light Booth near Registration to join the global movement to celebrate light. The International Year of Light and Light-Based Technologies (IYL 2015) is a global initiative to raise awareness of how optical technologies promote sustainable development and provide solutions to worldwide challenges in energy, education, communications, and health. IYL programs promote public and political understanding of the central role of light in the modern world while also celebrating noteworthy anniversaries in 2015. Be part of IYL 2015!

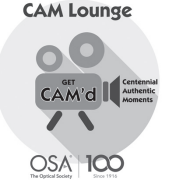
http://www.light2015.org

CAM Lounge

OSA is turning 100 in 2016! We're asking all OSA members to be a part of the celebration by participating in short videos. CAM (Centennial Authentic Moments) is an ongoing program of collecting scientific selfies where members will talk about what it means to be an OSA Member, how has OSA helped in their careers, what inspired them to get into the field of optics and what excites them about their current work in three minutes or less. The collection of these short videos will be featured on OSA's centennial website.

CAM Lounge Hours

Sunday, 18 October	12:00–16:00
Monday, 19 October	09:00–16:00
Tuesday, 20 October	09:00–16:00
Wednesday, 21 October	09:00–16:00



Stay Connected

Conference Materials

Technical Digest and Postdeadline Papers

Technical attendees have EARLY (at least one week prior to the conference) and FREE continuous online access to the FiO/LS 2015 technical digest and Postdeadline papers. These 1-2-page summaries of tutorial, 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. You will be directed to the conference page where you will see the .zip file links at the top of the page. [Please note: if you are logged in successfully, you will see your name in the upper right-hand corner.]

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.

Conference Program Update Sheet

Technical program changes received just prior to the meeting 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 mobile app. We encourage you to review them carefully to stay informed on changes to the program.

Program Playback: Recorded Content

We are delighted to announce we are continuing to offer this valuable enhancement free to FiO/LS full technical registrants. More than 40% of the sessions at this year's conference is being digitally captured for on-demand viewing. The pre-selected content includes the plenary presentations and selected hot topics representing the full breadth of the FiO program. Session content will be available for on demand viewing until **23 December 2015**. All captured session content will be live for viewing within forty-eight hours of being recorded. Just look for the symbol in the Agenda of Sessions to easily identify the presentations being captured.

1. Visit the conference website at **www.frontiersinoptics.com**
2. Select the purple "View Presentations" link on the right side of the web page
3. Log in using your email address and password used for registration. You will be directed to the conference page where you will see the .zip file links at the top of the page. [Please note: if you are logged in successfully, you will see your name in the upper right-hand corner.]

Access to the recorded sessions is limited to full technical attendees only.

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, formally known as Optics InfoBase. 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 (above).

Exhibit Buyers' Guide

The Exhibit Buyers' Guide is composed of descriptions and contact information for exhibiting companies at this year's conference, and exhibit hall activities. Guides will be provided to every FiO/LS attendee as part of registration. All exhibitor information changes will be communicated in the FiO/LS mobile application. We encourage you to review the mobile application carefully to stay informed of changes to the program.

Program Updates Board

Onsite Program changes will be posted on an update board located at the registration desk. Check daily for new information and/or refernce the FiO/LS mobile app.

Join the Social Conversation at FiO/LS 2015!

We will be providing the latest updates throughout the conference using Twitter. Do you have a Twitter handle?! Follow @Opticalsociety on Twitter. Tweet about your conference experience using #FiO15 in your tweets. Stop by the OSA booth for more details.

Join the conversation.
Follow @Opticalsociety on Twitter.
Use hashtag **#FiO15**

Young Professional Bloggers

Watch for OSA's own Young Professional and Student Bloggers reporting on conference events and their unique experiences at FiO! The Luminous Insights Blog posts will be shared via the Conference Twitter stream #FiO15

FiO/LS Mobile Application

Frontiers in Optics/Laser Science 2015 (FiO/LS 2015) has gone mobile again this year using CrowdCompass! We strongly encourage you to download our mobile guide to enhance your experience at FiO/LS 2015. You'll be able to plan your day with a personalized schedule and browse exhibitors, maps and general show info.

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.

Exhibit Hall

Search for exhibitors in alphabetical order, and set a bookmark reminder to stop by their booth. Tap on the map icon within a description, and you'll find their location on an expo floor map. View a daily schedule of all activities occurring on the show floor.

Attendees

All FiO/LS registered attendees are listed in the app. Send a contact request to an attendee, and initiate another valuable networking opportunity.

Download the App

The app is compatible with iPhone, iPad, iPod Touch and Android devices.

To get the guide, choose one of the methods below:

1. Visit **www.frontiersinoptics.com/app** to download the application.
2. Scan the following image with your mobile phone (QR-Code reader required, e.g. 'Red Laser', 'Barcode Scanner')

2016 OSA Optics and Photonics Topical Meetings and Congresses		Submit your abstract by:
High-Intensity Lasers and High-Field Phenomena (HILAS) Mid-Infrared Coherence Sources (MICS) Compact (EUV & X-ray) Light Sources	OSA High-Brightness Sources and Light-Driven Interactions Congress 20–22 March Long Beach, California, USA osa.org/HighBrightnessOPC	18 November 2015
Cancer Imaging and Therapy Clinical and Translational Biophotonics Optics and the Brain Optical Tomography and Spectroscopy	OSA Biomedical Optics Congress 25–28 April Fort Lauderdale, Florida, USA osa.org/biomed	16 December 2015
OSA Optical Interference Coatings (OIC)	19–24 June Tucson, Arizona, USA osa.org/oic	25 February 2016
OSA Propagation through and Characterization of Atmospheric and Oceanic Phenomena Topical Meeting	27-29 June Washington, DC, USA osa.org/pcDVT	February 2016
OSA International Conference on Ultrafast Phenomena (UP)	17–22 July Santa Fe, New Mexico, USA osa.org/up	26 January 2016
Integrated Photonics Research, Silicon, and Nano-Photonics Novel Optical Materials and Applications Optical Sensors Photonic Networks and Devices Signal Processing in Photonic Communications Specialty Optical Fibers	OSA Advanced Photonics Congress 17–21 July Vancouver, Canada osa.org/PhotonicsOPC	15 March 2016
3D Image Collection and Display Adaptive Optics: Analysis, Methods & Systems (AO) Applied Industrial Optics (AIO) Computational Optical Sensing and Imaging (COSI) Digital Holography & 3-D Imaging (DH) Imaging Systems and Applications (IS) Laser Applications to Chemical, Security and Environmental Analysis (LACSEA) Mathematics in Imaging	OSA Imaging and Applied Optics Congress 25–28 July Heidelberg, Germany osa.org/ImagingOPC	22 March 2016
OSA Latin America Optics & Photonics Conference (LAOP)	08–11 August Medellin, Colombia osa.org/laop	05 April 2016
Australian Conference on Optical Fibre Technology (ACOFT) Bragg Gratings, Photosensitivity and Poling in Glass Waveguides (BGPP) Nonlinear Photonics (NP)	OSA Photonics and Fiber Technology Congress 05–08 September Sydney, Australia osa.org/FiberandPhotonicsOPC	03 May 2016
OSA Advanced Solid State Lasers Conference and Exhibition (ASSL) OSA Application of Lasers for Sensing & Free Space Communication (LS&C)	30 Oct–04 Nov Boston, Massachusetts osa.org/assl; osa.org/lsc	June 2016
Optical Nanostructures and Advanced Materials for Photovoltaics (PV) Optics and Photonics for Energy & the Environment (E2) Optics for Solar Energy (SOLAR) Solid-State and Organic Lighting (SOLED)	OSA Light, Energy and the Environment Congress November/December Leipzig, Germany osa.org/EnergyOPC	August 2016

Conference Plenary Sessions and Awards Ceremony

Tuesday, 20 October, 08:00–09:30 and
Wednesday, 21 October, 08:00–09:30
Regency Ballroom

Join your colleagues to recognize recent OSA and APS/Division of Laser Science award and honor recipients. The sessions include the Ives Medal Address, the Schawlow Prize Lecture and two plenary presentations.

The order of events:

Tuesday, 20 October

Welcome

LIGO and the Coming Dawn of Gravitational Wave Physics and Astronomy, David Reitze, *Caltech, USA*

OSA Award and Honor Presentations

Ives Medal Lecture – Optical Coherence Tomography – Translating Technology to Clinical Practice, James G. Fujimoto, M*IT, USA*

Closing Remarks

Wednesday, 21 October

Welcome

Astrophotonics: Future Developments in Astrophysics and Instrumentation, *Joss Bland-Hawthorn, University of Sydney, Australia*

OSA Fellow Member and Honorary Member Presentations

Schawlow Prize Lecture – Using Light to Build Quantum Networks of Atoms, Christopher Monroe, *University of Maryland, USA*

Closing Remarks

Plenary Presentations

Astrophotonics: Future Developments in Astrophysics and Instrumentation, *Joss Bland-Hawthorn, University of Sydney, Australia*

Over the past 15 years, astrophotonics – the interface between photonics and astronomical/space instrumentation – has led to important advances in adaptive optics, laser communications, interferometry, vortex coronography, precision spectroscopy through fibre etalons, filtering through photonic lanterns and multicore fibre gratings, and so on. There is an important role here for nanophotonics if nano-patterning can be achieved over large surfaces (~100mm OD).

These advances will be exploited by a new generation of astronomical instruments, as we describe. The case for photonics becomes even more compelling in an era of extremely large telescopes (25-42m aperture) now under construction.

Joss is one of Australia's leading astronomers. He was born in Kent, England, educated in Oxford and Birmingham, before coming to Australia in 1982 to undertake a PhD. In the period 1985-1993, Joss was an astrophysicist at the Institute for Astronomy in Hawaii, a Fellow at the Institute for Advanced Study Princeton, and a professor of physics at Rice University Texas. In 1993, he returned to work at the Anglo-Australian Observatory, Sydney, eventually to become Head of the research and development team.

In 2007, he moved to the University of Sydney to take up an Australian Federation Fellowship. In 2014, he was awarded an Australian Laureate Fellowship to continue his work in astrophysics and astrophotonics. Today he is the Director of the Sydney Institute of Astronomy and Principal Investigator for the Sydney Astrophotonic Instrumentation Labs.

He has been the recipient of many prizes including the Muhlmann Prize in 2009 (USA) and the Jackson-Gwilt Medal in 2012 (UK). In 2010, Joss was the Merton College Fellow and the Leverhulme Professor at Oxford. In 2012, Joss was elected to the Australian Academy of Science, an august body of Australia's 400 leading scientists, and The Optical Society. He has published 400 refereed papers with 30,000 citations and an h-index of 80.

LIGO and the Coming Dawn of Gravitational Wave Physics and Astronomy, David Reitze, *Caltech, USA*

For the past 50 years, researchers have searched in vain for gravitational waves, miniscule ripples in space-time emitted from the most violent events in the cosmos. To move gravitational-wave detection beyond the realm of impossibility, we have just finished construction on Advanced LIGO, a pair of 4 km arm length laser interferometers capable of measuring displacements approaching 10^{-19} m at their most sensitive frequencies, redefining the meaning of 'extreme precision measurement'. LIGO brings together high energy astrophysics and many aspects of optical science and engineering in a unique way with the ambitious goal of detecting gravitational waves and opening a new window onto the universe.

David Reitze holds positions as both the Executive Director of the Laser Interferometer Gravitational-wave Observatory (LIGO) Laboratory at the California Institute of Technology and a Professor of Physics at the University of Florida. Based at Caltech, he heads a laboratory of 180 scientists and engineers responsible for the construction and operation of the LIGO interferometers at Hanford WA and Livingston LA.

Upon completing a B.A. in Physics from Northwestern University in 1983, he obtained a Ph.D. in Physics from the University of Texas at Austin in 1990 where his research on ultrafast solid-liquid phase transitions solved a hundred year old problem on the nature of liquid carbon. Since then, he has worked extensively

in the fields of ultrafast laser spectroscopy and experimental gravitation-wave detection. From 2007-2011, he served as the Spokesperson of the LIGO Scientific Collaboration, a group of almost 1000 scientists who carry out the science program of LIGO.

His current research interests focus on development of precision interferometric methods approaching the zeptometer level and on the search for gravitational waves from astrophysical sources. A Fellow of the American Physical Society and The Optical Society, he has authored nearly 250 refereed publications. Since 2012, one of his main efforts has been directed toward establishing a third LIGO interferometer in India.

Awards Ceremony

APS Arthur L. Schawlow Prize and Lecture

Awarded by the Division of Laser Science of the American Physical Society, the 2015 Arthur L. Schawlow Prize in Laser Science recognizes outstanding contributions to basic research that uses lasers to advance our knowledge of the fundamental physical properties of materials and their interaction with light.

2015 Arthur L. Schawlow Prize in Laser Science Recipient

Using Light to Build Quantum Networks of Atoms, Christopher Monroe, *Joint Quantum Institute and University of Maryland, USA*

For pioneering research in the use of lasers to realize the elements of quantum information processing with trapped atomic ions, including demonstrations of remote entanglement for quantum communication protocols and use of frequency combs for high-speed qubit manipulation and entanglement.

Laser-cooled atomic ions are standards for quantum information science, acting as qubit memories with unsurpassed levels of quantum coherence while also allowing near-perfect measurement. When qubit state-dependent optical dipole forces are applied to a collection of trapped ions, their Coulomb interaction is modulated in a way that allows the entanglement of the qubits through quantum gates that form the basis of a quantum computer. Similar optical forces allow the simulation of quantum many-body physics, where recent experiments are approaching a level of complexity that cannot be modelled with conventional computers. Scaling to much larger numbers of qubits can be accomplished by coupling trapped ion qubits through optical photons, where entanglement over remote distances can be used for quantum communication and large-scale distributed quantum computers. Laser sources and quantum optical techniques are the workhorse for such quantum networks, and will continue to lead the way as future quantum hardware is developed.

Christopher Monroe is an experimental atomic physicist who specializes in the isolation of individual atoms for studies in quantum physics and applications in quantum information science. After getting his undergraduate degree from MIT, Monroe studied with Carl Wieman at the University of Colorado, earning his PhD in Physics in 1992.

From 1992-2000 he was a postdoc then staff physicist at the National Institute of Standards and Technology, in the group of David Wineland. With Wineland, Monroe led the research team that demonstrated the first quantum logic gate in 1995, and exploited the use of trapped atoms for applications in quantum information science. In 2000, Monroe became Professor of Physics and Electrical Engineering at the University of Michigan, where he pioneered the use of single photons to couple quantum information between atoms and also demonstrated the first electromagnetic atom trap integrated on a semiconductor chip.

From 2006-2007 he was the Director of the National Science Foundation Ultrafast Optics Center at the University of Michigan. In 2007 he became the Bice Zorn Professor of Physics at the University of Maryland and a Fellow of the Joint Quantum Institute. In 2008, Monroe's group succeeded in producing quantum entanglement between two widely separated atoms and for the first time teleported quantum information between matter separated by a large distance. Since 2009 his group has investigated the use of ultrafast laser pulses for fast quantum entanglement operations and also pioneered the use of trapped ions for quantum simulations of many-body models related to quantum magnetism.

Frederic Ives Medal /Jarus W. Quinn Prize

Recognizing overall distinction in optics, the Frederic Ives Medal is the highest award of the Society. It was endowed in 1928 by Herbert E. Ives, a distinguished charter member and 1924-1925 OSA President, to honor his father, who was noted as the inventor of modern photoengraving and who made pioneering contributions to color photography, three-color process printing, and other branches of applied optics. The medalist is asked to present a plenary address at OSA's Annual Meeting. The prize is funded by the Jarus W. Quinn Ives Medal Endowment, raised by members at the time of Quinn's retirement in recognition of his 25 years of service as OSA's first Executive Director. This year's Frederic Ives Medal/Jarus W. Quinn Prize will be presented to **James G. Fujimoto** for pioneering the field of optical coherence tomography (OCT) and for leading the field to widespread medical application and major commercial impact.

Optical Coherence Tomography – Translating Technology to Clinical Practice
James G. Fujimoto, *Massachusetts Institute of Technology, USA*

Optical coherence tomography (OCT) is based on photonics and has had a powerful impact in medicine and research. This presentation describes the history, recent advances and process of translating OCT technology from laboratory to clinic.

James G. Fujimoto obtained his bachelors, masters, and doctorate from the Massachusetts Institute of Technology. He performed his doctoral studies under the supervision of Prof. Erich Ippen in ultrafast optics. Since 1985 Dr. Fujimoto has been in the Department of Electrical Engineering and Computer Science and Research Laboratory of Electronics at MIT where he is

currently Elihu Thomson Professor of Electrical Engineering. Dr Fujimoto's group and collaborators were responsible for the invention and development optical coherence tomography (OCT). His group's paper, "Optical Coherence Tomography," which appeared in Science in 1991 has remained one of the highest cited papers in the field of biophotonics. OCT is now standard clinical imaging modality in ophthalmology for the detection and treatment monitoring of macular degeneration, diabetic retinopathy and glaucoma. There are an estimated 20-30 million ophthalmic imaging procedures performed worldwide every year. There are hundreds of researchers internationally working on OCT in such diverse fields as cardiology, endoscopy and cancer surgery. Last year, the global sales of OCT systems exceeded 400 million US dollars and there are ~40 OCT systems companies.

Dr. Fujimoto has been influential as an educator and is also active in scientific service, having served as co-chair of international meetings such as the Conference on Lasers and Electro Optics, the European Conferences on Biomedical Optics, and Ultrafast Phenomena. Since 2003 Dr. Fujimoto has served as co-chair of the SPIE Biomedical Optics symposium, the largest international meeting on biophotonics. He served as a Director of the OSA from 2000 to 2003 and is currently serving as a Director of the SPIE.

Working with Mr. Eric Swanson, Dr. Fujimoto was a co-founder of the startup company Advanced Ophthalmic Devices, which developed OCT for ophthalmic imaging and was acquired by Carl Zeiss. The team also co-founded LightLab Imaging, which developed cardiovascular OCT and was acquired by Goodman, Ltd and St. Jude Medical.

Dr. Fujimoto received the Discover Magazine Award for Technological Innovation in 1999, was co-recipient of the Rank Prize in Optoelectronics in 2002, received the Zeiss Research Award in 2011, was co-recipient of the Champalimaud Vision Prize in 2012 and received the IEEE Photonics Award in 2014. He is in the National Academy of Engineering, American Academy of Arts and Sciences, and National Academy of Sciences. Dr. Fujimoto is also a Fellow of the OSA, SPIE, APS and IEEE.

APS/Division of Laser Science Award

Arthur L. Schawlow Prize

Christopher Monroe, *University of Maryland, USA*

OSA Awards and Honors

OSA Fellowships

Peter E. Andersen, *Danmarks Tekniske Universitet, Denmark*

Adela Ben-Yakar, *University of Texas at Austin, USA*

Robert P. Breault, Breault *Research Organization Inc., USA*

P. Scott Carney, *University of Illinois at Urbana-Champaign, USA*

Dean R. Evans, *U.S. Air Force Research Laboratory, USA*

John Charles Howell, *University of Rochester, USA*

Yunjiang Rao, *University of Electronic Science and Technology of China, China*

David Howard Reitze, *California Institute of Technology, USA*

OSA Honorary Member

Robert W. Hellwarth

2015 Frederic Ives Medal/Jarus W. Quinn Prize

James G. Fujimoto, *Massachusetts Institute of Technology, USA*
For pioneering the field of optical coherence tomography (OCT) and for leading the field to widespread medical application and major commercial impact.

Esther Hoffman Beller Medal

Govind P. Agrawal, *University of Rochester, USA*
For inspiring and educating a generation of scientists and engineers involved with fiber optic communications and other photonics technologies through his seminal textbooks and high-impact scientific articles.

Max Born Award

John D. Joannopoulos, *Massachusetts Institute of Technology, USA*
For numerous contributions to nanophotonics, including pioneering the "numerical experiments" approach for nanophotonics.

Michael S. Feld Biophotonics Award

Bruce Jason Tromberg, *Beckman Laser Institute and Medical Clinic, University of California, Irvine, USA*
For serving as an advocate for and a leader of the biophotonics community as well as for pioneering the development and clinical application of spatially and temporally modulated light imaging.

Paul F. Forman Team Engineering Excellence Award

Logic Analysis Tool Team (or LAT Team), *Fremont, California, USA*
For the development and characterization of the Logic Analysis Tool that detects photon emissions from integrated circuits fabricated in advanced process technologies with operating voltages down to 0.5 V.

Joseph Fraunhofer Award/Robert M. Burley Prize

Russell A. Chipman, *University of Arizona, USA*
For outstanding contributions in the development of metrology facilities for imaging polarimetry and spectro-polarimetry.

Nick Holonyak, Jr. Award

Qing Hu, *Massachusetts Institute of Technology, USA*
For pioneering contribution to high-performance THz quantum-cascade lasers and their applications in imaging and sensing.

Edwin Land Medal (co-sponsored with IS&T)

Joseph Mangano, *DARPA, USA*, Mordechai Rothschild, *MIT Lincoln Laboratory, USA*, and David Shaver, *DARPA, USA*
For contributions to the excimer laser ArF and modern deep-UV photolithography for the semiconductor industry.

Emmett Leith Medal

Yeshaiahu Fainman, *University of California, San Diego, USA*
For extension of Fourier optics methods to the femtosecond and nanometer regimes.

Ellis R. Lippincott Award
Dana D. Dlott, *University of Illinois at Urbana-Champaign, USA*
For the development of methods to measure vibrational energy flow in molecules with ultrafast time and atomic length scale resolution

Adolph Lomb Medal
Jeremy Nathan Munday, *University of Maryland, USA*
For pioneering contributions to plasmonic and photonic light-trapping in solar cells.

C. E. K. Mees Medal
Warren Sloan Warren, *Duke University, USA*
For the development of controlled laser pulses and nonlinear imaging techniques to enable applications ranging from clinical diagnosis to scientific analysis of Renaissance artwork.

William F. Meggers Award
Paul S. Julienne, *National Institute of Standards and Technology (NIST), USA*
For seminal contributions to precision photoassociation and magnetic-Feshbach spectroscopy of ultracold atoms, and the application of these techniques to the formation of cold polar molecules

David Richardson Medal
Daniel R. Neal, *Abbott Medical Optics Inc., USA*
For innovative technical leadership in the design, fabrication, and commercialization of wavefront sensing devices.

R. W. Wood Prize
Naomi Halas and Peter Nordlander, *Rice University, USA*
For introducing nanoparticles with tunable optical resonances and the concept of plasmon hybridization to explain their properties and revolutionizing the understanding of optical properties of metallic nanostructures

OSA's awards and medals are endowed through the OSA Foundation. The OSA Foundation is proud to support this prestigious program and recognize outstanding contributions in optics and photonics. For more information about the OSA Foundation, please visit www.osa.org/foundation or contact staff at foundation@osa.org.

OSA Foundation

Awards 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 (CAP-ETF), 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 scholarship is awarded annually to a graduate student who has demonstrated both research excellence and significant service to the optics or physics community.

Congratulations to our 2015 award recipient:

Itai Epstein, *Tel-Aviv Univ., Israel*

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 student membership, an award stipend of $300 USD and an award certificate.

Congratulations to our finalists competing at FiO:

FiO 1: Optical Design and Instrumentation
Zachary De Santis, *Univ. of Rochester, USA*
Dennis Floyd Gardner, *Univ. of Colorado at Boulder, USA*

FiO 2: Optical Sciences
Omar Santiago Magana Loaiza, *Univ. of Rochester, USA*
Scott Wandel, *Pennsylvania State Univ., USA*
Daniel Maser, *National Inst. of Standards & Tech, USA*

FiO 3: Optics in Biology and Medicine
Dan MacDougall, *Dalhousie Univ., Canada*
Colin Constant, *Univ. of Central Florida, CREOL, USA*

FiO 4: Fiber Optics and Optical Communications
Hui Chen, *Stevens Inst. of Tech., USA*
Haomin Yao, *The Inst. of Optics, Univ. of Rochester, USA*
Eduardo Temprana, *UCSD, USA*

FiO 5: Integrated Photonics
Yannick Salamin, *ETH Zurich, Switzerland*
Kenneth M. Goodfellow, *Univ. of Rochester, USA*
Michael G. Wood, *Ohio State Univ., USA*

FiO 6: Quantum Electronics
Claire Autebert, *Laboratory MPQ, France*
Jianwei Wang, *Centre for Quantum Photonics, H.H. W., UK*

FiO 7: Vision and Color
Rebecca Holmes, *Univ. of Illinois at Urbana-Champaign, USA*

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 the Frontiers in Optics. Grants are awarded to the presenter and usually the first author of the paper. Congratulations to the 2015 Incubic/Milton Chang Travel Grant Recipients:

Aadhi A., *Physical Research Laboratory, India*
Alem Gebru, *Univ. of Stellenbosch, South Africa*
Haomin Yao, *Univ. of Rochester, USA*
H. Esat Kondakci, *Univ. of Central Florida, USA*
Itai Epstein,*Tel-Aviv Univ., Israel*
Litty V. Thekkekara, *Swinburne Univ. of Technology, Australia*
Milad I. Akhlaghi, *Univ. of Central Florida, USA*
Moshe G. Harats, *The Hebrew Univ. of Jerusalem, Israel*
Omar Calderon-Losada, *Universidad de los Andes, Colombia*
Vishwatosh Mishra, *IIT Kharagpur, India*

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 Univ. Department of Physics and individual contributors.

Congratulations to our 2015 grant recipient:

Zi Jing Wong, *Univ. of California, Berkeley, USA*

OSA Foundation Student Travel Grants

The OSA Foundation is pleased to provide travel support to help students from developing nations attend FiO. Each grant recipient receives $1,500 USD to offset costs associated with traveling to the conference.

Congratulations to our 2015 grant recipients:

Aadhi A., *Physical Research Laboratory, India*
Anirban Sarkar, *IIT Kharagpur, India*
Catalina Hurtado Castaño, *Universidad Nacional de Colombia, Colombia*
Franciele Renata Henrique, *Univ, of Sao Paolo, Brazil*
Inga Saknite, *Univ. of Latvia, Latvia*
Luis Joel Mávita Granillo, *CICESE, Mexico*
Nithyanandan K., *Pondicherry Univ., India*
Praveen Phinehas M, *Vellore Inst. of Technology (VIT), Chennai, India*
Sonika Obheroi, *Vellore Inst. of Technology (VIT), Chennai, India*
Tsung-Han Tsai, *National Taiwan Univ., Taiwan*

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.

Congratulations to our 2015 grant recipients:

Haoran Ren, *Swinburne Univ. of Technology, Australia*
Nithyanandan K., *Pondicherry Univ., India*

Carl E. Anderson Award for Outstanding Doctoral Dissertation

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, 19 October from 08:00–10:00 in the Hillsborough Room. The winner will be announced during the Laser Science Banquet on Tuesday, 20 October from 19:00–22:00 (Gordon Biersch, 33 East San Fernando St., San Jose, CA).

OSA Foundation Grant Recipients

The OSA Foundation benefitted more than 9,400 people in 2014. We inspire future optics innovators, support career development for optics students, recent graduates and young professionals, and recognize distinguished achievement in the field through the presentation of awards and honors.

We would like to congratulate our 2015 grant recipients. Through the following programs we have been able to provide over 30 grants to help students attending FiO. For more information on who we are and what we do, visit www.osa.org/Foundation.

You can help to inspire and support the next generation of science and engineering innovators by making a donation to the OSA Foundation. For a limited time, all donations are matched 100% by the Optical Society—so your gift has twice the impact. To learn more and to make a donation online, visitwww.osa.org/foundation, or stop by the OSA booth.

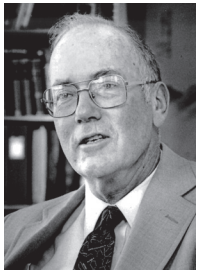
OSA
Foundation

Special Symposia

Townes Symposium: Reminiscences — Scientific and Personal

Sunday, 18 October, 16:30–18:30
Regency Ballroom

Organizer: Elsa Garmire, *Dartmouth College, USA*



In 1958, at Bell Laboratories, Charles Hard Townes, one of the foremost pioneers of quantum electronics, and Arthur Schawlow invented the laser, explaining its geometry, operating principles and presenting its foundational theory. The laser, operating at optical frequencies, was based on Townes's invention at Columbia University of the maser (microwave analog of the laser) which he demonstrated experimentally in 1954. Townes received the Nobel Prize in 1964, along with Soviet scientists Nikolai Basov and Alexander Prokhorov.

This symposium brings together participants from every step of his professional career, including Joseph Giordmaine, who was his student at Columbia. In 1961 Townes moved to MIT as Provost while he ran a research group in nonlinear optics, contributing pioneering ideas to stimulated Raman and Brillouin scattering, self-trapping and self-phase modulation. Raymond Chiao and Elsa Garmire were his students at MIT and Paul Kelley was a colleague from Lincoln Laboratory. In 1967, Townes moved to University of California at Berkeley; Robert Boyd was his student there in nonlinear optics, and Kenneth Gustafson was a colleague. Townes spent the last half of his life investigating Quantum Electronics in astronomy. Former Berkeley astronomy student Paul Goldsmith, now at JPL, will describe the new ideas Townes brought to astronomy. Finally, Martin Richardson, director of the Townes Laser Institute at University of Central Florida, will describe Townes' dynamism during the last ten years of his life. These panelists will provide an overview of this extraordinary scientist's approach to research and teaching. Townes passed away in January 2015 at the age of 99.

Invited Speaker:

Paul Goldsmith, *NASA Jet Propulsion Laboratories, USA*

Panelist:

Robert Boyd, *Univ. of Rochester, USA; Univ. of Ottawa, Canada*

Raymond Chiao, *Univ. of California Merced, USA*

Joseph Giordmaine, *AT&T and NEC Labs (retired), USA*

Kenneth Gustafson, *Univ. of California Berkeley, USA*

Paul Kelley, *The Optical Society; Tufts Univ. (retired), USA*

Martin Richardson, *Townes Laser Institute, Univ. of Central Florida, USA*

International Year of Light – Science to Solutions Special Session

Monday, 19 October, 16:00–18:00
Regency Ballroom

Moderator: Eric Mazur, *Harvard University, USA*

The International Year of Light Special Session, open to the public, will showcase examples of how optics has made, and will make, a difference in society. Speakers will highlight the connection between fundamental scientific research to solutions to problems with societal impact. The topical coverage will span issues such as energy, climate, health care, and telecommunications. The talks are intended to be short (10-20 min), in TED-talk style, designed to engage and inspire. Registered technical attendees are also encouraged to attend the International Year of Light/OSA Presidents Reception - "Light up the Night" from 18:30–20:30 at the City Hall Rotunda.

Invited Speakers

Nonlinear Optics: The Good, Bad, Ugly, Beautiful, Elsa Garmire, *Dartmouth College, USA* WiO

Abstract: Nonlinear Optics can be many things: good when creating new frequencies, improving lasers, manufacturing, offering new science; bad when damaging optics; ugly in telecommunications by limiting signals through fibers; beautiful when creating solitons.

Space Based Measurements of Atmospheric Carbon Dioxide: A New Tool for Monitoring Our Environment, David Crisp, *Jet Propulsion Laboratory, NASA, USA*

Abstract: Precise, global measurements of atmospheric carbon dioxide and other greenhouse gases by the NASA Orbiting Carbon Observatory-2 (OCO-2) and other satellites provide new tools to monitor and manage the processes that control their atmospheric concentrations.

Biophotonics and the Future of Personal Health Monitoring, Bruce Tromberg, *University of California at Irvine, USA*

Abstract: Medical Optics provide unique, dynamic information about tissue structure and biochemical composition. Matching technologies with clinical needs will reduce health care costs and drive the development of wearable, bedside technologies for personalized medicine.

Computing at the Speed of Light, Michal Lipson, *Columbia Univ., USA* WiO

Abstract: By 2020, data centers will consume in the US alone more than 250 megawatts of electricity. As Data-centers are expected to carry a large portion if not the majority of all kinds of computations in the future, driving this power consumption down is a major engineering, industrial as well as political concern. Light as a means for propagating high amounts of computing data, is recognized today as the most promising direction for solving this paradigm. Light, in contrast to electronics, does not dissipate power as it propagates. The challenge with this approach is that until recently silicon- the basic material used in microelectronics and computing today- has been considered a low quality optical material. We have shown the ability to control the flow of light. at GHz frequencies using a nano-structure that enhance the natural electro-optic properties of silicon. This ability to create active optical devices on silicon is the basis for the burgeoning field of silicon photonics, or light on a silicon chip.

Applications of Laser Spectroscopy to Meet Challenges in Medicine, Katarina Svanberg, *Lund Laser Centre, Switzerland* WiO

Abstract: Laser spectroscopy is a valuable tool both in the detection and the therapy of human malignancies. The most important prognostic factor for cancer patients is early tumor discovery. If malignant tumors are detected during the non-invasive stage, most tumors show a high cure rate of more than 90 %. Laser-induced fluorescence (LIF) can be used for monitoring the biomolecular changes in tissue under transformation from normal to dysplastic tissue and further to cancer before structural morphological changes are seen at a later stage. Photodynamic therapy is a selective therapy modality for human malignancies. To overcome the limited light penetration in superficial illumination interstitial delivery (IPDT) with the light transmitted to the tumors via optical fibers has been developed. Interactive feed-back dosimetry is of importance for optimizing this modality and such a concept has been developed. Another technique is based on gas in scattering media absorption spectroscopy (GAS-MAS). It can be used to detect free gas (oxygen and water vapor) in hollow organs in the human body and has been applied to the detection of the human sinus cavities. It might guide in the therapy choice for infections whether to prescribe antibiotics or not. The technique may also be a valuable tool for surveillance of prematurely born infants.

How Light Shaped Science: From Fleas to Qubits, Ian Walmsley, *University of Oxford, UK*

Abstract: Optics is among the oldest branches of science, and yet remains among the most fruitful. It has provided either new phenomena or new technology that underpin many of the major discoveries in physics over the past 400 years. Yet it is only in the past century that its disparate properties have been understood in a unified way, and even now there are new insights into the structure of the natural world emerging from this understanding. And, as is so often the case, new technologies are also emerging, which promise once again to open new vistas in science and new applications that will change society.

Symposium on Photoreceptor Analysis and Single-cone-mediated Vision

Monday, 19 October, 08:00–10:00
Crystal

Organizer: Brian Vohnsen, *Univ. College Dublin, Ireland*

Twenty-five years ago detailed post-mortem ocular histology gave spectacular insight into the organization of cone and rod photoreceptor cells in the human retina. Subsequent progress with implementation of adaptive optics for aberration correction has made in-vivo analysis of single retinal cells feasible in both the healthy eye and in eyes affected by disorders. The same technologies allow vision to be explored at the fundamental limit set by the size and spacing of single photoreceptors and ganglion cells. This symposium will highlight milestones that have made these advances feasible with state-of-the-art technologies and address outstanding challenges for the implementation of improved diagnostic capabilities that not only will increase our understanding of the last optical steps of the visual process but also help combat vision loss.

Invited Speakers:

Human Photoreceptor Topography - 25 Years and Looking Ahead, Christine Curcio, *Univ. of Alabama at Birmingham, USA*

Single Cell Imaging In Photoreceptor Degenerative Disease, Christopher Langlo, *Medical College of Wisconsin, USA*

Waveguide Properties of Cone Photoreceptors, Don Miller, *Indiana Univ., USA*

Probing Human Spatial and Color Vision on a Cellular Scale, Austin Roorda, *Univ. of California Berkeley, USA*

Laser Science Symposium on Undergraduate Research

Monday, 19 October, 10:00–16:00
Glen Ellen

Organizer: Harold Metcalf, *Stony Brook Univ., USA*

This special DLS annual symposium started in 2001 and has rapidly become one of the most successful DLS traditions. During the past several years the number of undergraduates presenting papers has grown from only 10 to more than 40, and the talks have been of outstanding quality, some absolutely stellar. Last year's posters were outstanding and generated a great deal of lively interest and on-the-spot discussion.

This year's symposium will consist of morning poster sessions, along with afternoon oral sessions. The event provides an opportunity for student members for the community, who are already among the finest

young scientists to be found anywhere, to present their work before an audience of their peers, as well as the larger optics community. All are invited and encouraged to attend the session.

Symposium on Optics for Global Health and Low Resource Settings

Monday, 19 October, 13:30–15:30
Crystal

Organizer: Laszlo Veisz, *Max-Planck-Institute fur Quantenoptik, Germany*

Optical sensing allows measurements of important climate-related parameters, such as greenhouse gas and aerosol densities, from both land and space-based platforms. The measurements are often made at wavelengths where technology is not as mature as in the visible and near-infrared region. Efforts to measure these parameters place stringent demands on light sources (which often must be high power and single frequency), detectors (which must detect the faintest light levels at non-traditional wavelengths), and understanding of long-range propagation effects. Contributions are sought which explore novel approaches to satisfying the demands of optical climate-related measurements.

Invited Speakers:

Measuring Greenhouse Gases from Aircraft and Spacecraft using Lidar, Jim Abshire, *NASA Goddard Space Flight Ctr., USA*

New Airborne and Ground-based Techniques for Remotely Mapping Multiple Gas Sources and Quantifying Individual Mass Emission Rates, Bill Hirst, *BP Shell, USA*

Applications of Cavity Ring Down Spectroscopy in the Earth Sciences, Chris Rella, *Picarro, USA*

Precision Atmospheric Trace Gas Monitoring with Frequency Comb Lasers, Greg Rieker, *Univ. of Colorado, USA*

Symposium Honoring Adolf Lohmann

Wednesday, 21 October, 11:00–18:15
Sacramento

Organizer: Joseph Mait, US Army Research Laboratory, USA

Contributed papers are encouraged in honor of Adolf W. Lohmann (1925-2013), an OSA Fellow Emeritus known for his contributions to the fields of optical information processing and holography. Topics of particular interest include fractional transformations, phase-space optics, super resolution, temporal optical processing, optical processing with partially coherent light, and flatland optics. To be considered for this symposium submit to the topic category, 1.8 Adolf W. Lohmann Symposium.

Invited Speakers:

Phase-Space Optics, One Photon at a Time, Harry Barrett, *Univ. of Arizona, USA*

Optical Processing Inside a Degenerate Cavity Laser, Asher Friesem, *Weizmann Inst. of Science, Israel*

Adolf Lohmann and his Contributions to Optics, Joe Goodman, *Stanford Univ., USA*

Optical Interconnection - Early Concepts and Novel Approaches, Juergen Jahns, *Univ. of Hagen, Germany*

Fractional Fourier and Linear Canonical Transforms in Optics, Uriel Levy, *The Hebrew Univ. of Jerusalem, Israel*

Adolf Lohmann's Approach to Phase-Space Optics, Jorge Ojeda-Castaneda, *Univ. of Guanajuato, Mexico*

When the Difference Between Coherent and Incoherent Imaging Begins to Blur, Bill Rhodes, *Florida Atlantic Univ., USA*

Having Fun with Lohmann Optics, Stefan Sinzinger, *Technische Univsitat Ilmenau, Netherlands*

Symposium on Optical Remote Sensing for the Climate

Wednesday, 21 October, 13:30–15:00
Crystal

Organizer: Melissa Skala, *Vanderbilt Univ., USA*

2015 is the "International Year of Light," and this symposium accordingly highlights the tremendous impact that optical technologies can have on global health. Portable, accurate, and low cost light-based technologies have already demonstrated successes in screening and treatment for an array of pathologies in low resource settings. The potential of these technologies continues to grow with increased interest in engineering world health.

Invited Speakers:

Mobile Technologies for Personalized Diagnostics and Global Health, David Erickson, *Cornell Univ., USA*

Democratization of Next-Generation Imaging, Sensing and Diagnostics Tools Through Computational Photonics, Aydogan Ozcan, *Univ. of California Los Angles, USA*

Manu Prakash, *Stanford Univ., USA*

Low-Cost Optical Diagnostic Systems for Point of Care Applications, Tomasz Tkaczyk, *Rice Univ., USA*

Symposium on Applications of Low Noise Frequency Combs

Thursday, 22 October, 13:00–17:30
Crystal

Organizer: Bill Kuo, *Univ. of California San Diego, USA*

Frequency combs have become a hot topic of research over the last decade. Recent methods for generating low-noise frequency combs have spawned a host of new applications, including optical communications, spectroscopy, biomedical applications, signal processing, and numerous sensing applications. This symposium will cover the applications enabled by low-noise, highly coherent frequency combs, and include a panel discussion with the invited speakers.

Invited Speakers:

Perspective of New Infrastructure of Fiber Communication: The Role of Coherent Light in SDM Era, Yoshinori Awaji, *NICT, Japan*

Signal Processing using Optical Frequency Combs, Ronald Esman, *MITRE, USA*

Optical-to-RF Frequency Synthesis: Application Priorities for Ultra-low Phase Noise, David Howe, *NIST, USA*

Exabit Optical Network based on Optical Comb Distribution for High-performance Datacenters: Challenges and Strategies, Takashi Inoue, *AIST, Japan*

Digital Coherence W-band Radio-over-fiber System, Ken-ichi Kitayama, *Univ. of Osaka, Japan*

Frequency Combs as Sources for Tbit/s Communications Systems, Juerg Leuthold, *ETH, Switzerland*

Comb-locked Arbitrary Signal Synthesis, Radan Slavik, *Southampton Univ., UK*

Microwave Generation using Optical Frequency Combs, Steven Wilkinson, *Raytheon, USA*

Special Events

Annual OSA Student Chapter Leadership Conference

Sunday, 18 October, 07:00–17:00
Grand Hall Hyatt Place San Jose Downtown, 282 Almaden Boulevard, San Jose, CA

The invitation-only Student Leadership Conference brings together over 200 OSA Student Chapter leaders from around the globe to network, present posters and learn about successful chapter management and the popular International OSA Network of Students (IONS). The program also features professional development presentations from esteemed leaders in the field.

Townes Memorial Reception

Sunday, 19 October, 18:30–20:00
Club Regent, Lobby Level
Complimentary for FiO/LS Technical Attendees*

Sponsored by THORLABS

Get the FiO/LS 2015 conference off to a great start by attending the Townes Reception. Meet with colleagues from around the world and enjoy light hors d'oeuvres.

*This event is complimentary for FiO/LS Technical attendees only. Please bring your conference registration badge. Non-technical attendees and guest tickets are available for $75 USD each.

OSA Student Member Reception

Sunday, 18 October, 19:00–22:00
Da Kine Island Grill, 23 N. Market St., San Jose, CA

This reception is a fun event that encourages Student Members of OSA to meet, enjoy refreshments and have a good time! Note that membership status will be checked.

No charge to all OSA Student Members. Must be 21 or over to consume alcohol.

Frontiers in Photonic Detection Panel Discussion

Monday, 19 October, 12:00–13:30
Belvedere

The OSA Photonic Detection Technical Group will hosting an interactive panel discussion providing an opportunity for professionals and students to learn about and discuss the latest advances in the field of photonic detection. Includes a boxed lunch. RSVP required. Contact TGactivities@osa.org to register, pending availability.

Sponsored by OSA Technical Groups

Nonlinear Optics Technical Group Workshop

Monday, 19 October, 12:00–13:30
Atherton

Join the OSA Nonlinear Optics Technical Group for a special workshop including a discussion on future directions in the field of nonlinear optics. Includes a boxed lunch. RSVP required. Contact TGactivities@osa.org to register, pending availability.

Sponsored by OSA Technical Groups

OSA Fellow Members Lunch

Monday, 19 October, 12:00–13:30
Ballroom, The Westin San Jose, 302 S. Market Street, San Jose, CA

Advance reservation for the event was required. Check at the OSA booth to see if there is still space available.

Meet OSA's Journal Editors

Monday, 19 October, 18:00–19:00
Club Regent, Lobby Level

OSA's journal Editors invite you to join them for conversation and refreshments. The Editors welcome your questions, concerns and ideas for the journals, such as:

- What are best practices when submitting your manuscript?
- What constitutes a useful manuscript review?
- What criteria do journal editors look for in submitted manuscripts?
- How do you propose a Feature Issue topic for publication in an OSA Journal?
- Other topics of interest to you

Refreshments will be provided. All are welcome.

OSA Microscopy and Optical Coherence TomographyTechnical Group Poster Session

Monday 19 October, 18:00–19:00
Atherton

Join the Microscopy and Optical Coherence Tomography Technical Group for a focused poster session. This session will bring together students and colleagues for an opportunity to share their latest research findings, exchange ideas, and facilitate collaborations in relevant areas.

Sponsored by OSA Technical Groups

International Year of Light/OSA President's Reception - "Light up the Night"

Monday, 19 October, 18:30–20:30
City Hall Rotunda, 200 E. Santa Clara Street, San Jose, CA

Complimentary for FiO/LS Technical Attendees*

OSA President Philip Russell invites you to celebrate the International Year of Light by reaching new heights! Enjoy delicious bites and beverages in City Hall's 110-foot tall Rotunda. Mix and mingle with friends old and new as we light up the night in downtown San Jose.

*This event is complimentary for FiO/LS Technical attendees only. Please bring your conference registration badge. Non-technical attendees and guest tickets are available for $75 USD each.

The City Hall Rotunda is a short 10 minute walk from The Fairmont Hotel

INTERNATIONAL YEAR OF LIGHT 2015

Better than Fakin' it Good: Multifunctional Bioreplication

Tuesday, 20 October, 12:00–13:30
Fairfield Room, The Fairmont San Jose

Organized by the Environmental Sensing Technical Group, this event will feature a talk by Dr. Akhlesh Lakhtakia of Pennsylvania State University on bioreplication and its use in the eradication of emerald ash borer. Includes a boxed lunch. RSVP required. Contact TGactivities@osa.org to register, pending availability.

Sponsored by OSA Technical Groups

Optical Material Studies Technical Group Workshop

Tuesday, 20 October, 12:00–13:30
Cupertino

Join the OSA Optical Material Studies Technical Group for a special workshop discussing recent advances in optical materials. Dr. Debashis Chanda of the University of Central Florida will present his talk 'Printed Large Area Flexible Hybrid Photonic-Electronic Systems' as part of this technical group workshop. Includes a boxed lunch. RSVP required. Contact TGactivities@osa.org to register, pending availability.

Sponsored by OSA Technical Groups

OSA Student Chapter Competition: IYL-To-Go

Tuesday, 20 October, 14:30–16:00; Winners announced at 16:00.
Imperial Ballroom

OSA challenges you to showcase your chapter's best ideas for youth education outreach during its annual meeting Frontiers in Optics/Laser Science. This year's competition is IYL-To-Go. For a chance to win up to $500 USD for your chapter, we're asking you to create optical demonstrations for children and science teachers that connect with the mission of the International Year of Light to improve public understanding of how light affects our daily lives. These youth education demos should be completely portable and easy to recreate all over the world. Volunteer judges will rate chapters on effectiveness, creativity, presentation and supplies.

INTERNATIONAL YEAR OF LIGHT 2015

Joint FiO/LS Poster Sessions

Tuesday, 20 October, 14:30–16:00
Wednesday, 21 October, 09:30–11:00
Imperial Ballroom

Poster presentations offer an effective way to communicate new research findings and provide a venue for lively and detailed discussion between presenters and interested viewers. Don't miss this opportunity to discuss current research one-on-one with the presenters. The Optical Society will be offering a prize for Best Poster Presentations. Presentations will be judged onsite and the winner will be announced at the conclusion of the conference.

Exhibitor Appreciation Reception

Tuesday, 20 October, 16:00–17:00
Imperial Ballroom

Sponsored by OSA Industry Development Associates

Exhibitors, finish up your first day and come relax and mingle with your fellow exhibitors. Join us in the exhibit hall immediately following the close of the show for some food and beverages sponsored by OSA Industry Development Associates. Join OSA and discover the benefits of Industry Membership. OSA can help corporations optimize product development resources and reduce time to market by giving professionals access to quality information, quality interactions and premium opportunities for collaboration. Join today! Contact industry@osa.org or (202) 416-1482 for more information.

Minorities and Women in OSA (MWOSA) Networking Reception

Tuesday, 20 October, 16:00–17:00
Free of Charge – RSVP Required
Atherton

Please join the MWOSA community for a networking reception where we will celebrate the OSA Foundation grant award recipients. If you have any questions regarding the event please Email mwosa@osa.org.

OSA Annual Business Meeting

Tuesday, 20 October, 17:00–17:45
Fairfield

Learn more about OSA and join the OSA Board of Directors for the Society's annual business meeting. The 2014 activity reports will be presented and the results of the 2015 Board of Directors election will be announced.

APS Division of Laser Science Annual Business Meeting

Tuesday, 20 October, 17:00–18:00
Belvedere

All members and interested parties are invited to attend the annual business meeting of the 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 your opportunity to help define the operations of the DLS and the LS Conference.

OSA Member Reception: Trip the Light Fantastic

An International Year of Light-apalooza
Tuesday, 20 October, 18:30–20:30
Grande Ballroom, The Westin San Jose, 302 S. Market Street, San Jose, CA

Complimentary and for OSA Members Only*

The Optical Society cordially invites **OSA Members** to a celebratory night for the International Year of Light.

The poet John Milton wrote, "Com, and trip it as ye go, / On the light fantastick toe." As we start to wind down on this glorious year that focused the world's attention on light, let's take Milton's advice and let loose. For one special evening, OSA Members will enjoy the company of friends and colleagues. We'll provide the beverages, appetizers, and music. You just need to bring your dancing shoes (oh, and your conference registration badge or OSA Membership card).

If you join OSA on-site, please bring your receipt.

*This event is complimentary and is for OSA Members. If you would like to bring a guest, tickets are available for $75 USD each.

Not a member yet? Join today to attend this complimentary OSA Member event.

Laser Science Banquet

Tuesday, 20 October, 19:00–21:00
Gordon Biersch Restaurant, 33 East San Fernando St, San Jose, CA

Join your colleagues for the annual LS Banquet. Tickets are required for this event and can be purchased at registration for US $65. There is a limited quantity of tickets and tickets must be purchased by 12:00 on Monday, 19 October.

OSA Members, Family and Friends Tour

Wednesday, 21 October, 10:00–12:15
Rosicrucian Egyptian Museum and Planetarium, 1660 Park Ave., San Jose, CA

Bus will depart from the Fairmont San Jose's main entrance at 10:15.

No charge to OSA members and their families. Children are welcome.

Sponsored by OSA Members, Family and Friends

Architecturally inspired by the Temple of Amon at Karnak, the Rosicrucian Egyptian Museum and Planetarium houses the largest collection of Egyptian artifacts on exhibit in western North America, including objects from pre-dynastic times through Egypt's early Islamic era. Voted by Trip Advisor as one of the top sites to visit in San Jose, enjoy a 90-minute guided tour of the museum's exhibits, which focus on gods and religion, kings and pharaohs, and burial practices.

VIP Industry Leaders Networking Event: Connecting Corporate Executives, Recent Graduates and Students

Wednesday, 21 October, 12:30–14:00
Club Regent, Lobby Level

Includes a boxed lunch. RSVP Required.

Presented by OSA Industry Development Associates

This session brings together Industry Executives to share their business experience – from how they started their careers, lessons learned along the way, to using their degree in an executive position – with Young Professionals and Students. The program starts with informal networking during lunch and then transitions into "speed meetings" – small, brief visits with 6-8 executives to discuss careers, industry trends or other career topics.

Space is limited. Members of OSA's Young Professionals program will be given registration priority, but students and recent graduates are also welcome and encouraged to register.

On-site registration will be accepted pending availability. Please contact vipevents@osa.org if you would like to register.

To join the Young Professionals program, email yp@osa.org.

Meet the Editors of the APS Journals

Wednesday, 21 October, 13:00–14:30
Imperial Ballroom

The Editors of the APS 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. All are welcome. We hope you will be able to join us.

OSA Science Educators' Day (EDAY)

Wednesday, 21 October, 17:00–20:00
Regency 1

This annual event focuses on effective and innovative approaches to science education, with an emphasis on hands-on, interactive classroom lessons.

Interactive Teaching and Peer Instruction, Eric Mazur; *Harvard University, USA*

Eric Mazur is the Balkanski Professor of Physics and Applied Physics at Harvard University and Area Dean of Applied Physics. An internationally recognized scientist and researcher, he leads a vigorous research program in optical physics and supervises one of the largest research groups in the Physics Department at Harvard University. Mazur founded several companies and plays an active role in industry.

In addition to his work in optical physics, Mazur has been very active in education. In 1990 he began developing Peer Instruction, a method for teaching large lecture classes interactively. He is the author of *Peer Instruction: A User's Manual* (Prentice Hall, 1997), a book that explains how to teach large lecture classes interactively. In 2006 he helped produce the award-winning DVD *Interactive Teaching*. Dr. Mazur's teaching method has developed a large following, both nationally and internationally, and has been adopted across many disciplines.

Dr. Mazur has received numerous awards, including the Esther Hoffman Beller award from the Optical Society (OSA) and the Millikan Medal from the American Association of Physics Teachers (AAPT). In 2014 Mazur became the inaugural recipient of the Minerva Prize for Advancements in Higher Education. He is Fellow of the Optical Society (OSA) and Fellow of the American Physical Society (APS). He is a Member of the Royal Academy of Sciences of the Netherlands and a Member of the Royal Holland Society of Sciences and Humanities.

Dr. Mazur is author or co-author of 298 scientific publications, 36 patents, and several books, including the Principles and Practice of Physics (Pearson, 2014), a book that presents a groundbreaking new approach to teaching introductory calculus-based physics. Mazur is a sought-after speaker on optics and on education.

Optical Fabrication and Testing Technical Group Networking Event

Wednesday, 21 October, 18:00–20:00
Fairfield Room, The Fairmont San Jose

Join members of the Optical Fabrication and Testing Technical Group for a chance to learn more about this group and connect with fellow attendees who share an interest in optical fabrication and testing.

Sponsored by OSA Technical Groups

OIDA Town Hall Forum on Biophotonics Challenges & Opportunities

Wednesday, 21 October, 18:00–20:00
Club Regent, Lobby Level

OSA Industry Development Associates

New! You're Invited to OSA's Free Town Hall Forum on Biophotonics

Please join us for an open town-hall meeting, where thought leaders debate and share perspectives that are critical to understanding the rapidly expanding biophotonics market. Questions to be discussed include:

- What is the enabling technology that has the most market traction?
- What are the challenges and opportunities among photonics technologies today?
- Where is the best potential for funding?

This event's new, interactive format will prioritize key findings for future use by the community. Happy hour drinks and snacks are complimentary.

FiO Postdeadline Paper Presentations

Wednesday, 21 October, 20:00–22:00
See the Update Sheet in your registration bag for exact times and locations

The FiO 2015 Technical Program Committee accepted a limited number of postdeadline papers for presentation. The purpose of postdeadline sessions is to give participants the opportunity to hear new and significant material in rapidly advancing areas. Only those papers judged to be truly excellent and compelling in their timeliness were accepted.

Exhibition Information

Visit the Frontiers in Optics 2015 Exhibit in the **Imperial Ballroom** and get a glimpse of the latest optical innovations! The FiO 2015 exhibit floor will feature companies representing a broad range of the best products and applications in the optics and photonics industry. Don't miss this opportunity to learn about new products, find technical and business solutions and gain the most up-to-date market perspective of your industry.

There is no charge to attend the exhibit—it's open to all registered attendees!

Exhibit Hours

Tuesday, 20 October	09:30–16:00
Wednesday, 21 October	09:30–14:00

Exhibit Hall Unopposed Exhibit-Only Times

Tuesday, 20 October	09:30–10:30 12:00–13:00 14:30–16:00
Wednesday, 21 October	09:30–11:00 12:30–13:30

Joint FiO/LS Poster Sessions

Imperial Ballroom

Poster presentations offer an effective way to communicate new research findings and provide an opportunity for lively and detailed discussion between presenters and interested viewers. Make sure to visit the poster sessions in the Exhibit Hall to see the more than 80 posters scheduled for presentation.

Tuesday, 20 October	14:30–16:00
Wednesday, 21 October	09:30–11:00

Exhibitor Appreciation Reception

Tuesday, 20 October, 16:00–17:00
Imperial Ballroom

Sponsored by OSA Industry Development Associates

Exhibitors, finish up your first day and come relax and mingle with your fellow exhibitors. Join us in the exhibit hall immediately following the close of the show for some food and beverages sponsored by OSA Industry Development Associates. Join OSA and discover the benefits of Industry Membership. OSA can help corporations optimize product development resources and reduce time to market by giving professionals access to quality information, quality interactions and premium opportunities for collaboration. Join today! Contact industry@osa.org or (202) 416-1482 for more information.

FiO 2015 Participating Companies:

(as of 09/22/2015)

AIP Publishing
American Association of Physics Teachers
American Elements
American Institute of Physics
Cambridge University Press
Chroma Technology Corp.
Energetiq Technology, Inc.
Fianium, Inc.
IDEX Optics & Photonics
Inrad Optics
Jasper Display Corp.
KMLabs
LEUKOS
Light Brigade, Inc., The
Liquid Instruments
Mahr-ESDI
Newport Corporation
NKT Photonics Inc.
Ophir-Spiricon, LLC
Optimax Systems, Inc.
Optromix, Inc.
OSA Industry Development Associates
PHASICS Corp.
Pure Photonics
Santec USA Corporation
SPIE
Steinmeyer, Inc.
Syntec Optics
Thorlabs
Toptica Photonics, Inc.
TRIOPTICS USA
University of Arizona, College of Optical Sciences

FiO/LS Committee

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

Frontiers in Optics 2015
Technical Program Committee

David Hagan, *Univ. of Central Florida, CREOL, USA,* **General Chair**
Nikola Alic, *Univ. of California at San Diego*, USA, **General Chair**
Nozomi Nishimura, *Cornell Univ., USA,* **Program Chair**
Ronald Reano, *Ohio State Univ., USA,* **Program Chair**

FiO 1: Optical Design and Instrumentation

Ronguang Liang, *Univ. of Arizona, USA,* **Subcommittee Chair**
Michael Gehm, *Duke Univ., USA*
John Koshel, *Univ. of Arizona, USA*
Stephen Kuebler, *Univ. of Central Florida, CREOL, USA*
Byoungho Lee, *Seoul Natl. Univ., Korea*
Yi-Hsin Lin, *Natl. Chiao Tung Univ., Taiwan*
Jannick Rolland, *Univ. of Rochester, USA*
Kevin Rolland-Thompson, *Synopsys Inc, USA*
Qiwen Zhan, *Univ. of Dayton, USA*

FiO 2: Optical Sciences

Laszlo Veisz, *Max Planck Inst. for Quantum Optics, Germany*, **Subcommittee Chair**
Selçuk Aktürk, *Istanbul Technical Univ., Turkey*
Ian Coddington, *Natl. Inst. of Standards and Technology, USA*
Cameron Geddes, *LBL, USA*
Igor Jovanovic, *Penn State Univ., USA*
Carlos Lopez Mariscal, *Naval Research Lab, USA*
Rodrigo Lopez-Martens, *École Natl. Supérieure de Techniques Avancées, France*
Stephen Maxwell, *Natl. Inst. of Standards and Technology, USA*
Jie Qiao, *Rochester Inst. of Technology, USA*
Koichi Yamakawa, *Japan Atomic Energy Agency, Japan*

FiO 3: Optics in Biology and Medicine

Melissa Skala, *Vanderbilt Univ., USA,* **Subcommittee Chair**
Steven Adie, *Cornell Univ., USA*
J. Quincy Brown, *Tulane Univ., USA*
Alvara Casas-Bedoya, *Univ. of Sydney, Australia*
Bernard Choi, *Univ. of California at Irvine, USA*
Conor Evans, *Massachusetts General Hospital, USA*
Martin Leahy, *Natl. Univ. of Ireland Galway, Ireland*
Aydogan Ozcan, *Univ. of California at Los Angeles, USA*
Alvin Yeh, *Texas A&M Univ., USA*

FiO 4: Fiber Optics and Optical Communications

John Marciante, *Univ. of Rochester, USA,* **Subcommittee Chair**
John Ballato, *Clemson Univ., USA*
Mikhail Brodsky, *ATT Research, USA*
Iyad Dajani, *Air Force Research Lab., USA*
Fabrizio Di Pasquale, *Scuola Superiore Sant'Anna, Pisa, Italy*
Goëry Genty, *Univ. of Tempere, Finland*
Morten Ibsen, *Univ. of Southampton, UK*
Bill Kuo, *Univ. of California at San Diego, USA*
Thomas Murphy, *Univ. of Maryland, USA*
Chongjin Xie, *Alcatel-Lucent Labs, USA*

FiO 5: Integrated Photonics

Joyce Poon, *Univ. of Toronto, Canada*, **Subcommittee Chair**
Paul Barclay, *Univ. of Calgary, Canada*
Badhise Ben Bakir, *CEA-Leti, France*
Ivan Biaggio, *Lehigh Univ., USA*
Nicolas Fang, *Massachusetts Inst. of Technology, USA*
William Green, *IBM T. J. Watson Research Ctr., USA*
Wataru Nakagawa, *Montana State Univ., USA*
Nicolae-Coriolan Panoiu, *Univ. College London, UK*
Mahmoud Rasras, *Masdar Inst., United Arab Emirates*
Lin Zhu, *Clemson Univ., USA*

FiO 6: Quantum Electronics

Alexander V. Sergienko, *Boston Univ., USA*, **Subcommittee Chair**
Ryan Camacho, *Sandia Natl. Lab, USA*
Hui Cao, *Yale Univ., USA*
Luca Dal Negro, *Boston Univ., USA*
Sara Ducci, *Univ. of Paris VII, France*
Jim Franson, *Univ. of Maryland Baltimore County, USA*
Yuri Kivshar, *Australian Natl. Univ., Australia*
John Rarity, *Univ. of Bristol, UK*
Fabio Sciarrino, *Univ. of Rome La Sapienza, Italy*
Duncan Steel, *Univ. of Calgary, USA*
Rupert Ursin, *Univ. of Vienna, Austria*

FiO 7: Vision and Color

Brian Vohnsen, *Univ. College Dublin, Ireland,* **Subcommittee Chair**
Stacey Choi, *Ohio State Univ., USA*
Enrique-Josua Fernandez, *Univ. de Murcia, Spain*
Ravi Jonnal, *Univ. of California at Davis, USA*
Andrew Metha, *Univ. of Melbourne, Australia*
Ramkumar Sabesan, *Univ. of California at Berkeley, USA*
Yuhua Zhang, *Univ. of Alabama at Birmingham, USA*

Laser Science Program Committee

Galina Khitrova, *College of Optical Sciences, Univ. of Arizona, USA,* **General Chair**
Randy A. Bartels, *Colorado State Univ., USA,* **Program Chair**

Laser Science Session Organizers

Accelerating Beams in Optics and Beyond
Ido Kaminer, *Technion Isreal Inst. of Technology, Israel*

Innovative Metallic-Emitter Coupled Systems
Josh Hendrickson, *Wright-Patterson Air Force Base, USA*

Semiconductor Nanooptics
Sangam Chatterjee, *Philipps Univ. Marburg, Germany*

Novel Fiber Lasers
Nasser Peyghambarian, *Univ. of Arizona, USA*

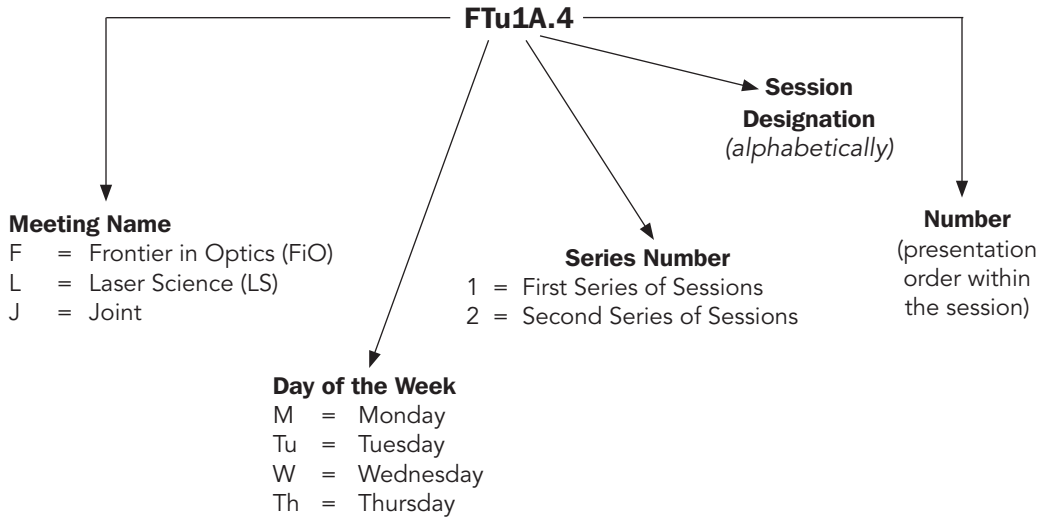
Computational Optical Imaging
Lei Tian, *Univ. of California at Berkeley, USA*

Advances in Nonlinear Laser Spectroscopy
Jesse Wilson, *Duke Univ., USA*

Precision Laser Spectroscopy
Dylan Yost, *Univ. of Colorado at Boulder, JILA, USA*

Light Propagation in Scattering Media
Jeff Field, *Colorado State Univ., USA*

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 FW1A.4 indicates that this paper is part of the Frontiers in Optics Meeting and is being presented on Wednesday (W) in the first series of sessions (1), and is the first parallel session (A) in that series and the fourth paper (4) presented in that session.

Agenda of Sessions — Sunday, 18 October

07:00–17:00	**OSA Annual Student Chapter Leadership Conference (Invitation Only),** *Hyatt Place San Jose, Grand Hall*
12:00-16:00	**CAM Lounge,** *Market Street Foyer*
12:00–18:30	**Registration,** *Market Street Foyer*
16:30–18:30	**FS1A • Townes Memorial Symposium,** *Regency Ballroom*
18:30–20:00	**Townes Memorial Reception,** *Club Regent, Lobby Level (Sponsored by Thorlabs)*
19:00–22:00	**OSA Student Member Reception,** *Da Kine Island Grill, 23 N. Market St., San Jose, CA*

Monday, 19 October

	California	Valley	Crystal	Gold	Empire
07:00–18:00	**Registration,** *Market Street Foyer*				
08:00–10:00	**FM1A • Laser-plasma-based Secondary Sources I**	**FM1B • Integrated Plasmonics** ▶	**FM1C • Symposium on Photoreceptor Analysis and Single-cone-mediated Vision** ▶	**FM1D • Nonlinear Optics in Micro or Nano-Optical Structures I** ▶	**FM1E • Emerging Technologies for High Speed Optical Communications I** ▶
09:00-16:00	**CAM Lounge,** *Market Street Foyer*				
10:00–10:30	**Coffee Break,** *Market Street & South Tower Foyers*				
10:30–12:00	**FM2A • Laser-plasma-based Secondary Sources II**	**FM2B • Biophotonics for Point-of-Care and Global Health Applications** ▶	**FM2C • Novel Methods for Tissue Imaging and Therapy** ▶	**FM2D • Nonlinear Optics in Micro or Nano-Optical Structures II** ▶	**FM2E • Emerging Technologies for High Speed Optical Communications II** ▶
12:00–13:30	**Lunch** *(on your own)*				
12:00–13:30	**Frontiers in Photonic Detection Panel Discussion,** *Belvedere*				
12:00–13:30	**Nonlinear Optics Technical Group Workshop,** *Atherton*				
12:00–13:30	**OSA Fellow Members Lunch** (Advance registration required), *Ballroom, The Westin San Jose, 302 S. Market Street, San Jose, CA*				
13:30–15:30	**FM3A • Laser-plasma-based Secondary Sources III**	**FM3B • Plasmonics and Nanophotonics** ▶	**FM3C • Symposium on Optics for Global Health and Low Resource Settings** ▶	**FM3D • Nonlinear Optics in Micro or Nano-Optical Structures III** ▶	**FM3E • Optical Design** ▶ (ends at 15:15)
15:30–16:00	**Coffee Break,** *Market Street & South Tower Foyers*				
16:00–18:00	**FM4A • International Year of Light – Science to Solutions Special Session,** *Regency Ballroom*				
18:00–19:00	**OSA Microscopy and Optical Coherence Tomography Technical Group Poster Session,** *Atherton*				
18:00–19:00	**Meet OSA's Journal Editors,** *Club Regent, Lobby Level*				
18:30–20:30	**International Year of Light/OSA President's Reception,** *City Hall Rotunda, 200 E. Santa Clara Street, San Jose, CA*				

All sessions/events to be held at The Fairmont San Jose unless otherwise noted.

Key to Shading

Frontiers in Optics | Laser Science | Joint | ▶ Recorded Session

<table>
<tr><th>Fairfield</th><th>Sacramento</th><th>Hillsborough</th><th>Piedmont</th><th>Glen Ellen</th></tr>
<tr><td colspan="5">Registration, Market Street Foyer</td></tr>
<tr><td>FM1F • Novel Concepts in Waveguide Optics
(ends at 09:30)</td><td>FM1G • Optical Fabrication and Testing</td><td>LM1H • Carl E. Anderson Award for Outstanding Doctoral Dissertation in Laser Science</td><td>LM1I • Nonlinear and Spectroscopic Imaging I</td><td></td></tr>
<tr><td colspan="5">CAM Lounge, Market Street Foyer</td></tr>
<tr><td colspan="4">Coffee Break, Market Street & South Tower Foyers</td><td rowspan="8">Laser Science Symposium on Undergraduate Research
(See program distributed with registration materials for complete information)
10:00-12:30 LM2J • Laser Science Symposium on Undergraduate Research Poster Session
12:30–14:00 LM3J • Laser Science Symposium on Undergraduate Research I
14:00–16:00 LM4J • Laser Science Symposium on Undergraduate Research II</td></tr>
<tr><td>FM2F • Advances in Ocular Biometry and Studies of the Anterior Eye</td><td>FM2G • Optical Metrology
(begins at 11:00)</td><td>LM2H • Computational Optical Imaging I</td><td>LM2I • Accelerating Wavepackets in Optics and Beyond I</td></tr>
<tr><td colspan="4">Lunch (on your own)</td></tr>
<tr><td colspan="4">Frontiers in Photonic Detection Panel Discussion, Belvedere</td></tr>
<tr><td colspan="4">Nonlinear Optics Technical Group Workshop, Atherton</td></tr>
<tr><td colspan="4">OSA Fellow Members Lunch (Advance registration required), Ballroom, The Westin San Jose, 302 S. Market Street, San Jose, CA</td></tr>
<tr><td>FM3F • Retinal Imaging, Vasculature, and Photoreceptor Modelling in Healthy and Diseased Eyes</td><td>FM3G • Novel Materials and Design for Optical Fibers</td><td>LM3H • Semiconductor NanoOptics I
(ends at 15:45)</td><td>LM3I • Accelerating Wavepackets in Optics and Beyond II</td></tr>
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</table>

Agenda of Sessions — Tuesday, 20 October

	California	Valley	Crystal	Gold
07:00–18:00	**Registration,** *Market Street Foyer*			
08:00–09:30	**JTu1A • Joint FiO/LS Plenary and Awards Session I,** *Regency Ballroom*			
09:00–16:00	**CAM Lounge,** *Market Street Foyer*			
09:30–16:00	**Exhibit Hall Open,** *Imperial Ballroom* **Ribbon Cutting Ceremony at 09:30**			
09:30–10:30	**Unopposed Exhibit Only Time,** *Exhibit Hall, Imperial Ballroom* **Coffee Break (09:30-10:00)**			
10:30–12:00	**FTu2A • Integrated Quantum Optics I**	**FTu2B • Photonic Crystals** ▶	**FTu2C • Wearable Imaging Optics** ▶	**FTu2D • Microscopy I** ▶
12:00–13:00	**Lunch Break** *(on your own)* and **Unopposed Exhibit Only Time,** *Exhibit Hall, Imperial Ballroom*			
12:00–13:30	**Optical Material Studies Technical Group Workshop,** *Cupertino*			
12:00–13:30	**Better than Fakin' it Good: Multifunctional Bioreplication,** *Fairfield*			
14:30–16:00	**OSA Student Chapter Competition,** *Exhibit Hall, Imperial Ballroom*			
13:00–14:30	**FTu3A • Nonlinear Optics in Micro or Nano-Optical Structures IV**	**FTu3B • Novel Communications Technologies** ▶	**FTu3C • Photonic Structures for Energy** ▶	**FTu3D • Microscopy II** ▶
14:30–16:00	**JTu4A • Joint FiO/LS Poster Session I,** *Exhibit Hall, Imperial Ballroom*			
14:30–16:00	**Unopposed Exhibit Only Time,** *Exhibit Hall, Imperial Ballroom* **Coffee Break (14:30-15:00)**			
16:00–18:00	**FTu5A • Nonlinear Optics in Micro or Nano-Optical Structures V**	**FTu5B • Studying Human Vision with Animal Eyes and Exploring the Limits of Human Vision** ▶	**FTu5C • Optomechanics and Photonic Nanostructures** ▶	**FTu5D • Wavefront Sensing and Adaptive Optics** ▶
16:00–17:00	**Exhibitor Appreciation Reception (exhibitors only Sponsored by OSA Industry Development Associates,** *Exhibit Hall, Imperial Ballroom*			
16:00–17:00	**Minorities and Women in OSA (MWOSA) Networking Reception,** *Atherton*			
17:00–17:45	**OSA Annual Business Meeting,** *Fairfield*			
17:00–18:00	**APS Division of Laser Science Annual Business Meeting,** *Belvedere*			
18:30–20:30	**OSA Member Reception,** *Grande Ballroom, The Westin San Jose, 302 S. Market Street, San Jose, CA*			
19:00–22:00	**Laser Science Banquet,** *Gordon Biersch, 33 East San Fernando St, San Jose, CA*			

All sessions/events to be held at The Fairmont San Jose unless otherwise noted.

Key to Shading

Frontiers in Optics Laser Science Joint ▶ Recorded Session

Empire	Glen Ellen	Sacramento	Hillsborough	Piedmont
Registration, *Market Street Foyer*				
JTu1A • Joint FiO/LS Plenary and Awards Session I, *Regency Ballroom*				
CAM Lounge, *Market Street Foyer*				
Exhibit Hall Open, *Imperial Ballroom* **Ribbon Cutting Ceremony at 09:30**				
Unopposed Exhibit Only Time, *Exhibit Hall, Imperial Ballroom* **Coffee Break (09:30-10:00)**				
FTu2E • Engineered Frequency Combs in Passive and Active Systems I		**FTu2F • General Quantum Electronics I**	**LTu2G • Precision Laser Spectroscopy I**	**LTu2H • Novel Fiber Lasers I**
Lunch Break *(on your own)* and **Unopposed Exhibit Only Time,** *Exhibit Hall, Imperial Ballroom*				
Optical Material Studies Technical Group Workshop, *Cupertino*				
Better than Fakin' it Good: Multifunctional Bioreplication, *Fairfield*				
OSA Student Chapter Competition, *Exhibit Hall, Imperial Ballroom*				
FTu3E • Engineered Frequency Combs in Passive and Active Systems II	**FTu3F • Lasers and Electro-optics**	**FTu3G • General Quantum Electronics II**	**LTu3H • Nonlinear and Spectroscopic Imaging II**	**LTu3I • Novel Fiber Lasers II**
JTu4A • Joint FiO/LS Poster Session I, *Exhibit Hall, Imperial Ballroom*				
Unopposed Exhibit Only Time, *Exhibit Hall, Imperial Ballroom* **Coffee Break (14:30-15:00)**				
FTu5E • Laser-matter Interaction		**FTu5F • Optical Trapping and Manipulation**	**LTu5G • Precision Laser Spectroscopy II**	**LTu5H • Novel Fiber Lasers III**
Exhibitor Appreciation Reception (exhibitors only) Sponsored by OSA Industry Development Associates, *Exhibit Hall, Imperial Ballroom*				
Minorities and Women in OSA (MWOSA) Networking Reception, *Atherton*				
OSA Annual Business Meeting, *Fairfield*				
APS Division of Laser Science Annual Business Meeting, *Belvedere*				
OSA Member Reception, *Grande Ballroom, The Westin San Jose, 302 S. Market Street, San Jose, CA*				
Laser Science Banquet, *Gordon Biersch, 33 East San Fernando St, San Jose, CA*				

Agenda of Sessions — Wednesday, 21 October

	California	Valley	Crystal	Gold
07:00–18:00	**Registration,** *Market Street Foyer*			
08:00–09:30	**JW1A • Joint FiO/LS Plenary and Awards Session II,** *Regency Ballroom*			
09:00–16:00	**CAM Lounge,** *Market Street Foyer*			
09:30–14:00	**Exhibit Hall Open,** *Exhibit Hall, Imperial Ballroom*			
09:30–11:00	**JW2A • Joint FiO/LS Poster Session II,** *Exhibit Hall, Imperial Ballroom*			
09:30–11:00	**Unopposed Exhibit Only Time,** *Exhibit Hall, Imperial Ballroom* **Coffee Break (09:30–10:00) Sponsored by IDEX Optics & Photonics**			
10:00-12:15	**OSA Friends and Family Tour of Rosicrucian Egyptian Museum and Planetarium** (Bus departs from Fairmont San Jose's main entrace at 10:15)			
11:00–12:30	**FW3A • General Optical Sciences I**	**FW3B • Integrated Photonics for Communications: Datacenters and Networks I** ▶	**FW3C • Frequency Comb Generation and Applications** ▶	**FW3D • Quantum Optical Measurement and Technologies I** ▶
12:30–13:30	**Lunch Break** *(on your own)* and **Unopposed Exhibit Only Time,** *Exhibit Hall, Imperial Ballroom*			
12:30–14:00	**VIP Industry Leaders Networking Event,** *Club Regent, Lobby Level*			
13:00–14:30	**Meet the Editors of the APS Journals,** *Exhibit Hall, Imperial Ballroom*			
13:30–15:30	**FW4A • General Optical Sciences II**	**FW4B • Integrated Photonics for Communications: Datacenters and Networks II** ▶	**FW4C • Symposium on Optical Remote Sensing for the Climate** ▶ (ends at 15:00)	**FW4D • Quantum Optical Measurement and Technologies II** ▶
15:30–16:00	**Coffee Break,** *Market Street & South Tower Foyers*			
16:00–18:00	**FW5A • Quantum Optical Measurement and Technologies III**	**FW5B • Integrated Photonics for Communications: InP Platforms and Lasers** ▶ (ends at 17:30)	**FW5C • Novel Concepts in Plasmonics** ▶	**FW5D • Polarization Imaging** ▶
17:00–20:00	**OSA Science Educators' Day,** *Regency Ballroom I*			
18:00–20:00	**Optical Fabrication and Testing Technical Group Networking Event,** *Fairfield*			
18:00–20:00	**OIDA Town Hall Forum on Biophotonics Challenges & Opportunities,** *Club Regent, Lobby Level*			
20:00–22:00	**FiO Postdeadline Paper Session** *The complete schedule can be found in the PDP program and the FiO Mobile App.*			

All sessions/events to be held at The Fairmont San Jose unless otherwise noted.

Key to Shading

☐ Frontiers in Optics ☐ Laser Science ☐ Joint ▶ Recorded Session

Empire	Glen Ellen	Sacramento	Hillsborough	Piedmont
Registration, *Market Street Foyer*				
JW1A • Joint FiO/LS Plenary and Awards Session II, *Regency Ballroom*				
CAM Lounge, *Market Street Foyer*				
Exhibit Hall Open, *Exhibit Hall, Imperial Ballroom*				
JW2A • Joint FiO/LS Poster Session II, *Exhibit Hall, Imperial Ballroom*				
Unopposed Exhibit Only Time, *Exhibit Hall, Imperial Ballroom* **Coffee Break (09:30–10:00) Sponsored by IDEX Optics & Photonics**				
OSA Friends and Family Tour of Rosicrucian Egyptian Museum and Planetarium (Bus departs from Fairmont San Jose's main entrace at 10:15)				
FW3E • Novel Integrated Optical Structures	**FW3F • Novel Light Generation and Manipulation in Fiber Devices I**	**FW3G • Symposium Honoring Adolf Lohmann I**	**LW3H • Novel Photonics** (ends at 12:45)	**LW3I • Computational Optical Imaging II**
Lunch Break *(on your own)* and **Unopposed Exhibit Only Time,** *Exhibit Hall, Imperial Ballroom*				
VIP Industry Leaders Networking Event, *Club Regent, Lobby Level*				
Meet the Editors of the APS Journals, *Exhibit Hall, Imperial Ballroom*				
FW4E • Optical Coherence Tomography	**FW4F • Novel Light Generation and Manipulation in Fiber Devices II**	**FW4G • Symposium Honoring Adolf Lohmann II**	**LW4H • Semiconductor NanoOptics II**	**LW4I • Advanced Imaging**
Coffee Break, *Market Street & South Tower Foyers*				
FW5E • General Optics in Biology and Medicine	**FW5F • Novel Light Generation and Manipulation in Fiber Devices III**	**FW5G • Symposium Honoring Adolf Lohmann III** (ends at 18:15)	**LW5H • Semiconductor NanoOptics III** (starts at 16:30)	**LW5I • Precision Laser Spectroscopy III**
OSA Science Educators' Day, *Regency Ballroom I*				
Optical Fabrication and Testing Technical Group Networking Event, *Fairfield*				
OIDA Town Hall Forum on Biophotonics Challenges & Opportunities, *Club Regent, Lobby Level*				
FiO Postdeadline Paper Session *The complete schedule can be found in the PDP program and the FiO Mobile App.*				

Agenda of Sessions — Thursday, 22 October

	California	Valley	Crystal	Gold
07:30–17:30	**Registration,** *Market Street Foyer*			
08:00–10:00	**FTh1A • General Optical Sciences III**	**FTh1B • Light Manipulation in Plasmonic Structures** ▶	**FTh1C • Coherence, Interference and General Optics I** ▶	**FTh1D • Integrated Quantum Optics II** ▶
10:00–10:30	**Coffee Break,** *Market Street & South Tower Foyers*			
10:30–12:00	**FTh2A • General Optical Sciences IV**	**FTh2B • Photonics on Silicon** ▶	**FTh2C • Coherence, Interference, and General Optics - II** ▶ (begins at 10:45)	**FTh2D • Quantum Communications I** ▶
12:00–13:00	**Lunch** *(on your own)*			
13:00–15:00	**FTh3A • Ultrafast Laser Applications I**	**FTh3B • Integrated Photonics for Communications: Hybrid Integration on Silicon I** ▶	**FTh3C • Symposium on Applications of Low Noise Frequency Combs I** ▶	**FTh3D • Quantum Communications II** ▶
15:00–15:30	**Coffee Break,** *Market Street & South Tower Foyers*			
15:30–17:30	**FTh4A • Ultrafast Laser Applications II**	**FTh4B • Integrated Photonics for Communications: Hybrid Integration on Silicon II** ▶	**FTh4C • Symposium on Applications of Low Noise Frequency Combs II** ▶	**LTh4D • Complex Dynamics** (ends at 17:15)

All sessions/events to be held at The Fairmont San Jose unless otherwise noted.

Key to Shading

Frontiers in Optics | Laser Science | Joint | ▶ Recorded Session

Empire	Glen Ellen	Sacramento	Hillsborough	Piedmont
Registration, *Market Street Foyer*				
FTh1E • Optical Fiber Sensors I: Applications	FTh1F • Computational Optical Sensing and Imaging	FTh1G • Optics and Photonics of Disordered Systems I	LTh1H • Complex Wave Propagation	LTh1I • Innovative Metallic-Emitter Coupled Systems I
Coffee Break, *Market Street & South Tower Foyers*				
FTh2E • Optical Fiber Sensors II: Biosensors	FTh2F • High Power Raman Fiber Lasers	FTh2G • Optics and Photonics of Disordered Systems II	LTh2H • Light Propagation in Scattering Media	LTh2I • Innovative Metallic-Emitter Coupled Systems II
Lunch *(on your own)*				
FTh3E • Optical Fiber Sensors III: Devices	FTh3F • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning I	FTh3G • Computational Optical Sensing and Imaging II	FTh3H • Fiber Lasers and Amplifiers	LTh3I • Innovative Metallic-Emitter Coupled Systems III
Coffee Break, *Market Street & South Tower Foyers*				
FTh4E • Optical Fiber Sensors IV: Methods	FTh4F • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning II	FTh4G • Computational Optical Sensing and Imaging III	LTh4H • Stable Laser Systems	LTh4I • Novel Laser Systems

07:00–18:00 Registration, *Market Street Foyer*

08:00–10:00
FM1A • Laser-plasma-based Secondary Sources I
Presider: Laszlo Veisz; Max-Planck-Institut fur Quantenoptik, Germany

FM1A.1 • 08:00 Invited
Multi-GeV Electron Beams at the Berkeley Lab Laser Accelerator, Anthony J. Gonsalves[1], Kei Nakamura[1], Joost Daniels[1,2], Hann-Shin Mao[1], Carlo Benedetti[1], Carl Schroeder[1], Csaba Toth[1], Jeroen Van Tilborg[1], Daniel Mittelberger[1], Stepan Bulanov[1,3], Jean-Luc Vay[1], Cameron G. Geddes[1], Eric Esarey[1], Wim P. Leemans[1,3]; [1]*ATAP, Lawrence Berkeley National Lab, USA;* [2]*Univ. of Technology Eindhoven, Netherlands;* [3]*Univ. of California Berkeley, USA.* Multi-GeV electron beams from nonlinear laser-plasma acceleration were achieved in cm-scale plasma waveguides. Self-focusing caused trapping in multiple plasma periods. These processes are strongly parameter dependent, requiring precise plasma control for stable acceleration.

08:00–09:45
FM1B • Integrated Plasmonics
Presider: Ivan Biaggio; Lehigh Univ., USA

FM1B.1 • 08:00
Fabrication and Optical Transmission Properties of ZnO Nanowire Waveguide Arrays, Huizhong Xu[1], Thomas Lamson[1], Sahar Khan[1], Orlando Lopez[1], Shadab Hassan[1], Charles Kim[1]; [1]*St. John's Univ., USA.* We demonstrate the fabrication of ZnO nanowire arrays of controlled diameter and spacing and show that strong resonant transmission of visible light through ZnO nanowaveguide arrays in a silver film can be achieved.

FM1B.2 • 08:15
Silicon Nanoparticles for Waveguiding, Reuben M. Bakker[1], Ye Feng Yu[1], Ramón Paniagua-Domínguez[1], Boris Luk'yanchuk[1], Arseniy Kuznetsov[1]; [1]*Data Storage Inst., Singapore.* Guiding of photon energy on the subwavelength scale has long been a goal of the nanophotonics community. We present experimental results on guiding visible light using silicon nanoparticles with losses as low as 2.5dB/100 micrometers.

08:00–10:00
FM1C • Symposium on Photoreceptor Analysis and Single-cone-mediated Vision
Presider: Ann Elsner; Indiana Univ., USA

FM1C.1 • 08:00 Invited WiO
Human Photoreceptor Topography - 25 years and Looking Ahead, Christine A. Curcio[1]; [1]*Univ. of Alabama at Birmingham, USA.* A comprehensive map of photoreceptors in human retinas enabled visualization and quantification of vision's initial sampling array, informing today's in vivo imaging techniques with sub-cellular resolution and mechanistic approaches to retinal pathology.

08:00–10:00
FM1D • Nonlinear Optics in Micro or Nano-Optical Structures I
Presider: Andrew White; Univ. of Queensland, Australia

FM1D.1 • 08:00 Invited
Nonlinear Silicon Photonics, Martino Bernard[2], Massimo Borghi[1], Mher Ghulinyan[2], Santanu Manna[1], Mattia Mancinelli[1], Georg Pucker[2], Fernando Ramiro Manzano[1], Alessandro Trenti[1], Lorenzo Pavesi[1]; [1]*Universita degli Studi di Trento, Italy;* [2]*Centro Materiali e Microsistemi, Bruno Kessler Foundation, Italy.* The nonlinear optical properties of silicon based whispering gallery resonators are here presented. Silicon as well as silicon nitride and silicon nanocrystals based optical microresonators where third order and second order nonlinearities are evidenced have been studied.

08:00–10:00
FM1E • Emerging Technologies for High Speed Optical Communications I
Presider: Alexei Pilipetskii; TE SubCom, USA

FM1E.1 • 08:00 Invited
Multicore Space Division Multiplexed Unrepeatered Transmission beyond 100-Tb/s Capacity, Hidehiko Takara[1], T. Mizuno[1], Yoko Miyamoto[1]; [1]*NTT Network Innovation Labs, Japan.* The paper describes high capacity unrepeatered transmission using multicore-fiber-based remote optically-pumped amplifier. Recent development on transmission technologies based on multicore space-division-multiplexing is also reviewed.

07:00–18:00 Registration, *Market Street Foyer*

08:00–09:30
FM1F • Novel Concepts in Waveguide Optics
Presider: Tsung-Han Tsai, National Taiwan Univ., Taiwan

FM1F.1 • 08:00
Coupling Length Phase Matching in Parallel Waveguides, Ivan Biaggio[1], Virginie Coda[2], Germano Montemezzani[2]; [1]*Lehigh Univ., USA;* [2]*Lab LMOPS, Univ. of Lorraine and Supelec, France.* We show that phase-matching for frequency conversion is possible in a system consisting of two parallel waveguides without any spatial modulation of linear or nonlinear optical properties, both for second and for third-order effects.

FM1F.2 • 08:15
Coupling Length Phase Matching for Third-Order Frequency Downconversion in Dual Core Fibers, Ivan Biaggio[1], Virginie Coda[2], Germano Montemezzani[2]; [1]*Lehigh Univ., USA;* [2]*Lab LMOPS, Univ. of Lorraine and Supelec, France.* The coupling between parallel waveguides leads to a quasi-phase matching effect that allows to obtain phase matching for third-order down conversion and other third-order processes in silica fibers. Several phase matching conditions are found.

08:00–09:45
FM1G • Optical Fabrication and Testing
Presider: Rongguang Liang; Univ. of Arizona, USA

FM1G.1 • 08:00 Invited
Manufacturing of Low Cost Precision 3D Micro Optics, Hui Li[1], Neil Naples[1], Allen Y. Yi[1]; [1]*Ohio State Univ., USA.* Conventional lithography based micromachining methods often involves in complex facilities, templates and repeated mechanical alignments. In a departure from cleanroom based process, we aimed to establish a cost-effective, high precision, true 3D micromachining method with high flexibility.

08:00–10:00
LM1H • Carl E. Anderson Award for Outstanding Doctoral Dissertation in Laser Science
Presider: Kristan Corwin; Kansas State Univ., USA

LM1H.1 • 08:00
Spawning Rings of Exceptional Points out of Dirac Cones, Bo Zhen[1,2], Chia Wei Hsu[3,1], Yuichi Igarashi[4], Ling Lu[1], Ido Kaminer[1,2], Adi Pick[5], Song-Liang Chua[6], John Joannopoulos[1], Marin Soljacic[1]; [1]*MIT, USA;* [2]*Technion, Israel;* [3]*Yale Univ., USA;* [4]*NEC, Japan;* [5]*Harvard Univ., USA;* [6]*DSO National Labs, Singapore.* We demonstrate that an accidental Dirac cone can evolve into a ring of exceptional points in a photonic crystal slab. Radiation fundamentally changes the band structure even though there is no material loss or gain.

08:00–10:00
LM1I • Nonlinear and Spectroscopic Imaging I
Presider: Marcus Cicerone; NIST, USA

LM1I.1 • 08:00 Invited
Enhancing Pigmented or Transparent Tissue Imaging with Laser Pulse Shaping, Warren S. Warren[1], Martin C. Fischer[1], Francisco E. Robles[1], Jesse Wilson[1], Sanghamitra Deb[1]; [1]*Duke Univ., USA.* Enhanced control over femtosecond lasers (pulse shaping or pulse train modulation) improves contrast in tissue imaging. Pump-probe applications to melanoma diagnosis and cross phase modulation measurement in transparent tissues will be presented.

FM1A • Laser-plasma-based Secondary Sources I—Continued

FM1A.2 • 08:30 Invited

Generation of Sub-cycle Attosecond Pulses from a Single Laser-driven Relativistic Electron Sheet, Wenjun Ma[1], Jianhui Bin[1], Hongyong Wang[2], Mark Yeung[2], Christian Kreuzer[1], Matthew Streeter[3], Peta Foster[4], Steven Cousens[5], Brendan Dromey[5], Xueqing Yan[6], Juergen Meyer-ter-Vehn[7], Matt Zepf[2,5], Jörg Schreiber[1,7]; [1]*Faculty of Physics, Ludwig-Maximilians U, Germany;* [2]*Helmholtz Inst. Jena, Germany;* [3]*Blackett Lab, Imperial College London, UK;* [4]*Central Laser Facility, STFC Rutherford Appleton Lab, UK;* [5]*Dept. of Physics and Astronomy, Queen's Univ. Belfast, UK;* [6]*State Key Lab of Nuclear Physics and Technology, Peking Univ., China;* [7]*Max-Planck-Inst. of Quantum Optics, Germany.* Techniques that produce bright isolated attosecond pulses are very attractive for attosecond science. Here we report recent experimental results on generation of sub-cycle attosecond pulses from a signle laser-driven relativistic electron sheet.

FM1A.3 • 09:00 WiO

THz-Induced, High-Energy Electron Emission from Tungsten Nanotips, Sha Li[1], R.R. Jones[1]; [1]*Univ. of Virginia, USA.* Single-cycle THz pulses have been used to induce high energy (several keV) electron emission from nano-tipped tungsten wires. Comparison of the maximum electron energy as a function of tip radius and cone angle provides insight into the emission mechanism and local electron-field interaction.

FM1B • Integrated Plasmonics—Continued

FM1B.3 • 08:30 Invited WiO

Practical Platform for Nanophotonics with Refractory Plasmonic Metal Nitrides and Transparent Conducting Oxides, Alexandra Boltasseva[1]; [1]*Purdue Univ., USA.* Advances in plasmonic materials, especially CMOS-compatible materials including transition metal nitrides and transparent conducting oxides, enables a new generation of devices for applications in on-chip optics, data storage, and energy conversion.

FM1B.4 • 09:00

Fundamental Limits to Plasmonic Response, Owen Miller[1], Athanasios G. Polimeridis[2], M. T. H. Reid[1], Marin Soljacic[3], Alejandro Rodriguez[4], Steven Johnson[1]; [1]*Dept. of Mathematics, MIT, USA;* [2]*Skolkovo Inst. of Science and Technology, Russia;* [3]*Dept. of Physics, MIT, USA;* [4]*Dept. of Electrical Engineering, Princeton Univ., USA.* We present fundamental limits to metallic (plasmonic) response. Applied to radiative heat transfer, our limits generalize the concept of a black body to the near field, where we present designs that may offer significant enhancements.

FM1C • Symposium on Photoreceptor Analysis and Single-cone-mediated Vision—Continued

FM1C.2 • 08:30 Invited

Waveguide Properties of Cone Photoreceptors, Donald T. Miller[1]; [1]*Indiana Univ., USA.* Photoreceptors waveguide light, but the extent to which they do remains controversial. We provide new insight into the complexity of this process using AO-OCT to isolate reflections that originate in the inner and outer segments.

FM1C.3 • 09:00 Invited

Single Cell Imaging In Photoreceptor Degenerative Disease, Christopher Langlo[1], Alfredo Dubra[3,2], Joseph Carroll[1,2]; [1]*Cell Biology, Neurobiology and Anatomy, Medical College of Wisconsin, USA;* [2]*Ophthalmology, Medical College of Wisconsin, USA;* [3]*Biophysics, Medical College of Wisconsin, USA.* Degenerative photoreceptor disease represents a major cause of blindness, for which new therapies are emerging. Here I discuss *in vivo* photoreceptor imaging as it applies to disease monitoring and tracking of therapeutic response.

FM1D • Nonlinear Optics in Micro or Nano-Optical Structures I—Continued

FM1D.2 • 08:30

Stabilized on-chip optical frequency comb, Shu-Wei Huang[1], Jinghui Yang[1], Mingbin Yu[2], Dim-Lee Kwong[2], Chee Wei Wong[1]; [1]*UCLA, USA;* [2]*The Inst. of Microelectronics, Singapore.* We report the first stabilized CMOS-compatible on-chip Kerr frequency comb at 220 mHz instability. The system is a promising compact platform for coherent Raman spectroscopy, coherent optical communication, optical arbitrary waveform generation, and astrophysical spectrography.

FM1D.3 • 08:45

Cavity-enhanced second harmonic generation via topology optimization, Zin Lin[1], Xiangdong Liang[2], Marko Loncar[1], Steven Johnson[2], Alejandro Rodriguez[3]; [1]*Harvard Univ., USA;* [2]*Mathematics Dept., MIT, USA;* [3]*Electrical Engineering, Princeton Univ., USA.* We describe a large-scale optimization approach that enables automatic discovery of photonic structures for achieving high-efficiency second-harmonic generation.

FM1D.4 • 09:00

Optomechanics of Random and Nonlinear Media, Silvia Gentilini[1], Robert W. Boyd[4], Claudio Conti[3,2]; [1]*ISC-CNR, UOS Sapienza, Italy;* [2]*Physics, Univ. "La Sapienza" of Rome, Italy;* [3]*ISC-CNR, Italy;* [4]*Physics, Univ. of Ottawa, Canada.* We theoretically investigate the effects of randomness and nonlinearity on optical forces. Disorder enhances the light induced mechanical effects and ultra-fast nonlinear polarization may give a negative contribution to the optical pressure.

FM1E • Emerging Technologies for High Speed Optical Communications I—Continued

FM1E.2 • 08:30

Comparison of Homogeneous and Heterogeneous 2LP-mode Multicore Fibers for High Spatial Multiplicity, Yuki Tobita[1], Takeshi Fujisawa[1], Kunimasa Saitoh[1], Shoichiro Matsuo[2], Katsuhiro Takenaga[2]; [1]*Hokkaido Univetsity, Japan;* [2]*Fujikura Ltd., Japan.* We compare homogeneous and heterogeneous 2LP-mode multicore fibers (MCFs) and find that the heterogeneous MCF can improve a tradeoff relationship between low inter-core crosstalk and short cutoff wavelength, resulting in high spatial multiplicity.

FM1E.3 • 08:45

Impulse Response Analysis of Strongly-Coupled Three-Core Fibers, Takeshi Fujisawa[1], Kunimasa Saitoh[1]; [1]*Hokkaido Univ., Japan.* Impulse response of strongly-coupled 3-core fibers is analyzed from weak to strong coupling regime based on multimode generalized nonlinear Schrödinger equation. Measured and calculated impulse responses are in good agreement, showing the validity of discussion.

FM1E.4 • 09:00

Design of Portable Multiplexer for Use with Spatial Domain Multiplexed Communication Systems, Syed H. Murshid[1], Saud Alanzi[1], Bilas Chowdhury[1], Gregory Lovell[1], Rayan Enaya[1]; [1]*Florida Inst. of Technology, USA.* A portable multiplexer for use with spatially multiplexed optical fiber communications system is presented that utilizes multiple hollow core tubes at fixed angles adding stability, reliability, robustness and ease of use to spatial multiplexers.

09:00-16:00 CAM Lounge, *Market Street Foyer*

FiO | LS

FM1F • Novel Concepts in Waveguide Optics—Continued

FM1F.3 • 08:30
Phase-matched Second harmonic generation in 1D photonic crystal in the Laue geometry, Vladimir B. Novikov[1], B. I. Mantsyzov[1], A. I. Maydykovskiy[1], T. V. Murzina[1]; [1]*M. V. Lomonosov Moscow State Univ., Russia.* Phase-matched second harmonic generation is observed experimentally in the Laue diffraction scheme in 1D porous quartz based photonic crystals infiltrated by a ferroelectric salt.

FM1F.4 • 08:45 WiO
A high-performance polarization splitter-rotator designed by wavefront matching method, Shuntaro Makino[1], Takeshi Fujisawa[1], Kunimasa Saitoh[1]; [1]*Hokkaido Univ., Japan.* A high-performance polarization splitter-rotator based on a mode-conversion taper and a mode-sorting asymmetric Y-branch waveguides is designed by wavefront matching method. A high transmission in a wide wavelength range is demonstrated.

FM1F.5 • 09:00 WiO
Broadband LP_{01}/LP_{11} PLC-based mode multi/demultiplexer designed by wavefront matching method, Yoko Yamashita[1], Shuntaro Makino[1], Takeshi Fujisawa[1], Kunimasa Saitoh[1], Nobutomo Hanzawa[2], Taiji Sakamoto[2], Takashi Matsui[2], Kyozo Tsujikawa[2], Fumihiko Yamamoto[2]; [1]*Hokkaido Univ., Japan;* [2]*NTT Corporation, Japan.* A broadband, large fabrication tolerance LP_{01}/LP_{11} PLC-based mode multi/demultiplexer design is presented by using wavefront mathing method. The low-loss bandwidth of the optimized structure is 4-times wider than that of conventional structure.

FM1G • Optical Fabrication and Testing—Continued

FM1G.2 • 08:30
Shape Adaptive Grinding of Silicon Carbide Aspheric Optic, Anthony Beaucamp[1], Yoshiharu Namba[2], Phillip Charlton[3], Samyak Jain[3]; [1]*Kyoto Univ., Japan;* [2]*Chubu Univ., Japan;* [3]*Zeeko LTD, UK.* Shape Adaptive Grinding (SAG) is a novel finishing process capable of achieving optical surface finish on silicon carbide. In this paper, we report on the application of SAG to grinding of aspheric optics.

FM1G.3 • 08:45 WiO
A surface profilometer based on laser confocal feedback, weiping wang[1], Shulian Zhang[1]; [1]*Dept. of Precision and Instruments, Tsinghua Univ., China.* An optical surface profilometry method is developed based on microchip Nd:YVO_4 laser feedback and confocal technologies.The signal is detected using heterodyne approach to ensure environmental robustness and invulnerability to the laser instability.

FM1G.4 • 09:00
An experimental study for characterizing surface roughness by speckle pattern analysis, Abdiel O. Pino[1]; [1]*Technological Univ. of Panama, Panama.* We presented a method of measure of the rugosity based in the analysis of the texture of the speckle's pattern. We used GLCM to extract the rugosity. Our experimental results correlates appropriately with autocorrelation function.

LM1H • Carl E. Anderson Award for Outstanding Doctoral Dissertation in Laser Science—Continued

LM1H.2 • 08:30
Helicity and Duality Symmetry in Light Matter Interactions: Theory and Applications, Ivan Fernandez-Corbaton[1,2]; [1]*Macquarie Univ., Germany;* [2]*Inst. of Nanotechnology, Karslruhe Inst. of Technology, Germany.* Treating polarization by means of the electromagnetic helicity leads to new insights in different problems: Optical activity, zero backscattering, metamaterials for transformation optics and nanophotonics phenomena involving angular momentum.

LM1H.3 • 09:00
Coherent Diffractive Imaging Using Randomly Coded Masks, Matthew Seaberg[1,2], Joshua Turner[1], Alexandre d'Aspremont[2,3]; [1]*SLAC National Accelerator Lab, USA;* [2]*CNRS, France;* [3]*DI, ENS, France.* We report the first experimental demonstration of encoded coherent diffractive imaging using a series of randomly coded masks. This technique enables high quality coherent imaging without the use of typical object constraints.

LM1I • Nonlinear and Spectroscopic Imaging I—Continued

LM1I.2 • 08:30 Invited WiO
Mid-Infrared Photothermal Imaging, Michelle Y. Sander[1]; [1]*Electrical and Computer Engineering, Photonics Center, Division of Materials Science and Engineering, Boston Univ., USA.* In photothermal imaging label-free characterization of molecular vibrational bonds is combined with spatial information. A mid-infrared photothermal system with high specificity and sensitivity using a near-infrared fiber and a tunable quantum cascade laser is presented.

LM1I.3 • 09:00 Invited
Spectroscopic Photoacoustic Imaging for the Detection of Lymph Node Metastases, Geoffrey Luke[2,1], Konstantin Sokolov[3], Stanislav Emelianov[4,1]; [1]*Biomedical Engineering, Univ. of Texas at Austin, USA;* [2]*Thayer School of Engineering, Dartmouth College, USA;* [3]*Imaging Physics, MD Anderson Cancer Center, USA;* [4]*Electrical and Computer Engineering, Georgia Inst. of Technology, USA.* We demonstrate the ability for spectroscopic photoacoustic imaging to detect the presence of metastases in murine lymph nodes based on functional and, with the introduction of targeted nanoparticle contrast agents, molecular expressions.

09:00-16:00 CAM Lounge, *Market Street Foyer*

FM1A • Laser-plasma-based Secondary Sources I—Continued

FM1A.4 • 09:15
Ultrafast Non-Paraxial Autofocusing Pulses for High-Gradient Electron Acceleration, Liang Jie Wong[2,1], Ido Kaminer[2]; [1]*Sg Inst. of Manufacturing Tech, Singapore;* [2]*MIT, USA.* We present ultrafast non-paraxial autofocusing beams that exhibit abrupt, ultra-intense focusing in both space and time. We demonstrate their ability to linearly accelerate on-axis electrons with effective gradients exceeding 300 GeV/m.

FM1A.5 • 09:30
Staging and Transport of Laser Plasma Accelerators, Jeroen Van Tilborg[1], Sven Steinke[1], Cameron G. Geddes[1], Nicholas Matlis[1], Anthony J. Gonsalves[1], Brian Shaw[1], Kei Nakamura[1], Carl Schroeder[1], Joost Daniels[1], Julius Huijts[1], Wim P. Leemans[1]; [1]*Lawrence Berkeley National Lab, USA.* We present experiments on the coupling of two closely-spaced Laser Plasma Accelerators by a plasma mirror, aimed at increasing the electron energy while preserving compactness. The critical role of magnetic transport between stages is investigated.

FM1A.6 • 09:45
Influence of Orientational Nonlinearity on Third-Harmonic Generation at Organic Solvents, Emerson C. Barbano[1], Maria Miguez[1], Sérgio C. Zilio[1], Lino Misoguti[1]; [1]*Universidade de Sao Paulo, Brazil.* We report studies of orientational nonlinearities influence on THG at interfaces of a cuvette filled with organic solvents by means of pulse duration. Electronic and orientational nonlinearities are affected distinctly depending of pulse duration.

FM1B • Integrated Plasmonics—Continued

FM1B.5 • 09:15
Compensating Plasmonic Losses by Wavefront Manipulation, Itai Epstein[1], Yuval Tsur[1], Ady Arie[1]; [1]*Tel Aviv Univ., Israel.* We demonstrate experimentally the generation of unique surface-plasmon beams, which compensate the inherent losses of plasmons without using gain media, and show that these beams can extend the limited propagation length of surface-plasmons.

FM1B.6 • 09:30
Spectral Light Separator: The Subwavelength-size Device to Spectrally Decompose Light in an Efficient Way, Yasin Buyukalp[1], Peter B. Catrysse[1], Wonseok Shin[1], Shanhui Fan[1]; [1]*E. L. Ginzton Lab and Dept. of Electrical Engineering, Stanford Univ., USA.* We exploit the unique properties of deep-subwavelength resonant apertures in a metallic film to design an extremely efficient, subwavelength-size device to decompose light into its spectral components with negligible spectral crosstalk and without spatial coregistration errors.

FM1C • Symposium on Photoreceptor Analysis and Single-cone-mediated Vision—Continued

FM1C.4 • 09:30 Invited
Probing Human Spatial and Color Vision on a Cellular Scale, Austin J. Roorda[1]; [1]*Univ. of California Berkeley, USA.* A combination of high resolution imaging and eye tracking enables vision testing on a cellular scale. The aim of the talk will be to demonstrate how eye movements can facilitate fine spatial and color vision.

FM1D • Nonlinear Optics in Micro or Nano-Optical Structures I—Continued

FM1D.5 • 09:15
Nonlinear Cavity Response under Coherent Excitation: Numerical and Experimental Investigation, Samuel F. Serna Otálvaro[1,2], Jeremy Oden[2], Xavier Le Roux[1], Philippe Delaye[2], Eric Cassan[1], Nicolas Dubreuil[2]; [1] *France;* [2]*Laboratoire Charles Fabry, Institut d'Optique, Université Paris-Sud 11, France.* We present a study on the transient operation of a microcavity under a coherent excitation. Through appropriate shaping of the incident signal, the coupling efficiency and the enhancement of the nonlinearities are shown to be increased.

FM1D.6 • 09:30 WiO
Four-Wave Mixing in Silicon-Rich Nitride Waveguides, Miranda Mitrovic[1], Xiaowei Guan[1], Hua Ji[1], Leif K. Oxenløwe[1], Lars H. Frandsen[1]; [1]*Dept. of Photonics Engineering, Technical Univ. of Denmark, Denmark.* We demonstrate four-wave mixing wavelength conversion in silicon-rich nitride waveguides which are a promising alternative to silicon for nonlinear applications. The obtained conversion efficiency reaches -13.6 dB while showing no significant nonlinear loss.

FM1D.7 • 09:45
Stable Optical Vortices Solitons Propagation in CS_2, Albert Reyna Ocas[1], George Boudebs[2], Boris A. Malomed[1,3], Cid B. de Araujo[1]; [1]*Universidade Federal de Pernambuco, Brazil;* [2]*Université d'Angers, France;* [3]*Tel Aviv Univ., Israel.* The stable propagation of two-dimensional vortex solitons in CS_2 is reported. The intensity dependence of the nonlinear refractive index and three photon absorption are the key mechanisms to arrest the azimuthal symmetry breaking.

FM1E • Emerging Technologies for High Speed Optical Communications I—Continued

FM1E.5 • 09:15
All-optical OFDM Transmission Systems RZ-DQPSK Signaling, Seyededriss Mirniaharikandi[1]; [1]*Florida Inst. of Technology, USA.* A RZ-DQPSK modulation technique is propsed for all-optical orthogonal frequency-division multiplexing transmission system. The performance of the proposed system is eveluated and compared to that of traditional NRZ-DQPSK scheme.

FM1E.6 • 09:30 Invited
Nonlinear Fourier Transform for Optical Communications, Sergei K. Turitsyn[1]; [1]*Aston Univ., UK.* The nonlinear Fourier transform, also known as eigenvalue commnications, is a transmission and signal processing technique that makes positive use of the nonlinear properties of fibre channels. I will discuss recent progress in this field.

10:00–10:30 Coffee Break, *Market Street & South Tower Foyers*

FiO

LS

FM1F • Novel Concepts in Waveguide Optics—Continued

FM1F.6 • 09:15
High-Density Low-Crosstalk Waveguide Superlattice, Weiwei Song[1], Robert Gatdula[1], Siamak Abbaslou[1], Ming Lu[2], Aaron Stein[2], Warren Y. Lai[1,3], John Provine[4], Fabian Pease[4], Demetrios N. Christodoulides[5], Wei Jiang[1,6]; [1]*Dept. of Electrical and Computer Engineering, Rutgers Univ., USA;* [2]*Center for Functional Nanomaterials, Brookhaven National Lab, USA;* [3]*Inst. for Advanced Materials, Devices, and Nanotechnology, Rutgers Univ., USA;* [4]*Dept. of Electrical Engineering, Stanford Univ., USA;* [5]*School of Optics/CREOL, Univ. of Central Florida, USA;* [6]*National Lab of Solid State Microstructures,, Nanjing Univ., China.* Waveguides are ubiquitous in silicon photonics. The density of waveguides is crucial to the integration density. We propose and demonstrate a waveguide superlattice that enables high-density waveguide integration at a half-wavelength pitch with low crosstalk.

FM1G • Optical Fabrication and Testing—Continued

FM1G.5 • 09:15 Invited
Billion Droplets Harnessed to Form 3d Printed Optics, Jyrki Saarinen[1]; [1]*Univ. of Eastern Finland, Finland.* 3D printing for optics utilizes inkjet printing of UV curable materials. Even billion tiny droplets build up macroscopic optical components with nanoscale surface roughness without any need for postprocessing.

LM1H • Carl E. Anderson Award for Outstanding Doctoral Dissertation in Laser Science—Continued

LM1H.4 • 09:30 WiO
Direct Mapping of Optical Near Field Forces from Plasmonic Nano-tweezers, Yang Zhao[1], Amr Saleh[1], Marie Anne van de Haar[2], Albert Polman[2], Jennifer Dionne[1]; [1]*Stanford Univ., USA;* [2]*FOM Inst. AMOLF, Netherlands.* Near field optical forces from a plasmonic nano-aperture shows great promise to directly trap biological specimens in nano-meter dimensions. Here we directly map optical forces through a nano coaxial tweezer using atomic force microscopy.

LM1I • Nonlinear and Spectroscopic Imaging I—Continued

LM1I.4 • 09:30 Invited
Nanoscale Spectroscopic Imaging with Photo-induced force Microscopy, Junghoon Jahng[1], Eric O. Potma[1]; [1]*Univ. of California Irvine, USA.* Photo-induced force microscopy produces images with spectroscopic contrast at nanometer scale resolution. In this presentation, the basic principles of the photo-induced force microscope are described and application examples of this technique are highlighted.

10:00–10:30 Coffee Break, *Market Street & South Tower Foyers*

FiO

10:30–12:00
FM2A • Laser-plasma-based Secondary Sources II
Presider: Igor Jovanovic; Pennsylvania State Univ., USA

FM2A.1 • 10:30 Tutorial
Laser-Plasma-Based Secondary Sources: Accelerating Particles and Light, Christian Spielmann[1,2]; [1]*Univ. of Jena, Germany;* [2]*Helmholtz Institut Jena, Germany.* Extraordinary progress has been made in the understanding of laser-based processes in the relativistic intensity regime. We have now a detailed understanding how to accelerate particles and realize brilliant pulsed hard x-ray sources.

Christian Spielmann studied and did his PhD in 1992 at the TU Vienna. After post-doc stays at the University of California in San Diego and the TU Vienna he habilitated 1999 in Vienna. In 2001 he went to the University of Würzburg as professor. Since 2008 he is chair at the Quantum Electronics department at the University of Jena, where he works on strong field optics and x-ray science. Besides his research activities he is a member of the Board of Director of the Abbe Center of Photonics and speaker of the graduate school of the Helmholtz Institute Jena.

FM2A.2 • 11:15
Linear and Nonlinear Thomson Scattering Observed Perpendicular to a Relativistic Laser, Dallas Smith[1], Michael Ware[1], Justin Peatross[1]; [1]*Brigham Young Univ., USA.* We analyze single-photon fundamental, second and third harmonic light scattered out the side of an intense laser focus, interacting with individual free electrons. Such measurements provide additional insights into interaction dynamics via non-phase-matched incoherent emission.

10:30–12:00
FM2B • Biophotonics for Point-of-Care and Global Health Applications
Presider: Aydogan Ozcan; Univ. of California Los Angeles, USA

FM2B.1 • 10:30 Invited
Optically Modulated Electrokinetic Particulate and Fluid Manipulation, Steve Wereley[1]; [1]*Purdue Univ., USA.* Illumination patterns are used to drive electrothermal flows for sorting and manipulating particulates for Lab-on-Chip applications. Plasmonics has been used to enhance the optical coupling.

FM2B.2 • 11:00
Google Glass-based Rapid Analysis of Immuno-chromatographic Diagnostic Tests, Steve Feng[1], Romain Caire[1], Bingen Cortazar[1], Mehmet Turan[1], Andrew Wong[1], Aydogan . Ozcan[1,2]; [1]*Electrical Engineering, Univ. of California, Los Angeles, USA;* [2]*Bioengineering, Univ. of California, Los Angeles , USA.* For rapid, real-time disease diagnostics, we demonstrate the ability of the Google Glass to perform qualitative and quantitative analysis of lateral-flow immuno-chromatographic diagnostic tests.

FM2B.3 • 11:15 WiO
Microfluidic Device Fabrication Utilizing Virtual Masks and Photochemical Etching, Lonna Edwards[1], Kaiyuan Wang[1], Chris Edwards[1], Xin Yu[1], Shailendra Srivastava[1], Gang L. Liu[1], Lynford L. Goddard[1]; [1]*Univ. of Illinois - UC, USA.* We demonstrate using virtual masks to perform photochemical etching to facilitate microfluidic device fabrication. Applications of this cost-efficient alternative to conventional fabrication methods are expansive in many fields such as medical diagnostics.

10:30–11:45
FM2C • Novel Methods for Tissue Imaging and Therapy
Presider: Steven Adie; Cornell Univ., USA

FM2C.1 • 10:30 Invited
Design and Validation of a Spatial Frequency Domain Imaging (SFDI) System for Biomedical Research Applications, David Cuccia[1]; [1]*Modulated Imaging Inc, USA.* We have developed a turn-key LED-based multispectral structured-light imaging platform for biomedical research, with a focus on enabling spatial frequency domain imaging (SFDI). We will cover system validation in-silico, on phantoms, and with pre-clinical models.

FM2C.2 • 11:00 Invited
High-speed Fluorescence Histology For Near-patient Surgical Pathology, J. Quincy Brown[1]; [1]*Tulane Univ., USA.* We describe high-speed structured illumination microscopy, combined with fast-acting topical fluorescent stains which recapitulate H&E histology, as an accurate and practical alternative to frozen section analysis in surgical pathology for detection of positive tumor margins.

10:30–12:00
FM2D • Nonlinear Optics in Micro or Nano-Optical Structures II
Presider: Mattia Mancinelli, Universita degli Studi di Trento, Italy

FM2D.1 • 10:30 Invited WiO
Low Power Nonlinear Optics in Nanophotonic Structures, Jelena Vuckovic[1]; [1]*Stanford Univ., USA.* Very strong light-matter interaction and optical nolinearity at the level of few photons is achieved by employing optical nanocavities (e.g., in GaAs, GaP, SiC) with embedded quantum emitters, such as quantum dots and color centers.

FM2D.2 • 11:00
Towards High-Throughput Opto-Mechanical Flow Cytometry, Kewen Han[1], JunHwan Kim[1], Gaurav Bahl[1]; [1]*Univ. of Illinois at Urbana Champaign, USA.* We use opto-mechanical sensing on hollow-core silica whispering gallery resonators to perform high throughput mechanical measurements on rapidly flowing single particles and cells.

FM2D.3 • 11:15
Towards Automated Deterministic Comb Generation in Microresonators: Overcoming Thermal Shift, Jose A. Jaramillo-Villegas[1,2], Yang Liu[1], Pei-Hsun Wang[1], Yi Xuan[1,3], Daniel E. Leaird[1], Minghao Qi[1,3], Andrew M. Weiner[1,3]; [1]*School of Electrical and Computer Engineering, Purdue Univ., USA;* [2]*Facultad de Ingenierías, Universidad Tecnológica de Pereira, Colombia;* [3]*Birck Nanotechnology Center, Purdue Univ., USA.* We present a computer automated method to generate optical frequency combs in microring resonators and measure its characteristics in fine changes in frequency detuning taking advantage of thermal red shift at thermal equilibrium points.

10:30–12:00
FM2E • Emerging Technologies for High Speed Optical Communications II
Presider: Sergei Turitsyn, Aston Univ., UK

FM2E.1 • 10:30 Invited
High-speed, Long-haul, Quasi-singlemode Transmission Using Few-mode Fiber, Alan Pak Tao Lau[1], Qi Sui[2], John D. Downie[3], William A Wood[3], Jason Hurley[3], Snigdharaj Mishra[3], Chao Lu[4], Hwa-yaw Tam[1], P.K.A. Wai[4]; [1]*Photonics Research Center, Dept. of Electrical Engineering, Hong Kong Polytechnic Univ., Hong Kong;* [2]*Inst. of Photonics Technology, Jinan Univ., China;* [3]*Corning Incorporated, USA;* [4]*Photonics Research Center, Dept. of Electronic and information Engineering, The Hong Kong Polytechnic Univ., Hong Kong.* We review recent developments in quasi-single-mode (QSM) transmissions using few-mode fibers (FMF) with appropriate DSP algorithms as an alternative to overcome fiber nonlinearity in long-haul optical communication systems.

FM2E.2 • 11:00
50 GBaud 16-QAM Transmission Over 2125 km Based on an Injection-Locked Fabry-Perot Laser Carrier, Eduardo Temprana[1], Ping Piu Kuo[1], Nikola Alic[2], Stojan Radic[1,2]; [1]*UCSD, USA;* [2]*Qualcomm Inst., USA.* We propose a transmitter based on injection locking a low-cost Fabry-Perot laser to a reference Optical Frequency Comb. We demonstrate transmission of 50 GBaud 16-QAM over 2125 km relying on Digital Back Propagation.

FM2E.3 • 11:15
45Gb/s PAM4 VCSEL 850/940nm Transmission over OM3 and OM4 Multimode Fibers, Reza Motaghian[1], Ilya Lyubomirsky[1], Henry Daghighian[1], Chris Kocot[1]; [1]*Finisar, USA.* We present experimental data demonstrating 45Gb/s VCSEL transmission over 200m of OM3 and 300m of wideband OM4 fibers at 850/940nm. The measured PAM4 OMA-sensitivity was -15.0 dBm at 2e-4 over 100m OM3 fiber at 850/940nm.

Fairfield

Sacramento

Hillsborough

Piedmont

FiO

LS

10:30–12:00
FM2F • Advances in Ocular Biometry and Studies of the Anterior Eye
Presider: Brian Vohnsen, Univ. College Dublin, Ireland

FM2F.1 • 10:30 Invited WiO
Advances in Anterior Segment OCT: Crystalline and Intraocular Lens Applications, Susana Marcos[1], Pablo Perez-Merino[1], Eduardo Martinez-Enriquez[1], Mengchan Sun[1], Miriam Velasco[1]; [1]*Consejo Sup Investigaciones Cientificas, Spain.* We quantified anterior-segment geometry in young eyes and eyes implanted with IOLs using quantitative custom-developed sOCT. Crystalline lens curvature and high-order surface-elevation terms changed with accommodation. OCT-based computer eye-models predicted optical aberrations in pseudophakic eyes.

FM2F.2 • 11:00 Invited
Brillouin Microscopy for Tissue and Cell Biomechanics, Giuliano Scarcelli [1]; [1]*Univ. of Maryland , USA.* We have developed an all-optical approach to measure material mechanical properties using Brillouin light scattering. Brillouin imaging uses the elastic modulus as contrast mechanism. We demonstrate its application *in vivo* for tissue and cellular biomechanics.

11:00–12:00
FM2G • Optical Metrology
Presider: Simon Thibault; Universite Laval, Canada

FM2G.1 • 10:30
Withdrawn.

FM2G.2 • 10:45
Withdrawn.

FM2G.3 • 11:00
Simple and Accurate Optical Height Sensor for Wafer Inspection Systems, Kei Shimura[1], Naoya Nakai[1], Koichi Taniguchi[1]; [1]*Hitachi High-Technologies Corporation, Japan.* We have developed a height sensor in which eight slits are projected on a surface obliquely and their image is detected by an area sensor. Accuracy of 0.3 um is achieved on patterned wafer.

FM2G.4 • 11:15
Space based measurements of Atmospheric Carbon Dioxide: A New Tool for Monitoring our Environment, David Crisp[1]; [1]*Jet Propulsion Lab, USA.* Precise, global measurements of atmospheric carbon dioxide and other greenhouse gases by the NASA Orbiting Carbon Observatory-2 (OCO-2) and other satellites provide new tools to monitor and manage the processes that control their atmospheric concentrations.

10:30–12:00
LM2H • Computational Optical Imaging I
Presider: Rafael Piestun; Univ. of Colorado at Boulder, USA

LM2H.1 • 10:30 Invited
Extreme Imaging and Beyond, Keisuke Goda[1]; [1]*Univ. of Tokyo, Japan.* I introduce a unique ultrafast optical imaging method known as sequentially timed all-optical mapping photography (STAMP) which enables motion-picture femto-photography at an unprecedented frame rate of more than a trillion frames per second.

LM2H.2 • 11:00
Active Illumination Low-light Computational Correlation Microscopy, Milad Akhlaghi Bouzan[1], Thomas Kohlgraf-Owens[1], Aristide Dogariu[1]; [1]*CREOL, College of Optics and Photonics, Univ. of Central Florida, USA.* We present a low-light, reflection mode correlation imaging technique based on sequential random patterns illumination and integrated backscattered light intensity. Live cell and low contrast target imaging at very low-light levels are demonstrated experimentally.

LM2H.3 • 11:15
Star Test Polarimetry at Low Light Levels, Thomas G. Brown[1], Miguel Alonso[1]; [1]*The Inst. of Optics, USA.* Star Test Polarimetry is a method of deducing the complete Stokes vector by applying statistical inference to a polarization-dependent point spread function. We present an analysis and experimental test of this measurement when applied to very low light levels.

10:30–12:00
LM2I • Accelerating Wavepackets in Optics and Beyond I
Presider: Jeffrey Field, Colorado State Univ., USA

LM2I.1 • 10:30 Invited
Physics and Applications of Airy Beams and Optical Accelerating Waves, Demetrios N. Christodoulides[1]; [1]*Univ. of Central Florida, USA.* We provide an overview of recent developments in the area of Airy beams and optical accelerating waves. Applications of these wavefronts will be discussed along with prospects of using similar concepts in other technical disciplines.

LM2I.2 • 11:00 Invited
Physics and Applications of Accelerating Beams in Optics, John M. Dudley[1], Francois Courvoisier[2]; [1]*Institut FEMTO-ST, Universite de Franche-Comte, France;* [2]*Institut FEMTO-ST, Université de Franche-Comté, France.* We review the state of the art of accelerating beams, discussing their properties from perspectives of geometrical optics, Maxwell's equations and catastrophe theory, and surveying results from femtosecond material processing to random rogue wave generation.

California	Valley	Crystal	Gold	Empire

FiO

FM2A • Laser-plasma-based Secondary Sources II—Continued

FM2A.3 • 11:30
Staged, Guided Laser-Plasma Accelerators Towards Thomson Photon Sources and High Energy Physics, Cameron G. Geddes[1], Sven Steinke[1], Jeroen van Tilborg[1], Brian Shaw[1,2], Nicholas Matlis[1], Anthony J. Gonsalves[1], Kei Nakamura[1], Julius Huijts[1], Daniel Mittelberger[1], Joost Daniels[1], Csaba Toth[1], Jean-Luc Vay[1], Alexadre Bonatto[1], Sergey Rykovanov[1,3], Carl Schroeder[1], Carlo Benedetti[1], Eric Esarey[1], Wim P. Leemans[1,2]; *[1]BELLA Center, Lawrence Berkeley National Lab, USA; [2]Dept. of Physics, U.C. Berkeley, USA; [3]Helmholtz Inst., Germany.* Experiments characterize two high-gradient laser-plasma accelerators in series, each powered by a separate laser pulse, with application to deceleration for compact high energy photon sources and to high energy future particle physics colliders.

FM2A.4 • 11:45
Measured Thomson Scattering from Diffuse Free Electrons in a Strong Laser Field, Justin Peatross[1], Michael Ware[1]; *[1]Brigham Young Univ., USA.* We report an absolute measurement of radiation emitted from free electrons emitted out the side of an intense laser focus. The measurement confirms the QED prediction that emitted radiation is independent of electron wave-packet size.

FM2B • Biophotonics for Point-of-Care and Global Health Applications—Continued

FM2B.4 • 11:30
Differentiation of Morphotic Elements in the Human Blood Using Optical Coherence Tomography and Microfluidic Chip., Pawel Ossowski[1,2], Anna Raiter[2], Anna Szkulmowska[2], Maciej Wojtkowski[1,2]; *[1]Inst. of Physics, Faculty of Physics, Astronomy and Informatics, Nicolaus Copernicus Univ. , Poland; [2]AM2M LLC-LP, Poland.* We propose a novel microfluidic optical flow cytometry technique of differentiating biological objects in microfluidic devices using OCT backscattered light initially disturbed by the object and secondarily scattered by a material of known optical properties.

FM2B.5 • 11:45
CMOS-Based Implantable Glucose Monitoring Device with Glucose-Responsive Fluorescent Hydrogel, Toshikazu Kawamura[1], Tomohiro Hirai[1], Hironari Takehara[1], Hiroaki Takehara[1], Toshihiko Noda[1], Kiyotaka Sasagawa[1], Takashi Tokuda[1], Teru Okitsu[2], Shoji Takeuchi[2], Jun Ohta[1]; *[1]Nara Inst. of Science and Technology, Japan; [2]The Univ. of Tokyo, Japan.* We designed an implantable glucose monitoring device combining a CMOS line sensor with a glucose-responsive fluorescent hydrogel. The structure of the device was optimized and the performance was improved.

FM2C • Novel Methods for Tissue Imaging and Therapy—Continued

FM2C.3 • 11:30
Two-Photon Mueller Matrix-Second-Harmonic Generation Microscopy of Porcine Samples, Chukwuemeka Okoro[1], Kimani C. Toussaint[1]; *[1]Univ. of Illinois Urbana-Champaign, USA.* Quantitative assessment of collagen-based porcine samples is performed using two-photon Mueller matrix analysis of second-harmonic generation (SHG) images. A depolarization parameter is evaluated as a function of sample type and thickness.

FM2D • Nonlinear Optics in Micro or Nano-Optical Structures II—Continued

FM2D.4 • 11:30
Observation of PT-symmetric optical solitons in time-domain photonic lattices, Martin Wimmer[2,3], Alois Regensburger[2], Mohammad-Ali Miri[1], Christoph Bersch[2], Demetrios N. Christodoulides[1], Ulf Peschel[4]; *[1]Univ. of Central Florida, USA; [2]Inst. of Optics, Information and Photonics, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany; [3]Erlangen Graduate School in Advanced Optical Technologies, Germany; [4]Inst. of Solid State Theory and Optics, Friedrich Schiller Univ. Jena, Germany.* We report the first experimental observation of optical solitons in PT-symmetric temporal lattices. By utilizing a judicious balance between gain, loss and nonlinear effects, such self-trapped states remain stable over long distances.

FM2D.5 • 11:45
Ultra-narrowband tunable microwave filter created by stimulated Brillouin scattering in a Silicon chip, Alvaro Casas-Bedoya[1], Blair Morrison[1], Mattia Pagani[1], David Marpaung[1], Benjamin Eggleton[1]; *[1]Univ. of Sydney, Australia.* We demonstrate the first tunable microwave photonic filter based on stimulated Brillouin scattering in a silicon nanowire. We use the low on-chip SBS gain to create a notch with 48dB of suppression and 98MHz linewidth.

FM2E • Emerging Technologies for High Speed Optical Communications II—Continued

FM2E.4 • 11:30 Invited
High Capacity Fiber Optic Submarine Transmission Systems, Alexei N. Pilipetskii[1]; *[1]TE SubCom, USA.* Today's submarine transmission systems carry tens of Tb/s of transmission capacity. The talk will examine specifics of undersea transmission, modern enabling technologies and their limitations. The fundamental issues challenging further long-term transmission capacity growth will be reviewed.

12:00–13:30 Lunch *(on your own)*

12:00–13:30 Frontiers in Photonics Detection Panel Discussion, *Belvedere*

12:00–13:30 Nonlinear Optics Technical Group Workshop, *Atherton*

12:00–13:30 OSA Fellow Members Lunch (Advance registration required), *Ballroom, The Westin San Jose, 302 S. Market St., San Jose, CA*

Fairfield

FiO

FM2F • Advances in Ocular Biometry and Studies of the Anterior Eye—Continued

FM2F.3 • 11:30 Invited

Advances in Presbyopia Correction and Cataract Surgery, Geun-Young Yoon[1]; [1]*Univ. of Rochester, USA.* The talk will focus on recent advances in optimizing outcomes of presbyopia correction and cataract surgery by using new ophthalmic lens designs, in vivo imaging modality and binocular combination of unequal optical blur.

Sacramento

FiO

FM2G • Optical Metrology—Continued

FM2G.5 • 11:30

A Novel Precise Laser Beam Pointing Method with Dielectric Elastomer, Tomohiko Hayakawa[1], Lihui Wang[1], Masatoshi Ishikawa[1]; [1]*Univ. of Tokyo, Japan.* We proposed to manipulate the exit direction of laser beam precisely by controlling a thickness of a dielectric elastomer actuator. There is no mechanical movement in the system, the direction is determined based on position instead of angle, so this application is valid for long distance.

FM2G.6 • 11:45 WiO

Reconstruction of High-Resolution Spectra from a Interferometric/Dispersive Spectrometer, Phyllis Ko[1], Jill Scott[2], Igor Jovanovic[1]; [1]*Pennsylvania State Univ., USA;* [2]*Idaho National Lab, USA.* A hybrid interferometric/dispersive instrument is used to measure laser-induced plasma spectra. An analysis method that rapidly reconstructs the high-resolution source spectra was developed for this instrument.

Hillsborough

LS

LM2H • Computational Optical Imaging I—Continued

LM2H.4 • 11:30 Invited

Wide-field Adaptive Optics Without Guide Stars, Jerome C. Mertz[1], Jiang Li[1], Devin R. Beaulieu[1], Hari Paudel[1], Roman Barankov[1], Thomas Bifano[1]; [1]*Boston Univ., USA.* We describe a wave-sensor implementation of conjugate adaptive optics applicable to widefield (i.e. non-scanning) microscopy, which can provide aberration corrections over large fields of view without the use of guide stars.

Piedmont

LS

LM2I • Accelerating Wavepackets in Optics and Beyond I—Continued

LM2I.3 • 11:30 Invited

Diffractionless Waves of Constant Intensity, Konstantinos Makris[1], Ziad Musslimani[2], Demetrios N. Christodoulides[3], Stefan Rotter[1]; [1]*Inst. for Theoretical Physics, Vienna Univ. of Technology, Austria;* [2]*Mathematics, Florida State Univ., USA;* [3]*College of Optics-CREOL, Univ. of Central Florida, USA.* We introduce a new class of diffraction-free waves in inhomogeneous photonic environments. Such waves have *constant intensity* in all space and exist only in complex potentials with gain and loss.

12:00–13:30 Lunch *(on your own)*

12:00–13:30 Frontiers in Photonics Detection Panel Discussion, *Belvedere*

12:00–13:30 Nonlinear Optics Technical Group Workshop, *Atherton*

12:00–13:30 OSA Fellow Members Lunch (Advance registration required), *Ballroom, The Westin San Jose, 302 S. Market St., San Jose, CA*

California	Valley	Crystal	Gold	Empire

FiO

13:30–15:30
FM3A • Laser-plasma-based Secondary Sources III
Presider: Cameron Geddes; Lawrence Livermore National Lab, USA

FM3A.1 • 13:30 Invited

The Impact of Temporal and Spatial Scales in Laser Driven Relativistic Fields on Ion Acceleration, Matthias Schnürer[1], Florian Abicht[1], Julia Braenzel[1], Lutz Ehrentraut[1], Alexander Andreev[1,2]; [1]*B1, Max Born Inst., Germany;* [2]*St. Petersburg Univ., Russia.* Absolute values of kinetic ion-energies depend on temporal and spatial scales in highly transient laser driven acceleration. Temporal and spatial scales are assessed with specific ion spectral investigation and with proton beam deflectometry.

FM3A.2 • 14:00 Invited

Resolving Ultrafast Molecular Dynamics via Multidimensional High Harmonic Spectroscopy, Barry D. Bruner[1], Hadas Soifer[2,1], Matteo Negro[3], Michele Devetta[3], Davide Faccialà[4], Valeria Serbinenko[5], Olga Smirnova[5], Caterina Vozzi[3], Salvatore Stagira[4], Nirit Dudovich[1]; [1]*Weizmann Inst. of Science, Israel;* [2]*Stanford Inst. for Materials and Energy Sciences, SLAC National Accelerator Lab, USA;* [3]*Instituto di Fotonica e Nanotecnologie, CNR, Italy;* [4]*Dipartimento di Fisica, Politecnico di Milano, Italy;* [5]*Max Born Inst. for Nonlinear Optics and Short Pulse Spectroscopy, Germany.* Extending the dimensionality of high harmonic generation (HHG) measurements is essential for revealing complex attosecond dynamics. We identify structural and dynamical features in molecular HHG spectra, and resolve the contributions of multiple ionization channels.

13:30–15:30
FM3B • Plasmonics and Nanophotonics
Presider: Alexandra Boltasseva; Purdue Univ., USA

FM3B.1 • 13:30

Localized Surface Plasmon-Enhanced Light Emitters based on Amorphous Silicon Quantum Dots through Plasmonic Subwavelength Metallic Crossed Gratings, Tsung-Han Tsai[1], Wing-Kit Choi[1], Hoang Yan Lin[1]; [1]*National Taiwan Univ., Taiwan.* We investigated experimentally the plasmon-enhanced emission enhancement of the amorphous silicon quantum dots light-emitting device with the subwavelength crossed Ag gratings as the top layer in the Ag/SiO_x:a-Si QDs/Ag sandwich cavity.

FM3B.2 • 13:45

Narrow bandwidth and Amplified emission of Amorphous Silicon Quantum Dots through the coupling between Fabry – Pérot cavity and Localized Surface Plasmons Modes, Tsung-Han Tsai[1], Wing-Kit Choi[1], Hoang Yan Lin[1]; [1]*National Taiwan Univ., Taiwan.* We investigated experimentally the influence of the coupling between the Fabry – Pérot cavity and localized surface plasmons modes on plasmon-enhanced photoluminescence of the a-Si QDs LEDs with the Ag/SiO_x:a-Si QDs/Au sandwich nanostructures.

FM3B.3 • 14:00

Combcopolimers of Regioregular Poly 3 Hexylothiophene Applied in Surface Plasmon Resonance Based NO_2 Sensor, Marcin T. Procek[1], Erwin Maciak[1], Agnieszka Stolarczyk[2], Tadeusz Pustelny[1]; [1]*Dept. of Optoelectronics, Silesian Univ. of Technology, Poland;* [2]*Dept. of Physical Chemistry and Technology of Polymers, Silesian Univ. of Technology, Poland.* In this work a novel combcopolimer of regioregular Poly 3-hexylothiophene (rr-P3HT) is applied as a gas (NO_2) sensing material. Gas sensing properties of this material is examined using surface plasmon resonance technique at room temperature.

13:30–15:30
FM3C • Symposium on Optics for Global Health and Low Resource Settings
Presider: J. Quincy Brown; Tulane Univ., USA

FM3C.1 • 13:30 Invited

Projection Microscopy for Medical Diagnostics, Manu Prakash[1]; [1]*Stanford Univ., USA.* Microscopy is gold standard for diagnosing many diseases. Conventional microscopes are costly, lack portability, and cause eye strain. We present a new ultra low-cost, portable, projection microscope for diagnostics with field testing in Kenya.

FM3C.2 • 14:00 Invited

Mobile Technologies for Personalized Diagnostics and Global Health, David Erickson[1]; [1]*Cornell Univ., USA.* I will review the existing commercial and technical roadblocks to the deployment molecular diagnostics to the consumer market and how they can be fundamentally altered by taking advantage of the now ubiquitous installed base of smartphones.

13:30–15:30
FM3D • Nonlinear Optics in Micro or Nano-Optical Structures III
Presider: Michael Raymer; Univ. of Oregon, USA

FM3D.1 • 13:30 Invited WiO

Plasmonic Nanostructures with Well-Controlled Geometry Lead to Designed Properties, Xiaoqin Li[1]; [1]*Univ. of Texas at Austin, USA.* Near field coupling between metallic nanoparticles opens a route for controlling light-matter interaction at nanometer length scale. Novel properties of plasmonic nanostructures can be realized by precisely control the geometry of nanoparticles.

FM3D.2 • 14:00

Non-local Soliton Interactions in Raman-gas Photonic Crystal Fibers, Mohammed F. Saleh[1,2], Andrea Armaroli[2,3], Andrea Marini[2,4], Federico Belli[2], Fabio Biancalana[1,2]; [1]*Heriot Watt Univ., UK;* [2]*Max Planck Inst. for the Science of Light, Germany;* [3]*Laboratoire FOTON, France;* [4]*ICFO-Institut de Ciencies Fotoniques, Spain.* Slow Raman response in gas-filled photonic crystal fibers enables non-local interactions between two successive ultrashort solitons. Different spatiotemporal modulation of the medium refractive index can be obtained by varying time delay between the solitons.

13:30–15:15
FM3E • Optical Design
Presider: Allen Yi; Ohio State Univ., USA

FM3E.1 • 13:30 Invited

Consumer Electronic Optics: The Quest for the Perfect Lens Design, Simon Thibault[1,2]; [1]*Universite Laval, Canada;* [2]*Immervision, Canada.* Small camera phone are becoming integral in our lives. Sensors have more pixels, they are smaller and smaller and the lens must fit within a cell phone enveloppe! Are we facing the miniaturisation limit? Together, we will try to understand the challenges for the lens designer.

FM3E.2 • 14:00 Invited

Freeform Optical Beam Shaping Following An Optimal Transport Map, Zexin Feng[2,1], Brittany Froese[3], Lei Huang[1], Mali Gong[1], Guofan Jin[1], Rongguang Liang[2]; [1]*Dept. of Precision Instrument, Tsinghua Univ., China;* [2]*Univ. of Arizona, USA;* [3]*Univ. of Texas at Austin, USA.* Following a ray map obtained from the optimal transport viewpoint, we will discuss how to effectively control both the irradiance and wavefront of a light beam using two freeform surfaces constructed by a simultaneous point-by-point procedure.

FiO

13:30–15:30
FM3F • Retinal Imaging, Vasculature, and Photoreceptor Modelling in Healthy and Diseased Eyes
Presider: Donald Miller; Indiana Univ., USA

FM3F.1 • 13:30 Invited

Imaging of Human Retinal Microvasculature Using Adaptive Optics Scanning Light Ophthalmoscope, Toco Yuen Ping Chui[1,2], Nikhil Menon[1,2], Nadim Choudhury[1,2], Alexander Pinhas[1,2], Yusufu N. Sulai[3], Alfredo Dubra[3,4], Richard B. Rosen[1,2]; [1]*Ophthalmology, New York Eye and Ear Infirmary of Mount Sinai, USA;* [2]*Ophthalmology, School of Medicine at Mount Sinai, USA;* [3]*Ophthalmology, Medical College of Wisconsin, USA;* [4]*Biophysics, Medical College of Wisconsin, USA. In vivo* microvascular imaging on healthy and diseased retinas using an adaptive optics scanning light ophthalmoscope (AOSLO) employed with fluorescein angiography and non-confocal imaging techniques will be discussed.

FM3F.2 • 14:00 Invited

Title to be Determined, Scott Fraser[1]; [1]*Univ. of Southern California, USA.* Abstract not available.

13:30–15:30
FM3G • Novel Materials and Design for Optical Fibers
Presider: Liang Dong, Clemson Univ., USA

FM3G.1 • 13:30 Invited

Large-Mode-Area All-Solid Photonic Bandgap Fibers for High Power Fiber Lasers, Liang Dong[1], Fanting Kong[1], Guancheng Gu[1], Thomas Hawkins[1], Maxwell Jones[1], Joshua Parsons[1], Monica Kalichevsky-Dong[1], Kunimasa Saitoh[2], Benjamin Pulford[3], Iyad Dajani[3]; [1]*Clemson Univ., USA;* [2]*Hokkaido Univ., Japan;* [3]*AFRL, USA.* All-solid photonic bandgap fibers have unsurpassed higher-order-mode suppression in large-mode-area designs, making them well suited for further power scaling of fiber lasers. We will review of some of the recent progress in this invited talk.

FM3G.2 • 14:00

Investigation of beam self-cleanup process at the multimode fiber edge created by photopolymerization, Haoyu Li[1,3], Yue Qi[1], Changliang Guo[1], John T. Sheridan[1], Pengbai Xu[2], Yongkang Dong[2], Shu Jia[3]; [1]*School of Electrical, Electronic and Communications Engineering, UCD Communications and Optoelectronic Research Centre, SFI-Strategic Research Cluster in Solar Energy Conversion, College of Engineering and Architecture, Univ. College Dublin, Ireland;* [2]*National Key Lab of Science and Technology on Tunable Laser, Harbin Inst. of Technology, China;* [3]*Dept. of Biomedical Engineering, Stony Brook Univ. , USA.* A method for beam self-cleanup is introduced by use of self-written waveguides in a photopolymer, acrylamide/polyvinyl alcohol. This work opens the door to study self-developing light cleanup and its further applications.

LS

13:30–15:45
LM3H • Semiconductor NanoOptics I
Presider: Tony Heinz; Stanford Univ., USA

LM3H.1 • 13:30 Tutorial

Can Opto-Electronics Provide the Motive Power for Future Vehicles?, Eli Yablonovitch[1]; [1]*Electrical Engineering and Computer Sciences Dept., Univ. of California Berkeley, USA.* A rear mirror to reflect band-edge luminescence helped break the world record for solar cell efficiency, 28.8%. It serendipitously reflects all infrared wavelengths, which can revolutionize thermo-photovoltaics. This enables conversion from heat to electricity with >50% efficiency.

Eli Yablonovitch is Director of the NSF Center for Energy Efficient Electronics Science (E^3S), a multi-University Center based at Berkeley. After a career in industry and Universities, he is now Professor of Electrical Engineering & Computer Sciences at UC Berkeley, where he holds the James & Katherine Lau Chair in Engineering. Based on his mantra "that a great solar cell also needs to be a great LED", his startup company Alta Devices has held the world record for solar cell efficiency since 2011, now 28.8%. Yablonovitch is regarded as a Father of the Photonic BandGap concept, and he coined the term "Photonic Crystal".

13:30–15:30
LM3I • Accelerating Wavepackets in Optics and Beyond II
Presider: Francois Courvoisier; Universite de Franche-Comte, France

LM3I.1 • 13:30 Invited

Accelerating Wavepackets, Mordechai Segev[1], Ido Kaminer[2], Elad Greenfield[1], Yaakov Lumer[1], Rivka Bekenstein[1], Jonathan Nemirovsky[1], Uri Bar-Ziv[1]; [1]*Technion Israel Inst. of Technology, Israel;* [2]*Physics, MIT, USA.* We review the recent progress on accelerating wavepackets, highlighting ideas common to many wave systems ranging from self-bending beams of Maxwell's equations and self-accelerating Dirac fermions to deep underwater ultrasonic beams propagating on curved trajectories.

LM3I.2 • 14:00 Invited

Bessel-like self-accelerating beams along predesigned trajectories, Juanying Zhao[1], Ioannis Chremmos[2], Nikolaos Efremidis[3], Zhigang Chen[1]; [1]*San Francisco State Univ., USA;* [2]*Max Planck Inst. for the Science of Light, Germany;* [3]*Univ. of Crete, Greece.* We design and demonstrate self-accelerating Bessel-like beams that can travel along predesigned arbitrary trajectories, including self-breathing, self-spiraling, and self-propelling Bessel-like beams, along with examples of particle manipulation with such fine-shaped beams.

FM3A • Laser-plasma-based Secondary Sources III—Continued

FM3A.3 • 14:30
Multilayer Mirrors for VUV-XUV Attosecond Pump-Probe Experiments, Alexander Guggenmos[1,2], Jürgen Schmidt[1], Stephan Heinrich[1,2], Bert Nickel[3], Ferenc Krausz[1,2], Ulf Kleineberg[1,2]; *[1]Ludwig-Maximilians-Universität München, Germany; [2]Max-Planck-Institut für Quantenoptik, Germany; [3]Center for NanoScience, Ludwig-Maximilians-Universität München, Germany.* Here, we report on the generation of two independent VUV/XUV attosecond pulses by means of a multilayer split mirror system where each half filters the appropriated pulse from a single High Harmonic gas source.

FM3A.4 • 14:45
Conical Cherenkov Terahertz Emission in Two-Color Laser-Produced Plasma, Yong Sing You[1,2], Luke Johnson[1,3], Thomas Antonsen[1], Ki-Yong Kim[1]; *[1]Univ. of Maryland at College Park, USA; [2]Stanford Univ., USA; [3]Naval Research Lab, USA.* We observe conical THz radiation from two-color laser-produced plasma at a broad range of densities. This conical emission results from Cherenkov-like phase-matching between fast moving ionization fronts and slow moving THz radiation.

FM3B • Plasmonics and Nanophotonics—Continued

FM3B.4 • 14:15 Invited
Photonic Jet and its Applications in Nano-Photonics, Hooman Mohseni[1]; *[1]Northwestern Univ., USA.* We present our latest results using photonic jets to produce arbitrary local patterns with 70 nm resolution on a large area in a single exposure. Our experimental results show promise for selective emitters and flat optics.

FM3B.5 • 14:45
Revealing dispersive phase change in plasmonic nano-objects, Xie Zeng[1], Haifeng Hu[2], Yongkang Gao[3], Dengxin Ji[1], Nan Zhang[1], Haomin Song[1], Kai Liu[1], Qiaoqiang Gan[1]; *[1]State Univ. of New York at Buffalo, USA; [2]Northeastern Univ., China; [3]Bell Labs, Alcatel-Lucent, USA.* The phase change dispersion during the surface plasmon wave coupling process was extracted experimentally using a slit-groove interferometer and validated through simulation, enriching the fundamental understanding of subwavelength optics on a chip.

FM3C • Symposium on Optics for Global Health and Low Resource Settings—Continued

FM3C.3 • 14:30 Invited
Democratization of Next-Generation Imaging, Sensing and Diagnostics Tools Through Computational Photonics, Aydogan Ozcan[1]; *[1]Univ. of California Los Angeles, USA.* I will review some of the emerging applications and future opportunities created by the use of mobile-phones and other consumer electronics devices for the development of next-generation imaging, sensing and diagnostics tools through computational photonics.

FM3D • Nonlinear Optics in Micro or Nano-Optical Structures III—Continued

FM3D.3 • 14:15
Higher-Order Spontaneous Parametric Down-Conversion With Back-Propagating Idler Using Submicron Poled KTP, Mark Bashkansky[1], J. Reintjes[2]; *[1]US Naval Research Lab, USA; [2]Sotera Defense Solutions, USA.* We demonstrate Spontaneous Parametric Down-Conversion in one-dimensional PPKTP waveguide with counter-propagating signal and idler beams. This is accomplished by using sub-micron poling and higher-order quasi-phase-matching interactions.

FM3D.4 • 14:30
Background-Free Characterization of Traveling-Wave Optomechanical Devices with Ultrafast Time Domain Spectroscopy, Aleem M. Siddiqui[1], Charles Reinke[1], Heedeuk Shin[2], Robert Jarecki[1], Andrew Starbuck[1], Peter T. Rakich[2]; *[1]Sandia National Labs, USA; [2]Yale Univ., USA.* We employ time-domain measurement of a guided-wave nano-optomechanical systems to reveal the transient phonon response which would otherwise be obscured by additional interwaveguide processes.

FM3D.5 • 14:45
Materials Analysis of Microspheres for Frequency Comb Generation, Nicolas N. Riesen[1], Shahraam Afshar V.[2], Alexandre Francois[1], Tanya M. Monro[2]; *[1]Inst. for Photonics and Advanced Sensing, Univ. of Adelaide, Australia; [2]Univ. of South Australia, Australia.* This paper evaluates the opportunities for using materials other than silica for frequency comb generation in whispering gallery mode microsphere resonators. It explores dispersion compensation at interesting wavelengths such as within the mid-IR.

FM3E • Optical Design—Continued

FM3E.3 • 14:30
System Design for a SPIDER Imager, Samuel T. Thurman[1], Richard L. Kendrick[2], Alan Duncan[2], Danielle Wuchenich[2], Chad Ogden[2]; *[1]Lockheed Martin Coherent Technologies, USA; [2]Lockheed Martin Advanced Technology Center, USA.* We describe system design principles for a Segmented Planar Imaging Detector for Electro-optical Reconnaissance (SPIDER) imager. SPIDER is a concept for making ultra-thin computational imaging systems based on photonic integrated circuits.

FM3E.4 • 14:45
Cloaking in Architecture, Tim Sharpe[2], Johannes K. Courtial[1]; *[1]Univ. of Glasgow, UK; [2]The Mackintosh Environmental Architecture Research Unit (MEARU), Glasgow School of Art, UK.* Ray-optical invisibility cloaking can, in principle, be achieved with micro-structured sheets that perform integral imaging. We discuss potential architectural applications, which range from purely aesthetic to energy-saving.

FiO

FM3F • Retinal Imaging, Vasculature, and Photoreceptor Modelling in Healthy and Diseased Eyes—Continued

FM3F.3 • 14:30 Invited WiO

OCT Angiography Methods in Imaging of the Human Choroid, Iwona M. Gorczynska[1], Justin V. Migacz[1], Robert J. Zawadzki[1], John S. Werner[1]; [1]*Dept. of Ophthalmology & Vision Science, Univ. of California Davis, Davis, CA, USA.* OCT angiography methods: speckle variance, amplitude decorrelation and phase variance will be compared in imaging of the human choroid. Application of split spectrum and volume averaging techniques will be demonstrated with swept source OCT data.

FM3G • Novel Materials and Design for Optical Fibers—Continued

FM3G.3 • 14:15

Fabrication and Side-Coupling Characterization of Hexagonal Lattice Single-Ring Hollow-Core PCFs, Nitin Edavalath[1], Michael H. Frosz[1], Jean-Michel Ménard [1], Philip S. Russell[1]; [1]*Max-Planck Inst. for the Science of Light, Germany.* A simple method for fabricating single-ring PCFs with precise azimuthal positioning of the cladding capillaries is presented. The fundamental and higher-order modes in two different structures are characterized using prism side-coupling.

FM3G.4 • 14:30

High Optical Transmission of Polymer Waveguides Fabricated Between Two Optical Fibers, Pshko Mohammed[1,2], William J. Wadsworth[2]; [1]*Univ. of Bath, UK;* [2]*Physics Dept., Univ. of Sulaimani, Iraq.* Polymer waveguide bridges 40μm to 600μm long have been fabricated between two optical fibers with transmission loss 0.5dB to 1.26 dB over a broad wavelength range. The waveguides were written without using a laser.

FM3G.5 • 14:45

Q-switched pulse generation in Yb- and Er-doped fiber laser with WS_2 saturable absorber, Guoqing Hu[1], Meng Zhang[1], Lingling Chen[3], Xuekun Zhu[1], Guohua Hu[4], Richard C. T. Howe[4], Xin Zhao[1], Zheng Zheng[1,2], Tawfique Hasan[4]; [1]*School of Electronic and Information Engineering, Beihang Univ., China;* [2]*Collaborative Innovation Center of Geospatial Technology, China;* [3]*Dept. of Optoelectronics Engineering, Shenzhen Univ., China;* [4]*Cambridge Graphene Centre, Univ. of Cambridge, UK.* We demonstrate Q-switched pulses with 13.6 and 179.6 nJ pulse energy in Yb- and Er-doped fiber lasers using a few-layer WS_2-PVA saturable absorber. We attribute the saturable absorption to edge-induced sub-bandgap states in WS_2.

LS

LM3H • Semiconductor NanoOptics I—Continued

LM3H.2 • 14:15 Invited

Strong Terahertz-Field Effect on Electron-Hole System in Quantum Wells, Koichiro Tanaka[1,2]; [1]*Dept. of Physics, Kyoto Univ., Japan;* [2]*Inst. for Integrated Cell-Material Sciences (WPI-iCeMS), Kyoto Univ., Japan.* We present strong terahertz light can modulate electron-hole pair creations in 2D-semiconductors. By means of THz pump and optical probe spectroscopy, we observed a strong spectral modulation of the 1s heavy-hole exciton peak of GaAs quantum wells due to Rabi splitting below 10 kV/cm. We also confirmed Franz-Keldysh type spectral modulation and its novel time-dependence in the higher field as high as 50 kV/cm.

LM3H.3 • 14:45 Invited

Structural, Electronic, and Optical Properties of Organic Electronic Materials from Density Functional Theory, Leeor Kronik[1]; [1]*Weizmann Inst. of Science, Israel.* I will present novel approaches within density functional theory that allow for quantitative predictions of structural, electronic, and optical properties, based on the concept of an optimally-tuned range-separated hybrid functional.

LM3I • Accelerating Wavepackets in Optics and Beyond II—Continued

LM3I.3 • 14:30 Invited

Guiding Discharges along Curved Paths, Matteo Clerici[3,1], Yi Hu[1,4], Philippe Lassonde[1], Carles Milián[5], Arnaud Couairon[5], Demetrios N. Christodoulides[6], Zhigang Chen[7], Luca Razzari[1], François Vidal[1], François Légaré[1], Daniele Faccio[3], Roberto Morandotti[1,2]; [1]*INRS-Energie Mat & Tele Site Varennes, Canada;* [2]*Inst. of Fundamental and Frontier Sciences, Univ. of Electronic Science and Technology of China, China;* [3]*School of Engineering and Physical Sciences, Heriot-Watt Univ., UK;* [4]*The MOE Key Lab of Weak Light Nonlinear Photonics, School of Physics and TEDA Applied Physics School, Nankai Univ., China;* [5]*Centre de Physique Theorique, CNRS, Ecole Polytechnique, France;* [6]*College of Optics - CREOL, Univ. of Central Florida, USA;* [7]*Dept. of Physics and Astronomy, San Francisco State Univ., USA.* We show that the intriguing properties of certain shaped laser beams, such as the ability to propagate on curved trajectories and to regenerate after obstacles, allow a novel control of an electric discharge in air.

California	Valley	Crystal	Gold	Empire

FiO

FM3A • Laser-plasma-based Secondary Sources III—Continued

FM3A.5 • 15:00
Power Enhancement Cavity for Burst-Mode Laser Pulses, Yun Liu[1], Abdurahim Rakhman[1,2], Michael Baude[1,2], Mark Notcutt[3]; [1]*Oak Ridge National Lab, USA;* [2]*Dept. of Physics and Astronomy, Univ. of Tennessee, USA;* [3]*Stable Laser Systems, USA.* We demonstrate a novel optical cavity scheme and locking method that can realize the power enhancement of picosecond UV laser pulses operating at a burst mode with arbitrary burst (macropulse) lengths and repetition rates.

FM3A.6 • 15:15
Characterization of Auger Recombination and Its Contribution to the Efficiency Droop in III-Nitride Quantum Wells, Mohammad Tollabi Mazraehno[1,2], Bastian Galler[2], Michael Binder[2]; [1]*Inst. of Applied Physics, Germany;* [2]*OSRAM Opto Semiconductors GmbH, Germany.* Tailored (AlGaIn)N multi-quantum well structures are characterized using low temperature photoluminescence spectroscopy. The results show that Auger recombination plays a key role in the efficiency droop in (AlGaIn)N based LEDs at high carrier densities.

FM3B • Plasmonics and Nanophotonics—Continued

FM3B.6 • 15:00
Broadband Circular Dichroism Through An Achiral Metasurface, Haoran Ren[1], Xiangping Li[1], Qiming Zhang[1], Min Gu[1]; [1]*Faculty of Science, Engineering and Technology, Swinburne Univ Tech, Australia.* We demonstrate a direct distinguishing feature of circularly polarized light through a single nano-aperture. Giant circular dichroism is achieved over a broad spectrum through an achiral metasurface with an orbital angular momentum beam.

FM3B.7 • 15:15 WiO
In-Situ and Real-Time Monitoring of Chemical Reactions Enabled by Ultra-Sensitive and Reproducible SERS, Jing Long[1], Tian Yang[1]; [1]*Shanghai Jiao Tong Univ., China.* The dimerization process of 4NBT to DMAB was driven by localized surface plasmons and monitored in-situ by ultra-sensitive and reproducible SERS in gold nanosphere-plane junctions. Raman spectral lines of possible intermediate products were observed repeatedly.

FM3C • Symposium on Optics for Global Health and Low Resource Settings—Continued

FM3C.4 • 15:00 Invited
Low-Cost Optical Diagnostic Systems for Point of Care Applications, Tomasz Tkaczyk[1]; [1]*Rice Univ. , USA.* I will discuss the designs, manufacturing methods, imaging performance and costs of integrated optical systems used for POC. A number of technological choices will be presented (opto-mechanics, optical elements, electronics and control). Examples of POC applications will be also provided.

FM3D • Nonlinear Optics in Micro or Nano-Optical Structures III—Continued

FM3D.6 • 15:00
Super Oscillating Nonlinear Crystal, Roei Remez[1], Ady Arie[1]; [1]*Tel Aviv Univ., Israel.* The spectral acceptance bandwidth of a standard nonlinear crystal is inversely proportional to the crystal length. We experimentally show that much narrower width is reached by modulating the nonlinear coefficient with a super-oscillation function.

FM3D.7 • 15:15
Nonlinear refractive index larger than linear index: towards all-optical switching with terahertz bandwidth using epsilon-near-zero thin film, Mohammad Z. Alam[1], Israel De Leon[1], Robert W. Boyd[1,2]; [1]*Univ. of Ottawa, Canada;* [2]*Inst. of Optics, Univ. of Rochester, USA.* We show that in epsilon-near-zero regime the nonlinear real index of an indium tin oxide thin film can be much larger than the linear part. This allows for greater than 10dB amplitude modulation with 500 fs.

FM3E • Optical Design—Continued

FM3E.5 • 15:00
Progress towards building pixelated transformation-optics devices, Euan Cowie[1], Cyril Bourgenot[2], David Robertson[2], Johannes K. Courtial[1]; [1]*Univ. of Glasgow, UK;* [2]*Dept. of Physics, Durham Univ., UK.* We report progress in the design and manufacture of micro-structured surfaces that change the direction of transmitted light rays. Such pixellated generalised refraction is general enough to design pixellated transformation-optics devices.

15:30–16:00 Coffee Break, *Market Street & South Tower Foyers*

16:00–18:00 International Year of Light – Science to Solutions Special Session, *Regency Ballroom*

18:00–19:00 OSA Microscopy and Optical Coherence Tomography Technical Group Poster Session, *Atherton*

18:00–19:00 Meet OSA's Journal Editors, *Club Regent, Lobby Level*

18:30–20:30 International Year of Light/OSA Presidents Reception, *City Hall Rotunda, 200 E. Santa Clara St., San Jose, CA*

FiO

FM3F • Retinal Imaging, Vasculature, and Photoreceptor Modelling in Healthy and Diseased Eyes—Continued

FM3F.4 • 15:00 WiO
Modelling Total Cones in the Macula from AOSLO Data, Ann E. Elsner[1], Stephen A. Burns[1]; [1]*Indiana Univ., USA.* We modelled the total cones within a central circle of 7 deg of retina, using from Adaptive Optics Scanning Laser Ophthalmoscope, finding an average of 221,000 cones. The coeficient variation was only .0767.

FM3F.5 • 15:15
Modeling High-Resolution SLO and OCT Retinal Imaging using Backscattering of Light from Elementary Sources, Brian Vohnsen[1], Stacey S. Choi[2], Nathan Doble[2], Elaine Wells-Gray[2], Heping Xu[3], Alan Stitt[3]; [1]*Univ. College Dublin , Ireland;* [2]*Ohio State Univ. , USA;* [3]*Queen's Univ., UK.* Photoreceptor imaging is feasible due to refractive-index discontinuities across the retinal layers. These can alter the light distribution at the visual pigments and impact vision. Here, we analyze a light-scattering model for improved retinal analysis.

FM3G • Novel Materials and Design for Optical Fibers—Continued

FM3G.6 • 15:00
Sub-wavelength confinement in dual capillary assisted chalcogenide core optical fiber for Mid-IR Applications, Viswatosh Mishra[1], Satya P. Singh[1], Raktim Haldar[1], Shailendra K. Varshney[1]; [1]*Indian Inst. of Technology Kharagpur, India.* The sub-wavelength confinement of electromagnetic field is exploited to attain unconventional, almost-flattened and tunable spectral behaviour of effective mode-area and multiple zero dispersion points in nano-sized dual air-capillary assisted chalcogenide optical fiber for mid-IR applications.

FM3G.7 • 15:15
Cascaded Photonic Crystal Fibers for Three-stage Third-order Soliton Compression, Zihao Cheng[1], Qian Li[1]; [1]*Peking Univ. Shenzhen Graduate School, China.* A detailed fiber design was presented for the first time for three-stage third-order soliton compression at the wavelength of 1.06 μm. A compression factor of 173 was realized, and the remained pedestal is only 58.25%.

LS

LM3H • Semiconductor NanoOptics I—Continued

LM3H.4 • 15:15 Invited
Visualization of Charge Carrier Dynamics in Semiconductor Nanowires Using Pump-Probe Microscopy, John Papanikolas[1]; [1]*Univ of North Carolina at Chapel Hill, USA.* Spatially resolved pump-probe microscopy is used to image carrier transport in individual nanowires. Diffusion of charge carriers in Si nanowires and charge separation in a nanowire encoded with an axial p-i-n junction will be discussed.

LM3I • Accelerating Wavepackets in Optics and Beyond II—Continued

LM3I.4 • 15:00 Invited
Linear and nonlinear exotic light wave packets physics and applications, Stelios Tzortzakis[1,2]; [1]*IESL-FORTH & Univ. of Crete, Greece;* [2]*Texas A&M Univ. at Qatar, Qatar.* Exotic linear and nonlinear wave packets propagating in isotropic and periodically modulated media present exciting propagation properties, like the support of robust intense light bullets and the remote deposition of very high laser intensities.

15:30–16:00 Coffee Break, *Market Street & South Tower Foyers*

16:00–18:00 International Year of Light – Science to Solutions Special Session, *Regency Ballroom*

18:00–19:00 OSA Microscopy and Optical Coherence Tomography Technical Group Poster Session, *Atherton*

18:00–19:00 Meet OSA's Journal Editors, *Club Regent, Lobby Level*

18:30–20:30 International Year of Light/OSA Presidents Reception, *City Hall Rotunda, 200 E. Santa Clara St., San Jose, CA*

California	Valley	Crystal	Gold	Empire

FiO

07:00–18:00 Registration, *Market Street Foyer*

08:00–09:30 JTu1A • Joint FiO/LS Plenary and Awards Session I, *Regency Ballroom*

09:00–16:00 CAM Lounge, *Market Street Foyer*

09:30–16:00 Exhibit Hall Open, *Imperial Ballroom*
Ribbon Cutting Ceremony at 09:30

09:30–10:30 Unopposed Exhibit Only Time, *Exhibit Hall, Imperial Ballroom*
Coffee Break (09:30-10:00)

10:30–12:00
FTu2A • Integrated Quantum Optics I
Presider: Linda Sansoni; Universität Paderborn, Germany

FTu2A.1 • 10:30 Invited
Quantum Computing, Jeremy L. O'Brien[1]; [1]*Univ. of Bristol, UK.* Of the various approaches to quantum computing, photons are appealing for their low-noise properties and ease of manipulation at the single qubit level; while the challenge of entangling interactions between photons can be met via measurement induced non-linearities. However, the real excitement with this architecture is the promise of ultimate manufacturability: All of the components—inc. sources, detectors, filters, switches, delay lines—have been implemented on chip, and increasingly sophisticated integration of these components is being achieved. We will discuss the opportunities and challenges of a fully integrated photonic quantum computer.

10:30–12:00
FTu2B • Photonic Crystals
Presider: Raphaël Van Laer; Ghent Univ. - imec, Belgium

FTu2B.1 • 10:30
Periodic Silicon Ridge Waveguides Exhibiting Degenerate Band Edge Resonances, Michael G. Wood[1], Justin R. Burr[1], Ronald M. Reano[1]; [1]*Ohio State Univ., USA.* We experimentally demonstrate degenerate band edge resonances in Si ridge waveguides that are compatible with active electro-optical devices. Quality factors of the first band edge resonances scale to the fifth-power of the number of periods.

FTu2B.2 • 10:45
Tight Control of Light Beams in Photonic Crystals with Spatially-Variant Unit Cells, Rashi Sharma[2], Stephen M. Kuebler[2], Jennefir Digaum[2], Raymond Rumpf[1], Javier Pazos[1]; [1]*Univ. of Texas at El Paso, USA;* [2]*Univ. of Central Florida, USA.* Spatially-variant photonic crystals can be used to direct light through tight turns, with turning radii as small as R_{bend} ~ 20 μm, whereas waveguides having similar R_{bend} exhibit high loss.

10:30–12:00
FTu2C • Wearable Imaging Optics
Presider: Rongguang Liang; Univ. of Arizona, USA

FTu2C.1 • 10:30 Invited
Optical Technologies for See through Wearable Displays: A Review, Bernard Kress[1]; [1]*Google, USA.* The recent hype in wearable VR, AR and Smart Glasses pushed industry to develop novel optical technologies implemening a wide variety of optical combining and sensing functionality. We are aiming at reviewing and classifying such technologies.

10:30–12:00
FTu2D • Microscopy I
Presider: Elliot Botvinick; UC Irvine Beckman Laser Inst., USA

FTu2D.1 • 10:30 Invited
In Vivo Imaging of Cell Dynamics in Animal Models of Neurological Disease using Nonlinear Microscopy, Chris B. Schaffer[1]; [1]*Cornell Univ., USA.* We use nonlinear microscopy to observe and manipulate cell behavior in the central nervous system, focusing on studies of how microvascular hemorrhages impact brain cell function and why brain blood flow is reduced in Alzheimer's disease.

10:30–12:00
FTu2E • Engineered Frequency Combs in Passive and Active Systems I
Presider: Ian Coddington; NIST, USA

FTu2E.1 • 10:30 Invited
Ultra-low Phase Noise Frequency Combs, Chien-Chung Lee[1], Dong Hou[1], Zhengyin Yang[1], Thomas R. Schibli[1]; [1]*Univ. of Colorado at Boulder, USA.* Emerging applications put increasing demands on the short-term stability of frequency combs. We review how ultra-low noise oscillator design combined with improved loop gain and bandwidth continue to enable these most challenging applications to date.

07:00–18:00 Registration, *Market Street Foyer*

08:00–09:30 JTu1A • Joint FiO/LS Plenary and Awards Session I, *Regency Ballroom*

09:00–16:00 CAM Lounge, *Market Street Foyer*

09:30–16:00 Exhibit Hall Open, *Imperial Ballroom*
Ribbon Cutting Ceremony at 09:30

09:30–10:30 Unopposed Exhibit Only Time, *Exhibit Hall, Imperial Ballroom*
Coffee Break (09:30-10:00)

10:30–11:45
FTu2F • General Quantum Electronics I
Presider: Rafael Piestun; Univ. of Colorado at Boulder, USA

FTu2F.1 • 10:30
Transfer of the orbital angular momentum of light to its polarization via classical nonseparability, Seyed Mohammad Hashemi Rafsanjani[1], Mohammad Mirhosseini[1], Omar S. Magana-Loaiza[1], Robert W. Boyd[1,2]; [1]*Univ. of Rochester, USA;* [2]*Physics, Univ. of Ottawa, Canada*. We demonstrate a protocol that utilizes nonseparability between different degrees of freedom of a beam of light to transfer an arbitrary, and a priori unknown, state of two different OAM modes onto the polarization, in a fashion that is analogous to teleportation using quantum entanglement.

FTu2F.2 • 10:45 WiO
Master Equation Approach for Quantum Noise in Atomic Systems for Gravitational-Wave Detection, Minchuan Zhou[1], Selim M. Shahriar[1]; [1]*Northwestern Univ., USA*. We use the master equation approach to compute the quantum noise in three different types of atomic systems and then compare the results to the Caves model for phase-insensitive amplifier/absorber, with application to Gravitational-Wave detection.

10:30–12:00
LTu2G • Precision Laser Spectroscopy I
Presider: Esther Baumann, NIST, USA

LTu2G.1 • 10:30 Invited
Precision Laser Spectroscopy of Leptonic Atoms, Paolo Crivelli[1]; [1]*ETH Zurich, Switzerland*. We report the status of our experiments aiming to improve the uncertainty of the current measurements of the 1S-2S transition frequency of Positronium and Muonium.

10:30–12:00
LTu2H • Novel Fiber Lasers I
Presider: Nasser Peyghambarian; Univ. of Arizona, USA

LTu2H.1 • 10:30 Invited
Bismuth-Doped Fiber Lasers Covering the Spectral Region 1150 – 1775 nm, Evgeny M. Dianov[1], Sergei V. Firstov[1], Mikhail Melkumov[1]; [1]*Fiber Optics Research Center RAS, Russia*. Bismuth-doped fibers are promising active media for the creation of lasers in the near IR region. This paper reviews recent results on the development of new efficient lasers – bismuth-doped fiber lasers operating at wavelengths 1150 – 1775 nm.

FTu2A • Integrated Quantum Optics I—Continued

FTu2A.2 • 11:00 Invited

Quantum Teleportation with Light-emitting-diodes, Richard M. Stevenson[1], Christiana Varnava[1,2], Jonas Nilsson[1], Joanna Skiba-Szymanska[1], Branislav Dzurnak[1], Marco Lucamarini[1], Richard V Penty[2], Ian Farrer[3], David A Ritchie[3], Andrew J Shields[1]; *[1]Toshiba Research Europe Limited, UK; [2]Cambridge Univ. Engineering Dept., UK; [3]Cavendish Lab, Univ. of Cambridge, UK.* Quantum teleportation can provide guaranteed information security to multi-partite quantum communication networks. We report photonic quantum teleportation using a practical semiconductor source of entangled light, based on a quantum dots within a light-emitting-diode.

FTu2A.3 • 11:30

Designing Light-Matter Interactions with Trapped Atoms in Two Dimensional Photonic Crystals Slabs, Juan Muniz[1], Su-Peng Yu[1], Andrew C. McClung[1], Michael J. Martin[1], Lucas S. Peng[1], Jonathan D. Hood[1], Akhisa Goban[1], Mingwu Lu[1], Chen-Lung Hung[1,2], H. Jeff Kimble[1]; *[1]Inst. for Quantum Information and Matter, Caltech, USA; [2]Physics Dept., Purdue Univ., USA.* We describe two-dimensional photonic crystals that support atom trapping as well as strong radiative coupling to guided modes. We explore tailoring interactions between atoms and photons, as well as ongoing experimental progress.

FTu2B • Photonic Crystals—Continued

FTu2B.3 • 11:00

Fast, low-energy switching in GaAs photonic crystal cavities, Ranojoy Bose[1], Jason S. Pelc[1], Charles M. Santori[1], Raymond G. Beausoleil[1]; *[1]HP Labs, USA.* We study free carrier dynamics in gallium arsenide (GaAs) photonic crystal cavities with resonances near the material band edge. We show that low estimated switching energy of 3 femtojoules can be achieved for 45% transmission contrast.

FTu2B.4 • 11:15 Invited

CMOS Compatible Photonic Crystal Nanobeam Cavity Sensors, Feng Liang[1], Qimin Quan[1]; *[1]Harvard Univ., USA.* The growing applications of nanoparticles in energy and healthcare demand new metrology techniques with improved sensitivity and requirement of lower sample concentration. We develop the CMOS compatible photonic crystal nanobeam cavities to size single nanoparticles.

FTu2C • Wearable Imaging Optics—Continued

FTu2C.2 • 11:00 Invited

Monolithic Light Guide Optics for See-through Smart Glasses & Smart Headphones, Khaled Sarayeddine[1]; *[1]Optinvent Inc., France.* Optinvent has developed a unique see-through display technology based on thin monolithic plastic light guide enabling AR and Thin form factor Smart glasses. New Smart headphones integrating this technology will be presented and discussed.

FTu2C.3 • 11:30

Eye-Tracked Extraocular Camera for Retinal Prostheses, Furkan E. Sahin[1], Ben P. McIntosh[1], Patrick J. Nasiatka[1], James D. Weiland[1], Mark S. Humayun[1], Armand R. Tanguay[1]; *[1]Univ. of Southern California, USA.* The optical design and system integration of an eye-tracked wide-angle extraocular camera for use in conjunction with intraocular retinal prostheses is described. This integrated system is capable of restoring foveation for those with retinal prostheses.

FTu2D • Microscopy I—Continued

FTu2D.2 • 11:00 WiO

Understanding the Dynamics of the Stem Cell Niche in the Small Intestine with Femtosecond Laser Photodisruption, Jiahn Choi[1], Daniel J. Joe[2], Poornima Gadamsetty[1], Nikolai Rakhilin[2], Pengcheng Bu[1,2], Steven Lipkin[3], Xiling Shen[2,1], Nozomi Nishimura[1]; *[1]Biomedical Engineering, Cornell Univ., USA; [2]Electrical Engineering, Cornell Univ., USA; [3]Division of Gastroenterology, Depts. of Medicine and Genetic Medicine, Weill Cornell Medical College, USA.* In the stem cell niche, contact between different cells is thought to regulate stem cell self-renewal. We investigate how lost stem cells are replaced by ablating cells with in vivo femtosecond laser photodisruption in mice.

FTu2D.3 • 11:15 WiO

Spectrally encoded confocal microscopy at the 1.9-μm wavelength window, Sisi Tan[1], Xiaoming Wei[1], Shanhui Xu[2], Zhongmin Yang[2], Bowen Li[1], Kenneth K. Y. Wong[1]; *[1]The Univ. of Hong Kong, Hong Kong; [2]Inst. of Optical Communication Materials and State Key Lab of Luminescent Materials and Devices, South China Univ. of Technology, China.* We demonstrate a spectrally encoded confocal microscopy (SECM) system at 1.9 μm using broadband supercontinuum (SC) source, which is capable of imaging at resolution of ~2 μm and field of view (FOV) of ~500 μm.

FTu2D.4 • 11:30

Hyperspectral Imaging of Thick Tissues based on Optical Sectioning Microscopy, Yu John Hsu[1], Chien-Hsiang Huang[1], Liang-Jhih Wang[1], Szu-Yu Chen[1]; *[1]National Central Univ., Taiwan.* An optical sectioning microscopic system was introduced for wide-field hyperspectral microscopy to improve the axial resolution in thick tissues applications. Within thick turbid specimens such as an intact leaf, such technique was successfully demonstrated.

FTu2E • Engineered Frequency Combs in Passive and Active Systems I—Continued

FTu2E.2 • 11:00 Invited

Optical Frequency Comb Generators for Trace Gas Sensing, Adam J. Fleisher[1], David A. Long[1], Joseph T. Hodges[1], Kevin O. Douglass[1], Stephen Maxwell[1], David F. Plusquellic[1]; *[1]NIST, USA.* Optical frequency comb generators for rapidly re-configurable trace gas sensing are demonstrated using high-bandwidth low-V_π electro-optic modulators and rapid-scanning microwave sources. These compact devices perform sensitive dual-comb spectroscopy with user-defined line spacing.

FTu2E.3 • 11:30

Dual-Comb Spectroscopy with Difference-Frequency-Generated Mid-Infrared Frequency Combs, Daniel Maser[1,2], Flavio C. Cruz[1,3], Gabriel Ycas[1], Todd Johnson[1,4], Andrew Klose[1], Fabrizio Giorgetta[1], Laura C. Sinclair[1], Ian Coddington[1], Nathan R. Newbury[1], Scott Diddams[1]; *[1]National Inst. of Standards & Tech, USA; [2]Dept. of Physics, Univ. of Colorado Boulder, USA; [3]Instituto de Fisica Gleb Wataghin, Universidade Estadual de Campinas, Brazil; [4]Dept. of Physics, Saint Johns Univ., USA.* Two mid-infrared frequency combs with average powers of up to 0.5 W were produced via difference frequence generation. Absorption in acetylene C_2H_2 was measured using mid-infrared dual-comb spectroscopy.

FTu2F • General Quantum Electronics I—Continued

FTu2F.3 • 11:00
5.5 W of Diffraction-Limited Green Light Generated by SFG of Tapered Diode Lasers in a Cascade of Nonlinear Crystals, Anders K. Hansen[1], Ole Jensen[1], Peter Andersen[1], Paul Michael Petersen[1]; [1]*Dept. of Photonics Engineering, Technical Univ. of Denmark, Denmark.* Diode-based high power visible lasers are perfect pump sources for, e.g., titanium-sapphire lasers. The combination of favorable scaling laws in both SFG and cascading of nonlinear crystals allows access to unprecedented powers in diode-based systems.

FTu2F.4 • 11:15
Transverse Mode "Polarization" in Optical Beams, Xiao-Feng Qian[1], Tanya Malhotra[1], James Maslek[1], Nick Vamivakas[1], Joseph Eberly[1]; [1]*Univ. of Rochester, USA.* The concept of generalized ``polarization" of transverse spatial modes for a classical light beam is introduced and is experimentally observed systematically through a novel tomographic measurement.

FTu2F.5 • 11:30
Entanglement Constraints in Multi-Qubit Systems, Xiao-Feng Qian[1], Miguel Alonso[1], Joseph Eberly[1]; [1]*Univ. of Rochester, USA.* We observe a novel type of multi-party entanglement constraint relations for arbitrary N-qubit pure state systems. A multi-dimensional geometric representation of such relations is presented.

LTu2G • Precision Laser Spectroscopy I—Continued

LTu2G.2 • 11:00 Invited
Precision Measurements of Hydrogen and Helium *n*=2 Fine Structure for Determining the Proton Size and the Fine-Structure Constant, Eric A. Hessels[1]; [1]*York Univ., Canada.* Precision measurements of *n*=2 hydrogen and helium will lead to precise determinations of the charge radius of the proton and the fine-structure constant. A new frequency-offset separated-oscillatory-field technique is employed. Shifts due to quantum-mechanical interference effects will be discussed.

LTu2G.3 • 11:30 Invited
1S-3S Hydrogen CW Laser Spectroscopy, Sandrine Galtier[1], Helene Fleurbaey[1], Simon Thomas[1], Pierre Clade[1], Saida Guellati[1], Lucile Julien[1], Francois Biraben[1], Francois Nez[1]; [1]*Laboratoire Kastler Brossel, UPMC-Sorbonne Universités, CNRS, ENS-PSL Research Univ., Collège de France, France.* The proton charge radius (r_p) puzzle has disrupted the test of quantum electrodynamics calculations from hydrogen spectroscopy. Currently, depending on the velocity distribution, two contradictory values of r_p can be extracted from our hydrogen experiment.

LTu2H • Novel Fiber Lasers I—Continued

LTu2H.2 • 11:00 Invited
Multi-Core Fiber Lasers, Axel Schulzgen[1], James Anderson[1], Clemence Jollivet[1], Amy Van Newkirk[1], Kay Schuster[2], Stephan Grimm[2]; [1]*CREOL, the College of Optics and Photonics, Univ. of Central Florida, USA;* [2]*Leibniz Inst. of Photonic Technology e.V., Germany.* The operation of multi-core fiber lasers with and without supermode selection will be discussed. Supermode specific gain measurements and roundtrip losses, as well as the dynamic behavior of multi-core fiber lasers will be presented.

LTu2H.3 • 11:30 Invited
Infrared Fiber Materials, Sources and Components, Rafael R. Gattass[1], Rajesh Thapa[2], Frederic H. kung[3], Lynda Busse[1], Jesse Frantz[1], L. Brandon shaw[1], Jasbinder Sanghera[1]; [1]*US Naval Research Lab, USA;* [2]*Sotera Defense Solutions, USA;* [3]*Univ. Research Foundation, USA.* We review the physical and optical properties of chalcognide fibers, recent advances in chalcogenide fiber technology, sources and devices fabricated from these fibers.

FTu2A • Integrated Quantum Optics I—Continued

FTu2A.4 • 11:45
Integrated Frequency Comb of Time-Bin Entangled Photon Pairs, Christian Reimer[1], Michael Kues[1], Piotr Roztocki[1], Benjamin Wetzel[1,8], Fabio Grazioso[1], Yaron Bromberg[7], Brent E. Little[2], Sai T. Chu[3], David J. Moss[1,4], Lucia Caspani[1,5], Roberto Morandotti[1,6]; [1]*INRS-EMT, Canada;* [2]*Xi'an Inst. of Optics and Precision Mechanics of CAS, , China;* [3]*Dept. of Physics and Material Science, City Univ. of Hong Kong, China;* [4]*School of Electrical and Computer Engineering, RMIT Univ., Australia;* [5]*School of Engineering and Physical Sciences, Heriot-Watt Univ., UK;* [6]*Inst. of Fundamental and Frontier Sciences, Univ. of Electronic Science and Technology of China, China;* [7]*Dept. of Applied Physics, Yale Univ., USA;* [8]*Dept. of Physics and Astronomy, Univ. of Sussex, UK*. We report the generation of multiple-frequency time-bin entangled photon pairs from a single integrated CMOS-compatible microring resonator. Entanglement on five channel pairs with visibilities above 82.6% (93.8% background-corrected) is demonstrated.

FTu2B • Photonic Crystals—Continued

FTu2B.5 • 11:45 WiO
Polarization splitter in silicon-on-insulator photonic crystal; design and simulation, Preeti Rani[1], Reena Dalal[1], Yogita Kalra[1], Ravindra K. Sinha[1]; [1]*Delhi Technological Univ., India*. In this paper, we report the polarization splitter based on coupling length in a two dimensional honeycomb photonic crystal slab. The simulation results show that the proposed design behaves as polarization mode splitter.

FTu2C • Wearable Imaging Optics—Continued

FTu2C.4 • 11:45
Polarizer and Diffusing Retroreflector Integration for Hands-Free Switching Telescopic Contact Lens, Glenn M. Schuster[1], Scott Cookson[2], Arthur Zhang[2], William Meyers[3], Joseph E. Ford[1]; [1]*Univ. of California, San Diego, USA;* [2]*Innovega Inc, USA;* [3]*Paragon Vision Sciences, USA*. We describe the fabrication and characterization of telescopic scleral contact lenses with embedded orthogonal polarizers over the 1x and 2.8x paths, and a diffusing retro-reflector, used with liquid crystal shutter glasses providing wink-controlled hands-free switching.

FTu2D • Microscopy I—Continued

FTu2D.5 • 11:45 WiO
Hyperspectral Multiphoton Microscopy: Demonstration of 48-channel Imaging *In Vivo*, Amanda Bares[1], Steven Tilley[2], Peter S. Doerschuk[1], Chris B. Schaffer[1]; [1]*Cornell Univ., USA;* [2]*Biomedical Engineering, Johns Hopkins Univ., USA*. We constructed a hyperspectral multiphoton microscope that records 48 channels of excitation/emission spectral data per pixel, while remaining insensitive to optical scattering. We demonstrate imaging of multiple spectrally overlapping fluorophores in mouse cortex, *in vivo*.

FTu2E • Engineered Frequency Combs in Passive and Active Systems I—Continued

FTu2E.4 • 11:45
Influence of Raman scattering on Kerr frequency comb in a silica toroidal microcavity, Takumi Kato[1], Tomoya Kobatake[1], Zhelun Chen[1], Ryo Suzuki[1], Takasumi Tanabe[1]; [1]*Keio Univ., Japan*. We investigate that the interaction between four-wave mixing and Raman scattering in a high-Q silica microcavity with a split-step algorithm. Raman-effect dominant states occur between a transition of stable Kerr comb formation.

12:00–13:00 Lunch Break *(on your own)* and **Unopposed Exhibit Only Time,** *Exhibit Hall, Imperial Ballroom*

12:00–13:30 Optical Material Studies Technical Group Workshop, *Cupertino*

12:00–13:30 Better than Fakin' it Good: Multifunctional Bioreplication, *Fairfield*

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FTu2F • General Quantum Electronics I—Continued

LTu2G • Precision Laser Spectroscopy I—Continued

LTu2H • Novel Fiber Lasers I—Continued

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12:00–13:00 **Lunch Break** *(on your own)* and **Unopposed Exhibit Only Time,** *Exhibit Hall, Imperial Ballroom*

12:00–13:30 **Optical Material Studies Technical Group Workshop,** *Cupertino*

12:00–13:30 Better than Fakin' it Good: Multifunctional Bioreplication, *Fairfield*

13:00–14:30
FTu3A • Nonlinear Optics in Micro or Nano-Optical Structures IV

Presider: Richard Stevenson; Toshiba Corp, UK

FTu3A.1 • 13:00 Invited

Quantum Metamaterials Based on Nonlinear Superconducting Resonators, Alexandre Karpov[1]; [1]*National Un.of Science and Techn (MISIS), Russia*. We will present experimental study of SQUID array based quantum superconductive metamaterials. The cryogenic Laser Scanning Microscope technique gives an insight to confirm a coherent response of the SQUID-based microwave resonator arrays and its tunability.

FTu3A.2 • 13:30 Invited

Quantum Optical Measurements with Classical Nonlinear Optics, John E. Sipe[1], Marco Liscidini[2]; [1]*Dept. of Physics, Univ. of Toronto, Canada;* [2]*Dipartimento di Fisica, Universita degli Studi di Pavia, Italy.* The quantum-correlated photon pairs that *would* be generated by a nonlinear optical device, were it operated in the quantum regime, can be characterized by nonlinear optical experiments done on the device in the classical regime.

13:00–14:30
FTu3B • Novel Communications Technologies

Presider: Syed Murshid; Florida Inst. of Technology, USA

FTu3B.1 • 13:00

Geometric Phase Shifter using Optical Wave-plates for Microwave Photonics, Tomoyuki Uehara[1], Kenichiro Tsuji[1], Noriaki Onodera[1]; [1]*National Defense Academy of Japan, Japan*. We demonstrate an RF geometric phase shifter using optical wave plates and optical polarizer for photonically generated microwave signal. The RF phase generated from orthogonally polarized lights was shifted from 0 to 360 degrees.

FTu3B.2 • 13:15

Proposal of a Bi-directional Fiber-To-The-Antenna System for Microwave Signal Distribution, Ana G. Correa-Mena[1], Pablo Hernandez-Nava[1], Abigail López-Rojas[1], Ignacio Zaldivar-Huerta[1], Alejandro García-Juárez[2], Armando Rojas-Hernández[2]; [1]*INAOE,- Puebla, Mexico;* [2]*Universidad de Sonora, Mexico*. We experimentally describe a bi-directional fiber-to-the-antenna communication system for microwave signals distribution. The uniqueness of this work is that only an optical source was used for this goal.

FTu3B.3 • 13:30 WiO

Multi-mode QKD over a Marine FSO Channel, Alyssa Jenkins[1], Ivan Djordjevic[1], Mark Neifeld[1]; [1]*Univ. of Arizona, USA*. We study the performance of the BB84 quantum key distribution technique in a marine environment. We quantify effects of loss, scattering, and turbulence on secret key rate and extend single channel results to multi-mode encodings.

13:00–14:30
FTu3C • Photonic Structures for Energy

Presider: Peter Rakich; Yale Univ., USA

FTu3C.1 • 13:00 Tutorial

Nanophotonics for Energy and Information Applications, Shanhui Fan[1]; [1]*Stanford Univ., USA*. We discuss some of the recent developments of nanophotonics for information and energy applications. As examples, we discuss the use of dynamic modulation for the purpose of creating non-reciprocal response as well as an effective gauge field for photons. We will also discuss the use of photonic structures for thermal radiation control, leading in particular to the demonstration of passive radiative cooling.

Shanhui Fan is a Professor of Electrical Engineering, and the Director of the Edward L. Ginzton Laboratory, at the Stanford University. He received his Ph. D in 1997 in theoretical condensed matter physics from MIT. His research interests are in nanophotonics. He has published over 350 refereed journal articles and has given over 270 invited talks, and was granted 53 US patents. Prof. Fan received a NSF Career Award, a David and Lucile Packard Fellowship , the National Academy of Sciences Award for Initiative in Research, and the Adolph Lomb Medal from the Optical Society. He is a Fellow of APS, OSA, SPIE, and IEEE.

13:00–14:30
FTu3D • Microscopy II

Presider: Chris Schaffer, Cornell Univ., USA

FTu3D.1 • 13:00 WiO

Plasmonic nanoisland-based cell microscopy for sub-diffraction-limited imaging, Taehwang Son[1], Youngjin Oh[1], Wonju Lee[1], Donghyun Kim[1]; [1]*School of Electrical and Electronic Engineering, Yonsei Univ., Korea*. We have explored sub-diffraction-limit cellular imaging using blocked nanoislands based on surface plasmon localization. Intracellular actin filaments were visualized on nanoislands and resolved by localized near-fields in the range of 100-150 nm.

FTu3D.2 • 13:15

Laser Scanning Stereomicroscopy with Bessel Beams, Yan Long Yang[1]; [1]*Xi'an Inst. of Optics and Precision Mechanics, Chinese Academy of Sciences, China*. A laser scanning fluorescence microscopy is designed with both the extended depth of field and stereoscopic ability, which allow us to view the whole volume of specimen at a speed of about 1 to several volumes per second directly with NVIDIA shutter glasses without post image processing.

FTu3D.3 • 13:30

Automation of Interferometric Synthetic Aperture Microscopy, Yang Xu[1], Yuan-Zhi Liu[1], Stephen A. Boppart[1], Paul S. Carney[1]; [1]*Univ of Illinois at Urbana-Champaign, USA*. We present an automated algorithm framework for determining the optimal parameters for interferometric synthetic aperture microscopy (ISAM). It significantly lowers the background requirement for operating ISAM machines, while achieving near-optimal ISAM reconstruction on OCT images.

13:00–14:30
FTu3E • Engineered Frequency Combs in Passive and Active Systems II

Presider: Ian Coddington, NIST, USA

FTu3E.1 • 13:00 Tutorial

Mid-Infrared and THz Quantum Cascade Laser Frequency Combs, Jérôme Faist[1]; [1]*ETH Zurich, Switzerland*. The locking mechanism of broadband mid-infrared and THz Quantum cascade frequency combs will be explained. Octave-spanning frequency, dispersion correction as well as proof of principle spectroscopy experiments will also be discussed.

Jérôme Faist obtained his Bachelor and Ph.D. in Physics, in the group of Prof. F.-K Reinhart from the Swiss Institute of Technology in Lausanne in 1985, 1989 respectively. After a post-doc in IBM Rueschlikon (89-91), he joined F. Capasso's group in Bell Laboratories in 1991 where he worked first as a post-doc and then as a Member of Technical Staff. From 1997 to 2007, he was professor in the physics institute of the University of Neuchâtel. In 2007, he became professor in the institute for quantum electronics of the ETH Zurich. His central role in the invention and first demonstration of the quantum cascade (QC) laser in 1994 was recognised by the IEE premium (1995), the IEEE/LEOS William Streifer award (1998), the Michael Lunn award (1999), the ISCS "Young scientist award" (1999), and the Swiss National Latsis Prize (2003). His present interests are the development of high performance QC lasers in the Mid and Far-infrared and the physics of coherence in intersubband transitions in the presence of strong magnetic fields.

13:00–14:30
FTu3F • Lasers and Electro-optics
Presider: Zhimin Shi, Univ. of Rochester, USA

FTu3F.1 • 13:00 Invited WiO
Integrated Hybrid Microcavities for Low Threshhold Lasers, Andrea M. Armani[1], Ce Shi[1], Nishita Deka[1], Kelvin Kuo[1]; [1]*Univ. of Southern California, USA.* By integrating new gain into hybrid ultra-high-Q cavities, two types of low-threshold optically-pumped lasers are demonstrated. The Ti-enhanced Raman laser and the gold nanorod plasmonic laser both have sub-mW thresholds.

FTu3F.2 • 13:30
Long term carrier-envelope-phase stabilization of a terawatt-class Ti:Sapphire laser, Adam M. Summers[1], Benjamin Langdon[2,3], Jon Garlick[3], Xiaoming Ren[4,1], Derrek Wilson[1], Stefan Zigo[1], Matthias Kling[5,1], Shuting Lei[6], Christopher Elles[7], Eric Wells[9], Erwin Poliakoff[8], Kevin Carnes[1], Vinod Kumarappan[1], Itzhak Ben-Itzhak[1], Carlos Trallero-Herrero[1]; [1]*J. R. Macdonald Lab, Kansas State Univ., USA;* [2]*Crunch Technologies, USA;* [3]*Kapteyn-Murnane Labs Inc, USA;* [4]*CREOL and Dept. of Physics,, Univ. of Central Florida, USA;* [5]*Physics Dept., Ludwig-Maximilians-Universitat, Germany;* [6]*Industrial and Manufacturing Systems Engineering, Kansas State Univ., USA;* [7]*Dept. of Chemistry, Univ. of Kansas, USA;* [8]*Dept. of Chemistry, Louisiana State Univ., USA;* [9]*Dept. of Physics, Augustana College, USA.* We demonstrate a terawatt class Ti:Sapphire laser, 20 mJ pulse energy, 26 femtosecond pulse duration, 1kHz repetition rate, with Carrier-envelope-phase (CEP) stabilized within 300 mrad RMS, measured single shot over 9 hours.

13:00–14:30
FTu3G • General Quantum Electronics II
Presider: Alexandre Karpov, NIST, USA

FTu3G.1 • 13:00 Invited
Computational Optical Imaging For Super-resolution Microscopy And Sensing Through Complex Media, Rafael Piestun[1]; [1]*Univ. of Colorado at Boulder, USA.* Optical computational imaging seeks enhanced performance and new functionality by the joint design of illumination, optics, detectors, and reconstruction algorithms. Two remarkable examples discussed here enable overcoming the diffraction limit and imaging through complex media.

FTu3G.2 • 13:30
Verification of a Heralded, Two-Photon Fock State with a Gang of Detectors, Roger A. Smith[1], Dileep V. Reddy[1], Dashiell L. Vitullo[1], Michael G. Raymer[1]; [1]*Univ. of Oregon, USA.* We propose an experimental method for measuring two-photon Fock states using a gang of detectors and demonstrate the creation of heralded, two-photon Fock states of light.

13:00–14:30
LTu3H • Nonlinear and Spectroscopic Imaging II
Presider: Michelle Sander; Boston Univ., USA

LTu3H.1 • 13:00 Invited
Nonlinear Optical Imaging in Art Conservation and Heritage Science, Martin C. Fischer[1], Tana Villafana[1], William Brown[2], John Delaney[3], Warren S. Warren[1]; [1]*Duke Univ., USA;* [2]*North Carolina Museum of Art, USA;* [3]*National Gallery of Art, USA.* Pump-probe microscopy can extract molecular and structural contrast with high spatial resolution even in thick, scattering samples. We will discuss the technique's principle and applications for imaging historic paintings and other cultural heritage objects.

LTu3H.2 • 13:30 Invited
In Vivo Spectroscopic Imaging by Retrieving Stimulated Raman Signal from Highly Scattered Photons, Chien-Sheng Liao[1], Ji-Xin Cheng[1], Pu Wang[1]; [1]*Purdue Univ., USA.* We demonstrate microsecond vibrational spectroscopic imaging by spatial frequency-multiplexing and single photodiode detection of stimulated Raman signals. Compared to the spectrometer setting, we improved the photon-collection efficiency by 200 times for scattering systems.

13:00–14:30
LTu3I • Novel Fiber Lasers II
Presider: Jason Auxier; US Naval Research Lab, USA

LTu3I.1 • 13:00 Invited
Q-switched Fiber Laser Based on the Kerr Effect of Multimode Interference Effect, Wei Shi[1]; [1]*Tianjin Univ., China.* We demonstrated an all-fiber passively Q-switched Er-Yb codoped fiber laser using a single mode-multimode-single mode fiber structure based on the multimode interference effect. To the best of our knowledge, this is the first demonstration of the Q-switched fiber laser based on a SMS structure.

LTu3I.2 • 13:30 Invited
Fiber-based Doppler Lidar for Vector Velocity and Altitude Measurements, Farzin Amzajerdian[1], Diego F. Pierrottet[2], Glenn D. Hines[1], Larry B. Petway[1], Bruce W. Barnes[1]; [1]*NASA Langley Research Center, USA;* [2]*Coherent Applications, Inc., USA.* A coherent Doppler lidar capable of providing accurate velocity and altitude data has been developed and demonstrated for future NASA missions to the solar system bodies requiring precision navigation and controlled soft landing.

FTu3A • Nonlinear Optics in Micro or Nano-Optical Structures IV—Continued

FTu3A.3 • 14:00
Quantum-Coherently Assisted Deep-UV Localization of Light in Active Plasmonic Heterostructures, Kosmas Tsakmakidis[1], Pankaj K. Jha[1], Yuan Wang[1], Xiang Zhang[1]; [1]*UC Berkeley, USA*. We introduce a new method to localize lightwaves. We show how the interaction of a gain medium with a planar deep-UV plasmonic heterostructure, at its zero-v_g point, *strongly* localizes light. A quantum-coherent drive provides a means to control the localization and dramatically improve the dynamics.

FTu3A.4 • 14:15
Divide and Conquer: Counting Photons on an Integrated Platform, Armando P. Leija[2], René Heilmann[1], Jan Sperling[3], Markus Gräfe[1], Matthias Heinrich[1], Stefan Nolte[1], Werner Vogel[3], Alexander Szameit[1]; [1]*Friedrich-Schiller-Universität Jena, Germany;* [2]*Inst. of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Germany;* [3]*Arbeitsgruppe Quantenoptik, Inst. für Physik, Universität Rostock, Germany.* We experimentally demonstrate a fully integrated photon-counting device based on a divide-and-conquer technique using linear optics in combination with standard on-off detectors.

FTu3B • Novel Communications Technologies—Continued

FTu3B.4 • 13:45
Characterization of Tellurite Fiber Samples Doped with Erbium and Ytterbium for Broadband Amplification, Thisien G. Montes[1], Jorge D. Marconi[2], Enver F. Chillce[1], Luiz C. Barbosa[1], Aldario C. Bordonalli[1]; [1]*Univ. of Campinas, Brazil;* [2]*Federal Univ. of ABC, Brazil.* A spectral characterization of erbium and ytterbium doped tellurite fibers pumped at 980-nm is presented. Samples offered up to 70-nm ASE bandwidth around 1550 nm and over 20-dB potential amplification between 1530 and 1585 nm.

FTu3B.5 • 14:00
Chaotic Semiconductor Lasers with Time-delay Signatures Suppressed by Feedback from Optimized FBGs, Song-Sui Li[1], Xiao-Zhou Li[1], Jun-Ping Zhuang[1], Sze-Chun Chan[1,2]; [1]*Dept. of Electronic Engineering, City Univ. of Hong Kong, China;* [2]*State Key Lab of Millimeter Waves, City Univ. of Hong Kong, China.* Chaotic dynamics is investigated in a semiconductor laser with fiber Bragg grating (FBG) feedback. By optimizing the FBG bandwidth and detuning frequency from the laser, time-delay signature suppression by over 10 times is observed experimentally.

FTu3B.6 • 14:15
Information processing using an autonomous all-photonic reservoir computer based on coherently driven passive cavities, Quentin Vinckier[1], Francois Duport[1], Marc Haelterman[1], Serge Massar[2]; [1]*OPERA-Photonique, ULB (Université Libre de Bruxelles), Belgium;* [2]*Laboratoire d'Information Quantique, ULB (Université Libre de Bruxelles), Belgium.* We study a realistic numerical model of an autonomous all-optical neural network based on two coherent optical cavities in order to demonstrate its high potential for high-speed signal processing with low power consumption.

FTu3C • Photonic Structures for Energy—Continued

FTu3C.2 • 13:45
Photonic Crystal Devices for Energy Applications, Jeremy N. Munday[1], Yunlu Xu[1]; [1]*Univ. of Maryland at College Park, USA.* Photonic crystals can be used to modify photon absorption and emission rates. Here we show how photonic crystals can yield higher power conversion efficiency in solar energy converters through an effective bandgap modification.

FTu3C.3 • 14:00 WiO
Fabrication and Characterization of Solar Supercapcitors Integrated with a Laser Scribed Graphene Oxide film, Litty Thekkekara[1], Baohua Jia[1], Yinan Zhang[1], Ling Qiu[2], Dan Li[2], Min Gu[1]; [1]*Swinburne Univ. of Technology, Australia;* [2]*Dept. of Materials Engineering, Monash Univ., Australia.* An on-chip concept of supercapacitor electrical energy storage integrated with solar cells using thin-film graphene oxide was demonstrated. The solar supercapacitor showed a 62% columbic efficiency with non-degradation in the solar cell performance.

FTu3C.4 • 14:15
Design and Analysis of Low Loss Highly Efficient Light Trapping Structure for GaAs Thin Film Solar Cells using Photonic Crystals as Diffraction Grating, Nikhil Deep Gupta[1], Vijay Janyani[1], Ghanshyam Singh[1], Hiroyuki Tsuda[2]; [1]*Malaviya National Inst. of Technolog, India;* [2]*Electrical and Electronics Dept., Keio Univ., Japan.* The paper demonstrates performance improvement of photonic crystal diffraction grating based GaAs thin film solar cell and shows that light trapping structure contributes more to the efficiency enhancement of thinner cells.

FTu3D • Microscopy II—Continued

FTu3D.4 • 13:45
Photothermal imaging for nanoparticle characterization using single element interferometer, Yuki Nagata[1], Yasuhiro Mizutani[2], Tetsuo Iwata[1], Yukitoshi Otani[3]; [1]*Tokushima Univ., Japan;* [2]*Osaka Univ., Japan;* [3]*Utsunomiya Univ., Japan.* A photothermal imaging microscope for single metal nanoparticles using single element interferometer has been developed. In this report, different diameters of the gold nanoparticles were discriminated by measuring the phase of photothermal signals.

FTu3D.5 • 14:00
Optical Sectioning in Interferometric Cross-Polarised Microscopy Towards Biological Imaging, Benjamin Miles[1], Henkjan Gersen[1]; [1]*Univ. of Bristol, UK.* Experimentally and theoretically characterising Interferometric Cross-Polarisation Microscopy presents strong evidence of the ability to optically section. This feature combined with high resolution and extinction ratios, suggests unique potential for imaging birefringent structures in living cells.

FTu3D.6 • 14:15
STED Imaging by Using Hollow Bessel Beam, Wentao Yu[1], Ziheng Ji[1], Xusan Yang[2], Zibo Gong[1], Yunfeng Xiao[1,3], Peng Xi[2], Kebin Shi[1,3]; [1]*State Key Lab for Mesoscopic Physics, School of Physics, Peking Univ., China;* [2]*Dept. of Biomedical Engineering, College of Engineering, Peking Univ., China;* [3]*Collaborative Innovation Center of Quantum Matter, China.* We report a STED microscope by using Bessel beam. Improved lateral resolution of deep-imaging at 84μm-depth was observed as 150nm, with comparison to a standard STED imaging resolution of 275nm measured at the same depth.

FTu3E • Engineered Frequency Combs in Passive and Active Systems II—Continued

FTu3E.2 • 13:45 WiO
Quantum cascade laser Kerr frequency comb generation, Caroline Lecaplain[1], Clément Javerzac-Galy[1], Erwan Lucas[1], John D. Jost[1], Tobias J. Kippenberg[1]; [1]*EPFL, Switzerland.* We report mid-infrared Kerr comb generation based on a quantum cascade laser pumping a crystalline microresonator. For the first time QCL light is coupled into a microresonator via a tapered chalcogenide fiber allowing mid-IR Kerr comb generation.

FTu3E.3 • 14:00
Hanbury Brown and Twiss Interferometry with Twisted Light, Omar S. Magana Loaiza[1], Mohammad Mirhosseini[1], Robert M. Cross[1], Seyed Mohammad Hashemi Rafsanjani[1], Robert W. Boyd[1,2]; [1]*UofR, USA;* [2]*Physics, Univ. of Ottawa, Canada.* We demonstrate that chaotic fluctuations of intensity give rise to the formation of correlations in the orbital-angular-momentum components and angular positions of thermal light. These correlations are manifested through Hanbury-Brown-and-Twiss interference in the orbital-angular-momentum basis.

FTu3E.4 • 14:15
Bandwidth Control in 5-μm Pulse Generation by Double-Chirped Optical Parametric Amplification, Scott Wandel[1], Guibao Xu[1], Yanchun Yin[1], Ming-wei Lin[1], Igor Jovanovic[1]; [1]*Pennsylvania State Univ., USA.* We simulate and experimentally demonstrate a versatile and efficient method to control the spectral bandwidth of short mid-infrared pulses produced by optical parametric amplification.

14:30–16:00 JTu4A • Joint FiO/LS Poster Session I, *Exhibit Hall, Imperial Ballroom*

14:30–16:00 Unopposed Exhibit Only Time, *Exhibit Hall, Imperial Ballroom*
Coffee Break (14:30-15:00)

14:30–16:00 OSA Student Chapter Competition, *Exhibit Hall, Imperial Ballroom*

FiO | LS

FTu3F • Lasers and Electro-optics—Continued

FTu3F.3 • 13:45
Withdrawn.

FTu3F.4 • 14:00 WiO
Effect of Fe impurity on fused silica surface damage induced by 355nm laser pulse, Hongjie Liu[1]; [1]*China Academy of Engineering Physics, Research Center of Laser Fusion , China.* The samples polished by cerium oxide, ferric oxide or processed by magnetorheological finishing show that not only Ce but also Fe element has a serious influence on laser-induced native damage.

FTu3F.5 • 14:15
Metamaterial Resonators for Dynamic Spatial Millimeter-Wave Modulators, Daniel L. Marks[1], David R. Smith[1]; [1]*Duke Univ., USA.* Many phase spatial modulators exist at optical frequencies such as liquid crystal cells. We present an alternative for millimeter-waves based on metamaterial resonators that produces strong phase modulation from a small tuning range.

FTu3G • General Quantum Electronics II—Continued

FTu3G.3 • 13:45 WiO
Ho:YAG Rod Amplifier For High Order Vortex Modes, Yuan Li[1], Zeyu Zhang[1], Wenzhe Li[1], Jerome Miller[1], Eric Johnson[1]; [1]*The Holcombe Dept. of Electrical and Computer Engineering, Clemson Univ., USA.* The amplification of Laguerre-Gaussian (LG) modes with orbital angular momentum is demonstrated in a Ho:YAG rod amplifier. Simulations are also carried out for verifying the experimental data and predicting the potential for high gain.

FTu3G.4 • 14:00
Controlling Directionality of Radiation Through Separable Bound States in the Continuum, Nicholas Rivera[1], Chia Wei Hsu[3], Bo Zhen[1], Hrvoje Buljan[2], John Joannopoulos[1], Marin Soljacic[1]; [1]*MIT, USA;* [2]*Univ. of Zagreb, Croatia;* [3]*Yale Univ., USA.* We demonstrate a general class of bound states in the continuum in separable systems that are realizable and show that tailored perturbations of these BICs allow control over the directionality and dimensionality of resonant radiation.

FTu3G.5 • 14:15
High-power, picosecond, 10 μm pulses via compression of a laser beat-wave in GaAs, Jeremy Pigeon[1], Sergei Tochitsky[1], Chan Joshi[1]; [1]*UCLA, USA.* We produce a train of high-power, 2 ps, 10 um laser pulses by multiple-four-wave-mixing compression of a 106 GHz CO_2 laser beat-wave in GaAs. The possibility of generating high-power, 300 fs, mid-IR pulses is discussed.

LTu3H • Nonlinear and Spectroscopic Imaging II—Continued

LTu3H.3 • 14:00 Invited
Broadband CARS - Instrumentation, Quantitation, and Application, Marcus T. Cicerone[1,2], Charles Camp[1], Young J. Lee[1]; [1]*Biomaterials, National Inst. of Standards and Technology, USA;* [2]*IPST, Univ. of Maryland - College Park, USA.* I will discuss capabilities and applications of broadband coherent anti-Stokes Raman scattering (BCARS) microscopy, focusing on optimized excitation paradigms, quantitative signal extraction, and applications in investigations of tissues and small organisms.

LTu3I • Novel Fiber Lasers II—Continued

LTu3I.3 • 14:00 Invited
Challenges of Near-Marine Boundary Layer Atmospheric and Turbulence Testing and Modeling, Tariq Manzur[1], Joshua Olson[2], Nasser Peyghambarian[2], Arturo Chavez-Pirson[2]; [1]*NAVSEA Naval Undersea Warfare Ctr, USA;* [2]*Univ. of Arizona, USA.* Abstract not available.

14:30–16:00 JTu4A • Joint FiO/LS Poster Session I, *Exhibit Hall, Imperial Ballroom*

14:30–16:00 Unopposed Exhibit Only Time, *Exhibit Hall, Imperial Ballroom*
Coffee Break (14:30-15:00)

14:30–16:00 OSA Student Chapter Competition, *Exhibit Hall, Imperial Ballroom*

14:30–16:00
JTu4A • Joint FiO/LS Poster Session I

JTu4A.1
Plasmonic NanoLenses: Size Based Sorting of Bacteria Like Bio-Particles, Xiangchao Zhu[1], Ahmet A. Yanik[1]; [1]*Baskin School of Engineering, Univ. of California, Santa Cruz, USA.* We demonstrate that plasmonic metasurfaces enables size based sorting of single bacteria like bio-particles within a wide dynamic range of 0.1 μm to 1 μm, by merely modulating the light intensity.

JTu4A.2 WiO
Generation of UV Laser Induced Point Defects in Fused Silica and Recombination by Oxygen Plasma, Xiaoyan Zhou[1]; [1]*China Acad Engin Physics, China.* Laser induced point defects with different parameters on fused silica in atmosphere or vacuum were studied. These defects can react with oxygen plasma, which provides a new way to prolong the lifetime of fused silica in high-power laser system.

JTu4A.3
Measurements of the Optical Anisotropy Parameters of CaF_2, BaF_2 and SrF_2 Crystals, Alexey Yakovlev[1], Ilya Snetkov[1], Oleg Palashov[1]; [1]*Inst. of Applied Physics RAS, Russia.* The material constant – optical anisotropy parameter ξ of CaF_2, BaF_2 and SrF_2 crystals was measured at three wavelengths. The orientation of the crystallographic axes corresponding to minimum value of the thermally induced depolarization was obtained.

JTu4A.4
Ultraviolet Emissions of Tb^{3+} by Three-photon Upconversion Proces, Xiaojie Xue[1], Tonglei Cheng[1], Dinghuan Deng[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Toyota Technological Inst., Japan.* Tb^{3+}/Yb^{3+} co-doped $NaYF_4$ microcrystals show intense ultraviolet upconversion emissions. The emissions of Tb^{3+} at 323, 338, 352, and 368 nm are observed for the first time. They are generated by a three-photon upconversion process.

JTu4A.5 WiO
Research on Chromatic Properties of Higher Order Kinoform Lenses for THz Radiation, Karolina Wegrzynska[1], Agnieszka Siemion[1], Martyna Rachoń[1], Jaroslaw Suszek[1], Maciej Sypek[1]; [1]*Warsaw Univ. of Technology, Poland.* The evaluation of chromatic properties of higher order kinoforms (phase structures with phase retardation of , p>1) in THz radiation was performed. Kinoforms of 1st and 2nd order were examined in paraxial and non-paraxial approaches.

JTu4A.6
How To Make Spins In Spin Hall Effect of Light Truly Separate, Bo Wang[1,2], Yan Li[1,2]; [1]*State Key Lab for Mesoscopic Physics,Dept. of Physics,Peking Univ., China;* [2]*Collaborative Innovation Center of Quantum Matter, China.* We theoretically demonstrate that the spin separation in spin Hall effect of light, even in nanometers, can be intuitively observed.

JTu4A.7
Optoelectronic Systems for Measuring of Instantaneous Frequency of Radiosignals With an Amplitude-Phase Modulation of Optical Carrier, Aleksandr Vasiletc[1], Oleg Morozov[1], Gennady Morozov[1], Marat Nurgazizov[1], Anvar Talipov[1]; [1]*KNRTU-KAI, Russia.* This article describes how to develop design principles of optoelectronic systems for radio signals instantaneous frequency measuring.

JTu4A.8
Super Long Distance of Self-similar Laser Beam Propagation in Medium with Nonlinear Absorption and Refraction, Vyacheslav Trofimov[1], Irina Zakharova[1]; [1]*Lomonosov Moscow State Univ., Russia.* 2D self-similar beam propagation in media with various types of nonlinear absorption and refraction is demonstrated by both computer simulation and analytical consideration. Under certain conditions, such beam propagates in this mode up to 8 diffraction lengths.

JTu4A.9
High Energy Level Excitation of Molecules due to Cascade Mechanism of Broadband THz Pulse Energy Absorption, Vyacheslav Trofimov[1], Dmitry Zagursky[1], Irina Zakharova[1]; [1]*Lomonosov Moscow State Univ., Russia.* Low intense broadband THz pulse propagation in a medium is investigated. Physical mechanism of medium response spectrum broadening in comparison with the incident pulse spectrum is proposed.

JTu4A.10 WiO
Fabrication of Whispering Gallery Mode microresonators via Two-photon polymerization, Nathalia B. Tomazio[1]; [1]*São Carlos Inst. of Physics , Brazil.* We propose the fabrication of microresonators which support Whispering Gallery Modes via Two-photon polymerization. The versality of this technique in fabricating microstructures with different properties opens the possibility for the development of a new generation of WGM resonators.

JTu4A.11
Withdrawn.

JTu4A.12
Random Flights in Turbid Media with Non-Uniform Optical Properties, Emiliano Teran[1], Eugenio Mendez[2]; [1]*Deparment of Physics, Universidad Autonoma de Sinaloa, Mexico;* [2]*Applied Physics Division, CICESE, Mexico.* We present a theoretical study on the propagation of light in turbid media with non-uniform optical properties. We perform numerical calculations with uniform and non uniforms systems using Monte Carlo simulations to study the media.

JTu4A.13
Smartphone Based Real-Time Observation Microscope, Yoon Tae Lim[1], Seonhee Hwang[1], Taeyoung Kang[1]; [1]*Nanobiophotonics, Korea (the Republic of).* In this study, we designed microscope for real-time observation of the cells. This microscope uses a smartphone as detector. Therefore, we can observe in real time cells through the remote control of smartphone.

JTu4A.14 WiO
Concentration measurement of LDL cholesterol using extraordinary optical transmission sensor, Hyerin Song[1], Heesang Ahn[1], Wonju Lee[2], Kyujung Kim[1]; [1]*Pusan National Univ., Korea;* [2]*Yonsei Univ., Korea.* For measuring concentration of LDL cholesterol which elevates viscosity of blood vessel, we applied extraordinary optical transmission (EOT) sensor. We find out an optimum nanostructure which generates SPs to sensitively measure diverse concentrations of diluted cholesterol.

JTu4A.15
Influence of phosphor self-heating on half-dome-phosphor packaged pc-WLED output performance, Bao-Jen Shih[1], Shih-Chen Chiou[1], Yu-Hua Hsieh[1], Te-Yuan Chung[1]; [1]*National Central Univ., Taiwan.* Simulations using ray-tracing and FEA are done on estimating the temperature distribution in a half-dome-phosphor pc-WLED. The phosphor temperature is always higher than the LED chip. An experiment validated and showed the influence is non-negligible.

JTu4A.16 WiO
Skin Erythema Assessment by an RGB Imaging Device: a Clinical Study, Inga Saknite[1], Aleksejs Zavorins[2], Janis Spigulis[1]; [1]*Univ. of Latvia, Latvia;* [2]*Dept. of Infectology and Dermatology, Riga Stradins Univ., Latvia.* In this study, skin erythema assessment of 90 rosacea patients was estimated by a simple, low-cost RGB imaging device. A new erythema index assessment algorithm is proposed and clinically validated. Comparison with dermatologist's visual assessment shows high correlation.

JTu4A.17
Matrix for wave propagation through a Spiral Phase Plate, Yisa S. Rumala[1]; [1]*City Univ. of New York, USA.* A matrix formalism for wave propagation through a spiral phase plate (SPP) is presented. From the matrix, analytic equations describing the wave characteristics on the input and output planes of the SPP device is calculated.

JTu4A.18 WiO
Theoretical model of a biexcitonic quantum dot-microcavity system under the influence of a constant magnetic field, Luisa Fernanda Ramirez Ochoa[1], Herbert Vinck Posada[1]; [1]*Universidad Nacional de Colombia, Colombia.* We study a quantum dot - microcavity system under the influence of an external magnetic field. We reproduce in a theoretical way the experimental reports and we study the entanglement properties.

JTu4A.19 WiO
Efficiency of THz Paper Optical Elements Depending on their Type and Manufacturing Techniques., Martyna Rachoń[1], Karolina Wegrzynska[1], Maciej Sypek[1], Jaroslaw Bomba[1], Artur Sobczyk[1,2], Jaroslaw Suszek[1], Agnieszka Siemion[1]; [1]*Physics, Warsaw Univ. of Technology, Poland;* [2]*Geodesy and Cartography, Warsaw Univ. of Technology, Poland.* Paper diffractive optical elements (ideal for fast prototyping) can be manufactured as binary, multiple-step or kinoform phase structures. We verify the overall efficiency depending on the structure type and the method of manufacturing.

JTu4A.20
Coupled optical and electrical numerical simulation for dual interface line grating Si thin film solar cells, Junfeng Qiao[1], Zhaoyu Zhang[1]; [1]*Peking Univ., China.* Coupled optical and electrical numerical simulation of Si thin film solar cells with front and back gratings structure are studied. Optimized results demonstrate both optical absorption and electrical response need to be taken into consideration.

JTu4A.21
Optimal Design of Chip-on-the-Tip Endoscope with a Large Depth of Field, Wang Qiang[1,2], Lee Sukhan[1,2]; [1]*Sungkyunkwan Univ., Korea;* [2]*Information and Communication Engineering, Intelligent Systems Research Inst., Korea.* This paper presents a novel objective lens design for an endoscope of extremely small diameter in a Chip-on-the-Tip (COT) configuration. The design provides 8mm DOF at a close distance, with 140 degree FOV, while allowing to be compactly packaged into a 1 mm diameter and 3 mm length.

JTu4A.22 WiO
The Effect of Oxygen Partial Pressures on the Formation of Cuprous Oxide Thin Films for Optoelectronic Applications, V. Vignesh[1], Rishabh Raj[1], Sonika Obheroi [1], R. Navamathavan[1]; [1]*Vellore Inst. of Technology, Chennai, India*. Our study delineates the optimal usage of high-quality Cu_2O thin films in optoelectronic applications by analyzing film deposition and crystallographic structure when contolled by sputtering parameters such as temperature, oxygen flow rate and deposition time.

JTu4A.23 WiO
Mechanically Tunable Thin Film High Refractive Index Contrast TiO_2–Gratings In Elastomeric Matrix, Philipp Gutruf[1], Eike Zellar[1], Sumeet Walia[1], Shruti Nirantar[1], Sharath Sriram[1], Madhu Bhaskaran[1]; [1]*RMIT, Australia*. A mechanically tunable grating is demonstrated by introducing titanium dioxide (TiO_2) nanoscale dot gratings into soft, elastomeric polydimethylsiloxane (PDMS). *In situ* diffraction angle measurements of strain-induced grating response are backed by finite element modelling.

JTu4A.24
Pulsed Laser Deposited GeTe-rich GeTe-Sb_2Te_3 Thin Films, Marek Bouska[1], Virginie Nazabal[2,1], Stanislav Pechev[3], Alain Moreac[2], Jan Gutwirth[4], Ludvik Benes[5], Petr Nemec[1]; [1]*Dept. of Graphic Arts and Photophysics, Univ. of Pardubice, Czech Republic;* [2]*Université de Rennes 1, France;* [3]*Institut de Chimie de la Matière Condensée de Bordeaux, France;* [4]*Dept. of General and Inorganic Chemistry, Univ. of Pardubice, Czech Republic;* [5]*Joint Lab of Solid State Chemistry, Univ. of Pardubice, Czech Republic*. Pulsed laser deposition was employed for the fabrication of GeTe-Sb_2Te_3 thin films with 6:1, 8:1, 10:1, and 12:1 (GeTe):(Sb_2Te_3) ratio. The characterization of as-deposited (amorphous) films as well as crystallized (annealed) films was performed.

JTu4A.25
Electrically switchable zone plates for wavefront sensing, Luis Joel Mávita Granillo[1], Citlali Eliosa[1], Luis . Rios[1], Roger S. Cudney[1]; [1]*CICESE, Mexico*. We present theoretical and experimental results of wavefront sensing using arrays of ferroelectric Fresnel zone plates. Arrays of high quality zone plates smaller than 270 µm x 270 µm were made.

JTu4A.26
Experimental Analysis of All Optical Lens Demultiplexer for Spatial Domain Multiplexed Communication Systems, Syed H. Murshid[1], Bilas Chowdhury[1], Rayan Enaya[1], Gregory Lovell[1]; [1]*Florida Inst. of Technology, USA*. Experimental analysis of a multi lens de-multiplexer for spatial division multiplexing is presented. Data for 635 nm as well as 1550 nm laser sources including coupled power and estimated errors is tabulated and presented.

JTu4A.27
Experimental Verification of All Optical Hollow Core Fiber Spatial Domain Demultiplexer, Syed H. Murshid[1], Saud Alanzi[1], Gregory Lovell[1]; [1]*Florida Inst. of Technology, USA*. Experimental large scale testing of all optical hollow core fiber de-multiplexer for applications in spatially multiplexed communication systems. Includes power coupling analysis and compared to prior simulated results to confirm validity of the design.

JTu4A.28
Invariant Chromatic Dispersion Properties of Tellurite Hybrid Microstructured Optical Fibers With Buffer Layer, Hoang Tuan Tong[1], Kouki Takenaka[1], Harutaka Kawamura[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Toyota Technological Inst., Japan*. Tellurite hybrid microstructured optical fibers with a buffer layer around the core are developed to provide invariant chromatic dispersion to the fluctuation of core diameter and maintain the broad gain bandwidth of fiber-optical parametric amplification.

JTu4A.29
Experimental Observation of Multiple Dispersive Waves and Mid-infrared Solitons in a Birefringence Tellurite Microstructured Optical Fiber, Tonglei Cheng[1], Hoang Tuan Tong[1], Xiaojie Xue[1], Dinghuan Deng[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*ofmlab, Japan*. Multiple dispersive waves emitted by multiple mid-infrared solitons in a birefringence tellurite microstructured optical fiber are demonstrated. Obvious multiple soliton self-frequency shifts are observed in the mid-infrared region.

JTu4A.30
Withdrawn.

JTu4A.31
Spectral and Performance Analysis for the Propagation and Retrieval of Signals from Modulated Chaos Waves Transmitted through Modified von Karman Turbulence, Fathi Mohamed[1], Monish R. Chatterjee[1]; [1]*Univ. of Dayton, USA*. A transfer function formalism is applied to track propagation of modulated chaos waves through modified von Karman phase turbulence; the demodulated signal is examined vis-à-vis performance relative to turbulence strength in comparison with non-chaotic propagation.

JTu4A.32
Novel features of Anderson localization in a partially random Bragg grating, Arash Mafi[1,2]; [1]*Dept. of Physics & Astronomy, Univ. of New Mexico, USA;* [2]*Center for High Technology Materials, Univ. of New Mexico, USA*. It is shown that for partially random Bragg gratings, the logarithm of the average intensity transmittance over the reciprocal wavevector space is a conserved quantity, independent of the amount of disorder.

JTu4A.33 WiO
SS-OCT Based Evaluation of Possible Impact on Vision Quality Caused by Long-Term Wear of Soft Contact Lenses., Ewa Maczynska[1], Hong Chou Lyu[1], Karol Karnowski[1], Ireneusz Grulkowski[1], Maciej Wojtkowski[1]; [1]*Faculty of Physics, Astronomy and Informatics, Nicolaus Copernicus Univ. , Poland*. Swept-source optical coherence tomography is a new approach in metrology of contact lenses. We developed this method and used to preliminary study evaluation of possible long-term effects of contact lenses wear on vision quality.

JTu4A.34
Optical properties of Cu doped TiO_2 using First Principle calculations, Raju M Esakki Muthu[1]; [1]*Vidya Jyothi Inst. of Technology, India*. The optical absorption spectrum and dielectric constant of Cu doped TiO_2 was studied theoretically using Time-Dependent Density-Functional Perturbation Theory to enhance the optical response of the material in visible region.

JTu4A.35
Scanning Polarimetric Scatterometer for Two-Dimensional Rough Surfaces, Juan M. López-Téllez[1], Neil C. Bruce[1], Rigoberto Nava-Sandoval[1]; [1]*CCADET, UNAM, Mexico*. We present the mechanical design and polarization optics of a goniometric scatterometer for studying the polarized light scattering from 2D rough surfaces. The optical instrumentation includes a Mueller polarimeter based on liquid-crystal retarders.

JTu4A.36
Compensation of self-phase modulation through linear coupling in nonlinear directional fiber couplers, Nestor Lozano-Crisostomo[1], Julio C. Garcia-Melgarejo[1], Ponciano Rodriguez-Montero[1], Daniel A. May-Arrioja[2], Jose J. Sanchez Mondragon[1], Govind Agrawal[3]; [1]*INAOE, Mexico;* [2]*CIO, Mexico;* [3]*The Inst. of Optics, Univ. of Rochester, USA*. We study the effect of the linear coupling on self-phase modulation (SPM) in a nonlinear directional fiber coupler (NLDC) when a single-input excitation is considered.

JTu4A.37
Efficient frequency doubling ultrafast Ti:Sapphire laser through the type-I NCPM of ReCOB crystals, Zhengping Wang[1], Yanqing Liu[1], Xun Sun[1], Xinguang Xu[1]; [1]*State Key Lab of Crystal Materials and Inst. of Crystal Materials, Shandong Univ., China*. Nonlinear optical (NLO) crystals $ReCa_4O(BO_3)_3$ (ReCOB) were found to be excellent materials for frequency doubling ultrafast Ti:Sapphire laser through type-I non-critical phase matching (NCPM) style to get 357 ~ 464 nm spectrum region.

JTu4A.38
Detection of Glomerulonephritis in the Murine Kidney by Optical Coherence Elastography, Chih Hao Liu[2], Young Du[2], Manmohan Singh[2], Jiasong Li[2], Chen Wu[2], Zhaolong Han[2], Chandra Mohan[2], Kirill Larin[2,1]; [1]*Molecular Physiology and Biophysics, Baylor College of Medicine, USA;* [2]*Dept. of Biomedical Engineering, Univ. of Houston, USA*. This work demonstrates the feasibility of using OCE for early detection of pathological changes in the mechanical properties of the kidney, which would complement information provided by structural images.

JTu4A.39 WiO
Masking Time-Delay Features in Multimode Vertical-Cavity Surface-Emitting Lasers, Aliza Khurram[1], Hong Lin[1]; [1]*Bates College, USA*. Polarization resolved time-delay signatures are experimentally studied for a multimode VCSEL subject to double-cavity, polarization-rotated optical feedback. Concealment of time-delay signatures is observed in certain parameter regimes.

JTu4A.40
Manipulating the photonic spin Hall effect of fan-shaped cylindrical vector beams, Peng Li[1], Yi Zhang[1], Sheng Liu[1], Jianlin Zhao[1]; [1]*Northwestern Polytechnical Univ., China*. We develop a theoretical model to reveal the intriguing spin-dependent split for freely propagating cylindrical vector beams which modulated by fan-shaped obstacles in the perspective of angular diffraction.

JTu4A • Joint FiO/LS Poster Session I—Continued

JTu4A.41
Third Harmonic Generation in Multilayer Structures: Oblique Incidence, Han Li[1], Partha P. Banerjee[1], Joseph Haus[1]; [1]*Electro-Optics, Univ. of Dayton, USA.* Under nondepleted pump assumption, third harmonic generation (THG) generated by obliquely incident fundamental frequency (FF) waves in a nonlinear multilayer structure is derived analytically by a recursive transfer matrix method (RTMM).

JTu4A.42 WiO
Extraordinary transmission-based axial imaging of live cells, Wonju Lee[1], Kyujung Kim[2], Jong-ryul Choi[3], Youngjin Oh[4], Donghyun Kim[1]; [1]*School of Electrical and Electronic Engineering, Yonsei Univ., Korea (; [2]Dept. of Cognomechatronics Engineering, Pusan National Univ., Korea; [3]Daegu-Gyeongbuk Medical Innovation Foundation, Korea; [4]Samsung Electronics, Korea.* We explored extraordinary transmission based axial imaging of cells. Penetration of transmitted light was controlled by varying the nanoaperture size, and axial distribution of intracellular protein was observed for different depth investigation.

JTu4A.43
Linearization of Transmission Function of Acousto-Optic Modulator, Georgy Korol[1], Dmitry Moskaletz[2], Oleg Moskaletz [1]; [1]*St Univ. of Aerospace Instrumentation, Russia; [2]Electrotechnical Univ., Russia.* The possibility of nonlinear transmission function transparency linearization in acousto-optic modulator (AOM) form on theoretical optics and nonlinear functional analysis methods base is described.

JTu4A.44 WiO
pH Sensing Using a Silica Toroid Microcavity, Misako Kobayashi[1], Jiro Nishimura[1], Takasumi Tanabe[1]; [1]*Keio Univ., USA.* We realized high sensitive pH sensing of liquid by using silica toroid microcavities deposited with PAA/PAH multilayers and demonstrated the packaging of a tapered fiber and a microcavity in a liquid channel.

JTu4A.45
Temporal cavity soliton generation without laser scan in a crystalline microcavity with negative TO coefficient, Tomoya Kobatake[1], Takumi Kato[1], Hiroki Itobe[1], Takasumi Tanabe[1]; [1]*Keio Univesity, Japan.* We numerically investigate the generation of a Kerr comb in a crystalline microcavity with negative TO coefficient such as CaF_2, where we found that a temporal soliton can be generated without a laser scan.

JTu4A.46
Metamaterial Optical Antireflection Coating, Wonkyu Kim[1], Joshua Hendrickson[2], Junpeng Guo[1]; [1]*Univ. of Alabama in Huntsville, USA; [2]Wright-Patterson Air Force Base, USA.* A subwavelength metal/air-gap grating metamaterial is investigated for polarization-selective optical antireflection coating. The metamaterial has designer's dielectric property for TM polarization and metallic property for TE polarization. Optical antireflection can be realized for TM polarization.

JTu4A.47
Snapshot spectro-ellipsometry based on interferometric polarization modulation, Daesuk Kim[1]; [1]*Chonbuk National Univ., Korea.* This paper describes a snapshot spectro-ellipsometry based on interferometric polarization modulation. The proposed method enables us to obtain an accurate spectral Stokes vector of a thin film object in msec.

JTu4A.48
High Speed Supercontinuum Light Source Based Nanoparticle Spectral Imaging, Arpad Jakab[1], Carsten Soennichsen[1]; [1]*Johannes Gutenberg Univ., Germany.* We present a supercontinuum light source based high speed spectral imaging dark field microscopy setup allowing to measure over 1000 particles in less than 10 seconds with a refractive index sensitivity resolution of below 0.001.

JTu4A.49
Adaptive Optics in Two-photon Microscopy Using Coherence-gated Wave-front Sensing, Yong Hu[1]; [1]*Univ. of Kent, UK.* By implementing a coherence-gated wave-front sensor and the adaptive optics into a two-photon microscope, the fluorescence signal exactly from the focal plane of the objective lens can be selected, and the wave-front aberration in this region can be corrected.

JTu4A.50 WiO
Manipulation of Calcite Crystals in a Beam with a Polarization Singularity, Catherine Herne[1], Alexander MacDonald[1], Ann O'Brien[1]; [1]*SUNY New Paltz, USA.* We demonstrate the rotation of birefringent calcite in a laser mode with a polarization singularity. The rotation direction of the calcite changes at different transverse coordinates depending on the circular polarization of the mode at each location.

JTu4A.51 WiO
Coupling Light in and out of Polymeric Microstructures Through Fiber Tapers, Franciele Henrique[1], Cleber R. Mendonça[1]; [1]*São Carlos Inst. of Physics, Univ. of São Paulo, Brazil.* The two-photon polymerization technique was used to produce Rhodamine B doped microstructures. To investigate their optical properties, a system of excitation and collection through fiber tapers was developed.

JTu4A.52 WiO
Holographic Gratings with Applications in Optoelectronic Systems to Transmit Multichannel Information, María del Rocío Gómez-Colín[2], Alejandro García-Juárez[2], Ignacio Zaldivar-Huerta[1], Sandra Toxqui-López[3], Alicia Vera Marquina[2], Luis Arturo García-Delgado[2], Ana Lilia Leal-Cruz[2]; [1]*INAOE,- Puebla, Mexico; [2]Universidad de Sonora, Mexico; [3]Benemérita Universidad Autónoma de Puebla, Mexico.* We describe an optical and chemical procedure to obtain holographic gratings of dichromated gelatin and its integration to an optoelectronic scheme configured as multichannel system to transmit audio signals.

JTu4A.53
Sub-cycle electron dynamics in orthogonal two-color fields, JiWei Geng[1], WeiHao Xiong[1], XiangRu Xiao[1], LiangYou Peng[1], Qihuang Gong[1]; [1]*Peking Univ., China.* We theoretically investigate the sub-cycle electron dynamics in orthogonally polarized two-color laser fields by exact solution to the 3D TDSE. combined with two semi-classical methods. We find that both the nonadiabatic effects and the Coulomb potential play very important roles.

JTu4A.54
Applied kHz Optical Remote Sensing for Determination of Insect Flight Direction and Relative Size, Alem K. Gebru[2,1], Mikkel Brydegaard[2,1], Erich Rohwer[1], Pieter Neethling[1]; [1]*Univ. of Stellenbosch, South Africa; [2]Physics, Lund Univ. , Sweden.* An applied kHz optical remote sensing system is implemented to determine the flight direction of an insect with respect to wind direction, and its relative size using near- and shortwave infrared light *in situ*.

JTu4A.55 WiO
Study on the Environmental Stability of Nickel Ion Doped Photopolymer Material for Data Storage Applications, Aswathy G[1], Sudha C. Kartha[1], Rajesh C S[1]; [1]*CUSAT, India.* The aim of this study was to improve storage and shelf life of the photopolymer material by incorporating nickel ions into it as a cross linker. The material shows stable diffraction efficiencies for three years.

JTu4A.56
Optical Monitoring of TBI: Survey and Study of Design Parameters, Robert Francis[1,2], James Florence[1], Duncan MacFarlane[1]; [1]*Univ. of Texas at Dallas, USA; [2]Raytheon, USA.* Patients undergoing head trauma present intracranial maladies that may not be detected by diagnostic and monitoring instruments. This paper surveys recent TBI studies and presents optical modeling of design parameters for imaging TBI.

JTu4A.57
Real-time Optical Realization of Circle Hough Transform with Incoherent Light, Ariel Fernández[1], José Ferrari[1]; [1]*Universidad de la Republica, Uruguay.* We present an optical implementation of the circle Hough transform with an electrical lens with variable focal length and annular pupil. The system works under incoherent light and it is suitable for real-time applications. Validation experimental results are provided.

JTu4A.58
Dual-Polarity Linear Ion Trap Femtosecond Laser-Induced Ionisation/Dissociation Mass Spectroscopy for Proteomics, Taran Driver[1], Thomas R. Barillot[1], Amelle Zair[1], Jon P. Marangos[1], Leszek J. Frasinski[1], Marina Edelson-Averbukh[1]; [1]*Imperial College London, UK.* Peptides are irradiated by femtosecond near-infrared pulses, initiating tunnel ionisation and non-ergodic molecular dissociation. Mass spectrometric analysis of the fragments gives unique structural and dynamical information for femtosecond molecular dynamics research and bioanalytical applications.

JTu4A.59 WiO
Buffer Gases Pressures Effect on Diode Pumped Rubidium Vapor Laser, Lingling Dai[2], Ming Ding[1], Yulong Liu[1]; [1]*Beihang Univ., China; [2]Beihang Univ., China.* We discuss the methane pressure within buffer gases effects on the performance of diode pumped rubidium vapor laser. With the methane pressure increasing from 100torr to 760torr, fluorescence efficiency decreases, optical-to-optical efficiency increases 10% approximately.

JTu4A.60
3D Video Feedback, Ross Hunter[1], Neel MacKinnon[1], Gavin MacAuley[1], Gabriel Battcock[1], Michael Forret[1], Graham Gibson[1], Johannes K. Courtial[1]; [1]*Univ. of Glasgow, UK.* We investigate video feedback with a 3D camera and 3D TV.

JTu4A.61
Ultra-long Photonic Jet by Hemispherical Micro-particles, Zaichun Chen[1]; [1]*Singapore Univ. of Technology and Design, Singapore.* Micro-particle assisted nano-imaging has proven its success in the past years. The microparticles engineered in hemispherical configuration are designed and optimized to generate an ultra-long photonic jet of 1.7 μm at 400 nm light irradiation.

JTu4A • Joint FiO/LS Poster Session I—Continued

JTu4A.62
PSF Analysis of Reflective Objectives based Nonlinear 4Pi Tomography, Hao Chenglong[1,2], Changyuan Yu[1], Hao Li[2], Xia Yu[2], Ying Zhang[2]; *[1]National Univ. of Singapore, Singapore; [2]Singapore Inst. of Manufacturing Technology, Singapore.* We proposed the nonlinear (second harmonic generation) 4Pi type C microscope using reflective objective in mid-infrared region. It provided a potential and practical solution of high resolution, deep penetration tomography in bio-medical application.

JTu4A.63
Investigation of Cross-Polarized Wave Generated at Simultaneous Spatial and Temporal Focusing, Oleg Chekhlov[1], Yunxin Tang[1], Chris J. Hooker[1], Steve Hawkes[1], Cristina Hernandez-Gomez[1], Rajeev Pattathil[1]; *[1]STFC Rutherford Appleton Lab, UK.* Space-time focusing of spatially-chirped laser pulses is used to generate a cross-polarized wave (XPW) in a single BaF_2 crystal. We demonstrate 65 uJ output of XPW filter with improved spectral and temporal quality.

JTu4A.64
Optofluidic Ring Cavity Lasers Fabricated by 3-D Femtosecond Laser Writing Technology, Hengky Chandrahalim[1], Qiushu Chen[1], Ali A. Said[2], Mark Dugan[2], Philippe Bado[2], Xudong Fan[1]; *[1]Univ. of Michigan, USA; [2]Translume Inc., USA.* We fabricated a 3-D monolithically integrated optofluidic laser in a fused-silica chip using femtosecond laser pulses. Rhodamine 6G dissolved in quinoline was used as the gain medium and lasing was achieved at a pump threshold of 15 μJ/mm^2.

JTu4A.65
Angular spectrum solutions for the PWE: Half-integer order Bessel beams, Adrian Carbajal-Dominguez[1], Jorge Bernal[1], Gabriel Martinez-Niconoff[2], Ibis Ricardez-Vargas[1], Jose Segovia-Lopez[1]; *[1]Universidad Juárez Autonoma de Tabasco, Mexico; [2]Coord. de optica, Instituto Nacional de Astrofisica, optica y electronica, Mexico.* In this work we show that solutions to Paraxial wave equation in the angular spectrum of plane waves representation lead to new optical beams: half-integer order Bessel beams.

JTu4A.66
Recording dynamics and temperature impact on volume holograms in fluorite crystals with color centers, Vladimr Borisov[1], Andrey Veniaminov[1], Ekaterina Barausova[1], Alexandr Angervaks[1], Alexandr Shcheulin [1], Alexandr Ryskin[1]; *[1]ITMO Univ., Russia.* Real-time holographic grating recording in an additively colored fluorite crystal at 180-200°C was monitored. After exposure, the diffraction efficiency was measured as a function of temperature, and significant departure of maximum diffraction was discovered.

JTu4A.67
Implementation of Sequence Generator using Electro-Optic Effect of Mach-Zehnder Interferomete, Santosh Kumar[1], Ashish Bisht[1], Gurdeep Singh[1], Angela Amphawan[2]; *[1]Dept. of Electronics & Communication Engineering, DIT Univ., India; [2]InterNetWorks Research Lab, School of Computing, Universiti Utara Malaysia, Malaysia.* In this paper, a novel scheme for an optical sequence generation based on electro-optic effect of lithium niobate in Mach-Zehnder interferometer structure is presented. It can be significant for pattern generation and encryption.

JTu4A.68
Thorough Exploration of Optical Performance of Waveguides Made on Cr: LiSAF by Femtosecond Laser Writing., Demian Biasetti[1,2]; *[1]Centro de Investigaciones Opticas, Argentina; [2]CONICET, Argentina.* We report waveguides fabricated in Cr:LiSAF by using femtosecond laser micromachining. We characterized the optical wave guiding performance and the luminiscence of waveguides including a comparison with bulk emission, in order to investigate the induced stress aside the focal volume.

JTu4A.69
Spectroscopy of the Lowest Two-Photon Transition for Molecules in Solution by Automated DFWM, Ivan Biaggio[1], Marten Beels[1]; *[1]Lehigh Univ., USA.* We use degenerate four-wave mixing with wavelength-tunable picosecond pulses to study the second hyperpolarizability of molecules in solution. The full dispersion of both real and imaginary parts of the polarizability can be obtained using a semi-automated method.

JTu4A.70
Moiré Patterns and their Suppression during Digital Recording and Reconstruction of Fresnel Holograms, Peiyun Li[1], Yun Zhao[1], Partha P. Banerjee[1], Andy Chong[1]; *[1]Univ. of Dayton, USA.* Moiré patterns during digital recording and reconstruction of Fresnel holograms have been analyzed for 1-D and 2-D objects. Elimination of these Moiré patterns can be achieved using pulsed, instead of CW, illumination.

JTu4A.71
Temperature-Dependent Fluorescent Dyes Application for Measuring the Millimeter Wave Absorption in Liquids Simulating Biological Tissue, Danylo Babich[1], Valentina Pobiedina[1], Yakunov Andrey[1]; *[1]Taras Shevchenko National Univ., Ukraine.* Fluorescent organic dyes solutions are used for non-contact measurement of the microwave absorption in liquids simulating biological tissue. There was the microwaves absorption temperature equivalent measured for three liquids (water, glycerol, and ethylene glycol).

JTu4A.72 WiO
Fine Detection of Radiation Pressure on Optical Wings Using Micro Oscillators, Alexandra B. Artusio-Glimpse[1], Michelle Chabot[1], Alan D. Raisanen[1], Grover Swartzlander[1]; *[1]Rochester Inst. of Technology, USA.* Finite element results are reported for a micromechanical oscillator used to measure the piconewton force and attonewton-meter torque imparted to a micron-scale optical wing when illuminated with a 300 mW uniform laser beam.

JTu4A.73
Tamper proof? Tampering tests of optical physically unclonable functions, Benjamin R. Anderson[1], Ray Gunawidjaja[1], Hergen Eilers[1]; *[1]Washington State Univ., USA.* We test the tamper indicating ability of optical physically unclonable functions (O-PUFs) based on scattering nanocomposites and unique optical signatures for optimized reflection. The O-PUFs are found to be highly sensitive to tampering.

JTu4A.74
Effects of Misalignment on Diffraction of Laguerre-Gauss Vortex Beams by a Circular Aperture, Anindya Ambuj[1], Reeta Vyas[1], Surendra Singh[1]; *[1]Univ. of Arkansas, USA.* Diffraction of Laguerre-Gauss vortex beams by a circular aperture, when the beam and aperture axes differ is studied theoretically and experimentally for different angular momentum indices and relative displacements of beam and aperture axes.

JTu4A.75
Assessing the performances of an object recognition technique based on correlation and edge enhancement, Ayman Alfalou[1]; *[1]ISEN-Brest, France.* A recognition technique based on correlation has been developed. To improve the correlator performances we have proposed a correction that consists in emphasizing the contour of the object based on phase contrast method.

JTu4A.76
Modal analysis of transverse Anderson localization near the boundary of a one-dimensional disordered optical lattice, Behnam Abaie[1,2], Arash Mafi[1,2]; *[1]Dept. of Physics & Astronomy, Univ. of New Mexico, USA; [2]Center for High Technology Materials, Univ. of New Mexico, USA.* Using modal analysis, it is shown that Anderson localized modes near the boundaries of a disordered lattice have the same decay exponent on the lattice side as any other mode in the bulk.

JTu4A.77
Higher order dispersion effects for ultrashort pulse generation directly from a mode-locked laser with an intra-cavity highly nonlinear medium, Shinichi Inayoshi[1], Akiyuki Maruko[1], Takeshi Yoshida[1], Keisuke Kyomoto[1], Kento Kato[1], Hiroaki Okunishi[1], Kyousuke Shimabayashi[1], Motoki Morioka[1], Hiroki Kadoya[1], Keisuke Hayashi[1], Toru Sato[1], Shun Takashima[1], Sakae Kawato[1]; *[1]Univ. of Fukui, Japan.* We analyzed third- and fourth-order dispersion effects on ultrashort pulse propagation in a mode-locked Yb:YAG laser with an intra-cavity highly nonlinear medium.

JTu4A.78 WiO
Z-scan for a Nonlocal Thin Media with More than One Nonlinear Response, Beatriz A. Martínez Irivas[1], Maximino L. Arroyo Carrasco[1], Marcela M. Mendez Otero[1], Ruben Ramos Garcia[2], Marcelo D. Iturbe Castillo[2]; *[1]Benemérita Univ Autonoma de Puebla, Mexico; [2]Optica, Instituto Nacional de Astrofisica, Optica y Electronica, Mexico.* In this work we propose a model that allows to calculate the z-scan curves by a thin nonlocal media that exhibit more than one nonlinear response, both refractive and absorptive, with same or different nonlocality.

JTu4A.79
Influence of the Nonlinear Absorption in the Far-field Diffraction Patterns by a Thin Nonlocal Media, Beatriz A. Martínez Irivas[1], Maximino L. Arroyo Carrasco[1], Marcela M. Mendez Otero[1], Ruben Ramos Garcia[2], Marcelo D. Iturbe Castillo[2]; *[1]Benemérita Univ Autonoma de Puebla, Mexico; [2]Optica, Instituto Nacional de Astrofisica, Optica y Electronica , Mexico.* Far field diffraction patterns of a thin nonlocal media that presents nonlinear absorption are analyzed numerically for different degrees of nonlocality in order to show the modifications induced by the nonlinear absorption.

JTu4A.80 WiO
Incoherent Broadband Cavity Enhanced Absorption Spectroscopy Using a Supercontinuum Source in the Mid-IR, Caroline G. Amiot[1,2], Antti Aalto[1], Juha Toivonen[1], Goëry Genty[1]; *[1]Tampere Univ. of Technology, Finland; [2]Institut FEMTO-ST, France.* We developed an all-fiber based supercontinuum source spanning from 1300 to 3700 nm. We used it to perform highly sensitive gas detection using incoherent broadband cavity enhanced absorption spectroscopy.

JTu4A.81
Langmuir-Trojan Two-electron Wavepackets on Regular Polygon Orbits in Atoms and Quantum Dots, Matt Kalinski[1]; *[1]Utah State Univ., USA.* We show that our recently discovered regular polygon orbits originated from the free fall of the electron onto the nucleus in strong magnetic field can be extended to two-electron Langmuir-like Trojan configurations in such fields.

JTu4A • Joint FiO/LS Poster Session I—Continued

JTu4A.82
High-power Nd-doped fiber lasers tunable from 872 to 936nm, Baptiste Leconte[1], Benoit Cadier[2], Hervé GIlles[1], Sylvain Girard[1], Thierry Robin[2], Mathieu Laroche[1]; [1]*CIMAP-ENSICAEN, France;* [2]*IXFIBER, France.* High-power and tunable operation of Nd-doped fiber lasers at wavelengths as short as 872nm is reported. Using a reflective VBG, we showed a narrow linewidth (~35pm) laser emission with a maximum output power of 22W.

JTu4A.83
Frequency Analysis for 3D Localization-based Optical Microscopy, Bryce Schroeder[1], Shu Jia[1]; [1]*Stony Brook Univ., SUNY, USA.* We conducted a comprehensive frequency-domain analysis of a recently-reported self-bending point spread function (SB-PSF) and compared it with Gaussian and astigmatic PSFs, quantifying its advantages for 3D localization-based optical microscopy.

JTu4A.84
Investigation of Free Charge Carrier Effects in Silicon Membranes., Wilfrid I. Ndebeka[1], Herbert Stafast[1], Erich Rohwer[1], Christine Steenkamp[1], Pieter Neethling[1]; [1]*Univ. of Stellenbosch, South Africa.* Transmission signals from silicon membranes show unexpected nonlinear effects when irradiated with a femtosecond laser at 800 nm. The nonlinear behavior of the transmitted signal is explained using free charge carrier absorption (FCA) in silicon.

JTu4A.85
4D Two-photon Fluorescence Hyperspectral Image of Mesophyll Cells inside Intact Leaves, Poyu Su[1], Ting-Ying Lee[1], Szu-Yu Chen[1]; [1]*National Central Univ., Taiwan.* The two-photon fluorescence hyperspectral microscopy based on parallel recording is applied to obtain 4D *x-y-z-λ* images of mesophyll cells in intact leaves. Through principal component analysis, information of photonsystems within each mesophyll cell can be revealed.

JTu4A.86
On the Fundamental Limits of Far-Field Detection of Active Microsphere Whispering Gallery Modes, Nicolas N. Riesen[1], Tess Reynolds[1], Alexandre Francois[1], Tanya M. Monro[2]; [1]*Inst. for Photonics and Advanced Sensing, Univ. of Adelaide, Australia;* [2]*Univ. of South Australia, Australia.* This paper investigates the Q-factor limits for far-field collection of the whispering gallery modes of active microspheres. It is shown that non-resolvable 'mode-splitting' arising from slight asphericity accounts for the typically low Q-factors.

NOTES

California	Valley	Crystal	Gold	Empire

FiO

16:00–18:00
FTu5A • Nonlinear Optics in Micro or Nano-Optical Structures V
Presider: John Sipe; Univ. of Toronto, Canada

FTu5A.1 • 16:00 WiO
Efficient Single Photon Emission and Collection Based on Excitation of Gap Surface Plasmons, Hang Lian[1], Ying Gu[1], Juanjuan Ren[1], Fan Zhang[1], Luojia Wang[1], Qihuang Gong[1]; [1]*Peking Univ., China*. Combining ultrahigh photon emission rate of gap plasmons with efficient extraction into low-loss nanofibres, we theoretically demonstrate one-dimensional nanoscale guiding of high rate single photons of 770 γ_0 into designed nanofibres in metallic nanorod-coupled nanofilm structures.

FTu5A.2 • 16:15
Optimization of Optical Forces in Nanoscale Photonic Waveguides via Dispersion Engineering, Aleem M. Siddiqui[1], Charles Reinke[1], Peter T. Rakich[2]; [1]*Sandia National Labs, USA;* [2]*Yale Univ., USA*. By relating the response theory of optical forces to waveguide dispersion, we are able to employ dispersion engineering to optimize radiation pressure forces at the nanoscale in W1 photonic crystal waveguides.

FTu5A.3 • 16:30 WiO
On Chip Verification of CHSH Inequality in Mode Entangled State Using the Electro Optic Effect in Waveguide, Divya Bharadwaj[1], Krishna Thyagarajan[1], Konrad Banaszek[2]; [1]*Dept. of Physics, Indian Inst. of Technology, Delhi, India;* [2]*Faculty of Physics, Univ. of Warsaw, Poland.* In this paper we propose a method to check for CHSH inequalities of a spatial mode entangled state using dynamic mode converters using the electro optic effect in a KTP channel waveguide.

16:00–18:00
FTu5B • Studying Human Vision with Animal Eyes and Exploring the Limits of Human Vision
Presider: Susana Marcos; Consejo Sup Investigaciones Cientificas, Spain

FTu5B.1 • 16:00 Invited
Retinal Imaging and Cone Pointing Measurements in the Living Chick Eye, Nathan Doble[1], Maria Walker[2], Leonardo Blanco[3], Rebecca Kivlin[4], Stacey S. Choi[1]; [1]*Ohio State Univ., USA;* [2]*Univ. of Houston College of Optometry, USA;* [3]*Ecole polytechnique, Université Paris-Saclay, France;* [4]*New England College of Optometry, USA.* The chick eye is commonly used in the study of ocular growth and emmetropization. High resolution imaging results and measurement of the individual cone pointing in the living chick eye will be presented.

FTu5B.2 • 16:30 Invited
Mouse Retinal Imaging with Wavefront Sensorless Adaptive Optics, Marinko Sarunic[1]; [1]*Simon Fraser Univ., Canada.* Wavefront Sensorless Adaptive Optics combined with Optical Coherence Tomography and fluorescence confocal Scanning Laser Ophthalmoscopy for structural and functional imaging of the mouse retina in-vivo using a MEMS deformable mirror and a novel adaptive lens.

16:00–18:00
FTu5C • Optomechanics and Photonic Nanostructures
Presider: Carrado Sciancalepore, CEA-LETI, France

FTu5C.1 • 16:00 Invited
Harnessing Photon-phonon Coupling in Integrated Optical Circuits, Raphaël Van Laer[1], Bart Kuyken[1], Alexandre Bazin[1], Dries Van Thourhout[1], Roel G. F. Baets[1]; [1]*Ghent Univ. - imec, Belgium*. We present the state-of-the-art of stimulated Brillouin scattering in integrated optical circuits, with a particular focus on recent observations in silicon waveguides. In addition, we report on a spatiotemporal symmetry between Brillouin-active waveguides and optomechanical cavities.

FTu5C.2 • 16:30 WiO
A Hybrid Opto-Mechanical Micro-Disk Inertia Sensor, Ghada Dushaq[1], Tadesse Mulugeta[1], Mahmoud S. Rasras[1]; [1]*Masdar Inst., United Arab Emirates*. We numerically present optically enabled micro-disk inertia sensor. It consists of a disk-shaped proof mass integrated on top of an optical waveguide. It exhibits a sensitivity of 12dB/μm displacement and a dynamic range of 1g-10g.

16:00–18:00
FTu5D • Wavefront Sensing and Adaptive Optics
Presider: Zhimin Shi; Univ. of South Florida, USA

FTu5D.1 • 16:00
Mitigation of Deep Turbulence Effects with SPGD Based Adaptive Optics System, Ernst E. Polnau[1], Mikhail Vorontsov[1], Rodolfo Llinás[2]; [1]*Univ. of Dayton, USA;* [2]*New York Univ., USA*. A low-cost AO system designed to be installed into a amateur astronomical telescope was tested in deep turbulence conditions. The results demonstrate potentials of the technique for star-image quality improvement in amateur astronomical telescopes.

FTu5D.2 • 16:15
Efficient Prescription Retrieval from PSF Data, Dustin B. Moore[1], James R. Fienup[1]; [1]*Univ. of Rochester, USA*. Reverse-accumulation automated differentiation is applied to retrieve optical prescription parameters from point spread function data, yielding a 4.6x speed improvement over existing methods.

FTu5D.3 • 16:30
Flow-Field Measurements Through Phase-Boundaries Using Wavefront Shaping, Nektarios Koukourakis[1], König Jörg[2], Büttner Lars[1], Czarske Jürgen[1]; [1]*TU Dresden, Germany;* [2]*IFW Dresden, Germany.* We propose that aberrations introduced by single phase boundaries can be compensated by analysing the Fresnel reflex. Flow-field measurements based on image correlation through fluctuating and rough phase boundaries are used for validation.

16:00–18:00
FTu5E • Laser-matter Interaction
Presider: Ian Coddington, NIST, USA

FTu5E.1 • 16:00 Invited
Laser Processing for Thin Film Solar Cell Materials, Brian J. Simonds[1]; [1]*National Inst. of Standards and Technology, USA*. In this work, I will describe research of laser processing techniques of CdTe and Si for photovoltaic applications. Processes have been developed that show improved material quality and device operation. Defect spectroscopy, device measurements, and surface science studies support these claims.

FTu5E.2 • 16:30 Invited
Engineering Anisotropy in Glass with Ultrafast Laser Assisted Nanostructuring, Martynas Beresna[1], Rokas Drevinskas[1], Jingyu Zhang[1], Mindaugas Gecevicius[1], Peter Kazansky[1]; [1]*Univ. of Southampton, UK.* Recent applications of femtosecond laser assisted self-assembled nanostructures will be overviewed. Specifically, polarization sensitive optical elements and 5-dimensional optical data storage with practically unlimited life-time will be demonstrated and discussed.

FiO

16:00–18:00
FTu5F • Optical Trapping and Manipulation
Presider: Alvaro Casas-Bedoya; Univ. of Sydney, Australia

FTu5F.1 • 16:00 Invited
Optical Characterization of Pericellular Mechanical Heterogeneity, Mark Keating[1], Abhishek Kurup[1], Elliot Botvinick[1]; [1]*UC Irvine Beckman Laser Inst., USA*. While there is strong evidence for roles of bulk tissue stiffness in cell regulation, roles for the pericellular mechanical microenvironment are less clear. We use optical microrheology to study these roles in 3D tissue culture.

FTu5F.2 • 16:30 Invited
New Directions in Optical Manipulation, Kishan . Dholakia[1]; [1]*Univ. of St Andrews, UK*. This talk describes combining beam shaping with the material properties of particles for enhanced manipulation. Additional work using new fibre optic approaches as well as combining trapping and imaging will be described.

LS

16:00–18:00
LTu5G • Precision Laser Spectroscopy II
Presider: R. Jason Jones; Univ. of Arizona, USA

LTu5G.1 • 16:00 Invited
Two-photon Frequency Comb Spectroscopy of Atomic Hydrogen with Chirped Laser Pulses, Arthur Matveev[1], Dylan C. Yost[2], Alexey Grinin[1], Theodor W. Hänsch[1], Thomas Udem[1]; [1]*Max-Planck-Institut fur Quantenoptik, Germany;* [2]*Univ. of Colorado, USA*. We report on the results of two-photon spectroscopy of 1S-3S transition in atomic hydrogen using picosecond mode-locked laser. The chirp of the laser pulses leads to frequency shift proportional to the velocity of the atoms.

LTu5G.2 • 16:30 Invited
Laser Spectroscopy of Muonic Atoms and Ions, Randolf Pohl[1]; [1]*Max-Planck-Institut fur Quantenoptik, Germany.* Laser spectroscopy of muonic atoms, where a nucleus is orbited by one negative muon, is a novel tool for tests of quantum electrodynamics and the Standard Model, determination of fundamental physical constants, and for nuclear physics.

16:00–18:00
LTu5H • Novel Fiber Lasers III
Presider: Tariq Manzur; NAVSEA Naval Undersea Warfare Ctr, USA

LTu5H.1 • 16:00 Invited
Narrow Linewidth CW Fiber Raman Amplifiers Based on SBS Suppressed Gain Fibers, James Nagel[1], Valery Temyanko[1], Nasser Peyghambarian[1], Jeremy Dobler[2], Evgeny M. Dianov[3], Mikhael Likhachev[3], M bubnov[3], M Salganskii[4], A Guryanov[4], D Lipatov[4]; [1]*Univ of Arizona, Coll of Opt Sciences, USA;* [2]*Harris Corporation, USA;* [3]*Fiber Optic Research Center, Russia;* [4]*Inst. of High Purity Substances, Russian Academy of Sciences, Russia*. We report on advancements in silicate-based Raman gain fibers for improving power and efficiency performance of narrow linewidth amplifiers. SBS suppression techniques are discussed specifically in the context of germanosilicate fibers and Raman amplification.

LTu5H.2 • 16:30 Invited
Novel Fiber Lasers in the Visible, SWIR, and MWIR, Jason M. Auxier[1]; [1]*US Naval Research Lab, USA*. This presentation will provide an overview of novel fiber laser sources in the visible, short-wave infrared (SWIR), and mid-wave infrared (MWIR). Additionally, recent work in the long-wave infrared (LWIR) will be presented.

FTu5A • Nonlinear Optics in Micro or Nano-Optical Structures V—Continued

FTu5A.4 • 16:45
Ultra Broadband Entanglement Analysis for High-Speed Quantum Key Distribution in Dense Wavelength Division Multiplexed Networks, Florian Kaiser[1], Djeylan Aktas[1], Laurent Labonté[1], Sébastien Tanzilli[1]; [1]*Laboratoire de Physique de la Matière Condensée, CNRS UMR 7336, Université Nice Sophia Antipolis, France.* Using broadband entangled photons at a telecom wavelength we measure dispersion in our fiber interferometers and counteract it by properly unbalancing the interferometers. Our scheme allows to increase bit rates in wavelength demultiplexed networks.

FTu5A.5 • 17:00
Ultra-Fast All-Optical Modulator Using Nano-Waveguide Embedded in High Pressure Buffer Gas, Mohamed Fouda[1], Selim Shahriar[1]; [1]*Northwestern Univ., USA.* We propose implementation of an ultra-fast, low power all-optical modulator at telecommunication wavelength via interaction of evanescent light field around a silicon nitride nano waveguide with Rubidium vapor under high pressure buffer gas.

FTu5A.6 • 17:15 WiO
Quantum Statistics Control with Multimode Plasmonic Nanocavity: Cavity-Openness-Induced Interferences, Dongxing Zhao[1], Ying Gu[1,2], Hongyi Chen[1], Juanjuan Ren[1], Tiancai Zhang[3], Qihuang Gong[1,2]; [1]*State Key Lab for Mesoscopic Physics, Dept. of Physics, Peking Univ., China;* [2]*Collaborative Innovation Center of Quantum Matter, China;* [3]*State Key Lab of Quantum Optics and Quantum Optics Devices, Inst. of Opto-Electronics, Shanxi Univ., China.* Using scattered field interference introduced by the high cavity openness, both bunched and antibunched fields can be obtained from a quantum emitter-plasmonic multimode nanocavity hybrid system.

FTu5B • Studying Human Vision with Animal Eyes and Exploring the Limits of Human Vision—Continued

FTu5B.3 • 17:00 Invited
Two-photon Autofluorescence Imaging of Retinal Structure and Function in the Living Primate Eye, Robin Sharma[6,2], Christina Schwarz[2], David R. Williams[1,2], Grazyna Palczewska[4], Krzysztof Palczewski[5,6], Jennifer J. Hunter[2,3]; [1]*The Inst. of Optics, USA;* [2]*Center for Visual Science, Univ. of Rochester, USA;* [3]*Flaum Eye Inst., Univ. of Rochester, USA;* [4]*Polgenix, Inc, USA;* [5]*Dept. of Pharmacology, Case Western Reserve Univ., USA;* [6]*Cleveland Center for Membrane and Structural Biology, Case Western Reserve Univ., USA.* The retina contains endogenous fluorophores (eg. NADH, retinoids and others) that are natural markers for physiology and morphology. Adaptive optics assisted two-photon excitation was employed to record fluorescence from these molecules throughout the retina in living macaques.

FTu5C • Optomechanics and Photonic Nanostructures—Continued

FTu5C.3 • 16:45
Optomechanical Crystals Fabricated by a CMOS Foundry, Rodrigo Benevides[1], Gustavo O. Luiz[1], Felipe G. Santos[1], Gustavo S. Wiederhecker[1], Thiago Alegre[1]; [1]*Universidade Estadual de Campinas, Brazil.* Photonics crystal optomechanical cavities fabricated on a commercial CMOS-compatible foundry are demonstrated. Despite the limited foundry design rules we could achieve a ultra-high Q (9.1×10^5) photonic crystals and optomechanical crystal cavities with large coupling rate (g_0=60 KHz).

FTu5C.4 • 17:00 Invited
Control of Coherent Information by Mixing Light and Sound in Photonic Circuits, Peter T. Rakich[1], Heedeuk Shin[1], Cox Jonathan[2], Robert Jarecki[2], Zheng Wang[3]; [1]*Yale Univ., USA;* [2]*Sandia National Labs, USA;* [3]*Electrical Engineering and Computer Science, Univ. of Texas at Austin, USA.* Through a new class hybrid-photonic phononic waveguide structures we show that artificial Brillouin nonlinearities can be created and manipulated in silicon. Exploiting the nonlocal nature of photon-phonon couplnig, we realize emit-receive functionalities to achieve coherent control of information.

FTu5D • Wavefront Sensing and Adaptive Optics—Continued

FTu5D.4 • 16:45
Wavefront Sensing via Attenuated Reflection using Near-Resonant Surface-Plasmon Polariton Excitation, Brian Vohnsen[1], Denise Valente[1]; [1]*Univ. College Dublin , Ireland.* Intensity variations are commonly used in curvature sensing of aberrations. Here, we demonstrate that attenuated reflection in near-resonant excitation of surface-plasmon polaritons can be used to determine gradients from which the wavefront may be reconstructed.

FTu5D.5 • 17:00 WiO
New Arrangements for Waveguide-Based Wavefront Sensors, Denise V. dos Santos[2], Diego Rativa[1], Brian Vohnsen[2]; [1]*Polytechnic School of Pernambuco, Univ. of Pernambuco, Brazil;* [2]*Advanced Optical Imaging Group, School of Physics, Univ. College Dublin, Ireland.* An array of parallel thin rectangular waveguides and a combination of rectangular and circular waveguides are proposed for wavefront sensing. The advantages and limitations of each are analyzed.

FTu5D.6 • 17:15
Compressive sensing with quadratic phase systems based cryptography, Inbarasan Muniraj[1], Changliang Guo[1], John T. Sheridan[1]; [1]*Univ. College Dublin , Ireland.* We examine the sparse-sensing mechanism of compressive sensing (CS) systems with the linear canonical transform based DRPE system. Encrypted data is randomly sampled using CS theory. Experimental results demonstrate the feasibility of the proposed technique.

FTu5E • Laser-matter Interaction—Continued

FTu5E.3 • 17:00
The Influence of an Electric Field on Reversible Photodegradation of a Dye-Doped Polymer, Benjamin R. Anderson[2], Mark G. Kuzyk[1]; [1]*Physics, Washington State Univ., USA;* [2]*Applied Sciences Lab, Washington State Univ., USA.* We generalize the statistical mechanical domain model of self healing dye-doped polymers to include the effects of an electric field and find that it predicts all observations including the effect of an applied electric field.

FTu5E.4 • 17:15 WiO
Direct Laser Writing of Fluorescent Silver Nanoclusters in Polyvinyl Alcohol Films, Nazanin Karimi[1], Puskal Kunwar[1], Juha Toivonen[1]; [1]*Tampereen Teknillinen Yliopisto, Finland.* We demonstrate successful fabrication of fluorescent microstructures by direct laser writing of silver nanoclusters in polyvinyl alcohol films using a cost-effective laser diode. The nanoclusters show very good photostability in the widely used polymer material.

FTu5F • Optical Trapping and Manipulation—Continued

FTu5F.3 • 17:00
Ultrabroadband plasmonic super absorbers for multiplexed surface enhanced Raman spectroscopy, Nan Zhang[1], Kai Liu[1], Haomin Song[1], Xie Zeng[1], Dengxin Ji[1], Qiaoqiang Gan[1]; [1]*State Univ. of New York at Buffalo, USA.* We developed an ultra-broadband super-absorbing metasurface substrate for SERS sensing. In contrast to conventional substrates working for limited excitation wavelengths, this structure can work for almost "all" laser lines from 450-nm to 1000-nm.

FTu5F.4 • 17:15 WiO
Optofluidic manipulation of microsphere by graded-index fiber with flat endface, Chenlin Zhang[1], Yuan Gong[1], Qun F. Liu[1], Yu Wu[1], Yunjiang Rao[1]; [1]*UESTC, China.* Optofluidic manipulation of microsphere is achieved by a graded-index fiber (GIF) with a flat endface. The manipulation length is controlled by strain on GIF and can be tuned up to 1000 μm.

LTu5G • Precision Laser Spectroscopy II—Continued

LTu5G.3 • 17:00 Invited
Probing Buffer-Gas Cooled Molecules with Direct Frequency Comb Spectroscopy in the Mid-Infrared, Benjamin Spaun[1], Bryan Changala[1], Bryce Bjork[1], Oliver Heckl[1], David Patterson[2], John Doyle[2], Jun Ye[1]; [1]*Univ. of Colorado at Boulder JILA, USA;* [2]*Physics, Harvard Univ., USA.* We demonstrate cavity-enhanced direct frequency comb spectroscopy on buffer-gas cooled molecules. By coupling a mid-infrared frequency comb to a high-finesse cavity surrounding a 4 K buffer-gas chamber, we obtain rotationally resolved absorption spectra of multiple vibrational bands of nitromethane.

LTu5H • Novel Fiber Lasers III—Continued

LTu5H.3 • 17:00 Invited
Compact Ultrafast Fiber Lasers for Nonlinear Optical Microscopy, Khanh Q. Kieu[1]; [1]*Univ. of Arizona, USA.* We discuss the development of compact, affordable femtosecond fiber lasers for nonlinear optical microscopy. Application in brain imaging and Barrett's cancer imaging will be presented.

California	Valley	Crystal	Gold	Empire
FiO				

FTu5A • Nonlinear Optics in Micro or Nano-Optical Structures V—Continued

FTu5A.7 • 17:30
Theory of Feedback Cooling of an Optically Trapped Nanoparticle into the Quantum Ground State, Brandon V. Rodenburg[1,2], Levi Neukirch[3,2], Monica Rizzo[1], Nick Vamivakas[4,2], Mishkat Bhattacharya[1,2]; [1]*Physics and Astronomy, Rochester Inst. of Technology, USA;* [2]*Center for Coherence and Quantum Optics, USA;* [3]*Physics and Astronomy, Univ. of Rochester, USA;* [4]*Inst. of Optics, Univ. of Rochester, USA.* Development of a quantum master equation describing an optically trapped and cooled nanoparticle is presented. Using this model, we describe how the center of mass motion can be cooled to the quantum ground state.

FTu5A.8 • 17:45
Raman Cooling of Solids through Density of States Engineering, Yin-Chung Chen[1], Gaurav Bahl[1]; [1]*Univ. of Illinois Urbana-Champaign, USA.* We show that engineering the 3D optical density of states of highly transparent solids can permit enhancement of anti-Stokes Raman scattering over Stokes scattering. When implemented through a diamond-structure photonic crystal in silicon, laser cooling using pure Raman scattering can be achieved.

FTu5B • Studying Human Vision with Animal Eyes and Exploring the Limits of Human Vision—Continued

FTu5B.4 • 17:30 WiO
Polarization Imaging in the Retina of a Dog Model of Alzheimer's Disease Enables Discrimination of Amyloid Deposits, Melanie C. Campbell[1], David Devries[1], Theodore Chow[1], Laura Emptage[1], Namrata Shah[1], Howard Dobson[2,3], Christopher Cookson[1], Marsha Kisilak[1]; [1]*Univ. of Waterloo, Canada;* [2]*inviCRO, USA;* [3]*Univ. of Guelph, Canada.* Beagle dogs suffer from a naturally occurring cognitive dysfunction syndrome, with symptoms and brain pathology similar to Alzheimer's disease. We show that polarization imaging correctly classifies 95% of amyloid deposits from surrounding retina in diseased dogs.

FTu5B.5 • 17:45 WiO
Testing the Limits of Human Vision with Single Photons, Rebecca Holmes[1], Bradley G. Christensen[1], Ranxiao F. Wang[2], Paul G. Kwiat[1]; [1]*Physics, Univ. of Illinois at Urbana-Champaign, USA;* [2]*Psychology, Univ. of Illinois at Urbana-Champaign, USA.* We discuss techniques using a heralded single-photon source to study the lower limit of human vision, and report some preliminary results, including a measurement of temporal integration at the few-photon level.

FTu5C • Optomechanics and Photonic Nanostructures—Continued

FTu5C.5 • 17:30
Molecular Optomechanics with Plasmons: Backaction at the nanoscale, Philippe Roelli[1], Christophe Galland[1], Nicolas Piro[1], Tobias J. Kippenberg[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland.* The plasmonic systems used in surface-enhanced Raman scattering are shown to be quivalent to optomechanical cavities. The new backaction force of the plasmon on the molecular vibration could lead to coherent amplification of vibrational motion.

FTu5C.6 • 17:45
Efficient electro-optic modulation of a weakly localized resonance in a photonic crystal waveguide, Yuta Ooka[1], Nurul Ashikin B. Daud[1], Tomohiro Tetsumoto[1], Takasumi Tanabe[1]; [1]*Tanabe photonic structure group, Japan.* We demonstrate ultrahigh Q and electro-optic modulation of weakly localized photonic crystal resonance in a fluctuated waveguide, where the position of the mode is controlled by reducing the width of the waveguide locally.

FTu5D • Wavefront Sensing and Adaptive Optics—Continued

FTu5D.7 • 17:30
Stability of unique optical signatures under translation and rotation, Benjamin R. Anderson[1], Ray Gunawidjaja[1], Hergen Eilers[1]; [1]*Washington State Univ., USA.* We measure the stability of unique spatial light modulator (SLM) based optical signatures under sample translation and rotation. The signature's stability is found to depend on sample type, beam size, and SLM bin size.

FTu5D.8 • 17:45
Designing Water Content Sensor of Several Kinds of Fuel Using Fiber Optic Coated with Gelatin as the Cladding, Alvien K. Sosilo[1], Ahmad N. Fauzy[1], Niki Etruly[1]; [1]*Engineering Physics, Institut Teknologi Sepuluh Nopember, Indonesia.* Gelatin can change its refraction index when submerged into a liquid and it effects on output power of the fiber optic. By measuring the output power, we could know the water content of several liquids.

FTu5E • Laser-matter Interaction—Continued

FTu5E.5 • 17:30
Importance of Hydrogen Bonding in Thermal Lens Study of Highly Absorbing Liquids, Sumit Singhal[1], Partha P. Roy[1], Debabrata Goswami[1]; [1]*Dept. of Chemistry, Indian Inst. of Technology Kanpur, India.* Effect of thermal load on highly absorbing hydrogen bonded liquids are explored. We find heat transfer is better facilitated in lesser hydrogen bonded liquids by convection through molecular motion in addition to conduction.

FTu5E.6 • 17:45
Annular Space-Time Focusing in Fused Silica, Thomas Lanier[1], Jeremy R. Gulley[1]; [1]*Kennesaw State Univ. , USA.* We describe simulations of nonlinear space-time focusing of femtosecond annular beams in silica. Adjusting the chirp of μJ pulses traversing a pair of concentric gratings leads to pronounced plasma blue-shift, and enhanced material modification localization.

16:00–17:00 Exhibitor Appreciation Reception (exhibitors only), *Exhibit Hall, Imperial Ballroom*

16:00–17:00 Minorities and Women in OSA (MWOSA) Networking Reception, *Atherton*

17:00–17:45 OSA Annual Business Meeting, *Fairfield*

17:00–18:00 APS Division of Laser Science Annual Business Meeting, *Belvedere*

18:30–20:30 OSA Member Reception, *Grande Ballroom, The Westin San Jose, 302 S. Market St., San Jose, CA*

19:00–22:00 Laser Science Banquet, *Gordon Biersch, 33 East San Fernando St, San Jose, CA*

FiO

FTu5F • Optical Trapping and Manipulation—Continued

FTu5F.5 • 17:30
Optical Advection, Veerachart Kajorndejnukul[1], Sergey Sukhov[1], Aristide Dogariu[1]; [1]*Univ. of Central Florida, CREOL, USA*. We demonstrate that under the external driving of a small bias optical force, the long range hydrodynamic interaction between colloidal particles can be harnessed to enhance the collective and directional transport.

FTu5F.6 • 17:45
Mechanical Action of Optical Spin-Orbit Interaction, Sergey Sukhov[1], Veerachart Kajorndejnukul[1], Roxana Rezvani Naraghi[1,2], Aristide Dogariu[1]; [1]*Univ. of Central Florida, CREOL, USA;* [2]*Dept. of Physics, Univ. of Central Florida, USA*. The transformation of spin angular momentum into an orbital one breaks the mirror symmetry of scattering. An adjacent interface further distorts the central symmetry and induces an anomalous lateral force on the scattering object.

LS

LTu5G • Precision Laser Spectroscopy II—Continued

LTu5G.4 • 17:30 Invited WiO
Molecular Spectroscopy with Two Laser Frequency Combs: From Vibrational to Doppler-Free Resolution, Nathalie Picque[1,2]; [1]*Max-Planck-Institut fur Quantenoptik, Germany;* [2]*Fakultät für Physik, Ludwig-Maximilians-Universität München, Germany*. Dual-comb systems become enabling tools for applications involving interferometry. Illustrations will be given in the field of broadband molecular spectroscopy, where linear and nonlinear effects are harnessed.

LTu5H • Novel Fiber Lasers III—Continued

LTu5H.4 • 17:30 Invited
Ultrafast Lasers Enabled by Graphene and Other 2D Materials, Zhipei Sun[1]; [1]*Dept. of Micro- and Nanosciences, Aalto Univ., Finland*. I will review the current state-of-the-art of ultrafast lasers mode-locked by graphene and other two-dimensional layered materials (including molybdenum disulfide, and black phosphorus).

16:00–17:00 Exhibitor Appreciation Reception (exhibitors only), *Exhibit Hall, Imperial Ballroom*

16:00–17:00 Minorities and Women in OSA (MWOSA) Networking Reception, *Atherton*

17:00–17:45 OSA Annual Business Meeting, *Fairfield*

17:00–18:00 APS Division of Laser Science Annual Business Meeting, *Belvedere*

18:30–20:30 OSA Member Reception, *Grande Ballroom, The Westin San Jose, 302 S. Market St., San Jose, CA*

19:00–22:00 Laser Science Banquet, *Gordon Biersch, 33 East San Fernando St, San Jose, CA*

07:00–18:00 Registration, *Market Street Foyer*

08:00–09:30 JW1A • Joint FiO/LS Plenary and Awards Session II, *Regency Ballroom*

09:00–16:00 CAM Lounge, *Market Street Foyer*

09:30–14:00 Exhibit Hall Open, *Exhibit Hall, Imperial Ballroom*

09:30–11:00 Coffee Break (09:30-10:00) and **Unopposed Exhibit Only Time,** *Exhibit Hall, Imperial Ballroom*

10:00–12:00 OSA Friends and Family Tour of Rosicrucian Egyptian Museum and Planetarium (Bus departs from Fairmont San Jose's main entrace at 10:15)

Exhibit Hall, Imperial Ballroom

JOINT FiO/LS

09:30–11:00
JW2A • Joint FiO/LS Poster Session II

JW2A.1
Graphene plasmonics for light trapping and absorption engineering in optoelectronic devices, Jianfa Zhang[1], Wei Xu[1], Zhihong Zhu[1], Wei Liu[1], Xiaodong Yuan[1], Shiqiao Qin[1]; [1]*National Univ. of Defense Technology, China*. We investigate the usage of graphene plasmonics for light trapping in optoelectronic devices which can enhance the absorption in surrounding materials by tens of times along with electrical tunability.

JW2A.2 WiO
High Sensitivity Hybrid Plasmonic Rectangular Resonator for Gas Sensing Applications, Aya Zaki[1,2], Khaled Kirah[1], Mohamed Swillam[2]; [1]*Faculty of Engineering, Ain Shams Univ., Egypt;* [2]*School of Science and Engineering, American Univ. in Cairo, Egypt*. A compact plasmonic rectangular sensor of effective fabrication cost is proposed. A hybrid coupling mechanism is utilized. The structure is optimized using numerical simulations. A high sensitivity of 1385 nm/RIU is reached at wavelength of 1.55 μm.

JW2A.3
Chip-integrated nearly perfect graphene absorber, Wei Xu[1], Zhihong Zhu[1], Ken Liu[1], Jianfa Zhang[1], Xiaodong Yuan[1], Qisheng Lu[1], Shiqiao Qin[1]; [1]*National Univ. of Defense Technolog, USA*. We exploit the concept of critical coupling to graphene based chip-integrated applications and numerically demonstrate that chip-integrated nearly perfect absorber at near-infrared can be obtained by graphene nearly critical coupling with a nanobeam cavity.

JW2A.4
Second Quantization of Gaussian Modes and Mode Interaction in Limited Space, Zhihao Xiao[1], R. Nicholas Lanning[1], Mi Zhang[2], Irina Novikova[2], Eugeniy E. Mikhailov[2], Jonathan P. Dowling[1]; [1]*Dept. of Physics & Astronomy, Louisiana State Univ., USA;* [2]*Dept. of Physics, College of William & Mary, USA*. We second quantize multiple orders of Gaussian modes. We analytically examine the interaction between modes when space is limited and the orthogonality between modes is destroyed. We numerically simulate the effect of interaction on squeezed vacuum states and show it matches experimental data.

JW2A.5
Influence of a Weak Continuous Wave Trigger on Continuous Wave Pumped Supercontinuum Generation, Cai Wen[1], Hui Huang[1], Zihao Cheng[1], Qian Li[1]; [1]*Peking Univ. Shenzhen Graduate School, China*. We demonstrate a simple continuous wave trigger scheme that can greatly enhance the stability of the continuous wave pumped supercontinuum generation.

JW2A.6
Hydrogel Coated Fiber Bragg Grating Based pH Sensor, Pabbisetti Vayu Nandana Kishore[1], Sai Shankar Madhuvarasu[1]; [1]*Physics, National Inst. of Technology, India*. Fiber Bragg grating based pH sensor is proposed. A pH responsive hydrogel which swells in presence of pH media is utilized for the study. The sensor head is subjected to different pH solutions ranging from pH 1 to pH 7. A linear increase of wavelength shift is observed.

JW2A.7
Design and Implementation of a Fiber Optic Corrosion Sensor based on Macrobend Losses using OTDR, Shailendra K. Varshney[1], Gagan S. Dhingra[1]; [1]*Indian Inst. of Technology Kharagpur, India*. We report fabrication and proof-of-concept of a simple corrosion sensor utilizing the intensity modulation due to macrobending losses. The sensor head consists of SMF bent into particular radius, held by "corrosion fuses" of different thicknesses.

JW2A.8
Metasurface Circular Polarization Splitter, Wei-Yi Tsai[1]; [1]*Dept. of physics, NTU, Taiwan*. Here, we present a meta-device which can resolve the handed of circular polarization and wavelength of incident light through diffraction angles.

JW2A.9
Superluminality Effect due to Femtosecond Laser Pulse Self-Trapping by the Nanorods Melting Front, Vyacheslav Trofimov[1], Tatiana Lysak[1]; [1]*Lomonosov Moscow State Univ., Russia*. We show a possibility for superluminality effect at a femtosecond pulse propagation in a medium with gold nanorods under the nanorods melting and a positive phase-amplitude grating, induced by laser radiation.

JW2A.10
Moving Soliton and Localized Soliton at PC Boundary, Vyacheslav Trofimov[1], Tatiana Lysak[1]; [1]*Lomonosov Moscow State Univ., Russia*. We demonstrate two new types of solitons in a nonlinear PC: the moving soliton, which moves across the PC layers and many times reflects from the PC boundaries, and the oscillating surface soliton that is localized near the PC boundary.

JW2A.11
Chracterization and fabrication of silica-gold composite toroidal optical microcavity, Sho Tamaki[1], Wataru Yoshiki[1], Takasumi Tanabe[1]; [1]*Keio Univ., Japan*. We fabricate silica-gold composite toroidal microcavity and investigate the nonlinear property both theoretically and experimentally. An efficient thermo-optic switching is demonstrated due to the enhanced absorption coefficient of the material.

JW2A • Joint FiO/LS Poster Session II—Continued

JW2A.12
Anatomy of Phase Locking in Parametric Frequency Combs, Hossein Taheri[1], Ali A. Eftekhar[1], Kurt Wiesenfeld[1], Ali Adibi[1]; [1]*Georgia Inst. of Technology , USA*. We investigate the dynamical origin of phase locking of optical frequency combs in Kerr-nonlinear media using few-mode approximations of the Lugiato-Lefever equation. We find analytical expressions which reveal the essence of phase locking.

JW2A.13 WiO
Analysis of electric field distribution in SPR refractive index sensor using different conducting metal oxides, Rana Tabassum[1]; [1]*Indian Inst. of Technology, Delhi, India*. We report comparative study of electric field distribution inside the probe coated with Ag and conducting metal oxides. For refractive index sensing, field inside TiO_2, SiO_2, SnO_2 and ZnO has been studied.

JW2A.14
Secret Key Rates of QKD Systems Over Time-Varying Free-Space Optical Channel, Xiaole Sun[1], Ivan Djordjevic[1], Mark Neifeld[1]; [1]*Univ. of Arizona, USA*. We study SKRs of QKD systems over time-varying FSO channels under strong turbulence. A channel predictive method is proposed to improve corresponding SKRs. The results show that the higher SKR can be obtained for better prediction accuracy.

JW2A.15
Theoretical Study of the Effect of Quantum Noise on the Nonlinear Dynamics of a Semiconductor Laser Subject to Two Filter Optical Feedbacks, Joseph Suelzer[1], Rupamanjari Ghosh[2], Awadhesh Prasad[3], Gautam Vemuri[1]; [1]*Indiana Univ.-Purdue Univ. Indianapolis, USA;* [2]*Shiv Nadar Univ., India;* [3]*Univ. of Delhi, India*. We demonstrate that the role of quantum noise in a semiconductor laser subject to two filtered feedbacks is to stabilize the laser dynamics such that stronger feedback levels are necessary for onset of chaos.

JW2A.16
Realization of Parity-Time-Symmetry Breaking in Delay Coupled Semiconductor Lasers, Joseph Suelzer[1], Yogesh Joglekar[1], Gautam Vemuri[1]; [1]*Indiana Univ.-Purdue Univ. Indianapolis, USA*. We present an experimental realization of PT-symmetry breaking in time-delay coupled semiconductor lasers and investigate the properties of the PT-threshold. A theoretical model is developed to explain the observations and agrees well with the data.

JW2A.17
Effect of a sinusoidal type modulation in the refraction index of a 1D photonic crystal, Daniel G. Suarez Forero[1], Alvaro Montaña Guerrero[1], Herbert Vinck Posada[1]; [1]*Universidad Nacional de Colombia, Colombia*. The effects of a periodic modulation on the refractive index of the intercavity zone of a 1D photonic crystal with two cavities are studied. It is found that this mechanism allows to manipulate the coupling between cavities.

JW2A.18
Optical Bistability with Two Serially Integrated InP-SOAs on a Single Chip, Michael Plascak[1], Jukka Viheriälä[2], Mircea Guina[2], Azad Siahmakoun[1]; [1]*Rose-Hulman Inst. of Technology, USA;* [2]*Optoelectronics Research Centre, Tampere Univ. of Technology, Finland*. Optical bistability has been achieved with two serially integrated MQW-InP SOAs in reverse-bias on a single chip. We demonstrate that switching speed in GHz range is possible and discuss performance limitations of the bistable device.

JW2A.19
Molecularly Imprinted Fiber Optic SPR Sensor for Parathion Methyl Detection, Anand M. Shrivastav[1], Banshi D. Gupta[1]; [1]*Indian Inst. of Technology, Delhi, India*. Fabrication and characterization of surface plasmon resonance based fiber optic sensor for parathion methyl detection using molecular imprinting have been reported. The operating range of the sensor is 10^{-13}M to 10^{-8} M.

JW2A.20
Angular Distribution of the Emission of a 2-D Optofluidic Random Laser, Anirban Sarkar[1], Shivakiran Bhaktha B. N.[1]; [1]*Indian Inst. of Technology Kharagpur, India*. We observe the regular diffraction pattern and angularly resolved random lasing spikes within a single diffraction line from a 2-D structured optofluidic random laser due to the randomness in the size distribution of the scatterers.

JW2A.21
Integrated Microring Resonator as a Perfect Absorber, Enrique Sanchez Cristobal[1], Jose J. Sanchez Mondragon[1], Mercedeh Khajavikhan[2]; [1]*Inst Nat Astrofisica Optica Electronica, Mexico;* [2]*CREOL, College of Optics and Photonics, Univ. of Central Florida, USA*. Coherent perfect absorption is demonstrated in an integrated microring resonator laterally coupled to two optical waveguides. Two counterpropagating waves of equal phase and intensity are launched into the microring resonator and eventually they get absorbed.

JW2A.22
Fiber Optic Gyroscope Based on the Registration of the Spatial Interference Pattern, Andrii Sakhno[1], Stanislav Tuzhanskyi[1]; [1]*Vinnytsia National Technical Univ., Ukraine*. Design of a fiber optic gyroscope (FOG) using a photosensitive line to scan interferograms is proposed. The suggested FOG design significantly reduces the impact of the following optical noise factors: zero drift, Rayleigh scattering, etc.

JW2A.23 WiO
Vibrational Spectroscopic (FTIR and FT-RAMAN) Studies, HOMO LUMO Analysis, NMR Chemical Shifts and Electrostatic Potential Surface of 2,3-DIBROMOFURAN, Sruti S[1], Rasheed M.P.[2]; [1]*ECE, St.Joseph's College of Engineering, India;* [2]*Physics, UD College, India*. The FTIR and FT Raman spectra of 2,3-dibromofuran have been recorded in the region 4000-400 cm-1 and 4000-100 cm-1 respectively. The optimized frequency, the observed geometry and intensity of vibrational bands of the sample were obtained using DFT using 6-311++G(d,p) basis set.

JW2A.24
Frequency Conversion of Short Optical Pulses in Negatively Spatially Dispersive Metamaterials, Alexander K. Popov[1], Sergey A. Myslivets[2,3]; [1]*Birck Nanotechnology Center, Purdue Univ., USA;* [2]*L.V. Kirensky Inst. of Physics SB RAS, Russia;* [3]*Siberian Federal Univ., Russia*. We show that particular spatial distributions of nanoscopic plasmonic building blocks in metamaterials may enable extraordinary nonlinear-optical frequency-shifted reflectivity and pulse shaping.

JW2A.25
Diagrammatic Representation of Multimode Raman Scattering with Stokes and Anti-Stokes Sidebands, Michal Parniak[1], Daniel Pecak[2], Wojciech Wasilewski[1]; [1]*Univ. of Warsaw, Poland;* [2]*Inst. of Physics, Polish Academy of Sciences, Poland*. We analyze the Raman interaction of Stokes and anti-Stokes sidebands with atomic coherence. The interaction is decomposed into a set of three-mode quantum operations. We represent these operations as two-mode squeezing and beamsplitters.

JW2A.26
Effect of Hole Transport Organic Layer on Characteristics of Hybrid Photovoltaic Structure, Antonio Olivares Vargas[1]; [1]*Inst Nat Astrofisica Optica Electronica, Mexico*. Here we report on the effect of PEDOT:PSS based p-type organic layer on characteristics of hybrid solar cells in p-i-n configuration. We demonstrated that isopropanol treatment of the PEDOT:PSS is effective for improving the performance characteristics of the device.

JW2A.27
Singular Phonons in a Helically Confined Degenerate Quantum Gas., Alex Okulov[1]; [1]*Russian Academy of Sciences, Russia*. The elementary excitations in ultracold quantum gas within helical optical potential produced by vortices with high angular momenta are considered via linearized Gross-Pitaevskii equation. The dispersion law is obtained.

JW2A.28
Tellurite Microstructured Optical Fiber Based Raman Soliton and Dispersive Wave Generation, Lei Zhang[1], Hoang Tuan Tong[1], Weiqing Gao[1], Harutaka Kawamura[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Toyato Technological Inst., Japan*. Tunable soliton and dispersive wave (DW) are generated by pumping a tellurite microstructured optical fiber near the zero dispersion wavelength. The soliton is redshifted to 1828.7 nm, and the DW is blueshifted to 1315.5 nm.

JW2A.29
Highly Efficient Dispersive Wave Emission in a Tellurite Microstructured Optical Fiber, Tonglei Cheng[1], Xiaojie Xue[1], Dinghuan Deng[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*ofmlab, Japan*. We demonstrate a highly efficient, stable and tunable dispersive wave emitted by the soliton in a tellurite microstuctured optical fiber. The conversion efficiency is over ~65%.

JW2A.30
Measuring M^2 values for On-Wafer Vertical Cavity Surface Emitting Lasers, William North[1], David Chacko[1], Peter Zeidler[1], Janice Blane[1], Kirk Ingold[1], Brian Souhan[1], James J. Raftery[1]; [1]*USA Military Academy, USA*. We report on M^2 measurements taken for on-wafer vertical cavity surface emitting lasers (VCSELs). We measured M^2 for oxide-confined VCSELs and photonic crystal (PhC) VCSELs of similar lasing aperture sizes.

JW2A.31
Study of Two-Dimensional Photonic Crystals and Photonic Crystals Slabs with Triangular Geometry, Erik P. Navarro Baron[1], Juan Vasco-Cano[2,3], Herbert Vinck-Posada[1]; [1]*Universidad Nacional de Colombia, Grupo de Óptica e Información Cuántica, Colombia;* [2]*Departamento de Física, Universidade Federal de Minas Gerais, Brazil;* [3]*DISSE - INCT de Nanodispositivos Semicondutores, Brazil*. In this work, we have done a study of band structures and eigenmodes of bidimensional photonic crystal and photonic crystals slabs of triangular air holes embedded in dielectric media in a hexagonal lattice.

JW2A • Joint FiO/LS Poster Session II—Continued

JW2A.32
Dispersion tailoring of a crystalline whispering gallery mode microcavity for octave-spanning Kerr frequency comb, Yosuke Nakagawa[1], Takumi Kato[1], Wataru Yoshiki[1], Yuta Mizumoto[1], Yasuhoro Kakinuma[1], Takasumi Tanabe[1]; [1]*Keio Univ., Japan.* We demonstrate the octave spanning optical Kerr frequency comb generation in the dispersion-tailored crystalline whispering gallery mode microcavity with a numerical simulation. We tailor the dispersion by shaping the microcavity into 'a goblet form.'

JW2A.33
Wavelength Independency of Orbital Angular Momentum (OAM) Channels in Spatially Multiplexed Systems, Syed H. Murshid[1], Saud Alanzi[1], Bilas Chowdhury[1]; [1]*Florida Inst. of Technology, USA.* The wavelength independency of OAM is presented showing that the location of spatially multiplexed (SDM) optical channels carrying OAM is independent of the wavelength of light.

JW2A.34
Dual mode and wavelength-division multiplexing, Tadesse S. Mulugeta[1], Mahmoud S. Rasras[1]; [1]*Masdar Inst. Of Science and Technology, United Arab Emirates.* Simultaneous mode and wavelength division multiplexing is proposed using integrated asymmetric directional coupler and multimode interference waveguide. Using numerical simulations, the device exhibits low insertion loss of 1.2dB and a cross-talk of -18dB.

JW2A.35
Band structure of honeycomb annular photonic crystal slabs, Cristian J. Mora Montano[1], Herbert Vinck-Posada[1], Juan Vasco-Cano[2]; [1]*Universidad Nacional de Colombia, Colombia;* [2]*Universidade Federal de Minas Gerais, Brazil.* We investigated the behavior of the band structure for a honeycomb annular lattice in a photonic crystal slab. Through GME structural parameters that maximize the band gap are characterized.

JW2A.36
Gate in a Nonlinear Subwavelength Dielectric Waveguide Array, Gregorio Mendoza Gonzalez[1], Erwin A. Marti-Panameno[1]; [1]*Facultad de Ciencias Físico Matemáticas, Benemérita Univ Autonoma de Puebla, Mexico.* In this work we present numerical results regarding the possibility to control the output position of the light in nonlinear arrays of subwavelength dielectric parallel waveguides. The main result is an AND logic gate due the interaction of two input beams.

JW2A.37
Technical Advantages for Weak-Value Amplification, Julian Martinez[1], Gerardo Viza[1], Gabriel Alves[2], Andrew Jordan[1], John Howell[2]; [1]*Univ. of Rochester, USA;* [2]*Universidade Federal do Rio de Janeiro, Brazil.* We measure beam deflections of an optical beam by monitoring the dark port in a Sagnac interferometer (weak-value technique) or by focusing the entire beam onto a split detector (standard technique). The weak-value technique performs favourable in precision when external modulations are present.

JW2A.38
Enhancement of Cross Phase Modulation Via a Resonating Cavity: Semiclassical Description, Julian Martinez[1], John Howell[1]; [1]*Univ. of Rochester, USA.* A classical description of cavity-based cross phase modulation in a ladder atomic system shows that large single-photon detuning offers enhancement proportional to the finesse of the resonator. The approach has a self-defined far-off-resonance effective cooperativity of unity.

JW2A.39
Quantum States in the Multipole Approach to Maxwell Theory of Light, Michele Marrocco[1]; [1]*ENEA, Italy.* Fundamental aspects of quantum optics are reproduced within the multipole approach to Maxwell theory of light. Results are given for Fock states, vacuum field and photon statistics of chaotic and coherent light.

JW2A.40
An analytical approach for calculating the FWM idler and signal wavelengths in a graded index multimode optical fiber, Elham Nazemosadat[2], Hamed Pourbeyram[1,3], Arash Mafi[1,3]; [1]*Dept. of Physics & Astronomy, Univ. of New Mexico, USA;* [2]*Dept. of Electrical Engineering and Computer Science, Univ. of Wisconsin-Milwaukee, USA;* [3]*Center for High Technology Materials, Univ. of New Mexico, USA.* We present a simple yet powerful analytical approach for calculating the four-wave mixing signal and idler wavelengths in a graded-index multimode optical fiber using the core radius, core-cladding index step, and mode group numbers.

JW2A.41
Measurement of Polarisability of Liquid using Fiber Optic Refractive Index Sensor, Raju M Esakki Muthu[1], Ashwin Kumar Kuchibhotla[1], Kumar Ravi[1], Badrinath Vadakkapattu Canthadai[1], Vengalrao Pachava[2]; [1]*Dept. of Physics, Vidya Jyothi Inst. of Technology, India;* [2]*Dept. of Physics, National Inst. of Technology - Warangal, India.* This work demonstrates the measurement of polarisability of liquid using a simple intensity modulated optical fiber sensor based on change in refractive index of the medium surrounding the fiber.

JW2A.42
Controlling Second Harmonic Generation with Counterpropagating Light, Amy L. Lytle[1], Etienne Gagnon[1]; [1]*Franklin & Marshall College, USA.* Experimental and numerical results verify the microscopic influence of coun- terpropagating light on the phase of the nonlinear polarization wave, providing detailed understanding of an all-optical method for quasi-phase matching.

JW2A.43
Withdrawn.

JW2A.44
Supercontinuum Generation in Fluoride Fibers Pumped By a 2 µm Q-switched Laser, Lai Liu[1], Kenshiro Nagasaka[1], Yasutake Ohishi[1], Takenobu Suzuki[1]; [1]*Toyota Technological Inst., Japan.* We experimentally realized mid-infrared supercontinuum generation in 8-m-long single mode fluoride fiber pumped by a 2 µm nanosecond Q-switched fiber laser with bandwidth about 2000 nm. The spectra broadening mechanism is modulation instability.

JW2A.45 WiO
Dual-Beam Optical Injection in Multimode Vertical-Cavity Surface-Emitting Lasers, Andrew Briggs[1], Aashu Jha[1], Hong Lin[1]; [1]*Bates College, USA.* We have experimentally explored dynamics of a multimode vertical-cavity surface-emitting laser subject to two-frequency orthogonal optical injection. Microwave signals are obtained in the double polarization switching and frequency locking regime.

JW2A.46
Virtual Photon Subtraction with Noisy Source in Continuous-Variable Quantum Key Distribution, Zhengyu Li[1], Xiang Peng[1], Hong Guo[1]; [1]*Peking Univ., China.* We propose a non-Gaussian postselection method to emulate the photon subtraction in continuous-variable quantum key distribution which extends the transmission distance. A method to further improve the performance for noisy source is also presented.

JW2A.47
A Wide-band Slow Light Regime Realized by Genetic Photonic Crystal Coupled Resonator Waveguides, Yiming Lai[1], Momchil Minkov[2], Vincenzo Savona[2], Romuald Houdré[3], Antonio Badolato[1]; [1]*Dept. of Physics and Astronomy, Univ. of Rochester, USA;* [2]*Lab of Theoretical Physics of Nanosystems, Ecole Polytechnique Federale de Lausanne EPFL, Switzerland;* [3]*Institut de Physique de la Matiere Condensee, Ecole Polytechnique Federale de Lausanne EPFL, Switzerland.* We present experimental results on the transmission and the bandstructure of novel coupled resonator optical waveguides (CROWs) in 2D photonic crystals. The CROWs were optimized by genetic algorithm and feature high group index-bandwidth product.

JW2A.48
Changing the Degree of Polarization of a Light Beam by Interferometric Path Information, Mayukh Lahiri[1], Armin Hochrainer[1], Gabriela Lemos[1,2], Radek Lapkiewicz[1], Anton Zeilinger[1,2]; [1]*VCQ, Faculty of Physics, Univ. of Vienna, Austria;* [2]*IQOQI, Austrian Academy of Sciences, Austria.* We present the results of an experiment in which the degree of polarization of a photon beam emerging from the output of a two-path interferometer is controlled by modulating the interferometric path information.

JW2A.49
Design of Highly Nonlinear Planar Waveguide for Supercontinuum Generation, Ajeet Kumar[1], Than Singh Saini[1], Ravindra K. Sinha[1]; [1]*Delhi Technological Univ., India.* We have designed a rib waveguide structure in highly nonlinear As_2Se_3 glass for mid-IR broadband supercontinuum generation. Proposed structure possesses nonlinear coefficient as high as 14190 $W^{-1}Km^{-1}$ with -5.82 ps/nm.km dispersion at 2900 nm.

JW2A.50 WiO
Near-Field Imaging and Spectroscopy of Gold Nanoantenna, Deirdre Kilbane[1], Anna-Katherina Mahro[1], Pascal Melchior[1], Stefan Mathias[1], Martin Aeschlimann[1]; [1]*Physics, Univ. of Kaiserslautern, Germany.* Near-field imaging and spectroscopy of ring resonators is performed with photoemission electron microscopy and a tuneable femtosecond laser source. Phase- and time-resolved near-field imaging is achieved with an actively stabilized interferometer.

JW2A.51
A Unique Observation of Power Play in the Instability Induced Supercontinuum Generation in Saturable Nonlinear Media, Nithyanandan K[1]; [1]*Pondicherry Univ., India.* The supercontinuum generation is observed to behave in a unique in saturable nonlinearity, such that the broadband is observed at shortest distance for pumping at saturation power, in comparison to all other pump power configurations.

JW2A • Joint FiO/LS Poster Session II—Continued

JW2A.52
Towards Quantum Frequency Conversion, Oscar Jimenez[1], Yiming Lai[2], Julio Cesar Garcia Melgarejo[1], Jose J. Sanchez Mondragon[1], Kartik Srinivasan[3], Antonio Badolato[2]; [1]*INAOE, Mexico;* [2]*Univ. of Rochester, USA;* [3]*CNST, NIST, USA.* We developed a high efficiency, low-loss and high fidelity quantum frequency conversion. The objective was to transduce photons emitted by quantum dots from NIR wavelengths (λ>1.1μm) to visible wavelengths (λ<0.70μm), where single-photon silicon detectors perform best.

JW2A.53
Highly Birefringent PCF Based Micro-displacement Sensor Using Tapered Fiber, Jitendra Dash[1], Sumit Dass[1], Rajan Jha[1]; [1]*I.I.T. Bhubaneswar, India.* We report a highly birefringent (HiBi) PCF based modal interferometer assisted with a tapered single mode fiber for micro displacement sensing. The displacement sensitivity of the low cost sensor is found to be 0.01 dBm/μm.

JW2A.54
Numerical Investigation of Optical Sampling with CMOS Compatible Waveguides in C-Band Wavelengths, Mahmoud Jazayerifar[1]; [1]*Technische Universität Berlin, USA.* Optical sampling based on four wave mixing in silicon and silicon nitride nano-waveguides is numerically studied. It is shown that optical sampling at high rates (~ 100 GHz) with typical straight silicon and silicon nitride waveguides is feasible.

JW2A.55
Two-Photon Amplification In Semiconductor-Superconductor Structures, Raja Marjieh[1], Evyatar Sabag[1], Alex Hayat[1]; [1]*Technion, Israel.* We study a new effect of Cooper-pair-based two-photon gain in semiconductor-superconductor structures, showing broadband enhancement of singly- and fully-stimulated ultrafast two-photon gain. These effects can have important implications in optoelectronics and in coherent-control applications.

JW2A.56
Phase Shift Signal Analysis for Bitapered Fiber Sensors, Joseph W. Haus[1], Daniel Jauregui Vazquez[2], Amit W. Ben Harush Negari[1], Juan M. Sierra Hernandez[2], Diego W. Garcia Mina[1], Branden King[1], Karolyn Hansen[1]; [1]*Univ. of Dayton, USA;* [2]*Electronics, Univ. of Guanajuato, Mexico.* Experimental transmission spectrums from bitapered optical fiber sensor system provide signal data over a range of wavelengths. The signals are analyzed using a Fourier decomposition method to extract the phase of the complex signal, which shows high sensitivity measurements.

JW2A.57
Tripartite Mechanical Entanglement in Quantum Optomechanical Systems, Monirul Hasan[1], Matthew J. Woolley[1]; [1]*School of Engineering and Information Technology, Univ. of New South Wales, Australia.* Electromagnetic cavity modes are useful for the control of macroscopic mechanical oscillators in the quantum regime. In a system of three mechanical modes coupled to three cavity modes, one can prepare and detect entangled states.

JW2A.58
Enhancement of Wavelength Selectivity of Color Holograms Based on Surface Plasmons, Pavel Hartman[1], Zuzana Chlebounová[1], Marek Škeren[1]; [1]*Czech Technical Univ. in Prague, Czech Republic.* Setup for enhancement of wavelength selectivity of transmission holographic filters based on surface plasmon is presented. Volume grating is used on the input side of the device for modifying the dispersive properties of the element.

JW2A.59
Second-Harmonic Generation in Highly Dispersive Media: Consequences of Dispersion on the Maker Fringes Method, Serge Gauvin[1]; [1]*Université de Moncton, Canada.* The standard formalism of second-harmonic generation appears inadequate in the case of highly dispersive nonlinear materials. The inaccuracy can be as high as 30 %. A more general but still simple formalism is described and appears preferable when the Maker fringes method is used.

JW2A.60 WiO
Five mode groups EDFA for Mode Division Multiplexing, Ankita Gaur[1], Vipul Rastogi[1]; [1]*Dept. of Physics, Indian Inst. of Technology Roorkee, India.* We propose a few-mode EDFA for amplification of 5 mode groups with less than 2.2 dB DMG over C-band using fundamental mode pumping. The annulus core EDF is studied using annulus and extra annulus doping.

JW2A.61
A Two-Level Atom as a Coupler of Cross Cavities, Julio Cesar Garcia Melgarejo[1], Nestor Lozano-Crisostomo[1], Dayana H. Peñalver Vidal[2], Ponciano Rodriguez-Montero[1], Jose J. Sanchez Mondragon[1]; [1]*Inst Nac Astrofisica Optica Electronica, Mexico;* [2]*Universidad Politécnica de Amozoc, Mexico.* We analyze the short and long-term behavior of the coupling between two cross cavities due to their interaction with a two-level atom.

JW2A.62
Photonic waveform generator by linear shaping of four spectral sidebands, Julien Fatome[1], Christophe Finot[1]; [1]*Universite de Bourgogne, France.* Changing the optical phase difference between four spectral sidebands is sufficient to synthesize various pulse shapes. Experiments at 40 GHz confirm that high quality parabolic, triangular or flat-top temporal intensity profiles can be achieved.

JW2A.63 WiO
Characterization of Metallic and Dielectric Thin Films Using Surface Plasmon Resonance and the Abelès - Brewster Technique, Yuliana M. Espinosa-Sánchez[1]; [1]*Centro de Investigaciones en Optica AC, Mexico.* We presented the design and implementation of *θ-2θ* system which can be used in its surface plasmon resonance mode or can be adapted to Abeles-Brewster technique. Using this system it is possible to characterize metallic and dielectric thin films.

JW2A.64
Performance Enhancement of Evanescent-field Based Optical Waveguide Bio-sensors Using Metal Under-cladding, Ranjeet Dwivedi[1], Manoj Kumar[1], Arun Kumar[1]; [1]*Indian Inst. of Technology, Delhi, India.* A thin metal under-cladding is shown to significantly enhance the evanescent-field in the cover region of an optical waveguide. Using this, a multimode interference based compact bio-sensor, having very high sensitivity (2500 nm/RIU) is proposed.

JW2A.65
The Dual-Tapered Fiber Sensors coated with Nanoparticles, Sean Sung-Yen Juang[1], Ming-Hui Chen[1], Wei-Jie Chen[1], Nan-Kuang Chen[2], Hsiang-Chen Chui[1]; [1]*National Cheng Kung Univ., Taiwan;* [2]*National United Univ., Taiwan.* We reported the design of the dual-tapered fibers. After depositing the nanoparticles on the tapered regions, the localized surface-plasmon resonance may induce the absoprtion spectra. This compact sensor can perform real-time refractive index sensing.

JW2A.66
Localized defect modes in a nonresonantly pumped exciton-polariton condensate, Ting-Wei Chen[1], Wen-Feng Hsieh[2], Szu-Cheng Cheng[1]; [1]*Dept. of Optoelectric Physics, Chinese Culture Univ., Taiwan;* [2]*Dept. of Photonics and Inst. of Electro-Optical Engineering, National Chiao Tung Univ., Taiwan.* The localized defect modes in a nonresonantly pumped polariton condensate are investigated. Under an attractive defect, a *hyperbolic cotangent* solution is remarkably stable, which doesn't exist in atomic systems and has never been reported before.

JW2A.67
High Performance Binary Blazed Polysilicon Grating Coupler with a Silicon Nitride Filling Layer, Huai Yi Chen[1]; [1]*Huafan Univ., Taiwan.* A binary blazed poly-silicon grating coupler with a silicon nitride filling layer was proposed. Compared with typical binary blazed silicon grating coupler, it can reduce the coupling angle and retain a high fiber coupling efficiency.

JW2A.68
Architectural Improvements of a Novel Embedded MSM Photodetector, Guillermo Fernando Camacho Gonzalez [1]; [1]*INAOE, Mexico.* We introduce a realistic improvement on a recent proposed embedded MSM photodetector that reduces the back reflected light to 11.04%. Therefore carriers creation efficiency increases, enhancing the sensitivity. This is useful for communication optoelectronic systems.

JW2A.69 WiO
Pulse Recycling and Weak Value Metrology, Courtney Byard[1], Trent Graham[1], Andrew Jordan[2,3], Paul G. Kwiat[1]; [1]*Univ. of Illinois at UC, USA;* [2]*Physics and Astronomy, Univ. of Rochester, USA;* [3]*Center for Coherence and Quantum Optics, Univ. of Rochester, USA.* Recycling undetected photons in a weak measurement can substantially improve the signal-to-noise ratio. We demonstrate a preliminary improvement by a factor of 1.36 over a system with no recycling, potentially reaching a factor of 4.

JW2A.70
Dimensional Effect on Poling in Lithium Niobate, Peter Bullen[1], Hsu-Cheng Huang[1], Richard Osgood[1]; [1]*Columbia Univ., USA.* We investigated the dimensional effect on poling in lithium niobate. By poling samples of varying thickness (25–500 μm), we found that thickness affected both domain broadening and coercive field significantly.

JW2A.71
Withdrawn.

JW2A.72
Implementation of 3-bit Synchronous Up Counter using Mach-Zehnder Interferometer for Optical Signal Processing, Santosh Kumar[1], Ashish Bisht[1], Divya Sharma[2], Angela Amphawan[3]; [1]*Dept. of Electronics & Communication Engineering, DIT Univ., India;* [2]*Dept. of Electronics & Communication Engineering, Shoolini Univ., India;* [3]*InterNetWorks Research Lab, School of Computing, Universiti Utara Malaysia, Malaysia.* An optical 3-bit synchronous up counter is demonstrated by using optical T flip flops and logic gates based on electro-optic effect of Mach Zehnder Interferometers, which can be cascaded for higher bit counting operation.

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JW2A.73
Implementation of an Optical Binary Cell of Random Access Memory based on Electro-Optic Effect in Mach-Zehnder Interferomete, Santosh Kumar[1], Ashish Bisht[1], Sanddep Sharma[1], Sanjeev Kumar Raghuwanshi[3], Angela Amphawan[2]; [1]*Dept. of Electronics & Communication Engineering, DIT Univ., India;* [2]*InterNetWorks Research Lab, School of Computing, Universiti Utara Malaysia, Malaysia;* [3]*Dept. of Electronics Engineering, Indian School of Mines, India.* An optical binary storage cell of a random access memory is demonstrated for Read/Write operation based on the electro-optic effect of Mach Zehnder Interferometer which can be arrayed to form optical memory units.

JW2A.74
Protein Hydrogel Immobilization via Multiphoton Plasmonic Lithography (MPPL), Bharath Bangalore Rajeeva[1], Mingsong Wang[1], Linhan Lin[1], Yuebing Zheng[1]; [1]*The Univ. of Texas at Austin, USA.* We regioselectively localize protein hydrogels over the hot spots of single gold nanotriangle using MPPL, and track the immobilization using dark-field scattering spectroscopy. This technique can be exploited to study biological interactions in the nanoscale.

JW2A.75
Simplified Bond-Hyperpolarizability Model Explanation of the Electric-Field-Induced Second-Harmonic Generation for Different Facets in Si, Adalberto Alejo-Molina[1], Jesús Escobedo-Alatorre[1], Kurt Hingerl[2], Edvaart Sethaziz Jatirian-Foltides [1]; [1]*CIICAp, UAEM, Mexico;* [2]*Center for Surface and Nanoanalytics, Johannes Kepler Univ., Austria.* In this work we discuss the respond from different facets of the Si crystal for the nonlinear phenomenon Electric-Field-Induced Second-Harmonic (EFISH) Generation. The technique to describe it is Simplified Bond-Hyperpolarizability Model.

JW2A.76
Effect of Illumination Length pn the Optical Absorption of Armchair Graphene Nanoribbons, Mahbub Alam[1,2], Paul Voss[1,2]; [1]*Georgia Inst. of Technology , France;* [2]*UMI 2958 Georgia Tech-CNRS, France.* We study nanoscale optical illumination of semiconducting armchair graphene nanoribbons. The optical absorption undergoes a sharp transition to the long-ribbon limit at approximately the de Broglie wavelength of the valence band electrons.

JW2A.77 WiO
Zero backscattering by ellipsoidal single nanoparticle, Reena Dalal[1], Preeti Rani[1], Yogita Kalra[1], Ravindra K. Sinha[1]; [1]*Delhi Technological Univ., India.* We report zero backscattering by ellipsoidal nanoparticles. Using generalized Kerker's (GK) condition, we have analyzed light is scattered in the forward direction for the particular wavelength of 908nm in our design, suppressing the backscattering completely.

JW2A.78
A Digital-like On-Chip Photonics Sensor, Osama AL Mrayat[1], Mahmoud S. Rasras[1]; [1]*Masdar Inst. of Science and Technolo, United Arab Emirates.* We propose compact photonics sensor with low limit of detection (LOD) and large dynamic range. It integrates cascaded-coupled micro ring resonators with Echelle Grating. Employing a thermo-optic tuning, LOD of $26x10^{-6}$ RIU can be achieved.

JW2A.79
Electronic spectra and lateral photocurrent in Si/Ge heterostructures with quantum dots , Yurii Hyrka[1]; [1]*OSA Student chapter, Ukraine.* The work generalizes the results of studies of morphological, structural, optical and electrical properties of SiGe/Si nanoheterostructures. It is shown that the photoconductivity of nanoheterostructures SiGe/Si in the infrared range depending on the component composition.

JW2A.80
Development of a Thermal Lens Microscope for Asphaltene Analysis., David Hernandez[1], Gustavo Martínez[1], Marco Ferreira [1], Vincent Piscitelli[1], Lorenzo Echevarria[2]; [1]*Universidad Central de Venezuela, Venezuela, Bolivarian Republic of;* [2]*Universidad Simon Bolivar, Venezuela, Bolivarian Republic of.* This paper shows the development of a thermal lens microscope to measure the response of thermal lens in different Venezuelan asphaltene solutions.

JW2A.81
Dual-wavelength tunable Er/Yb double-clad doped Q-switched fiber laser, Manuel Duran-Sanchez[1], Ricardo . Álvarez-Tamayo[1], Olivier Pottiez[2], Baldemar Ibarra-Escamilla[1], Georgina Beltrán-Pérez[3], Yazmin E. Bracamontes-Rodríguez[3], Evgeny A. Kuzin[1]; [1]*Optics, INAOE, Mexico;* [2]*Optics, CIO, Mexico;* [3]*FCFM, BUAP, Mexico.* A tunable dual-wavelength Q-switched ring cavity fiber laser with Er/Yb double-clad fiber is presented. Laser simultaneous wavelengths tuning is performed by fiber Bragg gratings compression/strain. Maximal laser lines separation is ~4 nm.

JW2A.82 WiO
Optogalvanic spectroscopy measurements of the electric field strength in a hydrogen glow discharge, Verónica González Fernández[1], Luis María Fuentes[1], Klaus Grützmacher[1], M.Concepción Pérez[1], M. Inmaculada de la Rosa[1]; [1]*Universidad de Valladolid, Spain.* A high-resolution spectroscopy method is used in order to measure the electric field distribution in a hollow cathode *glow discharge* in hydrogen.

JW2A.83 WiO
Intra-cavity Generation of Laguerre-Gauss Laser Beams Via a High-loss Circular Mask, Katelyn Hinman [1], Jessica P. Young[1]; [1]*Arkansas Tech Univ. , USA.* Generation of Laguerre-Gauss laser beams via a null within the laser cavity is demonstrated. The null is created by a high-loss mask. The relationship between mode order and mask to beam diameter ratio is discussed.

JW2A.84 WiO
Detection of Trace Materials Concomitant with Fingerprints Using a Multispectral UV Camera, Wenli Huang[1], Barry Shoop[1], Augustus Fountain III[2]; [1]*Electrical Engineering and Computer Science, US Military Academy, USA;* [2]*Edgewood Chemical Biological Center, Aberdeen Proving Ground, USA.* This paper presents the algorithms in detecting trace materials on fingerprints using a multi-wavelength UV camera. We evaluate two competitive approaches: The error diffusion neural network (EDN) and orthogonal space projection (OSP).

JW2A.85
All optical mode controllable Er-doped fiber random laser with distributed Bragg gratings, Wei Li Zhang[1], Rui Ma[1], Chenghao Tang[1], Yunjiang Rao[1], Xiaopei Zeng[1], Zinan Wang[1], Yuan Gong[1]; [1]*Univ. of Electronic Science and Technology of China, China.* An all-optical method to control lasing modes of Er-doped-fiber random lasers is proposed. Local gain distribution in the laser is perturbed by lateral injecting control light, and active coherent random modes selection is realized.

NOTES

11:00–12:30
FW3A • General Optical Sciences I
Presider: Igor Jovanovic; Pennsylvania State Univ., USA

FW3A.1 • 11:00
Experimental and Simulation Study of Polarization Singularities Using Birefringent Crystal Interferometer, Sunil Vyas[1], Yoko Miyamoto[1]; [1]*The Univ. of Electro-Communications, Japan.* Experimental and simulation studies are performed to study transformation of phase singularity into polarization singularity using birefringent crystal interferometer. Present results may be useful in understanding evolution of singularity.

FW3A.2 • 11:15
Lithography-free visible metasurface absorbers with tunable dielectric spacers, Kai Liu[1], Nan Zhang[1], Dengxin Ji[1], Haomin Song[1], Xie Zeng[1], Qiaoqiang Gan[1]; [1]*State Univ. of New York at Buffalo, USA.* We differentiate the spacer-dependent peak shift in coupled and decoupled super absorbing metasurfaces based on magnetic resonance and interference mechanism, respectively, which was experimentally validated by low-cost lithography-free fabrications.

FW3A.3 • 11:30
Modification of Light Transmission Channels by Inhomogeneous Absorption in Random Media, Seng Fatt Liew[1], Hui Cao[1]; [1]*Applied Physics, Yale Univ., USA.* We investigate the effects of spatially inhomogeneous absorption on transmission eigenchannels of light in random media. The high transmission channels circumvent absorbing regions and experience less attenuation compared to uniform absorption.

11:00–12:30
FW3B • Integrated Photonics for Communications: Datacenters and Networks I
Presider: Keren Bergman; Columbia Univ., USA

FW3B.1 • 11:00 Invited
Photonics Integrated Circuits for Access and Transport Network, Young-Kai Chen[1]; [1]*Alcatel-Lucent Bell Labs, USA.* In this talk, we will review recent advances in the photonic integrated circuit technologies, utilizing the compound semiconductor as well as the emerging CMOS-compatible silicon platform, to enable access and transport network.

FW3B.2 • 11:30 Invited
MEMS-Enabled Scalable Silicon Photonic Switches, Ming C. Wu[1], Tae Joon Seok[1], Sangyoon Han[1], Niels Quack[1]; [1]*Univ. of California Berkeley, USA.* Large-scale integrated photonic switches (50x50 and 64x64) have been realized by combining silicon photonics with efficient MEMS switching mechanisms. These switches are based on passive crossbar architecture, which is fundamentally more scalable than other switches.

11:00–12:30
FW3C • Frequency Comb Generation and Applications
Presider: Juerg Leuthold; ETH Zurich, Switzerland

FW3C.1 • 11:00 Invited
Broadband Frequency Combs on a Photonic Chip Using Soliton Induced Cherenkov Radiation, Tobias J. Kippenberg[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland.* This talk will review microresonator based optical frequency combs, that allow access to large (GHz) repetition rates, large power per comb line and chipscale integration. I will review recent progress in generating temporal solitons in a SiN microresonator. This process, along with soliton induced Cherenkov radiation can be used to create deterministically, low phase noise, numerically predictable combs that span 2/3 of an octave from a single CW laser.

FW3C.2 • 11:30
Comb characterization of Erbium All-fiber Hybrid Mode-locked ultra-short pulse Ring laser for Frequency Metrology, Vladimir A. Lazarev[1], Alexander Krylov[2], Dmitriy Dvoretskiy[1], Stanislav Sazonkin[1], Alexey Pnev[1], Dmitriy Shelestov[1], Valery Karasik[1], Alexey Kireev[3], Mikhail Gubin[3]; [1]*Bauman Moscow State Technical Univ., Russia;* [2]*Fiber Optics Research Centre, Russia;* [3]*P.N. Lebedev Physical Inst. of the Russian Academy of Sciences, Russia.* Stable 92.6 fs dechirped self-similar pulses were obtained at 1560 nm with 11.2 mW average output power. Similariton laser has low repetition rate deviation at 1 - 10^3 s, a single comb linewidth of 110 kHz and high reliability, which makes it promising for further development of the stabilized comb.

11:00–12:30
FW3D • Quantum Optical Measurement and Technologies I
Presider: Ian Walmsley; Univ. of Oxford, UK

FW3D.1 • 11:00 Invited
Photonic Quantum Simulation & Emulation, Andrew G. White[1,2]; [1]*Univ. of Queensland, Australia;* [2]*Centre for Engineered Quantum Systems & Centre for Quantum Computing and Communication Technology, Australia.* Here we examine the state-of-play in photonic quantum simulation and emulation. We discuss recent advances in photon technology, notably sources, detectors, and nonlinear interactions, and the implications for large-scale implementations, e.g. in the BosonSampling problem.

FW3D.2 • 11:30
Photon Temporal Modes as a Complete Framework for Quantum Information, Michael G. Raymer[1], Benjamin Brecht[2], Dileep V. Reddy[1], Christine Silberhorn[2]; [1]*Univ. of Oregon, USA;* [2]*Univ. of Paderborn, Germany.* We propose a quantum information framework that employs field-orthogonality of single-photon temporal modes. The three requirements–generation of resource states, the targeted and efficient manipulation of TMs, and their detection and characterization–can be fulfilled with current technology.

11:00–12:30
FW3E • Novel Integrated Optical Structures
Presider: Edris Sarailou, Univ. of Central Florida, CREOL, USA

FW3E.1 • 11:00
Nanostructured Polarizer Array for Infrared Wavelengths, Carol Baumbauer[1], Sean Nicolaysen[1], Benjamin Moon[1], Marquette Stevenson[1], David L. Dickensheets[1], Wataru Nakagawa[1]; [1]*Montana State Univ., USA.* Nanostructured polarization filters for wavelengths around 1.55 μm have been designed, fabricated and characterized. The design approach can be adapted to other wavelengths in the infrared and to create filter arrays with spatially varying characteristics.

FW3E.2 • 11:15
Experimental Investigation of a Nanoplasmonic Air-Slot Coupler Toward Dense Optical Integrated Circuits, Rami A. Wahsheh[1], Zhaolin Lu[2], Mustafa Abushagur[2]; [1]*Princess Sumaya Univ. for Technology, Jordan;* [2]*Rochester Inst. of Technology, USA.* Experimentally, we demonstrate that light can be coupled from a silicon waveguide into a plasmonic waveguide using an air-slot coupler. The theoretical and experimental results at 1550 nm are about 85% and 40%, respectively.

FW3E.3 • 11:30
Coherent Perfect Absorption in a Silicon Ring Resonator, Jacob M. Rothenberg[1], Christine Chen[1], Keren Bergman[1], Richard Osgood[1], Jason Ackert[2], Andrew Knights[2], Richard Grote[1,3]; [1]*Dept. of Electrical Engineering, Columbia Univ., USA;* [2]*Dept. of Engineering Physics, McMaster Univ., Canada;* [3]*: Dept. of Electrical and Systems Engineering, Univ. of Pennsylvania, USA.* We present the first experimental demonstration of coherent perfect absorption (CPA) in an integrated device. By leveraging the effects of CPA, phase-controlled modulation is achieved in a silicon photonic ring-resonator with an extinction of 8.12dB.

FiO

11:00–12:30
FW3F • Novel Light Generation and Manipulation in Fiber Devices I
Presider: Julien Fatome; Universite de Bourgogne, France

FW3F.1 • 11:00 Invited

Topographic Optical Fibers : New Perspectives in Nonlinear Guided Optics, Arnaud Mussot[1], Alexandre Kudlinski[1], Matteo Conforti[1], Abdelkrim Bendahmane[1], Flavie Braud[1], Francois Copie[1], Shaofei Wang[1], Stefano Trillo[2]; [1]*Univ Lille 1 Laboratoire PhLAM, France;* [2]*Dipartimento di Ingegneria, Università di Ferrara,, Italy.* We investigate theoretically and experimentally basic nonlinear effects such as soliton propagation or modulation instability in what we called topographic optical fibers, i.e. fibers which parameters are longitudinally modulated.

FW3F.2 • 11:30

Polarization properties of the solitons in the supercontinuum generation in twisted fiber pumped by ns pulses, Ariel Flores-Rosas[2,1], Sergio Mendoza-Vazquez[2], Berenice Posada-Ramirez[2], Orlando Diaz-Hernadez[2], Jesus G Escalera-Santos[2]; [1]*INAOE, Mexico;* [2]*Fisica, Universidad Autonoma de Chiapas, Mexico.* We investigate the polarization of solitons formed by the pulse breakup process at pumping by ns-long pulses in standard fiber with circular birefringence introduced by fiber twist, the fiber twist mitigates the random linear birefringence.

11:00–12:30
FW3G • Symposium Honoring Adolf Lohmann I
Presider: Joseph Mait; US Army Research Lab, USA

FW3G.1 • 11:00 Invited

Adolf Lohmann and his Contributions to Optics, Joseph W. Goodman[1]; [1]*Stanford Univ., USA.* J.W. Goddman's first meeting with Adolf will be reviewed and he will discuss a few of Adolf's many papers that were especially important to him.

FW3G.2 • 11:30

Multiplexing Computer-Generated Volume Holograms, Rafael . Piestun[1], Hayan Wang[1]; [1]*Univ. of Colorado at Boulder, USA.* Volumetric computer-generated holograms enable independent multiplexed control of the amplitude and phase of the optical field. Angular, wavelength and phase-shift multiplexing designs are implemented using scattering theory and projection algorithms in three-dimensional Fourier space.

LS

11:00–12:45
LW3H • Novel Photonics
Presider: Jesse Wilson, Duke Univ., USA

LW3H.1 • 11:00 Invited

Bright Tunable Photonic-Crystal-Fibre Light Sources in the Deep and Vacuum Ultraviolet, Philip S. Russell[1], Amir Abdolvand[1], Xin Jiang[1], Nicolas Joly[1], John Travers[1]; [1]*Max Planck Inst. for the Science of Light, Germany.* PCFs have been revolutionizing VUV and DUV light sources. He-filled hollow-core PCF has produced narrow and broad-band light in the VUV (down to 113 nm), and solid-core ZBLAN PCF a supercontinuum down to 200 nm.

LW3H.2 • 11:30 Invited

Title to be Determined, Xiang Zhang[1]; [1]*Univ. of California Berkeley, USA.* Abstract not available.

11:00–12:30
LW3I • Computational Optical Imaging II
Presider: William Rhodes; Florida Atlantic Univ., USA

LW3I.1 • 11:00 Invited

A Learning Approach to Optical Tomography, Demetri Psaltis[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland.* We form the 3D image of an object by minimizing the difference between the prediction of a network simulating the propagation of light through the object and the experimental measurement.

LW3I.2 • 11:30 Invited

Accurate 3D Nanoscale Imaging of Dipole-like Emitters, Matthew D. Lew[1]; [1]*Dept. of Electrical and Systems Engineering, Washington Univ. in St. Louis, USA.* Engineered point spread functions and modern image processing enable optical microscopes to measure the 3D position and orientation of single molecules with nanoscale precision and accuracy. Recent developments in methodologies and applications are discussed.

FW3A • General Optical Sciences I—Continued

FW3A.4 • 11:45
Molding the Flow of Light in Photonic Topological Insulators, Xiao-Dong Chen[2], Jian-Wen Dong[1,2]; *[1]Univ. of California Berkeley, USA; [2]School of Physics and Engineering, Sun Yat-Sen Univ., China.* We experimentally demonstrate the spin-filtered feature and robust transport of edge states in metacrystal waveguide. In addition, dispersion-immune photonic topological insulator is achieved by staggered photonic metacrystals.

FW3A.5 • 12:00
Time Resolved Spectroscopy on Thin Layers of Black Phosphorus, Ryan J. Suess[1,2], Mohammad M. Jadidi[1,2], Thomas E. Murphy[1,2], Martin Mittendorff[1]; *[1]Inst. for Research in Electronics & Applied Physics, Univ. of Maryland, USA; [2]Dept. of Electrical & Computer Engineering, Univ. of Maryland, USA.* We report transient transmission spectra for multi-layer black phosphorus. The data exhibits fast transient photobleaching and subsequent pump-induced absorption characterized by multiple relaxation times. Polarization resolved measurements reveal a high anisotropy in the optical response.

FW3A.6 • 12:15
Observation of Different Types of Spatial Correlations in the Biphoton's Fourier Plane, Omar Calderon[1], Jefferson Florez[1], Juan Villabona[1], Alejandra Valencia[1]; *[1]Universidad de los Andes, Colombia.* We report an experiment based on non-collinear type-II spontaneous parametric down-conversion that shows how the type of spatial correlation changes if the biphoton's Fourier plane is scanned vertically or horizontally.

FW3B • Integrated Photonics for Communications: Datacenters and Networks I—Continued

FW3B.3 • 12:00 Invited
Multimode VCSELs vs Si Photonics in the Data Center: A Techno-economical Comparison, Daniel Mahgerefteh[1], Craig Thompson[1]; *[1]Finisar Corporation, USA.* Will Si photonics replace MM VCSELs in the data center? We attempt to answer this question by comparing the two technologies based on their application space, cost structure, transmission reach, and power consumption.

FW3C • Frequency Comb Generation and Applications—Continued

FW3C.3 • 11:45
Coherent Dual-Comb Mode-locked Fiber Laser based on a Birefringent Ring Cavity, Xin Zhao[1], Zheng Gong[1], Ya Liu[1], Yuli Yang[1], Guoqing Hu[1], Zheng Zheng[1,2]; *[1]School of Electronic and Information Engineering, Beihang Univ., China; [2]Collaborative Innovation Center of Geospatial Technology, China.* Based on a passively mode-locked fiber cavity with relatively large birefringence, it is demonstrated that coherent dual-comb emissions with dual soliton pulse trains of slightly different repetition rates and nearly orthogonal polarization can be generated.

FW3C.4 • 12:00 Invited
Fast Random Event Detection Using Optical Frequency Comb, Vahid Ataie[1]; *[1]Univ. of California, San Diego, USA.* Application of tunable optical parametric frequency combs in spectral decomposition and detection of the non-repetitive high-speed and low SNR signal is discussed. A significant improvement in detection sensitivity is reported for the newly introduced receiver architecture.

FW3D • Quantum Optical Measurement and Technologies I—Continued

FW3D.3 • 11:45
Resolving Subwavelength Variations in the Response of NbN Nanowire Single Photon Detectors, Jelmer J. Renema[1], Qiang Wang[1], Rosalinda Gaudio[2], Andreas Engel[3], Martin P van Exter[1], Andrea Fiore[2], Michiel J. de Dood[1]; *[1]Universiteit Leiden, Netherlands; [2]Eindhoven Univ. of Technology, Netherlands; [3]Univ. of Zurich, Switzerland.* We use quantum detector tomography to identify photon assisted vortex entry as the photon detection mechanism in superconducting NbN nanowires. We exploit the polarization dependence to resolve the response of the nanowire with subwavelength resolution.

FW3D.4 • 12:00 WiO
Quantum Networks based on Cold Rydberg Atoms and an Optical Nanofiber, Krishnapriya S.R[1], Tridib Ray[1], Sile Nic Chormaic[1]; *[1]Okinawa Inst of Science & technology, Japan.* We discuss recent experimental progress towards realizing a quantum network based on Rydberg atoms trapped around an optical nanofiber. Initial tests are designed to demonstrate the formation of Rydberg atoms next to the dielectric surface.

FW3D.5 • 12:15
Beating the Standard Quantum Limit in Quantum Metrology despite Noise, Jan Kolodynski[1], Jonatan Bohr Brask[2], Rafael Chaves[3,4], Marcin Markiewicz[5], Antonio Acin[1,6], Madalin Guta[7], Rafal Demkowicz-Dobrzanski[5]; *[1]ICFO - The Inst. of Photonic Sciences, Spain; [2]Inst. for Theoretical Physics, Univ. of Geneva, Switzerland; [3]Inst. of Physics, Univ. of Freiburg, Germany; [4]Inst. for Theoretical Physics, Univ. of Cologne, Germany; [5]Faculty of Physics, Univ. of Warsaw, Poland; [6]ICREA - Institucio Catalana de Recerca i Estudis Avancats, Spain; [7]School of Mathematical Sciences, Univ. of Nottingham, UK.* We review the *quantum information theory* program analysing the impact of *noise in quantum metrology*, which has led to the first uncorrelated-noise model allowing for limitless quantum enhancement of measurement precision, consequently yielding an improved *atomic magnetometry* experimental proposal.

FW3E • Novel Integrated Optical Structures—Continued

FW3E.4 • 11:45
Ring Modulators in Standing-wave and Partial Standing Wave Operation on a Matched Interdigitated p-n Junction for Enhanced Efficiency, Fabio Pavanello[1], Xiaoge Zeng[1], Mark T. Wade[1], Milos A. Popovic[1]; *[1]Univ. of Colorado at Boulder, USA.* We propose microring modulators in (quasi)standing-wave operation with interdigitated p-n junctions matched to optical field nodes/antinodes, allowing higher modulation efficiency and speed than traveling-wave designs.Full-standing-wave and grating assisted geometries are proposed.

FW3E.5 • 12:00
Nonlinear Magnetic Scattering from Polymer Micro-ring Resonators, Ayan Chakrabarty[1], Cheng Zhang[1], Alexander A. Fisher[1], Elizabeth F. Dreyer[1], Qiaochu Li[1], L.Jay Guo[1], Stephen Rand[1]; *[1]Univ. of Michigan, USA.* Optical scattering from a high-Q polymer micro-ring resonator shows evidence of intense magnetic interactions due to a second order magneto-electric nonlinearity.

FW3E.6 • 12:15
Silicon NanoDimers for Magnetic and Electric Field Hotspots, Reuben M. Bakker[1], Dmitry Permyakov[2], Ye Feng Yu[1], Dmitry Markovich[2], Ramón Paniagua-Domínguez[1], Leonard Gonzaga[1], Anton Samusev[2], Yuri Kivshar[2,3], Boris Luk'yanchuk[1], Arseniy Kuznetsov[1]; *[1]Data Storage Inst., Singapore; [2]ITMO, Russia; [3]Nonlinear Physics Centre, Australia.* Dielectric nanostructures with a high refractive index are of interest for ultimate control of light in the near-field. We demonstrate, experimentally and numerically, the existence of electric and magnetic field hotspots near silicon nanodimers.

12:30–13:30 Lunch Break *(on your own)* and **Unopposed Exhibit Only Time,** *Exhibit Hall, Imperial Ballroom*

12:30–14:00 VIP Industry Leaders Networking Event, *Club Regent, Lobby Level*

13:00–14:30 Meet the Editors of the APS Journals, *Exhibit Hall, Imperial Ballroom*

FiO | LS

FW3F • Novel Light Generation and Manipulation in Fiber Devices I—Continued

FW3F.3 • 11:45
Spectral Analogue of the Soliton Effect Compression: Spectral Self-Compression, Levon K. Mouradian[1], Armine Grigoryan[1], Aghavni Kutuzyuan[1], Garegin Yesayan[1], Minas Sukiasyan[1], Hrach Toneyan[1], Aram Zeytunyan[1,2], Ruben Zadoyan[3], Alain Barthelemy[4]; [1]*Yerevan State Univ., Armenia;* [2]*Univ. of California, Irvine, USA;* [3]*Newport Technology & Applications Center, USA;* [4]*Dept. Photonique, XLIM Institut de Recherche, France.* The nonlinear process of the pulse spectral self-compression in a medium with anomalous dispersion, the spectral analogue of the soliton effect compression, is introduced on the basis of our experimental observation and detailed numerical analysis.

FW3F.4 • 12:00 Invited
Optical Vortices in Fiber, Siddharth Ramachandran[1]; [1]*Boston Univ., USA.* Long lived orbital angular momentum (OAM) states of light in fibers have recently been enabled by a class of so-called ring-fiber designs. We review their potential applications in areas ranging from telecommunications to nanoscale microscopy.

FW3G • Symposium Honoring Adolf Lohmann I—Continued

FW3G.3 • 11:45
Computer Generated Hologram in Spatial Division Multiplexing, Shoam Shwartz[1], Michael A. Golub[1], Shlomo Ruschin[1]; [1]*Physical Electronics, Tel Aviv Univ., Israel.* We report here on generic space-division multiplexing and demultiplexing units for high-throughput transmission in multimode fibers, with the aid of computer generated hologram spatial filters.

FW3G.4 • 12:00
Spectral shaping using nonlinear computer-generated holograms, Roy Shiloh[1], Anat Leshem[1], Ady Arie[1]; [1]*Tel-Aviv Univ., Israel.* Computer-generated holograms can shape the spatial domain, but also the spectral domain. We shape light spectra using quadratic nonlinear optics, in theory and experiment. These are readily extended to other wave-related fields, such as plasmonics.

FW3G.5 • 12:15
Planar Micro-Optics: Key Enabling Technology for Semiconductor Industry, Reinhard Voelkel[1]; [1]*SUSS MicroOptics SA, Switzerland.* Photolithography enabled semiconductor industry to shrink the minimum features on microchips below 20 nanometers today. Planar micro-optical elements play a decisive role for light shaping and metrology within high-end projection lithography systems.

LW3H • Novel Photonics—Continued

LW3H.3 • 12:00 Invited
Imaging Surface Plasmon Polaritons in Nanostructures with Transient Absorption Microscopy, Gregory V. Hartland[1], Paul Johns[1], Mary S. Devadas[1]; [1]*Dept. of Chemistry and Biochemistry, Univ. of Notre Dame, USA.* Surface Plasmon Polaritons (SPPs) are electromagnetic waves that propagate at metal-dielectric interfaces. In this paper transient absorption microscopy is used to image SPPs in gold nanowires, and study how they couple between nanostructures.

LW3H.4 • 12:30
Tunable Polariton Lasing in ZnO Whispering Gallery Microcavity, Liaoxin Sun[1], Hongxing Dong[2], Zhanghai Chen[2], Xuechu Shen[1], Wei Lu[1]; [1]*Shanghai Inst. of Technical Physics , China;* [2]*Fudan Univ., China.* A tunable polariton lasing is realized in a single ZnO tapered whispering gallery (WG) microcavity at room temperature. A tunable range of 100 meV and a minimum lasing threshold appeared at positive detuning of 42 meV are observed.

LW3I • Computational Optical Imaging II—Continued

LW3I.3 • 12:00 Invited
The Remarkably Flexible Ptychographic Data Set, Andrew Maiden[1], Peng Li[1]; [1]*Univ. of Sheffield, UK.* Ptychography is an experimentally simple form of phase retrieval with a surprisingly flexible dataset. Here I describe how 3D imaging, partial coherence, missing data and positioning errors can be accommodated within the ptychographic scheme.

12:30–13:30 Lunch Break *(on your own)* and **Unopposed Exhibit Only Time,** *Exhibit Hall, Imperial Ballroom*

12:30–14:00 VIP Industry Leaders Networking Event, *Club Regent, Lobby Level*

13:00–14:30 Meet the Editors of the APS Journals, *Exhibit Hall, Imperial Ballroom*

13:30–15:30
FW4A • General Optical Sciences II

Presider: Laszlo Veisz, Max-Planck-Institute fur Quantenoptik, Germany

FW4A.1 • 13:30
Visible and Near Infrared Polarization Control with Vanadium Dioxide, Alain Hache[1], Alexandre Doucet[1], Patrick Cormier[1], Jacques Thibodeau[1], Tran Vinh Son[1]; [1]*Universite de Moncton, Canada*. Vanadium dioxide, a material used in many filtering and imaging applications in the near-infrared, is shown to possess the capability of modifying the polarization of visible and infrared light.

FW4A.2 • 13:45
Extremely Efficient Two-Photon Absorption in Small Donor-Acceptor Substituted Organic Molecules, Ivan Biaggio[1], Marten Beels[1]; [1]*Lehigh Univ., USA*. The two-photon absorption cross section of optimized donor-acceptor substituted small molecules can become extremely large when compared to the size of the molecules and also when compared to the fundamental quantum limit

FW4A.3 • 14:00
Holographic Surface Gratings in Photorefractive Materials, Partha P. Banerjee[1], Dean Evans[2], Ujitha Abeywickrema[1]; [1]*Univ. of Dayton, USA;* [2]*WPAFB, Materials Directorate, USA*. Existence of surface gratings on a photorefractive material is proved by analyzing reflected diffraction orders of an incident reading beam. A novel technique is used to numerically eliminate the Fabry-Perot effect from diffracted orders.

13:30–15:30
FW4B • Integrated Photonics for Communications: Datacenters and Networks II

Presider: Young-Kai Chen; Alcatel-Lucent Bell Labs, USA

FW4B.1 • 13:30 Tutorial
Optical Interconnects for Computing Systems and the Need for Integration, Bert J. Offrein[1], Jonas Weiss[1], Antonio La Porta[1], Roger Dangel[1], Folkert Horst[1], Norbert Meier[1], Daneil Jubin[1]; [1]*IBM Research GmbH, Switzerland*. Optical interconnects play an increasingly important role in the intra-system communication in computing systems. To continue to scale system performance, new electro-optical integration approaches are required that increase bandwidth while reducing cost.

Bert Jan Offrein received his Ph.D. in nonlinear integrated optics from the University of Twente in 1994. He then joined IBM Research - Zurich establishing integrated optical devices for DWDM networks. In 1998, he changed to JDS Uniphase as a technical marketing and yield engineer for 980 nm pump lasers. One year later he returned to IBM Research – Zurich to lead the photonic device technology group realising state of the art adaptive integrated optical components. Since 2004, Bert Jan Offrein is the manager of the photonics group, addressing silicon photonics, electro-optic integration for system scaling and nano-photonic structures for quantum photonics.

13:30–15:00
FW4C • Symposium on Optical Remote Sensing for the Climate

Presider: Ian Coddington; NIST, USA

FW4C.1 • 13:30 Invited
Precision Atmospheric Trace Gas Monitoring with Frequency Comb Lasers, Gregory B. Rieker[2,1], Fabrizio Giorgetta[1], William Swann[1], Paul Schroeder[2], Jonathan Kofler[3], Laura C. Sinclair[1], Esther Baumann[1], Gabrielle Petron[3], Colm Sweeney[3], Peter P. Tans[3], Ian R. Coddington[1], Nathan R. Newbury[1]; [1]*National Inst. of Standards and Technology, USA;* [2]*Univ. of Colorado at Boulder, USA;* [3]*National Oceanic and Atmospheric Administration, USA*. Accurate monitoring of trace gases requires high sensitivity, drift-free instruments. Dual frequency comb spectroscopy is a promising technique for kilometer-scale open-path monitoring of trace gases, owing to its low systematic uncertainty, high stability, and absorption-model-based calibration.

FW4C.2 • 14:00 Invited
Applications of Cavity Ring Down Spectroscopy in the Earth Sciences, Chris W. Rella[1]; [1]*Picarro, Inc., USA*. We present new and emerging applications of Cavity Ring Down Spectroscopy for the study of carbon, nitrogen, and hyrdrological cycles, focusing on applications for which high accuracy and precision are key requirements.

13:30–15:30
FW4D • Quantum Optical Measurement and Technologies II

Presider: Marco Bellini; Istituto Nazionale di Ottica - CNR, Italy

FW4D.1 • 13:30 Invited
Integrated Photonic Systems for Quantum Technologies, Ian A. Walmsley[1], Ben Metcalf[1], Peter Humphreys[1], Steve Kolthammer[1], Peter Smith[2], James Gates[2]; [1]*Univ. of Oxford, UK;* [2]*ORC, Univ. of Southampton, UK*. Complex quantum systems reveal new phenomena that cannot be studied using classical simulation. Integrated photonics provides as effective means to engineer such systems, with direct application to quantum simulation and measurement.

FW4D.2 • 14:00
Linear Optical Quantum Metrology with Single Photons, Keith Motes[2], Jonathan Olson[1], Evan Rabeaux[1], Jonathan Dowling[1], Stephan Olson[3], Peter Rohde[4]; [1]*Dept. of Physics & Astronomy, Louisiana State Univ., USA;* [2]*Dept. of Physics and Astronomy, Macquarie Univ., Australia;* [3]*Dept. of Physics, Boise State Univ., USA;* [4]*Faculty of Engineering & Information Technology, Univ. of Technology, Australia*. We show that a passive, linear-optical interferometer (fed with only single-photon inputs and utilizing single-mode photodetection) is capable of beating the shotnoise limit, providing a potential pathway forward to practical quantum metrology.

13:30–15:30
FW4E • Optical Coherence Tomography

Presider: Alvaro Casas-Bedoya, Univ. of Sydney, Australia

FW4E.1 • 13:30 Invited
Towards All-Optical Quantification of Ciliary Physiology, Michael Choma[1]; [1]*Yale Univ., USA*. Cilia are organelles that generate microfluidic flows in the lungs, central nervous system, and Fallopian tubes. Quantitative flow diagnostic remain immature. I will present a comprehensive optical imaging-based approach for quantifying cilia flow physiology.

FW4E.2 • 14:00 WiO
OCT-Based Quantification of the Effect of a Drug on the Motility of Mammary Organoids, Xiao Yu[1,2], Richard Blackmon[1], Patricia Casbas-Hernandez[3], Melissa A. Troester[3,4], Amy Oldenburg[1,2]; [1]*Dept. of Physics and Astronomy, Univ. of North Carolina Chapel Hill, NC, USA;* [2]*Biomedical Research Imaging Center, Univ. of North Carolina Chapel Hill, NC, USA;* [3]*Dept. of Epidemiology, Gillings School of Global Public Health, Univ. of North Carolina Chapel Hill, USA;* [4]*Lineberger Cancer Center, Univ. of North Carolina Chapel Hill, NC, USA*. We quantified the effect of doxorubicin on the motility of mammary epithelial cells in 3D cultures by Optical Coherence Tomography. The measured cellular motility decreased in a time-dependent fashion after exposure to doxorubicin.

FiO

13:30–15:30
FW4F • Novel Light Generation and Manipulation in Fiber Devices II
Presider: Siddharth Ramachandran; Boston Univ., USA

FW4F.1 • 13:30 Invited

Nonlinear Polarization Manipulation in Optical Fibers, Pierre-Yves Bony[1], Massimiliano Guasoni[1], Marin Gilles[1], Antonio Picozzi[1], Stéphane Pitois[1], Guy Millot[1], Stefan Wabnitz[2], Julien Fatome[1]; *[1]CNRS - Université Bourgogne Franche-Comté, France; [2]Univ. of Brescia, Italy.* We describe the self-organization of light state-of-polarization in optical fiber based on a nonlinear cross-polarization interaction between an input signal and its backward replica. Several proof-of-principles for telecom applications are reported.

FW4F.2 • 14:00

Six Mode Selective Photonic Lanterns Using Either Step or Graded Index Fibers, Juan Carlos Alvaradp Zacarias[1,2]; *[1]CREOL, USA; [2]Óptica, Instituto Nacional de Astrofísica, Óptica y Electrónica, Mexico.* Low-loss all-fiber photonic lantern (PL) capable of selectively exciting the first six fiber modes of a multimode fiber (4 LP) using both step and graded index are demonstrated.

13:30–15:30
FW4G • Symposium Honoring Adolf Lohmann II
Presider: Rafael Piestun; Univ. of Colorado at Boulder, USA

FW4G.1 • 13:30 Invited

When the Difference Between Coherent and Incoherent Imaging Begins to Blur, William T. Rhodes[1]; *[1]Florida Atlantic Univ., USA.* We generally think that distinctions between coherent and incoherent imaging are clear, but they are not always so. I give examples of blurring of distinctions, beginning with two that Adolf Lohmann and I worked on.

FW4G.2 • 14:00

Minimizing Bias in a Millimeter Wave Imager, Joseph N. Mait[1], Christopher A. Schuetz[2], Richard D. Martin[3], Shouyuan Shi[2], Dennis W. Prather[2]; *[1]US Army Research Lab, USA; [2]Dept. of Electrical and Computer Engineering, Univ. of Delaware, USA; [3]Phase Sensitive Innovations, USA.* We present a procedure for designing two point spread functions in a millimeter wave imaging system whose difference produces a desired response with minimum bias and maximum signal-to-noise ratio.

Join the conversation.
Follow @Opticalsociety on Twitter.
Use hashtag **#FiO15**

LS

13:30–15:30
LW4H • Semiconductor NanoOptics II
Presider: Sangam Chatterjee; Philipps Universitat Marburg, Germany

LW4H.1 • 13:30 Invited

Optical Properties of van der Waals Heterostructures, Tony F. Heinz[1]; *[1]Stanford Univ., USA.* Monolayers of van-der-Waals materials can be combined to form a wide variety tailored heterostructures. In this paper, we discuss the resulting optical and optoelectronic properties of such heterostructures and how they relate to the properties of the isolated layers.

LW4H.2 • 14:00 Invited

Attosecond Electron Response in Nanoscale Interfaces, Peter Hommelhoff[1], Takuya Higuchi[1]; *[1]Friedrich-Alexander-Universität Erlangen, Germany.* A subcycle of intense laser light can force an electron to travel over nanometer lengthscales. We employ this ultrafast control of attosecond electron dynamics as key ingredient of nanoscale devices potentially operating at optical bandwidth.

13:30–15:30
LW4I • Advanced Imaging
Presider: David Cuccia; Modulated Imaging Inc, USA

LW4I.1 • 13:30 Invited

Spatial Frequency Domain Optical Imaging of Brain Blood Flow and Metabolism, Robert H. Wilson[1], Bruce J. Tromberg[1]; *[1]Univ. of California Irvine, USA.* Intrinsic signal optical imaging of rat cortex reveals unique information about neurovascular function in real time. Broadband spatial frequency domain imaging (SFDI) provides a platform for quantitative assessment and localization of intrinsic signals and cortical metabolism.

LW4I.2 • 14:00 Invited

Focusing Light Deep in Tissue with Ultrasound Guidestars, Puxiang Lai[1,2], Lihong V. Wang[1]; *[1]Washington Univ. in St Louis, USA; [2]Interdisciplinary Division of Biomedical Engineering, Hong Kong Polytechnic Univ., Hong Kong.* In this talk, we propose to use ultrasound, in the form of either ultrasonic encoding or photoacoustic sensing, as noninvasive localized guide stars to achieve optical focusing in deep tissue and tissue-like scattering media.

FW4A • General Optical Sciences II—Continued

FW4A.4 • 14:15
Multi-Security Scheme Combining Chaotic Modulation and Masking using Acousto-Optic Feedback Devices, Monish R. Chatterjee[1], Fares S. Almehmadi[1]; [1]*Univ. of Dayton, USA.* An input signal is encrypted onto a chaotic carrier in a hybrid Bragg cell and added to a separately generated chaotic mask with independent encryption keys. Simulations indicate considerable enhancement in system performance vis-à-vis security.

FW4A.5 • 14:30
Depolarizing Molecular Rotations in Magneto-Electric Scattering, Alexander A. Fisher[1], Ayan Chakrabarty[1], Elizabeth F. Dreyer[1], Stephen Rand[1]; [1]*Univ. of Michigan, USA.* Nonlinear light scattering experiments in solid and liquid dielectrics with a range of electronic structures point to the importance of molecular rotations in enhancing second-order magneto-electric interactions and generating depolarization.

FW4B • Integrated Photonics for Communications: Datacenters and Networks II—Continued

FW4B.2 • 14:15 Invited
Optics for Large Scale Datacenters, Hong Liu[1]; [1]*Google, USA.* We give an overview of interconnect requirements for large scale datacenters. We then present the scaling challenges of of various optical technologies to meet the performance and efficiency requirements of ever increasing bandwidth.

FW4C • Symposium on Optical Remote Sensing for the Climate—Continued

FW4C.3 • 14:30 Invited
Measuring Greenhouse Gases from Aircraft and Spacecraft using Lidar, James B. Abshire[1]; [1]*NASA Goddard Space Flight Center, USA.* This presentation will discuss the application of lidar approaches to remotely measure the column abundance of CO2 and other atmospheric greenhouse gases from space. It will discuss recent airborne campaigns, ongoing work and plans for future space missions.

FW4D • Quantum Optical Measurement and Technologies II—Continued

FW4D.3 • 14:15
Demonstration of Frequency Dependent Squeezing in the Audio Frequency Band, Tomoki Isogai[1], Eric Oelker[1], John Miller[1], Maggie Tse[1], Lisa Barsotti[1], Nergis Mavalvala[1], Matthew Evans[1]; [1]*MIT, USA.* We use a high finesse optical cavity to rotate squeezed light quadrature as function of frequency in the audio band, which is suitable for improving the sensitivity of gravitational-wave detectors over a wide frequency band.

FW4D.4 • 14:30
Multi-Correlated Two-Photon States within an Integrated Quantum Frequency Comb, Michael Kues[1], Christian Reimer[1], Benjamin Wetzel[1,9], Piotr Roztocki[1], Lucia Caspani[1,2], Fabio Grazioso[1], Yaron Bromberg[8], Brent E. Little[3], William J. Munro[4], Sai T. Chu[5], David J. Moss[1,6], Roberto Morandotti[1,7]; [1]*INRS-EMT, Canada;* [2]*School of Engineering and Physical Sciences, Heriot-Watt Univ., UK;* [3]*Xi'an Inst. of Optics and Precision Mechanics of CAS, China;* [4]*NTT Basic Research Labs, NTT Corporation, Japan;* [5]*Dept. of Physics and Material Science, City Univ. of Hong Kong, China;* [6]*School of Electrical and Computer Engineering, RMIT Univ., Australia;* [7]*Inst. of Fundamental and Frontier Sciences, Univ. of Electronic Science and Technology of China, China;* [8]*Dept. of Applied Physics, Yale Univ., USA;* [9]*Dept. of Physics and Astronomy, Univ. of Sussex, UK.* By superimposing two different spontaneous four-wave mixing processes inside a bi-modally pumped CMOS-compatible mircoring resonator, we report the generation of four-mode two-photon multi-correlated states and measure two-photon entanglement.

FW4E • Optical Coherence Tomography—Continued

FW4E.3 • 14:15
Real-time swept-source Doppler optical coherence tomography for middle ear diagnostics, Dan MacDougall[1], Thomas Landry[1], Manohar Bance[1], Jeremy Brown[1], Robert Adamson[1]; [1]*Dalhousie Univ., Canada.* Transtympanic middle ear imaging is a very promising application of optical coherence tomography (OCT). We present progress on the development of a real-time swept-source OCT imaging system with Doppler vibrography for in-clinic functional imaging in live patients.

FW4E.4 • 14:30 WiO
Optical Coherence Tomography and Profilometry based on Optical Sampling by Cavity Tuning, Lin Yang[1], Lingze Duan[1]; [1]*Univ. of Alabama in Huntsville, USA.* We report the demonstration of an optical coherence tomography and surface profilometry system based on optical sampling by cavity tuning. Our scheme provides a simple, cost-effective solution for rapid, large-depth noninvasive imaging.

FiO

FW4F • Novel Light Generation and Manipulation in Fiber Devices II—Continued

FW4F.3 • 14:15 WiO

Experimental Realization of Principal Modes in a Multimode Fiber with Strong Mode Mixing, Wen Xiong[1]; *[1]Yale Univ., USA.* We experimentally realized the principal modes in a multimode fiber with strong mode mixing. We further studied the spectral bandwidths of these principal modes and their dependence on the delay time and mode dependent loss.

FW4F.4 • 14:30

Mapping the Uniformity of Optical Microwires Using Phase-Correlation Brillouin Distributed Measurements, Desmond Chow[1], Joël Cabrel Tchahame Nougnihi[2], Andrey Denisov[1], Jean-Charles Beugnot[2], Thibaut Sylvestre[2], Lizhu Li[3], Raja Ahmad[3], Martin Rochette[3], Kenny Hey Tow[1], Marcelo A. Soto[1], Luc Thévenaz[1]; *[1]Inst. of Electrical Engineering, Ecole Polytechnique Fédérale de Lausanne, Switzerland; [2]Institut FEMTO-ST, Université de Franche-Comté, CNRS UMR 6174, France; [3]Dept. of Electrical and Computer Engineering, McGill Univ., Canada.* The distributed Brillouin gain profile of an ultrathin optical microwire made of chalcogenide-glass is characterized using a phase-modulated correlation-domain measurement technique. Method resolves variations of uniformity below 5% along a 13 cm-long microwire.

FW4G • Symposium Honoring Adolf Lohmann II—Continued

FW4G.3 • 14:15 Invited

Fractional Fourier and Linear Canonical Transforms in Optics, Uriel Levy[3], David Mendlovic[1], Haldun M. Ozaktas[2]; *[1]Tel Aviv Univ., Israel; [2]Bilkent Univ., Turkey; [3]The Hebrew Univ. of Jerusalem, Israel.* Fractional Fourier and linear canonical transforms are linear integral transforms that find widespread use in many areas of science and engineering. We review basic properties, including those in phase space, and their applications to optics.

LS

LW4H • Semiconductor NanoOptics II—Continued

LW4H.3 • 14:30 Invited

Ultrafast Hole Relaxation and Induced Biexciton Response in Single CdSe/ZnSe Quantum Dots, Denis Seletskiy[1], Christopher Hinz[1], Christian Traum[1], Benjamin Bauer[1], Alfred Leitenstorfer[1]; *[1]Dept. of Physics and Center for Applied Photonics, Univ. of Konstanz, Germany.* Two-color pump-probe studies reveal ultrafast dynamics of few-fermions in single epitaxial CdSe/ZnSe quantum dots. Induced biexciton absorption, sub-picosecond hole relaxation and deterministic single photon gain are observed under appropriate pumping conditions.

LW4I • Advanced Imaging—Continued

LW4I.3 • 14:30 Invited

New Directions in Light Sheet Microscopy, Kishan Dholakia[1]; *[1]Univ. of St Andrews, UK.* Light sheet microscopy using propagation invariant light beams is described. In particular I will describe studies using Airy beams which offer large fields of view with high resolution and low phototoxicity.

FW4A • General Optical Sciences II—Continued

FW4A.6 • 14:45
Saturation effects on terahertz generation at the surface of InA, Etienne Gagnon[1], Amy L. Lytle[1]; *[1]Franklin & Marshall College, USA.* We modify the 1D drift-diffusion equation to model the generation of terahertz from a train of ultrafast pulses at the surface of InAs. We present and compare numerical and experimental results.

FW4A.7 • 15:00
Giant Nonreciprocity in a Parity-Time reversal Symmetric Microstrip Dimer System, Roeny Thomas[1], Huanan Li[1], Fred Ellis[1], Tsampikos Kuttos[1]; *[1]Physics, Wesleyan Univ., USA.* A giant non-reciprocal transmission is demonstrated theoretically from a pair of coupled resonators with Parity-Time symmetry due to the interplay of existing exceptional point degeneracy, and the interaction with a gyro-magnetic substrate.

FW4A.8 • 15:15
Temporal Analog of Reflection and Refraction at a Temporal Boundary, Brent Plansinis[1], William R. Donaldson[2], Govind Agrawal[1,2]; *[1]The Inst. of Optics, Univ. of Rochester, USA; [2]Lab for Laser Energetics, Univ. of Rochester, USA.* We show numerically and analytically that an optical pulse that crosses over a temporal boundary in a dispersive medium acts as a temporal analog of the spatial reflection and refraction at a dielectric interface.

FW4B • Integrated Photonics for Communications: Datacenters and Networks II—Continued

FW4B.3 • 14:45 Invited WiO
Designing Performance-Energy Optimized Silicon-Photonic Interconnected Computing Systems, Keren Bergman[1]; *[1]Columbia Univ., USA.* Silicon photonic networks can offer energy-efficient communications bandwidths for scaling future computing. We describe the multi-level co-design of energy-performance optimized photonic architectures for communications-intensive applications.

FW4B.4 • 15:15
O-band wavelength (de-)multiplexers on SOI featuring quasi-athermal behavior and fabrication insensitiveness, Corrado Sciancalepore[1], Karim Hassan[1], Richard J. Lycett[2], Jacques-Alexandre Dallery[3], Sebastien Pauliac[1], Julie Harduin[1], Hélène Duprez[1], Ulf Weidenmueller[3], Dominic Gallagher[2], Sylvie Menezo[1], Badhise Ben Bakir[1]; *[1]CEA-Leti, USA; [2]Photon Design Ltd, UK; [3]Vistec ElectroBeam GmbH, Germany.* We report about design, fabrication, and testing of wavelength (de-)multiplexers in the O-band. Echelle gratings on SOI featuring high wafer- and lot-level uniformity as well as while quasi-athermal Mach-Zehnder-based architectures are presented.

FW4C • Symposium on Optical Remote Sensing for the Climate—Continued

15:30–16:00 Coffee Break,
Market Street & South Tower Foyers

FW4D • Quantum Optical Measurement and Technologies II—Continued

FW4D.5 • 14:45
Nondestructive Detection of Traveling Optical Photons in Real Time, Mahdi Hosseini[1], Kristin M. Beck[1], Yiheng Duan[1], Wenlan Chen[1], Vladan Vuletic[1]; *[1]Dept. of Physics and Research Lab of Electronics, MIT, USA.* We nondestructively observe individual optical photons in real time as they propagate through a slow-light medium. The nondestructive measurement is accomplished with another light that detects the atomic-excitation component of the slow photons.

FW4D.6 • 15:00
Scan-free direct measurement of an one-million-dimensional photonic state, Zhimin Shi[1], mohammad Mirhosseini[2], Jessica Margiewicz[1], Mehul Malik[2,3], Freida Rivera[1], Ziyi Zhu[1], Robert W. Boyd[2,4]; *[1]Univ. of South Florida, USA; [2]Inst. of Optics, Univ. of Rochester, USA; [3]Inst. for Quantum Optics and Quantum Information, Austrian Academy of Sciences, Austria; [4]Dept. of Physics, Univ. of Ottawa, Canada.* We describe a technique that directly measures a pure quantum state of arbitrary dimensions with a single setting of the measurement apparatus. We demonstrate our method by measuring a million-dimensional photonic spatial state.

FW4D.7 • 15:15
Bad Cavities for Good Memories: Suppression of Four-Wave Mixing in Raman Memories, Joseph Munns[1,2], Tessa F. Champion[1], Cheng Qiu[1], Patrick M. Ledingham[1], Dylan J. Saunders[1], Ian A. Walmsley[1], Josh Nunn[1]; *[1]Clarendon Lab, Univ. of Oxford, UK; [2]Controlled Quantum Dynamics CDT, Imperial College London, UK.* Quantum memories enable the synchronisation of photonic operations. Raman memories are a promising platform, but are susceptible to four-wave mixing noise. We present a demonstration of a cavity-enhanced Raman memory, showing suppression of four-wave mixing.

FW4E • Optical Coherence Tomography—Continued

FW4E.5 • 14:45
Spatially-Resolved ECM Nanotopology via Gold Nanorod Diffusion Mapping Using Polarization-Sensitive OCT, Richard Blackmon[1], Brian Chapman[2], Joseph Tracy[2], Rupinder Sandhu[3], Melissa A. Troester[3], Amy Oldenburg[1,4]; *[1]Physics and Astronomy, Univ. of North Carolina at Chapel Hill, USA; [2]Materials Science and Engineering, North Carolina State Univ., USA; [3]Lineberger Comprehensive Cancer Center, Univ. of North Carolina at Chapel Hill, USA; [4]Biomedical Research Imaging Center, Univ. of North Carolina at Chapel Hill, USA.* We demonstrate using PS-OCT to sense cross-sectional ECM nanotopology by mapping spatially resolved GNR diffusion. This novel approach will enable new applications in studying ECM remodeling such as tumorigenesis.

FW4E.6 • 15:00
1060 nm Vernier-Tuned Distributed Bragg Reflector (VT-DBR) Laser for Swept-Source OCT, Greg Bergdoll[1]; *[1]CalPoly State Univ. (SLO), USA.* We report the first wavelength-tunable 1060nm VT-DBR laser for use in SS-OCT applications. Electrical measurements demonstrate 1-3 nanosecond step response times for wavelength tuning. Optical linewidths less than 10 MHz are measured using self-homodyne interferometry.

FW4E.7 • 15:15
Quantifying Tissue Stiffness and the Effect of Nonlinearity using Compression Optical Coherence Elastography, Wes Allen[1], Philip Wijesinghe[1], Kelsey Kennedy[1], Lixin Chin[1], David Sampson[1], Brendan Kennedy[1]; *[1]Univ. of Western Australia, Australia.* We demonstrate the modification of optical coherence elastography to advance from relative strain images to quantified tissue stiffness on the micro-scale. We highlight the nonlinear dependence of tissue stiffness on the applied load and consider how nonlinearity may help characterise soft tissues.

FiO | LS

FW4F • Novel Light Generation and Manipulation in Fiber Devices II—Continued

FW4F.5 • 14:45 WiO

Influence of Acousto-Optic Coupling in Nonlinear Pulse Propagation Through Tapered Fiber Optics, Catalina Hurtado Castano[1], Rodrigo Acuna[1], Pedro Torres[1]; [1]*Universidad Nacional de Colombia, Colombia.* We study the influence of acousto-optic effect in nonlinear pulse propagation in tapered with two different diameters. A set of equations are used in order to compute analytically the acousto-optic coupling coefficient between the fundamental core mode and lower LP cladding modes in the structure.

FW4F.6 • 15:00 Invited

Nonlinear and Nonlocal Effects on Transverse Anderson Localizations in Disordered Fibers, Claudio Conti[1]; [1]*ISC-CNR Dep. Physics Univ. Sapienza, Italy.* Two dimensional disordered systems sustain localized modes that may interact in the presence of a nonlinear optical response. We consider the effect of nonlinearity and nonlocality on the degree of localization and on the mutual interaction of disorder induced localized states.

FW4G • Symposium Honoring Adolf Lohmann II—Continued

FW4G.4 • 14:45 WiO

Optical Beam Modal Analysis Via Generalized Two-Path Interferometry, Tanya Malhotra[1], Wesley E. Farriss[2], James R. Fienup[2], Ayman Abouraddy[3], Nick Vamivakas[2]; [1]*Physics and Astronomy, Univ. of Rochester, USA;* [2]*Inst. of Optics, Univ. of Rochester, USA;* [3]*Univ. of Central Florida, CREOL, The College of Optics & Photonics, USA.* A one dimensional optical implementation of the fractional Fourier Transform (fFT) using programmable lenses is presented. This set-up is used to implement a proof-of-principle experiment demonstrating a spatial mode-sorting Michelson interferometer based on a fFT generalized delay line.

FW4G.5 • 15:00 Invited

Optical Processing Inside a Degenerate Cavity Laser, Asher A. Friesem[1], Nir Davidson[1]; [1]*Weizmann Inst. of Science, Israel.* Optical processing inside a degenerate cavity laser is exploited for efficient control of the spatial coherence, unique phase locking of many coupled lasers, and rapid wavefront shaping. Supporting experimental and calculated results are presented.

LW4H • Semiconductor NanoOptics II—Continued

LW4H.4 • 15:00 Invited

Phonon-mediated Scattering in Quantum dot Cavity Systems, Stephen Hughes[1], Kaushik Roy-Choudhury[1]; [1]*Queen's Univ. at Kingston, Canada.* We present a polaronic quantum optics approach for modelling electron-phonon scattering in semiconductor cavity-QED structures containing quantum dots. We demonstrate several applications of the theory and connect to a number of recent experiments.

LW4I • Advanced Imaging—Continued

LW4I.4 • 15:00 Invited

Super-resolution Imaging with Airy Beams, Shu Jia[1]; [1]*SUNY Stony Brook, USA.* We demonstrated a self-bending point spread function (SB-PSF) based on self-accelerating Airy beams for three-dimensional (3D) super-resolution fluorescence microscopy. The approach offers several-fold improvement over previously reported 3D imaging methods.

15:30–16:00 Coffee Break, *Market Street & South Tower Foyers*

16:00–18:00
FW5A • Quantum Optical Measurement and Technologies III

Presider: Hyunseok Jeong; Seoul National Univ., Korea

FW5A.1 • 16:00 Invited

Novel Photonic Quantum Computing and Quantum Simulation, Lee Rozema[1], Philip Walther[1]; [1]*Universitat Wien, Austria.* I will present experimental results for the superposition of quantum gates enabling significant computational speed-ups. I will also present the quantum simulation of two XY-interacting spins and discuss the current status of new photonic quantum technology.

FW5A.2 • 16:30 Invited

Zero-Area Ultrashort Single Photons, Marco Bellini[1,2], Luca S. Costanzo[1,2], Antonio S. Coelho[3], Daniele Pellegrino[2], Milrian S. Mendes[4], Lucio Acioli[4], Katiuscia Cassemiro[4], Daniel Felinto[4], Alessandro Zavatta[1,2]; [1]*Istituto Nazionale di Ottica - CNR, Italy;* [2]*LENS and Dept. of Physics, Univ. of Florence, Italy;* [3]*Departamento de Engenharia, Instituto Camillo Filho, Brazil;* [4]*Departamento de Fisica, Universidade Federal de Pernambuco, Brazil.* We demonstrate that the interaction of ultrashort single photons with a dense resonant atomic sample deeply modifies the temporal shape of their wavepacket mode without degrading their non-classical character, and effectively generates zero-area single-photon pulses.

16:00–17:30
FW5B • Integrated Photonics for Communications: InP Platforms and Lasers

Presider: Ming Wu; Univ. of California Berkeley, USA

FW5B.1 • 16:00

Monolithic Three-Section Injection-Locked Laser for Optical Oversampled Analog-to-Digital Conversion, Edris Sarailou[1], Peter Delfyett[1]; [1]*Univ. of Central Florida, CREOL, USA.* A novel linear interferometric intensity modulator is demonstrated with an extremely low Vπ of 1.1 mV and a SFDR of 75 dB.Hz$^{2/3}$. This is achieved by modulating the passive section of the injection-locked mode-locked laser.

FW5B.2 • 16:15 Invited

InP Photonic IC-based Transmitters, Receivers, and Transceivers for Regional and Metro Networks, Vikrant Lal[1]; [1]*Infinera Corporation, USA.* Infinera is a pioneer in large-scale Photonic Integrated Circuit technology for long-haul DWDM systems. In this paper we report on recent progress in adapting the PIC technology for the fast-growing regional and metro cloud applications.

16:00–18:00
FW5C • Novel Concepts in Plasmonics

Presider: Monish Chatterjee; Univ. of Dayton, USA

FW5C.1 • 16:00

Ultra-small on-chip polarization splitters in hybrid plasmonic waveguides, Jianjun Chen[1], Chengwei Sun[1], Hongyun Li[1], Qihuang Gong[1]; [1]*Peking Univ., China.* Based on the large modal birefringence and the different field confinements of the transverse-electric and transverse-magnetic modes in the hybrid air-dielectric-metal waveguide, ultra-small on-chip polarization splitters are experimentally demonstrated.

FW5C.2 • 16:15

Manipulating Multiple Coupling in Plasmonic Nanoantenna Arrays, Linhan Lin[1], Yuebing Zheng[1]; [1]*Univerisity of Texas, USA.* A general strategy is developed to exploit the coordinated effects of multiple coupling in plasmonic nanoantenna arrays with metal-insulator-metal configuration for optimization of spectral response and local field enhancement.

FW5C.3 • 16:30

Optimal Design of Plasmonic Antennas for Geometric Phase Elements, Asad Tahir[1], Israel De Leon[1], Sebastian Schulz[1], Jeremy Upham[1], Robert W. Boyd[1,2]; [1]*Univ. of Ottawa, Canada;* [2]*Inst. of Optics, Univ. of Rochester, USA.* We discuss the design of V-shaped plasmonic antennas for optimal half-wave plate functionality, which in turn allows to the realization of optimal plasmonic Pancharatnam-Berry Phase Optical Elements.

16:00–18:00
FW5D • Polarization Imaging

Presider: Rongguang Liang, Univ. of Arizona, USA

FW5D.1 • 16:00 Invited

Full Stokes Imaging Polarimeter, Stanley Pau[1], Wei-Liang Hsu[1], Jeffrey Davis[1], Xingzhou Tu[1], Neal Brock[2], Shona Kroto[2], Mohammed Ibn-Elhaj[3]; [1]*Univ. of Arizona, USA;* [2]*4D Technology Corporation, USA;* [3]*Rolic Technologies Ltd., Switzerland.* Research in liquid crystal polymer retarder and polarizer has enabled the development of a new class of full Stokes division-of-focal-plane imaging polarimeter. The construction, calibration and performance of several polarimeters will be presented.

FW5D.2 • 16:30

Novel Imaging Spectro-polarimeter, Chunmin Zhang[2], Dingyi Wang[2,1], Tingkui Mu[2], Wenyi Ren[2,3], Chenlin Jia[2]; [1]*Physics, Univ. of New Brunswick, Canada;* [2]*Inst. of Space Optics and School of Sciences, Xi'an Jiaotong Univ., China;* [3]*School of Sciences, Northwest A&F Univ., China.* An innovative instrument based on Savart polariscope is proposed to simultaneously acquire image, spectrum, and full Stokes parameters of a target. The principle, scheme, and technique are discussed, and some preliminary results are presented.

16:00–18:00
FW5E • General Optics in Biology and Medicine

Presider: Michael Choma; Yale Univ., USA

FW5E.1 • 16:00 Invited

Molecular Imaging Through Centimeters of Tissue: High Resolution Imaging with Cerenkov Excitation, Brian W. Pogue[1]; [1]*Dartmouth College, USA.* Cerenkov light emission in tissue can be produced easily from radiotherapy beams, and this internal light source can be used to create high resolution excitation regions within tissue for molecular imaging. This is demonstrated by imaging through full body thickness of mice and rats.

FW5E.2 • 16:30 WiO

High-order Power Map and Low-order Lensmeter using a Smartphone Add-on, Monica Matsumoto[1], Vitor F. Pamplona[1], Matthias Hoffmann[1], Guilherme Uzejka[1], Nathaniel Sharpe[1]; [1]*Eyenetra, Inc., USA.* We developed a portable, low-cost, accurate, wavefront sensing lensmeter for optometry applications: the Netrometer. In addition to low-order measurements (SPH, CYL and AXIS), Netrometer portraits in real-time a power map of the perceived refractive values.

FiO

16:00–18:00
FW5F • Novel Light Generation and Manipulation in Fiber Devices III
Presider: Arnaud Mussot; Univ Lille 1 Laboratoire PhLAM, France

FW5F.1 • 16:00 Invited

Towards Raman-free Generation of Photons Pairs in Liquid Filled Hollow Core Photonic Crystal Fibres, Margaux Barbier[1], Thibault Harlé[1], Isabelle Zaquine[2], Philippe Delaye[1]; [1]*Laboratoire Charles Fabry, Institut d'Optique, France;* [2]*Télécom Paristech, Laboratoire Traitement et Communication de l'Information, France.* We present a new fibered architecture for generation of correlated photon pairs, in which the deleterious influence of Raman photons has been highly reduced by filling the core of a microstructured fiber with a liquid.

FW5F.2 • 16:30

Soliton-based MIR generation until 2.4 μm in a CS_2-core step-index fiber, Mario Chemnitz[1], Martin Gebhardt[2], Christian Gaida[2], Fabian Stutzki[2], Jens Limpert[2,3], Markus A. Schmidt[1]; [1]*Inst. for Photonic Technology, Germany;* [2]*Fiber & Waveguide Lasers, Inst. for Applied Physics, Germany;* [3]*Helmholtz-Inst. Jena, Germany.* Soliton-based MIR supercontinuum generation between 1.2 μm and 2.4 μm is presented using a highly nonlinear CS_2-core optical fiber and a 430 fs Tm-based pump source.

16:00–18:15
FW5G • Symposium Honoring Adolf Lohmann III
Presider: Ravi Athale; US Office of Naval Research

FW5G.1 • 16:00 Invited

Having Fun with Lohmann Optics, Stefan . Sinzinger[1]; [1]*Technische Universität Ilmenau, Germany.* Having fun with optics has always been one of the most important driving forces for Adolf Lohmanns ingenuity and creativity. We present some results of recent research projects and trace them back to typical Lohmann approaches.

FW5G.2 • 16:30 Invited

Optical Interconnection - Early Concepts and Novel Approaches, Jürgen Jahns[1]; [1]*Fernuniversität in Hagen, Germany.* Optical interconnection is finally coming of age. Optics offers high spatial and temporal bandwidth and the capability to reduce latency and power dissipation. Here, the early concepts and recent technology are reviewed.

LS

16:30–17:30
LW5H • Semiconductor NanoOptics III
Presider: Vincenzo Savona; Ecole Polytechnique Federale de Lausanne, Switzerland

LW5H.2 • 16:30 Invited

How Does One Exciton Split into Two in Organic Semiconductors?, Xiaoyang Zhu[1]; [1]*Columbia Univ., USA.* A singlet exciton can split into two triplets with energy and spin conservation in a process called singlet fission. This lecture will discuss how singlet fission proceeds through the correlated triplet pair, also called the multiexciton (ME) state.

16:00–17:30
LW5I • Precision Laser Spectroscopy III
Presider: Dylan Yost, Colorado State Univ. USA

LW5I.1 • 16:00 Invited

An XUV Dual-comb Source for Precision Spectroscopy, R. Jason Jones[1]; [1]*Univ. of Arizona, USA.* Intracavity high-harmonic generation has extended the frequency comb into the XUV spectral region. We demonstrate a dual-comb system enabling detection of individual comb teeth for a more robust approach to precision spectroscopy in the VUV/XUV.

LW5I.2 • 16:30 Invited WiO

Femtosecond-Level Synchronization Over Kilometer-Scale Turbulent Air Paths, Laura C. Sinclair[1], Jean-Daniel Deschênes[2], Fabrizio Giorgetta[1], William Swann[1], Esther Baumann[1], Ian Coddington[1], Nathan R. Newbury[1]; [1]*NIST, USA;* [2]*Université Laval, Canada.* We have demonstrated synchronization of two optical oscillators over a turbulent 4-km air path with sub-femtosecond short timescale time offset. Over a 50-hour measurement the long timescale wander in the time offset is <±20 fs.

FW5A • Quantum Optical Measurement and Technologies III—Continued

FW5A.3 • 17:00
Photon Addition and Subtraction: New Strategies in Metrology, Bryan T. Gard[1], Kaushik Seshadreesan[1], Benjamin Koltenbah[2], Claudio Parazzoli[2], Barbara Capron[2], Richard Birrittella[3], Christopher Gerry[3], Jonathan Dowling[1]; *[1]Louisiana State Univ., USA; [2]Boeing Research & Technology, USA; [3] Lehman College, The City Univ. of New York, USA.* We propose a strategy that provides resolution and sensitivity below the standard metrology limits using photon addition/subtraction at the output.

FW5A.4 • 17:15
Real-Time Quadrature Measurement of a Highly Pure Single-Photon State in an Exponentially Rising Wave Packet, Hisashi Ogawa[1], Hideaki Ohdan[1], Kazunori Miyata[1], Masahiro Taguchi[1], Kenzo Makino[1], Hidehiro Yonezawa[2], Jun-ichi Yoshikawa[1], Akira Furusawa[1]; *[1]The Univ. of Tokyo, Japan; [2]The Univ. of New South Wales, Australia.* We experimentally demonstrate real-time quadrature measurement of a highly pure single-photon state whose temporal wavepacket mode is in an exponentially rising shape generated by an asymmetric optical parametric oscillator.

FW5B • Integrated Photonics for Communications: InP Platforms and Lasers—Continued

FW5B.3 • 16:45
Single-longitudinal-mode lasing from a fiber cavity based on feedback from an on-chip microring resonator, Guangnan Chen[1], Xin Zhao[1], Zijun Yao[1], Zheng Zheng[1,2]; *[1]School of Electronic and Information Engineering, Beihang Univ., China; [2]Collaborative Innovation Center of Geospatial Technology, China.* We demonstrated single-longitudinal-mode (SLM) lasing from a Fabry-Perot fiber laser cavity enabled by narrow bandwidth feedback from a high-Q (>10^6) on-chip SiN microring resonator, where the remaining sidemodes are further suppressed by a saturable absorber.

FW5B.4 • 17:00 Invited
Progress in InP-based Photonic Integration, Meint Smit[1], Kevin Williams[1]; *[1]Technische Universiteit Eindhoven, Netherlands.* InP-based Photonic Integration is making rapid progress. InP-based foundry processes offer low-cost access to mature integration processes with high performance and wafer-scale integration of InP-based photonic circuits with silicon electronics is emerging.

FW5C • Novel Concepts in Plasmonics—Continued

FW5C.4 • 16:45
Directional Emission of Single Photons From Nanocrystal Quantum Dots Using a Hybrid Plasmonic-Dielectric Nanoantenna, Moshe G. Harats[2], Nitzan Livneh[1], Shira Yochelis[1], Yossi Paltiel[1], Ronen Rapaport[2,1]; *[1]The Dept. of Applied Physics, The Hebrew Univ. of Jerusalem, Israel; [2]Racah Inst. of Physics, The Hebrew Univ. of Jerusalem, Israel.* We design a hybrid plasmonic-dielectric nanoantenna for collimation of light emission from nanocrystal quantum dots at room temperature. We show single photon emission with a directional beam with FWHM of less than 3.5 degrees.

FW5C.5 • 17:00
Hot Electrons in Plasmonic Devices: Internal Photoemission and Quantum Limitations, Imran G. Hossain[1], Ahmet A. Yanik[1]; *[1]Baskin School of Engineering, Univ. of California, Santa Cruz, USA.* Hot-electrons in plasmonic devices offer an alternative route to overcome the bandgap limitations of semiconductors. However, experimentally recorded efficiencies are extremely low. We developed a bottom-up approach, and introduced high efficiency photoemission devices.

FW5C.6 • 17:15
Light and Rate Management in Nanowires, Zhihuan Wang[1], Bahram Nabet[1]; *[1]Drexel Univ., USA.* We analyze optoelectronic properties of core-shell nanowires explaining how both light management and transition rate management need to be included in order to explain their extraordinary absorption and emission properties.

FW5D • Polarization Imaging—Continued

FW5D.3 • 16:45
Ultra Compact Metasurface Radial/Azimuthal Polarization Converter, Zeyu Lei[1], Tian Yang[1]; *[1]Shanghai Jiao Tong Univ., China.* We demonstrate the generation of radially or azimuthally polarized beams using an ultra compact metasurface. The metasurface is composed of an array of gap plasmon resonators with distinct orientation angles.

FW5D.4 • 17:00 WiO
Withdrawn.

FW5D.5 • 17:15
Signal recovery in a Mie scattering experiment with space-variant polarizations, Brandon G. Zimmerman[1], Thomas G. Brown[1]; *[1]The Inst. of Optics, USA.* We describe an experimental test of the use of a (1d) space-variant polarization in Mie scattering experiments applied to suspensions and aerosols, with emphasis on the calibration procedures and background correction.

FW5E • General Optics in Biology and Medicine—Continued

FW5E.3 • 16:45
Measurement of Diffusive Transport at Liquid-Liquid Interfaces, Jose Guzman-Sepulveda[1], Diego E. Hurtado-Gimenez[1], Aristide Dogariu[1]; *[1]Univ. of Central Florida, USA.* We demonstrate a fiber-based optical technique for measuring the diffusive mass transport at liquid-liquid phase boundaries in miscible mixtures. The technique is non-invasive and permits continuous evaluation of spatially localized dynamics.

FW5E.4 • 17:00
Detection of Citrus Canker and Huanglongbing Using Fluorescence Imaging Spectroscopy (FIS) Technique and Two Different Computational Methods: Support Vector Machine and Neural Network, Caio Bruno Wetterich[2], Ruan F. Neves[2], José Belasque Junior[1], Luis G. Marcassa[2]; *[1]Esalq - Univ. of Sao Paulo, Brazil; [2]Univ. of Sao Paulo, Brazil.* We have used FIS to investigate citrus diseases. Texture features were extracted and used as input into classifiers. Results show that is possible differentiate the diseases that have similar symptoms using these two computational methods.

FW5E.5 • 17:15
Non-linearity in Simulations of Time Resolved Imaging Using the Diffusion Approximation Solution to the Transport Equation, Eduardo Ortiz-Rascón[1], Neil C. Bruce[1], Antonio A. Rodríguez-Rosales[1], Jesús Garduño-Mejía[1]; *[1]Univ Nacional Autonoma de Mexico, Mexico.* We present results of simulations regarding time-resolved transillumination imaging. The temporal extrapolation is performed with the diffusion approximation. The dependence on time used to discriminate photons and non-linearities in the imaging process are shown.

FW5F • Novel Light Generation and Manipulation in Fiber Devices III—Continued

FW5F.3 • 16:45
Detailed analysis of amplified spontaneous four-wave mixing in a multimode fiber, Hamed Pourbeyram[1,2], Elham Nazemosadat[3], Arash Mafi[1,2]; [1]*Dept. of Physics & Astronomy, Univ. of New Mexico, USA;* [2]*Center for High Technology Materials, Univ. of New Mexico, USA;* [3]*Dept. of Electrical Engineering and Computer Science, Univ. of Wisconsin-Milwaukee, USA.* Detailed theoretical and experimental analyses of the amplified spontaneous FWM in a multimode optical fiber hint at strong non-universality of the third order Kerr nonlinear tensor as a function of its frequency components.

FW5F.4 • 17:00
In-Amplifier Mid-IR Supercontinuum Generation in a Single-mode Er-doped Fluoride Glass Fiber, Jean-Christophe Gauthier[1], Martin Bernier[1], Vincent Fortin[1], Simon Duval[1], Réal Vallée[1]; [1]*Universite Laval, Canada.* Supercontinuum generation from 2.6 to 3.5μm is demonstrated in a single-mode fluoride EDFA seeded by an OPG source emitting 400ps pulses at 2.7μm. This approach is promising for the development of sources emitting around 3-5μm.

FW5F.5 • 17:15
Gain-spectrum flattening in a wideband parametric amplifier at 1.0 μm, Xiaoming Wei[1], Sisi Tan[1], Arnaud Mussot[2], Alexandre Kudlinski[2], Kevin K. Tsia[1], Kenneth K. Y. Wong[1]; [1]*The Univ. of Hong Kong, Hong Kong;* [2]*CNRS-Université Lille 1, France.* We demonstrate gain-spectrum flattening in a 40-dB ultra-wideband fiber parametric amplifier at 1.0 μm by incorporating the birefringence of gain medium. A bandwidth of ~100 nm with ripple less than 8 dB is achieved.

FW5G • Symposium Honoring Adolf Lohmann III—Continued

FW5G.3 • 17:00
The Internet, "Flatland," Perfect Shuffle, and Optics, Alan Huang[1]; [1]*Terabit Corporation, USA.* The Internet packet network should minimize the number of "hops" instead of total path length. This reduces the traffic, latency, power, and cost. This can be accomplished by using WDM and topologies based on higher dimensional spaces or Groups.

FW5G.4 • 17:15 Invited
Adolf Lohmann's Approach to Phase-Space Optics, Jorge Ojeda-Castaneda[1]; [1]*Univ. of Guanajuato, Mexico.* Lohmann favored the use of phase space representations for describing optical systems. We discuss the advantages and limitations associated to his approach, when describing periodic signals and imaging systems with extended depth of field.

LW5H • Semiconductor NanoOptics III—Continued

LW5H.3 • 17:00
Singlet-Exciton Fission Dynamics in Single-Crystalline Perfluoropentacene, Kolja Kolata[1], Tobias Breuer[1], Gregor Witte[1], Sangam Chatterjee[1]; [1]*Philipps Universitat Marburg, Germany.* The dynamics of photoexcited carriers are studied in single-crystalline perfluoropentace by spectrally and polarization-resolved fs-pump white-light-probe spectroscopy. Our results reveal a correlation between singlet-exciton fission and the slip-stacked arrangements of the individual molecules.

LW5H.4 • 17:15
Carrier Dynamics at Pentacene/Fullerene Interfaces Investigated by Time-Resolved Photoluminescence, Robin Döring[1], Andrea Karthäuser[1], Nils W. Rosemann[1], Tobias Breuer[1], Gregor Witte[1], Sangam Chatterjee[1]; [1]*Faculty of Physics and Materials Sciences Center, Philipps Universitat Marburg, Germany.* The dynamics of photoexcited carriers are studied in model pentacene-fullerene heterojunctions revealing signatures associated with charge-transfer states. The long lifetime of the higher-energy signature indicates robustness to non-radiative relaxation or carrier extraction mechanisms.

LW5I • Precision Laser Spectroscopy III—Continued

LW5I.3 • 17:00 Invited
Fundamental Symmetries, Dark Sector and Spectroscopy, Dmitry Budker[2,1]; [1]*Univ. of California Berkeley, USA;* [2]*Johannes Gutenberg Univ., Helmholtz Inst. Mainz, Germany.* I will discuss some recent work in these areas involving our group and collaborators. Please see https://budker.uni-mainz.de and http://budker.berkeley.edu for the latest updates.

FW5A • Quantum Optical Measurement and Technologies III—Continued

FW5A.5 • 17:30
Withdrawn.

FW5A.6 • 17:45
Realization of sub-Planck Structure from Compass States in Time-Frequency Domain, Ludmila Praxmeyer[1], Chih-Cheng Chen[1], Popo Yang[1], Shang-Da Yang[1], Ray-Kuang Lee[1]; [1]*National Tsing Hua Univ., Taiwan*. A sub-Planck structure from Compass states is reported experimentally through the correspondence between Wigner distribution function and frequency-resolved optical gating (FROG) measurement, with a time-bandwidth product smaller than that of a transform-limited pulse.

FW5C • Novel Concepts in Plasmonics—Continued

FW5C.7 • 17:30
Parity-Time Symmetry Breaking Laser, Zi Jing Wong[1], Liang Feng[1], Ren-Min Ma[1], Yuan Wang[1], Xiang Zhang[1]; [1]*Univ. of California, Berkeley, USA*. Exploration of the interplay between gain and loss in optical metamaterials can lead to novel device functionalities. Here we demonstrate a single-mode laser with unique cavity mode manipulation capability based on thresholdless parity-time symmetry breaking.

FW5C.8 • 17:45
Tamm-plasmon States in Broadband Dielectric-coated Mirror, Samir Kumar[1], Ritwick Das[1]; [1]*National Inst of Science Ed & Research, India*. We present a simple experimental route for exciting Tamm-plasmon-polariton (TPP) modes at the interface of distributed-Bragg-reflector and metal. We also discuss the spectral measurements on transverse-electric and transverse-magnetic polarized TPP modes for non-normal incidence.

FW5D • Polarization Imaging—Continued

FW5D.6 • 17:30
Berry Phase and Polarization Aberration, Russell A. Chipman[1]; [1]*Univ. of Arizona, USA*. As polarized light propagates through optical systems, the state folds at each refraction. Carrying the polarization state through the optical system leads to different Berry phase accumulation along different paths. Examples of this polarization aberration on the PSF and OTF are presented.

FW5D.7 • 17:45
Coherence Properties of Blackbody Radiation and Application to Energy Harvesting and Imaging with Nanoscale Rectennas, Peter Lerner [1], Paul Cutler[1,2], N M. Miskovsky[1,2]; [1]*SciTech Associates, LLC, USA;* [2]*Pennsylvania State Univ., USA*. We examine the blackbody radiation emitted from an array, which can be quasi-coherent and lead to a self-image, analogous to the Talbot-Lau self-imaging with thermal radiation. Self-emitted radiation may be used for non-destructive quality control of the array or in situ biological systems.

FW5E • General Optics in Biology and Medicine—Continued

FW5E.6 • 17:30
Printed Optical Phantoms for Whole Mouse Imaging, Brian B. Bentz[1], Anmol V. Chavan[1], Dergan Lin[1], Kevin J. Webb[1]; [1]*Purdue Univ., USA*. We show reconstructed images of realistic phantoms constructed using 3D printing. This approach is versatile, aids in the development of optical imaging methods, and can be used in the calibration of live mouse imaging data.

FW5E.7 • 17:45
Optically Controlled Subcellular Diffusion, Colin Constant[1], Jacob Kimmel[2], Kiminobu Sugaya[2], Aristide Dogariu[1]; [1]*Univ. of Central Florida, CREOL, USA;* [2]*Burnett School of Biomedical Sciences, Univ. of Central Florida, USA*. Optical radiation can affect actin, a globular protein that forms microfilaments and is vital for cellular motility. We show that intracellular actin movement can be preferentially enhanced along the direction of polarization without inducing phototoxicity.

17:00–20:00 OSA Science Educators' Day, *Regency Ballroom I*

18:00–20:00 OIDA Town Hall Forum on Biophotonics Challenges & Opportunities, *Club Regent, Lobby Level*

18:00–20:00 Optical Fabrication and Testing Technical Group Networking Event, *Fairfield*

20:00–22:00 FiO Postdeadline Paper Session
The complete schedule can be found in the PDP program and the FiO Mobile App.

FiO | LS

FW5F • Novel Light Generation and Manipulation in Fiber Devices III—Continued

FW5F.6 • 17:30 Invited

Solitons in Microring Resonantors: Amplification of Dispersive Waves, Cherenkov Combs and Raman Effect, Dmitry V. Skryabin[1]; [1]*Univ. of Bath, UK.* We discuss several phenomena associated with the dispersive wave interaction with solitons in microring resonators, which lead to the combs of Cherenkov radiation, soliton based parametric amplification and comb broadening induced by the Raman microring solitons.

FW5G • Symposium Honoring Adolf Lohmann III—Continued

FW5G.5 • 17:45 Invited

Phase-Space Optics, One Photon at a Time, Harrison H. Barrett[1], Luca Caucci[1], Kyle J. Myers[2]; [1]*Univ. of Arizona, USA;* [2]*Center for Devices and Radiological Health, Food and Drug Administration, USA.* The relationship between the Wigner Distribution Function and the spectral photon radiance is discussed for both physical optics and quantum optics. Computational methods and applications are surveyed, and photon-by-photon phase-space imagers are introduced.

17:00–20:00 OSA Science Educators' Day, *Regency Ballroom I*

18:00–20:00 OIDA Town Hall Forum on Biophotonics Challenges & Opportunities, *Club Regent, Lobby Level*

18:00–20:00 Optical Fabrication and Testing Technical Group Networking Event, *Fairfield*

20:00–22:00 FiO Postdeadline Paper Session
The complete schedule can be found in the PDP program and the FiO Mobile App.

07:30–17:30 Registration, *Market Street Foyer*

08:00–10:00
FTh1A • General Optical Sciences III

Presider: Cameron Geddes; Lawrence Livermore National Lab, USA

FTh1A.1 • 08:00
Progress Toward a Spin-Optomechanics Platform With Vacuum Levitated Nanodiamonds, Levi Neukirch[1,2], Eva von Haartman[3], Jessica Rosenholm[3], Nick Vamivakas[4,2]; [1]*Dept. of Physics and Astronomy, Univ. of Rochester, USA;* [2]*Center for Coherence and Quantum Optics, Univ. of Rochester, USA;* [3]*Pharmaceutical Sciences Lab, Faculty of Science and Engineering, Åbo Akademi Univ., Finland;* [4]*Inst. of Optics, Univ. of Rochester, USA.* We discuss experimental efforts to construct a hybrid spin-optomechanics platform using optically levitated nanodiamonds. Current results, including optomechanical manipulation of nitrogen vacancy fluorescence and spin state are presented.

FTh1A.2 • 08:15
Unidirectional lasing in PT-symmetric cavities, Hamidreza Ramezani[1], Hao-Kun Li[1], Yuan Wang[1], Xiang Zhang[1]; [1]*Univ. of California Berkeley, USA.* Using parity-time (PT) symmetry and Fano resonances we propose a new mechanism to realize unique spectral singularities with simultaneous unidirectional lasing and zero reflection mode in quasi 1D cavities.

FTh1A.3 • 08:30
Coherent Control of Photocurrent in Disordered Media, Seng Fatt Liew[1], Sebastien M. Popoff[1,2], Stafford W. Sheehan[3], Arthur Goetschy[1,4], Charles A. Schmuttenmaer[3], A. Douglas Stone[1], Hui Cao[1]; [1]*Applied Physics, Yale Univ., USA;* [2]*CNRS LTCI, Telecom ParisTech, France;* [3]*Chemistry, Yale Univerisity, USA;* [4]*ESPCI ParisTech, PSL Research Univ., Institut Langevin, France.* We demonstrate experimentally coherent control of photocurrent generation in a dye-sensitized solar cell(DSSC) by shaping the wavefront of incident laser beam. Destructive interference of light enhances optical absorption and conversion to electrons.

08:00–10:00
FTh1B • Light Manipulation in Plasmonic Structures

Presider: Fabio Pavanello; Univ. of Colorado at Boulder, USA

FTh1B.1 • 08:00 Invited
On Chip Light-vapor Interactions, Uriel Levy[1]; [1]*Hebrew Univ. of Jerusalem, Israel.* We demonstrate light vapor interactions at the nanoscale. Two systems are described. First, we discuss the integration of guided modes with vapor. Next, we demonstate coupled atomic-plasmonic resonances.

FTh1B.2 • 08:30
Integrated Nanoantenna Labels for Rapid Security Testing of Semiconductor Circuits, Ronen Adato[1], Aydan Uyar[1], Mahmoud Zangeneh[1], Boyou Zhou[1], Ajay Joshi[1], Bennett Goldberg[1], Selim Unlu[1]; [1]*Boston Univ., USA.* We demonstrate a multi-spectral imaging technique that utilizes integrated nanoantenna labels to enable rapid mapping of the type and location of every logical gate in an integrated circuit, and thereby detect hardware tampering.

08:00–10:00
FTh1C • Coherence, Interference and General Optics I

Presider: Martin Lavery; Univ. of Glasgow, UK

FTh1C.1 • 08:00 Invited
Optical Metrology with Lights Orbital Angular Mometum, Martin P. Lavery[1], David Robertson[2], Fiona Speirits[1], Stephen Barnett[1], Miles J. Padgett[1]; [1]*Univ. of Glasgow, UK;* [2]*Durham Univ., UK.* We present the design and development of single piece optical systems for the efficient measurement of lights orbital angular momentum. In addition, discuss the use of such light in the detection of rotational motion.

FTh1C.2 • 08:30
Probability Distributions for Orbital Angular Momentum and Local Circulation in Vortex Beams, Anderson M. Amaral[1], Edilson L. Falcao-Filho[1], Cid B. de Araujo[1]; [1]*Universidade Federal de Pernambuco, Brazil.* We discuss and experimentally demonstrate how to obtain the probability distributions for orbital angular momentum and local circulation in vortex beams of arbitrary shape.

08:00–10:00
FTh1D • Integrated Quantum Optics II

Presider: Jeremy L. O'Brien, Univ. of Bristol, UK

FTh1D.1 • 08:00 Invited
Photonic Quantum-information Processing with Quantum Dots in Photonic Crystals, Peter Lodahl[1]; [1]*Univ. of Copenhagen, Denmark.* We discuss experimental progress on the use of single quantum dots deterministically coupled to photonic-crystal waveguides for various applications in quantum-information processing.

FTh1D.2 • 08:30 Invited WiO
Nonlinear Integrated Quantum Optics, Linda Sansoni[1], Georg Harder[1], Stephan Krapick[1], Regina Kruse[1], Harald Herrmann[1], Tim J. Bartley[1], Christine Silberhorn[1]; [1]*Universität Paderborn, Germany.* The present waveguide technology for quantum source fabrication is at an early stage of development. Here we present novel approaches to source engineering which enable us to generate specific multipartite and large size quantum states.

08:00–10:00
FTh1E • Optical Fiber Sensors I: Applications

Presider: Olav Solgaard, Standford Univ., USA

FTh1E.1 • 08:00 Tutorial
Methods for Structural Health Monitoring Based on Long-Gauge and Distributed Fiber Optic Sensors, Branko Glisic[1]; [1]*Civil and Environmental Engineering, Princeton Univ., USA.* Fiber Optic Sensors (FOS) offer two unique strain sensing tools for Structural Health Monitoring (SHM) of civil structures and infrastructure: long-gauge sensors and truly distributed sensors, which enable global structural monitoring and integrity monitoring, respectively.

Branko Glišić received his degrees in Civil Engineering and Theoretical Mathematics at University of Belgrade, Serbia, and Ph.D. at the EPFL, Switzerland. After eight-year long experience at SMARTEC SA, Switzerland, he moved to Princeton University, where he holds position of Associate Professor at the Department of Civil and Environmental Engineering. His main areas of interest are Structural Health Monitoring (SHM), advanced sensors based on fiber-optics, large-area electronics and conductive polymers, SHM data management and analysis, smart structures, and heritage structures. He is author and co-author of numerous papers, short courses, and the book "Fibre Optic Methods for Structural Health Monitoring.

07:30–17:30 Registration, *Market Street Foyer*

08:00–10:00
FTh1F • Computational Optical Sensing and Imaging I
Presider: Michael Gehm; Duke Univ., USA

FTh1F.1 • 08:00 Invited WiO
High Resolution 3D Computational Imaging in Scattering Media, Laura Waller[1]; [1]*Univ. of California Berkeley, USA*. We describe new methods for high-resolution 3D imaging with illumination and detection-side coding of angle (Fourier) space with fast acquisition times. The result is a high-resolution gigapixel image in multiple depth planes with fast capture times.

FTh1F.2 • 08:30
An Implementation of One-Shot Compressive Imaging Using a Diffractive Optical Element, Alexander Macfaden[1], Stephen J. Kindness[1], Timothy D. Wilkinson[1]; [1]*Univ. of Cambridge, UK*. We propose and demonstrate a new implementation of compressive imaging using a diffractive optical element. This method utilises a static hologram to produces a spot array from which the original image can be recovered.

08:00–10:00
FTh1G • Optics and Photonics of Disordered Systems I
Presider: Massimo Gurioli; Universita degli Studi di Firenze, Italy

FTh1G.1 • 08:00 Invited
Using Disorder to Create New Nanophotonic Functionality, Mark Brongersma[1]; [1]*Stanford Univ., USA*. Complex aperiodic devices can outperform periodic ones and offer new functionalities. In this presentation, I will describe the realization and optical properties of ultra-compact, aperiodic groove-arrays in a metal film.

FTh1G.2 • 08:30
Lattice Topology Dictates Photon Statistics in One-Dimensional Disordered Lattices, Hasan E. Kondakci[1], Ayman Abouraddy[1], Bahaa Saleh[1]; [1]*CREOL, Univ. of Central Florida, USA*. We examine propagation of coherent light in one-dimensional disordered photonic lattices with non-trivial topological structures. We show that the field statistics becomes noncircular in the phase plane only in even-sited-ring and linear lattices with off-diagonal disorder.

08:00–10:00
LTh1H • Complex Wave Propagation
Presider: Shu Jia; SUNY Stony Brook, USA

LTh1H.1 • 08:00 Invited
Surface Gravity Water Wave Airy Wavepacket, Shenhe Fu[1,2], Yuval Tsur[1], Jianying Zhou[2], Lev Shemer[1], Ady Arie[1]; [1]*Tel-Aviv Univ., Israel;* [2]*Sun Yat-sen Univ., China*. We study the propagation dynamics of surface gravity water wave Airy pulses in the linear and nonlinear regimes. The low carrier frequency enables observing the position-dependent phase of the Airy pulse for the first time.

LTh1H.2 • 08:30
Optical Vortex Behavior due to Introduced Phase Disturbance, Mateusz Szatkowski[1], Agnieszka Popiolek-Masajada[1], Jan Masajada[1]; [1]*Dept. of Optics and Photonics, Wroclaw Univ. of Technology, Poland*. Presented work is the next step into creating effective procedure for surface topography reconstruction from Optical Vortex Scanning Microscope data. It focuses on optical vortex behavior due to object introduced by Spatial Light Modulator.

08:00–10:00
LTh1I • Innovative Metallic-Emitter Coupled Systems I
Presider: Joshua Hendrickson; US Air Force Research Lab, USA

LTh1I.1 • 08:00 Invited
Nanoscale Probing of Surface Plasmons with Single Quantum Dots, Edo Waks[1], Chad Ropp[1], Roland Probst[1], Zacharee Cummins[1], Sanghee Nah[1], John Fourkas[1], Benjamin Shapiro[1]; [1]*Univ. of Maryland at College Park, USA*. We demonstrate a method to probe the local density of states of surface plasmon polaritons using single quantum dots. We attain better than 10 nm spatial precision, and directly observe image dipole interference.

LTh1I.2 • 08:30 Invited WiO
Strongly Enhanced Light-Matter Interactions using Colloidally Synthesized Plasmonic Nanocavities, Maiken H. Mikkelsen[1]; [1]*Duke Univ., USA*. A colloidally synthesized and tunable plasmonic platform is utilized for control of radiative properties of dye molecules, CdSe/ZnS quantum dots, and monolayer MoS_2. We demonstrate 30,000-fold fluorescence enhancement, Purcell factors of 1,000, and ultrafast spontaneous emission.

FTh1A • General Optical Sciences III—Continued

FTh1A.4 • 08:45 WiO

Aspect-Ratio-Tailored Silver Nanoplates for Efficient Broad- and Tunable-Bandwidth Extinction in the Visible Range, Emma Anquillare[1], Owen D. Miller[1], Chia Wei Hsu[1,2], Brendan G. DeLacy[3], John Joannopoulos[1], Steven Johnson[1], Marin Soljacic[1]; [1]*MIT, USA;* [2]*Physics, Harvard Univ., USA;* [3]*Edgewood Chemical Biological Center, US Army, USA.* We computationally predict and experimentally demonstrate that aspect-ratio-tailored silver nanoplates excel at volume-minimized, visible-range extinction. Normalized extinction (σ_{ext}/V) closely approaches or meets theory limits in three windows and is a six-fold increase over previous experiments.

FTh1A.5 • 09:00

Arbitrary designable optical frequency conversion, Jian Zheng[1], Masayuki Katsuragawa[1,2]; [1]*Univ. of Electro-Communications, Japan;* [2]*JST ERATO-IOS, Japan.* We discuss arbitrarily-designable optical frequency conversions. As a typical example, we demonstrate the single frequency tunable laser that covers an ultra-broad spectral region from vacuum-ultraviolet to mid-infrared in a numerical experiment.

FTh1A.6 • 09:15

EM Wave Propagation in a Medium with Anisotropic Dielectric and Magnetic Tensors, Boris Y. Zeldovich[1], Nadia Baranova[2]; [1]*Univ. of Central Florida, CREOL, USA;* [2]*Q-Peak, Inc., USA.* Dependence of phase velocity on propagation direction is shown to be decoupled from birefringence. The latter is propagation difference for two polarizations; it depends on anisotropy of impedance tensor: square root of mu / epsilon.

FTh1B • Light Manipulation in Plasmonic Structures—Continued

FTh1B.3 • 08:45

Arbitrary Spectral Shaping of Plasmonic Broadband Excitations, Yuval Tsur[1], Itai Epstein[1], Ady Arie[1]; [1]*Tel Aviv Univ., Israel.* Surface plasmon polaritons having an arbitrary broadband spectrum are launched using holographic gratings, allowing unprecedented control over the temporal shape. Among the potential applications are broadband sensors and ultrashort pulse shaping.

FTh1B.4 • 09:00

Quadrupole Field in Plasmonic Crystal, Kyosuke Sakai[1], Takeaki Yamamoto[1], Tatsuya Omura[1], Keiji Sasaki[1]; [1]*Hokkaido Univ., Japan.* We theoretically propose plasmonic crystal with nanoring that supports quadrupole electric field inside of the ring. If such field distributions coincide with the wave function of molecules, multipole transitions might be provoked with higher rate.

FTh1B.5 • 09:15

Antenna Coupled Plasmonic Modulator, Yannick Salamin[1], Romain Bonjour[1], Wolfgang Heni[1], Christian Haffner[1], Claudia Hoessbacher[1], Yuriy Fedoryshyn[1], Marco Zahner[1], Delwin Elder[2], Larry Dalton[2], Christian Hafner[1], Juerg Leuthold[1]; [1]*ETH Zurich, Switzerland;* [2]*Univ. of Washington, USA.* We demonstrate direct up-conversion of a 60 GHz RF carrier onto an optical signal. The plasmonic modulator is seamlessly embedded in the RF receiving antenna. Therefore, neither electronic down-conversion nor electronic amplification is needed.

FTh1C • Coherence, Interference and General Optics I—Continued

FTh1C.3 • 08:45

A Coulomb-like Potential for Optical Vortices, Anderson M. Amaral[1], Edilson L. Falcao-Filho[1], Cid B. de Araujo[1]; [1]*Universidade Federal de Pernambuco, Brazil.* Optical Vortices (OV) can be characterized by their Topological Charge (TC). It is shown in this work that a distribution of TC over the beam transverse plane gives rise to a Coulomb-like potential for OV. Pure multipoles and 2D distributions of TC are analyzed in theory and experiments.

FTh1C.4 • 09:00 WiO

Three-dimensional Transfer-function of an Inhomogeneously Broadened Atomic Medium for All Optical Spatio-Temporal Video Clip Correlation, Mehjabin Sultana Monjur[1], Selim Shahriar[1]; [1]*Northwestern Univ., USA.* We show that an opto-atomic spatio-temporal correlator that recognizes rapidly a video clip contained in a video file in a temporally and spatially shift invariant manner can be modeled as a one-term, three-dimensional transfer function.

FTh1C.5 • 09:15

Light Interference in Position and Momentum Variables: the Spatial Alford and Gold Effect, Jefferson Florez[1], Omar Calderon-Losada[1], Luis-Jose Salazar-Serrano[1,2], Juan-Rafael Alvarez-Velasquez[1], Alejandra Valencia[1]; [1]*Universidad de los Andes, Colombia;* [2]*ICFO-Institut de Ciencies Fotoniques, Spain.* Intensity modulation of two parallel-propagating beams is observed in the Fourier plane when the beams' separation is such that they do not interfere in position. This is analogous to the temporal Alford and Gold effect.

FTh1D • Integrated Quantum Optics II—Continued

FTh1D.3 • 09:00 WiO

Integrated AlGaAs Source of Highly Indistinguishable and Energy-Time Entangled Photons, Claire Autebert[1], Natalia Bruno[2], Anthony Martin[2], Aristide Lemaitre[3], Carmen Gomez[3], Ivan Favero[1], Guiseppe Leo[1], Sara Ducci[1], Hugo Zbinden[2]; [1]*Lab MPQ, France;* [2]*Group of Applied Physics, Switzerland;* [3]*Lab LPN, France.* We demonstrate an AlGaAs source of highly indistinguishable and energy-time entangled photon pairs. The device is characterized through Hong-Ou-Mandel and a Franson interferometry experiments displaying visibilities of 89+/-3% and 95.6 +/-3.7%, respectively.

FTh1D.4 • 09:15 WiO

Low-noise Quantum Frequency Conversion in Titanium- diffused Lithium Niobate waveguide, Abu Thomas[1], Mackenzie A. VanCamp[1], Andrew Fraine[1], Alexander V. Sergienko[1]; [1]*Boston Univ., USA.* We demonstrate single-photon level Quantum Frequency Conversion using quasi-phase matched Ti:$LiNbO_3$ waveguides. The potential of such devices for higher dimensional encoding using temporal qdits and quantum optical arbitrary waveform generation is discussed.

FTh1E • Optical Fiber Sensors I: Applications—Continued

FTh1E.2 • 08:45

Fiber Optic Gas Monitoring System for Coal Mine Safety, Amiya R. Behera[1], Bo Dong[1], Anbo Wang[1]; [1]*Virginia Tech, USA.* A multiple gas monitoring system based on wavelength modulation spectroscopy has been designed and fabricated for atmospheric monitoring inside coal mines. The sensor system is evaluated for Methane detection from 0.01% to 50% concentration.

FTh1E.3 • 09:00

Solar Tracker Sensor Based on a Quadrant Optical Fiber Array, Diego J. Rátiva Millán[1], Denise Valente[2], Luis Arturo G. Malagón[1], Brian Vohnsen[2]; [1]*Universidade de Pernambuco, Brazil;* [2]*School of Physics, Univ. College Dublin, Ireland.* Exploring the directionality of light coupling to a waveguide, a quadrant of Ytterbium-Doped Fibers is proposed and analyzed for solar tracking systems.

FTh1E.4 • 09:15

The Dual-Polarization Interferometric Fiber Optic Gyroscope: an Optical Compensation Approach, Rongya Luo[1], Zinan Wang[1], Fangyuan Chen[1], Chao Peng[1], Zhengbin Li[1]; [1]*State Key Lab of Advanced Optical Communication Systems and Networks, Dept. of Electronics, Peking Univ., China.* By utilizing a Lyot depolarizer as a polarization filter, the dual-polarization interferometric fiber optic gyroscope realizes optical compensation in both reciprocal and nonreciprocal ports. A configuration in polarization maintaining sensing coil is proposed.

FiO | LS

FTh1F • Computational Optical Sensing and Imaging I—Continued

FTh1F.3 • 08:45
Multispectral single-channel 3D computational integral imaging using compressive sensing, Inbarasan Muniraj[1], Sudharsan Rajasekaran[1], Changliang Guo[1], John T. Sheridan[1]; [1]*Univ. College Dublin, Ireland.* We propose a simplest way of capturing multispectral 2D elemental images (EIs) in the computational integral imaging using compressive sensing (CS). Simulations show that the performance of 3D systems remains superior even when EIs are recovered from the sparse samples.

FTh1F.4 • 09:00
Lateral Chromatic Aberration Optimization in Wide-Field-of-View Computational Cameras, Furkan E. Sahin[1], Patrick J. Nasiatka[1], Armand R. Tanguay[1]; [1]*Univ. of Southern California, USA.* An imaging system design procedure for miniature wide-field-of-view computational cameras is presented. Improved performance can be achieved by allowing lateral chromatic aberration in the optical design, with correction provided in computational post-processing.

FTh1F.5 • 09:15
Structured Illumination Temporal Compressive Microscopy, Shuo Pang[1], Xin Yuan[2]; [1]*Univ. of Central Florida, CREOL, USA;* [2]*Bell Labs, USA.* We present a compressive video microscope based on structured illumination with incoherent light source. The setup can be easily adapted in a conventional epi-illumination microscope. We demonstrate a reconstructed video with frame rate of 200 frames per second.

FTh1G • Optics and Photonics of Disordered Systems I—Continued

FTh1G.3 • 08:45
Double threshold behavior in a resonance-controlled ZnO random laser, Ryo Niyuki[1], Hideki Fujiwara[1], Toshihiro Nakamura[2], Yoshie Ishikawa[3], Naoto Koshizaki[1], Takeshi Tsuji[4], Keiji Sasaki[1]; [1]*Hokkaido Univ., Japan;* [2]*Gumma Univ., Japan;* [3]*AIST, Japan;* [4]*Shimane Univ., Japan.* We observed double threshold behavior with the lasing peak blue-shift in a resonance-controlled ZnO random laser. The present study suggested the possibility for realizing strong coupling of excitons and single localized modes in random structures.

FTh1G.4 • 09:00
Control of Transmission Eigenchannels by Modifying the Geometry of Turbid Media, Raktim Sarma[1], Alexey Yamilov[2], Hui Cao[1]; [1]*Yale Univ., USA;* [2]*Missouri Univ. of Science & Technology, USA.* We manipulate light transport in a disordered waveguide by tailoring the boundary shape. The spatial structure of transmission channels is deterministically and significantly modified, enabling an efficient control of energy deposition inside the turbid medium.

FTh1G.5 • 09:15
Extreme value statistics of intensity fluctuations in random lasers, Ravitej Uppu[1], Sushil A. Mujumdar[1]; [1]*Tata Inst. of Fundamental Research, India.* We report a first study on the extreme value statistics of intensity in random lasers. The estimated extreme value index identified a forward transition from near-Gumbel to Frechet distribution, followed by the return.

LTh1H • Complex Wave Propagation—Continued

LTh1H.3 • 08:45
High-Power, Continuous-wave, Source Of Coherent Radiation In 2-D Airy Intensity Distribution, Aadhi A[1,2], Apurv Chaitanya N[1,2], Jabir M V[1], Pravin Vaity[1], R. P. Singh[1], Goutam Samanta[1]; [1]*Physical Research Lab, India;* [2]*Indian Inst. of Technology Gandhinagar, India.* We demonstrate a new class of tunable Airy beam source based on OPO, producing high-power, continuous-wave, single-frequency Airy beam radiation. The source provides total tunability of 460nm and maximum of 8.1W in 2D-Airy beam structure.

LTh1H.4 • 09:00
Talbot coupling of laser arrays in a degenerate cavity, Ronen Chriki[1], Vishwa Pal[1], Chene Tradonsky[1], Gilad Barach[1], Asher A. Friesem[1], Nir Davidson[1]; [1]*Weizmann Inst. of Science, Israel.* Talbot diffraction coupling is exploited for controlling phase locking and demonstrating topological charge effects in laser arrays formed in a degenerate cavity. Experimental and calculated results for different array geometries are demonstrated.

LTh1H.5 • 09:15 Invited
Momentum Space Dynamics of Electrons at Hybrid Interfaces, Benjamin Stadtmüller[1]; [1]*Technische Universität Kaiserslautern, Germany.* In this presentation, we will demonstrate how quasi-elastic electron lifetimes and momentum space dynamics of excited electrons at metal-organic hybrid interfaces can be studied by the combination of two-photon photoemission and momentum microscopy.

LTh1I • Innovative Metallic-Emitter Coupled Systems I—Continued

LTh1I.3 • 09:00 Invited
Enhancement of Two-Photon Luminescence from Quantum Emitters: Metamaterial-Enabled Chiral Selectivity, Sean Rodrigues[1], Yonghao Cui[1], Shoufeng Lan[1], Lei Kang[1], Wenshan Cai[1]; [1]*Georgia Inst. of Technology, USA.* We present a chiral metamaterial that exhibits both distinguishable linear and nonlinear features. The chiral center of the metamaterial is opened for direct access, where emitters occupying the light-confining regions produce chiral-selective enhancement of two-photon luminescence.

FTh1A • General Optical Sciences III—Continued

FTh1A.7 • 09:30
Radiation Pressure Measurement under Ambient Conditions Using a Microcantilever, Dakang Ma[1,2], Joseph Garrett[2,3], Jeremy Munday[1,2]; [1]*Dept. of Electrical and Computer Engineering, Univ. of Maryland, USA;* [2]*Inst. for Research in Electronics and Applied Physics, Univ. of Maryland, USA;* [3]*Dept. of Physics, Univ. of Maryland, USA.* Light reflection generates radiation pressure on an object. However, its measurement is often obscured by photothermal effects. An experiment is presented to separate them and to quantitatively measure the radiation pressure on a microcantilever in ambient conditions.

FTh1A.8 • 09:45
Reduced Reflection of Light in Random Amplifying Media, Seng Fatt Liew[1], Hui Cao[1]; [1]*Applied Physics, Yale Univ., USA.* We investigate the effect of light amplification on the minimum reflection channel in a random medium. Enhanced destructive interference of the excited resonant modes may cause a reduction in the minimum reflection with increasing gain.

FTh1B • Light Manipulation in Plasmonic Structures—Continued

FTh1B.6 • 09:30
Cavity Effect of a Dielectric Layer on Nanograting Structures, Chao Niu[1], Tiffany Huang[1], Xin Zhang[2], Haitao Liu[2], Weihua Zhang[3], Jonathan Hu[1]; [1]*Baylor Univ. , USA;* [2]*Nankai Univ., China;* [3]*Nanjing Univ., China.* We study the cavity effect of a dielectric layer on nanograting structures. Varying the thickness of the thin dielectric layer causes the waves in the cavity to oscillate between constructive and destructive interference.

FTh1B.7 • 09:45 WiO
Surface Plasmon Propagation Controlled by Electron Spin Resonance of Nitrogen Vacancy Centres, Zahraa Al-Baiaty[1], Benjamin Cumming[1], Min Gu[1]; [1]*Swinburne Univ., Australia.* We report on the observation of nanodiamond coupled surface plasma propagation under the microwave frequency pumping of the electron spin states of nitrogen-vacancy centres.

FTh1C • Coherence, Interference and General Optics I—Continued

FTh1C.6 • 09:30
Withdrawn.

FTh1C.7 • 09:45
High efficiency holographic optical traps for cold atoms, Sebastien Tempone-Wiltshire[1], Shaun P. Johnstone[1], Phillip T. Starkey[1], Kristian P. Helmerson[1]; [1]*Monash Univ., Australia.* We present a simple method of creating high quality holographic optical elements(HOEs) for cold atom trapping. This is achieved by exposing a photopolymer to an optical field tailored by a phase only spatial light modulator.

FTh1D • Integrated Quantum Optics II—Continued

FTh1D.5 • 09:30
Bell State Generation and Pump Filtering Using Inhomogeneously Poled Nonlinear Waveguides, James Titchener[1], Alexander Solntsev[1], Andrey Sukhorukov[1]; [1]*ANU, Australia.* We show that special domain poling patterns in arrays of coupled nonlinear waveguides can allow shaping of the photon pair wavefunction produced by down-conversion. This allows pump filtering and the reconfigurable generation of Bell states.

FTh1D.6 • 09:45
Entanglement distribution between integrated silicon photonic chips, Jianwei Wang[1], Damien Bonneau[1], Matteo Villa[1,2], Joshua Silverstone[1], Raffaele Santagati[1], Shigehito Miki[3], Taro Yamashita[3], Mikio Fujiwara[4], Masahide Sasaki [4], Hirotaka Terai[4], Michael G. Tanner[5], Chandra M. Natarajan[5], Robert H. Hadfield[5], Jeremy L. O'Brien[1], Mark G. Thompson[1]; [1]*Centre for Quantum Photonics, H. H. Wills Physics Lab & Dept. of Electrical and Electronic Engineering, Univ. of Bristol, UK;* [2]*Istituto di Fotonica e Nanotecnologie, Dipart di Fisica-Politecnico di Milano, Italy;* [3]*National Inst. of Information and Communications Technology (NICT), Japan;* [4]*National Inst. of Information and Communications Technology (NICT), Japan;* [5]*School of Engineering, Univ. of Glasgow, UK.* We demonstrate high-fidelity distribution of entanglement across two integrated silicon photonic chips, by observing a violation of a Bell-type inequality of 2.638±0.039. Entanglement states are generated and measured on-chip, and coherently distributed between chips.

FTh1E • Optical Fiber Sensors I: Applications—Continued

FTh1E.5 • 09:30 WiO
Lossy Mode Resonance Based Fiber Optic Chlorine Gas Sensor Using Zinc Oxide Nanoparticles, Sruthi P. Usha[1], Satyendra K. Mishra[1], Banshi D. Gupta[1]; [1]*Indian Inst. of Technology, Delhi, India.* We report the fabrication and characterization of a fiber optic chlorine gas sensor using lossy mode resonance (LMR) and ZnO nanoparticles. A peak shift of 14 nm with increasing concentration of chlorine gas is observed.

FTh1E.6 • 09:45 WiO
Electro-optic V-band Power Sensing System, Du-Ri Song[1], Seok Kim[1], Jae-Young Kwon[1], Dong-Joon Lee[1]; [1]*Korea Research Inst. of Standards and Science(KRISS), Korea.* We present an electro-optic sensing system for power and electric field measurements based on a photonic heterodyne scheme in the V-band. This system realizes endoscopic detection of fully guided travelling-electric fields within the waveguide.

10:00–10:30 Coffee Break, *Market Street & South Tower Foyers*

FiO | LS

FTh1F • Computational Optical Sensing and Imaging I—Continued

FTh1F.6 • 09:30
Compressive Sensing For Digital In-line Holographic Microscopy, Prakash Ramachandran[1], Praveen Phinehas[1], Zachariah Alex[1], Anith Nelleri[1]; [1]*Vellore Inst. of Technology, India*. Compressive sensing is applied for Digital in-line Holographic Microscopy assuming the object wave is sparse in spatial domain. The reconstructed complex image is free of noise when compared to conventional method of numerical reconstruction.

FTh1F.7 • 09:45
Image Fusion of Color Microscopic Images for Extended the Depth of Field, Roman Hurtado Perez[1], Carina Toxqui-Quitl[1], Alfonso Padilla-Vivanco[1]; [1] *Universidad Politecnica De Tulancingo, Mexico*. In optical microscopy, the depth of field (DOF) is limited by the physical characteristics of the image forming systems. In order to extend the DOF of a microscopic system, this paper a method of image fusion and multi-pronged approach based module gradient color planes is proposed.

FTh1G • Optics and Photonics of Disordered Systems I—Continued

FTh1G.6 • 09:30
Single Photon Quantum Walk in Waveguide Arrays with Next-nearest Neighbor Interaction, Surajit Paul[1], Krishna Thyagarajan[1]; [1]*Indian Inst. of Technology, Delhi, India*. We show how the next nearest neighbor interaction modifies the photon propagation characteristics in 1-D waveguide arrays and how this enables us to realize a 5 partite *W* state in an array of 5 equally spaced waveguides.

FTh1G.7 • 09:45 WiO
Evanescent-Vacuum-Induced Coupling Coefficient Enhancement in Nanocavity, Juanjuan Ren[1], Ying Gu[1,2], Hang Lian[1], Fan Zhang[1], Dongxing Zhao[1], Tiancai Zhang[3], Qihuang Gong[1,2]; [1]*State Key Lab for Mesoscopic Physics, Dept. of Physics, Peking Univ., China;* [2]*Collaborative Innovation Center of Quantum Matter,, China;* [3]*State Key Lab of Quantum Optics and Quantum Optics Devices, Inst. of Opto-Electronics, Shanxi Univ., China*. We theoretically demonstrate the coupling coefficient enhancement and nanoscale guiding of emitted photons in cavity quantum electrodynamics system consisting of a single emitter and a Ag nanorod in evanescent vacuum provided by a single-mode nanofiber.

LTh1H • Complex Wave Propagation—Continued

LTh1H.6 • 09:45 WiO
Near-Field Intensity Fluctuations: the Role of Disorder Correlations, Roxana Rezvani Naraghi[1,2], Sergey Sukhov[1], Aristide Dogariu[1]; [1]*1CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA;* [2]*Dept. of Physics,, Univ. of Central Florida, USA*. Near-field measurements on mesoscopic, strongly scattering media and systematic numerical calculations are used to establish the dependence between intensity distributions and the statistical homogeneity of random structures with controlled disorder.

LTh1I • Innovative Metallic-Emitter Coupled Systems I—Continued

LTh1I.4 • 09:30 Invited
Flat Nonlinear Optics: Efficient Frequency Conversion in Ultrathin Nonlinear Metasurfaces, Mikhail A. Belkin[1]; [1]*Univ. of Texas at Austin, USA*. We report highly-nonlinear ultrathin metasurfaces based on coupling of modes in plasmonic nanoresonators with intersubband nonlinearities with phase-control of nonlinear optical response. Nonlinear susceptibility $>10^6$ pm/V and conversion efficiency ~0.1% were measured for second-harmonic generation.

10:00–10:30 Coffee Break, *Market Street & South Tower Foyers*

FiO

10:30–12:00
FTh2A • General Optical Sciences IV

Presider: Laszlo Veisz, Max-Planck-Institute fur Quantenoptik, Germany

FTh2A.1 • 10:30
Phase Transformations Upon Generalised Refraction, Simon Horsley[2], Thomas Philbin[2], Johannes K. Courtial[1]; [1]*Univ. of Glasgow, UK;* [2]*Dept. of Physics and Astronomy, Univ. of Exeter, UK.* Many generalised laws of refraction would transform incident light-ray fields into wave-optically forbidden fields. We investigate the transformation of those light-ray fields that can be transformed.

FTh2A.2 • 10:45 WiO
Localized Parity-Time Symmetric Directionally Invisible Scatterers and Cloaks, Elisa Hurwitz[1], Greg Gbur[1]; [1]*UNC Charlotte, USA.* A technique for designing localized parity-time (PT) symmetric directionally invisible scatterers and cloaks is introduced and verified by numerical scattering simulations. Implications and generalizations of the method are discussed.

FTh2A.3 • 11:00 WiO
Superluminescent Diode Coupled with Etalon for Measuring CH_4 and CO_2 in Biogas, Ramya Selvaraj[1], Sulochana K[1], Nilesh J. Vasa[1], Shiva Nagendra S M[1]; [1]*Indian Inst. of Technology Madras, India.* Superluminescent diode based absorption spectroscopy is demonstrated for simultaneous measurement of CH_4 and CO_2 in biogas. A free space etalon is used to avoid interference from other gases and allow measurement with a low resolution spectrometer.

10:30–12:00
FTh2B • Photonics on Silicon

Presider: John Dallesasse; Univ of Illinois at Urbana-Champaign, USA

FTh2B.1 • 10:30
Cross Nonlinear Absorption in Silicon Waveguides, Young Zhang[1], Chad Husko[2,1], Simon Lefrancois[1], Isabella H. Rey,[4], Thomas Krauss[4], Jochen Schroeder[3], Benjamin Eggleton[1]; [1]*Univ. of Sydney, Australia;* [2]*Center for Nanoscale Materials, Argonne National Lab, USA;* [3]*School of Electrical and Computer Engineering, RMIT, Australia;* [4]*Dept. of Physics, Univ. of York, UK.* We investigated cross nonlinear absorption in silicon waveguides using the probe-pump scheme. An analytic solution of the probe is derived including XTPA. We experimentally extracted the effect of each loss on powers using a simple method.

FTh2B.2 • 10:45 Invited
Silicon Photonics Beyond the Silicon-on-Insulator Platform, Sasan Fathpour[1]; [1]*Univ. of Central Florida, CREOL, USA.* The silicon-on-insulator platform has several shortcomings for near- and mid-infrared integrated photonics. Heterogeneous platforms that integrate silicon with lithium niobate, tantalum pentoxide, chalcogenide glass and silicon nitride, as well as all-silicon waveguides are reviewed.

10:45–12:00
FTh2C • Coherence, Interference, and General Optics II

Presider: Stephen Kuebler, Univ. of Central Florida, USA

FTh2C.1 • 10:30
Withdrawn.

FTh2C.2 • 10:45
Chirped Bragg Grating for Beam Combining and Moiré Spectral Filtering, Boris Y. Zeldovich[1], Sergiy Kaim[1], Vadim Smirnov[2], Leonid Glebov[1,2]; [1]*Univ. of Central Florida, CREOL, USA;* [2]*OptiGrate Corp , USA.* Chirped Bragg Grating (CBG) at tilted incidence is shown producing wavelength-dependent transverse beam stretching allowing for spectroscopy and spectral beam combining. Moiré patterned CBG at normal incidence is shown producing spectral comb filter.

FTh2C.3 • 11:00
Beam Reflection by Transversely Chirped Volume Bragg Grating, Sergiy Mokhov[1], Ivan Divliansky[1], Leonid Glebov[1], Boris Y. Zeldovich[1]; [1]*Univ. of Central Florida, CREOL, USA.* Transversely chirped volume Bragg grating (TCVBG) provides tunability of resonant wavelength in different designs of laser cavities. Resonant reflectivity suppression and quality deterioration of Gaussian beam reflected by TCVBG are calculated, together with spectral characteristics.

10:30–12:00
FTh2D • Quantum Communications I

Presider: Wolfgang Tittel; Univ. of Calgary, Canada

FTh2D.1 • 10:30 Invited WiO
Distributing Secret Keys using Quantum Continuous Variables, Eleni Diamanti[2,1]; [1]*Telecom-Paristech, France;* [2]*CNRS, France.* We provide an overview of the state-of-the-art in continuous-variable quantum key distribution, including long-distance experiments and the analysis of the practical security of such implementations. We also discuss exciting perspectives in the field.

FTh2D.2 • 11:00 Invited
Recent Activities on Space Laser Communications in Japan and First In-Orbit Verification for Micro-Satellites, Morio Toyoshima[1]; [1]*Space Communication Systems Lab, National Inst. of Information and Communication Technology, Japan.* Recent activities on space laser communications in Japan are presented which include the world first in-orbit verification of space laser communications onboard micro-satellites and the future plan to conduct the basic satellite QKD experiments.

10:30–12:00
FTh2E • Optical Fiber Sensors II: Biosensors

Presider: David Hill; OptaSense, UK

FTh2E.1 • 10:30 Invited
High-performance Label-free Biosensing by Long Period Gratings, Francesco Baldini[1], Francesco Chiavaioli[1], Ambra Giannetti[1], Sara Tombelli[1], Cosimo Trono[1]; [1]*Ist di Fisica Applicata Nello Carrara, Italy.* Long period fiber gratings (LPGs) have been proposed as label-free biosensors since a few years. LPGs are an emergent, expanding and alternative option for measuring refractive index changes with respect to other label-free optical platforms.

FTh2E.2 • 11:00
***In Vivo* Pressure and Temperature Monitoring during Near Infrared Photo-Immunotherapy Using a Fiber Optic Sensor,** Zhijian Zhang[1], Hyungdae Bae[1], Tadanobu Nagaya[2], Yuko Nakamura[2], Peter Choyke[2], Hisataka Kobayashi[2], Miao Yu[1]; [1]*Dept. of Mechanical Engineering, Univ. of Maryland, USA;* [2]*National Inst.s of Health, USA.* We designed a fiber optic sensor with dual Fabry–Pérot cavities and demonstrated its real-time monitoring capability of pressure and temperature during a photo-immunotherapy process.

FiO

10:30–12:00
FTh2F • High Power Raman Fiber Lasers
Presider: Roger Stolen; Clemson Univ., USA

FTh2F.1 • 10:30 Invited
High Power Raman Fiber Lasers: Recent Progress, Yan Feng[1]; [1]*Shanghai Inst of Optics & Fine Mechanics, China*. Raman fiber lasers are known for wavelength agility. Recently, both spectral coverage and output power have progressed quickly, which expands the field of application of Raman fiber laser significantly.

FTh2F.2 • 11:00
Raman enhanced acoustically tailored single-frequency Raman fiber amplifiers, Iyad Dajani[1], Christopher L. Vergien[2], Jean-Claude Diels[2]; [1]*Directed Energy Directorate, Air Force Research Lab, USA;* [2]*Physics and Astronomy, Univ. of New Mexico, USA*. Acoustically tailored fiber was developed to mitigate stimulated Brillouin scattering (SBS) in single-frequency 1178 nm fiber based amplifiers, while enhancing Raman gain by 30%. We demonstrate single and two-stage amplifiers with 11.2 W and 22.2 W of output power.

10:30–12:00
FTh2G • Optics and Photonics of Disordered Systems II
Presider: Mark Brongersma; Stanford Univ., USA

FTh2G.1 • 10:30 Invited
Engeeniering and Imaging Random Photonic Modes, Massimo Gurioli[1]; [1]*Universita degli Studi di Firenze, Italy.* We demonstrate experimentally the ability to fully control and maps the spectral properties of an individual photonic mode in a two-dimensional disordered photonic GaAs slab with disordered distributions of circular air holes.

FTh2G.2 • 11:00
Deterministic Control of Photon Statistics by Activation of Chiral Symmetry in Disordered Lattices, Hasan E. Kondakci[2], Armando P. Leija[1], Alexander Szameit[1], Ayman Abouraddy[2], Demetrios N. Christodoulides[2], Bahaa Saleh[2]; [1]*Inst. of Applied Physics, Friedrich-Schiller-Universität Jena, Germany;* [2]*CREOL, Univ. of Central Florida, USA*. We experimentally demonstrate deterministic tuning of photon statistics from sub-thermal to super-thermal in off-diagonal disordered lattices. We achieve this by symmetrically exciting chiral-mode pairs with coherent light of different field distributions.

LS

10:30–11:30
LTh2H • Light propagation in Scattering Media
Presider: Jeffrey Field, Colorado State Univ., USA

LTh2H.1 • 10:30 Invited WiO
Coherent Control of Light Transmission and Absorption in Random Scattering Media, Hui Cao[1]; [1]*Yale Univ., USA*. We used wavefront shaping to enhance/suppress the transmission of coherent light through open highly scattering media. We further controlled the short-circuit current of a dye-sensitized solar cell by shaping the wavefront of a laser beam.

LTh2H.2 • 11:00
Polychromatic Transmission Eigenchannels of Scattering Media, Chia Wei Hsu[1], Arthur Goetschy[2], Yaron Bromberg[1], A. Douglas Stone[1], Hui Cao[1]; [1]*Yale Univ., USA;* [2]*Université Paris-Diderot, France*. We extend the concept of transmission eigenchannels to describe polychromatic light with a common wavefront. Due to the long-range spectral correlation of the media, significant enhancement of total transmission is possible even for broadband light.

10:30–12:00
LTh2I • Innovative Metallic-Emitter Coupled Systems II
Presider: Edo Waks; Univ. of Maryland at College Park, USA

LTh2I.1 • 10:30 Invited
Topological Edge States of Photons, Plasmons and Photon Pairs in Nanostructures, Alexander N. Poddubny[1,2]; [1]*Ioffe Inst., Russia;* [2]*ITMO Univ., Russia*. We will present latest experimental results for classical edge states of photons and plasmons in zigzag chains of resonant all-dielectric and plasmonic particles and discuss the quantum edge states of photon pairs.

LTh2I.2 • 11:00 Invited
Semiconductor-Superconductor Hybrid Devices, Evyatar Sabag[1], Raja Marjieh[1], Roni Winik [1], Shlomi Bouscher[1], Nimrod Ginzberg [1], Vicky Perepelook[1], Leonid Rybak[1], Alex Hayat[1]; [1]*Technion, Israel*. We showed superconducting proximity in semiconductor light-emitting diodes proposed by us for enhanced two-photon gain and electrically-driven entangled-photon sources. We produced high-Tc superconductivity in topological insulators and demonstrated high-Tc superconductor-semiconductor tunnel diodes.

FTh2A • General Optical Sciences IV—Continued

FTh2A.4 • 11:15
Generalizing and extending Kubelka-Munk theory, Chris Sandoval[1], Arnold Kim[1]; [1]*Natural Sciences, Applied Mathematics, Univ. of California, Merced, USA.* Kubelka-Munk theory approximates the flow of power through a plane parallel slab of a scattering medium. We derive it from the radiative transfer equation and generalize it to three dimensions for general boundary sources and non-homogeneous terms.

FTh2A.5 • 11:30
Tungsten Nanoring Perfect Absorber for Solar Thermophotovoltaic System, Fengyun Zhao[1], Junfeng Qiao[1], Zhaoyu Zhang[1]; [1]*Peking Univ., China.* Tungsten nanoring perfect absorber is studied numerically. The excitations of LSPR, SPPs and intrinsic bandgap absorption of tungsten result in broadband perfect absorption from 0.6μm to1.8μm, with absorbance more than 95%.

FTh2A.6 • 11:45 WiO
Complete Analytic Solution to Vortex Beam Diffraction Through a Triangular Aperture, Charlotte Stahl[1], Greg Gbur[1]; [1]*Univ of North Carolina at Charlotte, USA.* This paper lays out a rigorous analytical solution to on and off axis propagation for a vortex beam diffracting through a triangular aperture, with possible application in vortex-based communications.

FTh2B • Photonics on Silicon—Continued

FTh2B.3 • 11:15
Optimization of the Two-Layer Graphene Modulator on Silicon for High-Speed Operation, Goran Kovacevic[1], Shinji Yamashita[1]; [1]*Research Center for Advanced Science and Technology, Univ. of Tokyo, Japan.* We implement a self-developed numerical method to optimize the silicon waveguide dimensions of the modulator for high speed operation. Additionally, we propose a novel device structure which further increases the speed and reduces power consumption.

FTh2B.4 • 11:30
Withdrawn.

FTh2B.5 • 11:45
Frequency conversion via asymmetrically pumped four-wave-mixing Bragg scattering in silicon waveguides, Yun Zhao[1], Andrew Sarangan[1], Imad Agha[1,2]; [1]*Electro-Optics Graduate Program, Univ. of Dayton, USA;* [2]*Dept. of Physics, Univ. of Dayton, USA.* We experimentally demonstrate low-power frequency conversion within the telecom C-band via asymmetrically-pumped Four-wave-mixing Bragg scattering in a chip-scale silicon-on-insulator waveguide. Numerical methods are used to predict device performance.

FTh2C • Coherence, Interference, and General Optics II—Continued

FTh2C.4 • 11:15
Partial Coherence Theory of Optical Phased Arrays, Edward A. Watson[1,2]; [1]*Univ. of Dayton, USA;* [2]*Vista Applied Optics, LLC, USA.* We apply partial coherence theory formalism to describe the expected modulation transfer function associated with optical phased arrays with imperfect phasing. A particular example of a contiguous array with non-unity fill factor is considered.

FTh2C.5 • 11:30
Azimuthal Multiple Beam Interference Effects with Combinations of Vortex Beams, Jeffrey A. Davis[1], Ignacio Moreno[2], Taylor Womble-Dahl[1], Don Cottrell[1]; [1]*San Diego State Univ., USA;* [2]*Departamento de Ciencia de Materialesw, Universidad Miguel Hernandez, Spain.* We experimentally create azimuthal multiple beam interference effects using vortex beams with different topological charges. Because the radii of the beams depend on charge, smaller charges are Fresnel diffracted to the plane of the higher charge.

FTh2C.6 • 11:45
Restoring Sub-shot-noise Phase Sensitivity In a Realistic Two-photon Interferometry, Michal Jachura[1], Radoslaw Chrapkiewicz[1], Rafal Demkowicz-Dobrzanski[1], Wojciech Wasilewski[1], Konrad Banaszek[1]; [1]*Univ. of Warsaw, ul. Pasteura 5, 02-093 , Poland.* We demonstrate experimentally that a careful design of the spatial structure of interfered photons, combined with position-resolved coincidence detection, allows to recover sub-shot-noise phase sensitivity in regime that otherwise cannot even attain the shot-noise limit.

FTh2D • Quantum Communications I—Continued

FTh2D.3 • 11:30
Towards Space-to-Ground SuperDense Teleportation, Trent M. Graham[1], Chris Zeitler[1], Herbert J. Bernstein[3], Hamid Javadi[2], Paul G. Kwiat[1]; [1]*Dept. of Physics, Univ. of Illinois, USA;* [2]*Jet Propulsion Lab, USA;* [3]*School of Natural Science & ISIS Inst. for Science and Interdisciplinary Studies, Hampshire College, USA.* We use photons entangled in polarization and temporal mode to implement SuperDense Teleportation (SDT), a protocol for the transmission of states between remote parties. We are investigating the possibility implementing SDT between the International Space Station (ISS) and a receiver on Earth.

FTh2D.4 • 11:45
Implementation of Quantum and Classical Discrete Fractional Fourier Transforms, Armando P. Leija[1], Steffen Weimann[1], Maxime Lebugle[1], Markus Gräfe[1], René Heilmann[1], Stefan Nolte[1], Hector Moya-Cessa[2], Demetrios N. Christodoulides[3], Alexander Szameit[1]; [1]*Friedrich-Schiller-Universität Jena, Germany;* [2]*Optics Dept., INAOE, Mexico;* [3]*CREOL, UCF, USA.* We report on the experimental realization of quantum and classical discrete fractional Fourier transforms using photonic lattices. Our approach is fully integrated and free of bulk optical components.

FTh2E • Optical Fiber Sensors II: Biosensors—Continued

FTh2E.3 • 11:15
Graphene-based D-shaped polymer FBG for highly sensitive erythrocyte detection, Baicheng Yao[1], Yu Wu[1], David Webb[2], Jinhao Zhou[1], Yunjiang Rao[1], Andrew Pospori[2], Caibin Yu[1], Yuan Gong[1], Yuanfu Chen[1]; [1]*UESTC, China;* [2]*Aston Univ., UK.* By covering a monolayer of p-doped graphene on a D-shaped microstructured FBG, a graphene based D-shaped polymer fiber Bragg grating is proposed to detect human erythrocytes, with clinic acceptability and high sensitivity of sub ppm.

FTh2E.4 • 11:30 Invited
Fiber Optic Acoustic Sensors for In-vivo Studies, Olav Solgaard[1]; [1]*Stanford Univ., USA.* We present fiber optic Fabry-Perot acoustic sensors based on Photonic Crystal mirrors. The sensors combine a small form factor with high sensitivity and enable recording of acoustic signals from individual cardiomyocytes.

12:00–13:00 Lunch *(on your own)*

FiO | LS

FTh2F • High Power Raman Fiber Lasers—Continued

FTh2F.3 • 11:15 WiO

Analysis of Modal Instability in Raman Fiber Amplifiers, Shadi A. Naderi[2], Iyad Dajani[1], Jacob Grosek[1], Timothy Madden [1]; [1]*US Air Force Research Lab, USA;* [2]*Ball Aerospace & Technologies Corp., USA.* It is well-known that the modal instability is a limiting factor in achieving high power in Yb-doped fiber amplifiers. We investigate this phenomenon theoretically in cladding-pumped and core-pumped Raman fiber amplifiers.

FTh2F.4 • 11:30 Invited

Trends in High Power Raman Fibre Lasers, Johan Nilsson[1]; [1]*Univ. of Southampton, UK.* We review selected progress and properties of high-power fiber Raman lasers. These can produce power > 1 kW when tandem-pumped and are also starting to realize their potential when diode-pumped. Issues such as mode instabilities are also appearing.

FTh2G • Optics and Photonics of Disordered Systems II—Continued

FTh2G.3 • 11:15

Controllable Diffusion in Time-varying Random Potentials, Colin Constant[1], Sergey Sukhov[1], Aristide Dogariu[1]; [1]*Univ. of Central Florida, CREOL, USA.* Particles subjected to complex potentials that vary in both space and time can be sub- or super-diffusive. We demonstrate that their behavior can be controlled by adjusting the parameters of random optical potentials.

FTh2G.4 • 11:30

Feedback Delay Identification by Time-Dependent Exponent Evaluation for a Chaotic Semiconductor Laser, Xiao-Zhou Li[1], Song-Sui Li[1], Jun-Ping Zhuang[1], Jianbo Gao[2,3], Sze-Chun Chan[1,4]; [1]*Dept. of Electronic Engineering, City Univ. of Hong Kong, China;* [2]*Inst. of Complexity Science and Big Data Technology, Guangxi Univ., China;* [3]*PMB Intelligence LLC, USA;* [4]*State Key Lab of Millimeter Waves, City Univ. of Hong Kong, China.* Feedback delay time of a chaotic laser is experimentally extracted by calculating the time-dependent exponent Λ. The exponent is directly obtained through phase space reconstruction and contains the information of the largest Lyapunov exponent.

FTh2G.5 • 11:45

A Novel Method for Extracting the Linewidth Broadening Factor of Semiconductor Diode Lasers, Cheng Wang[1], Kevin Schires[1], Marek Osinski[3], Philip Poole[2], Frederic Grillot[1]; [1]*Telecom-Paristech, France;* [2]*National Research Council of Canada, Canada;* [3]*Univ. of New-Mexico, USA.* A novel experimental technique for extracting the linewidth broadening factor of semiconductor lasers is proposed. This approach is applicable to any types of diode lasers, both below- and above-threshold, and is insensitive to thermal effects.

LTh2H • Light propagation in Scattering Media—Continued

LTh2H.3 • 11:15 WiO

Near-field Corrections in Mesoscopic Transport, Roxana Rezvani Naraghi[1,2], Sergey Sukhov[1], Aristide Dogariu[1]; [1]*CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA;* [2]*Dept. of Physics, Univ. of Central Florida, USA.* In dense composites, light transport evolves through both propagating and evanescent channels. A novel propagation model is developed in terms of measurable far- and near-field scattering. Its accuracy is verified by systematic enhanced backscattering experiments.

LTh2I • Innovative Metallic-Emitter Coupled Systems II—Continued

LTh2I.3 • 11:30

Observation of Superconductivity in Self-Assembled Indium Island Epitaxially Grown on top of III-V Semiconductors, Michael R. Gehl[1], Ricky Gibson[1], Sander Zandbergen[1], Jasmine Sears[1], Nima Nader[2,3], Patrick Keiffer[1], Joshua Hendrickson[2], Alexandre Arnoult[4,5], Galina Khitrova[1]; [1]*Univ. of Arizona, USA;* [2]*Sensors Directorate, Air Force Research Lab, USA;* [3]*Solid State Scientific Corporation, USA;* [4]*LAAS-CNRS, France;* [5]*Université de Toulouse, France.* Molecular beam epitaxy (MBE) is used to grow indium islands on top of semiconductor structures. Electrical contacts to a single indium island are fabricated. Superconductivity is observed by a drop in the resistance at 3.33K.

LTh2I.4 • 11:45

Lasing from As Grown GaAs-AlGaAs Core-Shell Nanowires up to Room Temperature, Zhihuan Wang[1], Marc Currie[2], Paola Prete[3], Nico Lovergine[4], Bahram Nabet[1]; [1]*Drexel Univ., USA;* [2]*Optical Sciences Division, Naval Research Lab, USA;* [3]*IMM-CNR,, Research Unit of Lecce, Italy;* [4]*Dept. of Innovation Engineering, Univ. of Salento, Italy.* We discuss why as grown GaAs/AlGaAs core-shell nanowires can emit almost three orders of magnitude more light compared to the same material in thin-film and can lase without vertical structure at room temperature.

12:00–13:00 Lunch *(on your own)*

13:00–15:00
FTh3A • Ultrafast Laser Applications I

Presider: Cameron Geddes, Lawrence Livermore National Lab, USA

FTh3A.1 • 13:00 Tutorial

Overview of Performance and Progress with Inertially Confined Fusion Implosions on the National Ignition Facility, Omar Hurricane[1]; [1]*Lawrence Livermore National Lab, USA.* We discuss progress towards fusion ignition on the NIF. We cover some of the setbacks encountered during the progress of the research at the National Ignition Facility (NIF), but also cover the advances that have been made. The research strategy for the future will also be discussed.

Omar Hurricane is a Physicist at Lawrence Livermore National Laboratory (LLNL) in the thermonuclear and inertial confinement fusion design division ("AX"). He has also served as Program Element Leader of LLNL's AX Division since 2004 and previously worked as a Senior Scientist at the UCLA Institute of Plasma & Fusion Research. He received his B.S. in Physics and Applied Mathematics from Metropolitan State College Denver, and his M.S. and Ph.D. in Physics from the University of California, Los Angeles (UCLA).

13:00–15:00
FTh3B • Integrated Photonics for Communications: Hybrid Integration on Silicon I

Presider: Alwyn Seeds; Univ. College London , UK

FTh3B.1 • 13:00 Tutorial

Rethinking and Redesigning the Semiconductor Laser for Ultra Coherent Oscillation, Amnon Yariv[1]; [1]*Applied Physics and Materials Science, California Inst. of Technology, USA.* The spectral linewidth, or equivalently, the temporal coherence, of all lasers is fundamentally limited by quantum mechanics specifically by the quantum nature of light. This limit is largely dependent on the electromagnetic configuration of the laser and the atomic nature of the laser transition.

Amnon Yariv received the B.S., M.S., and Ph.D. degrees in electrical engineering from the University of California, Berkeley, in 1954, 1956, and 1958, respectively. In 1959, he joined Bell Telephone Laboratories, Murray Hill, NJ. In 1964, he joined the California Institute of Technology (Caltech), Pasadena, as an Associate Professor of electrical engineering, becoming a Professor in 1966. In 1980, he became the Thomas G. Myers Professor of electrical engineering and applied physics. In 1996, he became the Martin and Eileen Summerfield Professor of applied physics and Professor of electrical engineering. On the technical and scientific sides, he took part (with various co-workers) in the discovery of a number of early solid-state laser systems, in the original formulation of the theory of nonlinear quantum optics; in proposing and explaining mode-locked ultrashort-pulse lasers, GaAs optoelectronics; in proposing and demonstrating semiconductor-based integrated optics technology; in pioneering the field of phase conjugate optics; and in proposing and demonstrating the semiconductor distributed feedback laser.

13:00–15:00
FTh3C • Symposium on Applications of Low Noise Frequency Combs I

Presider: Ping Piu Kuo; Univ. of California, San Diego, USA

FTh3C.1 • 13:00 Invited

Perspective of New Infrastructure of Fiber Communication: The Role of Coherent Light in SDM Er, Yoshinari Awaji[1], Jun Sakaguchi[1], Takahide Sakamoto[1], Atsushi Kanno[1], Motohiro Kumagai[1], Ying Li[1], Tetsuya Ido[1], Naoya Wada[1], Tetsuya Kawanishi[2]; [1]*National Inst of Information & Comm Tech, Japan;* [2]*Waseda Univ., Japan.* Recent progresses in optical comb and communications technologies are realizing new synergies such as switching or frequency-standard distribution for coherent transmission. Both applications are quite useful for next generation infrastructure which will sustain enormous traffic.

FTh3C.2 • 13:30 Invited

Frequency Combs as Sources for Tbit/s Communications Systems, Juerg Leuthold[1], Christian Hafner[1], David Hillerkuss[1], Arvind K. Mishra[2]; [1]*ETH Zurich, Switzerland;* [2]*Sterlite Technol. Ltd., India.* Frequency combs are attractive subcarrier sources for Tbit/s superchannels that are about to outperform traditional sources. Meanwhile a variety of schemes offer up to hundreds of carriers of highest quality across a large spectral range.

13:00–15:00
FTh3D • Quantum Communications II

Presider: Eleni Diamanti; Telecom-Paristech, France

FTh3D.1 • 13:00 Invited

A Quantum Repeater based on Spectral Multiplexing, Wolfgang Tittel[1]; [1]*Inst. for Quantum Science and Technology, Univ. of Calgary , Canada.* Future quantum networks will require quantum repeaters to distribute entangled photons. I will present a quantum repeater architecture based on spectral multiplexing, detail system performance, and describe some recent experimental key results towards its implementation.

FTh3D.2 • 13:30 Invited

Photonic Quantum Information Processing Beyond Single-Photon Qubits, Hyunseok Jeong[1]; [1]*Dept. of Physics and Astronomy, Seoul National Univ., Korea.* In this talk, I will discuss several schemes for all-optical quantum information processing that have been developed to overcome formidable limitations of the well-known approaches based on single-photon qubits and continuous-variable states.

13:00–15:00
FTh3E • Optical Fiber Sensors III: Devices

Presider: Francesco Baldini, Inst. di Fisica Applicata Nello Carrara, Italy

FTh3E.1 • 13:00 Invited

Chalcogenide Glass Optical Fibers for Infrared Spectroscopies, Bruno Bureau[1], Virginie Nazabal[1], Catherine Boussard-Plèdel[1], Johann Troles[1]; [1]*Univ. of Rennes, France.* Chalcogenide glasses exhibit excellent transmission in the mid-infrared region. They could be shaped into various types of optical fibers which have been used for mid-infrared sensing in biology, medicine, CO_2 monitoring or exo-planet detection.

FTh3E.2 • 13:30

Nanostructured Sapphire Optical Fiber for Evanescent-Field Sensing, Hui Chen[1], Fei Tian[1], Jiri Kanka[2], Henry Du[1]; [1]*Stevens Inst. of Technology, USA;* [2]*Inst. of Photonics and Electronics, Academy of Sciences of the Czech Republic, Czech Republic.* We here report an innovative and scalable strategy of transforming a commercial unclad sapphire optical fiber to an all-alumina nanostructured sapphrie optical fiber (NSOF). We experimentally and numerically demonstrate its utility and benefit for evanescent-field SERS measurements.

13:00–15:00
FTh3F • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning I
Presider: Stephen Kuebler; Univ. of Central Florida, USA

FTh3F.1 • 13:00 Invited

Imprinted Plasmonic Surfaces as Flexible Reflective Color Displays, Debashis Chanda[1]; [1]*Univ. of Central Florida, USA.* A flexible reflective plasmonic display has been developed in which each pixel is shown to actively tune across the visible spectrum. This is significant for the development of low cost reflective displays on flexible substrates.

FTh3F.2 • 13:30

Chalcogenide Glass Processing for Direct Laser Writing of 3D Nano-Structures, Stephen M. Kuebler[1], Casey Schwarz[1], Chris Grabill[1], Shreya Labh[1], Gerald Richardson[1], Clara Rivero-Baleine[2], Kathleen Richardson[1], Alexej Pogrebnyakov[3], Theresa Mayer[3]; [1]*Univ. of Central Florida, USA;* [2]*Lockheed Martin, USA;* [3]*Pennsylvania State Univ., USA.* Multi-photon direct laser writing was used to photo-pattern nano-structures in thermally deposited glassy films of chalcogenide (ChG) clusters. Chemical composition, refractive index, and nano-structure morphology were characterized and related to ChG laser and etch processing.

13:00–15:00
FTh3G • Computational Optical Sensing and Imaging II
Presider: Amit Ashok; Univ. of Arizona, USA

FTh3G.1 • 13:00 Invited

Compressive Imaging at Extreme Limits of Coherence, Amit Ashok[1]; [1]*Univ. of Arizona, USA.* I will describe some recent results in compressive imaging at extreme limits of coherence. In the coherent limit, I will discuss compressive digital holography with sparse apertures and in the incoherent limit, I will talk about X-ray threat detection using compressive multiplexed measurements.

FTh3G.2 • 13:30 Invited

Fourier Ptychography for Multimodal Imaging, Guoan Zheng[1]; [1]*Univ. of Connecticut, USA.* We will discuss the recent progresses of the Fourier ptychographic imaging approach. We will demonstrate its applications in gigapixel microscopy, quantitative phase imaging, spectrum multiplexing, 3D holographic imaging, super-resolution fluorescence microscopy, and photographic imaging.

13:00–15:00
FTh3H • Fiber Lasers and Amplifiers
Presider: Johan Nilsson; Univ. of Southampton, UK

FTh3H.1 • 13:00 Tutorial

Raman Fiber Lasers and Amplifiers, Roger H. Stolen[1]; [1]*COMSET, Clemson Univ., USA.* Raman gain is optically-pumped optical amplification. We discuss the discovery of the Raman effect and Raman amplification. Relevant fiber properties are introduced along with an overview of different approaches to Raman amplification. Applications as lasers and lightwave system amplifiers are shown.

Roger Stolen is a distinguished visiting professor at the Center for Optical Materials Science and Engineering Technologies (COMSET) at Clemson University. He was with Bell Labs and AT&T Research from 1966 to 1998 and the Dept of Electrical Engineering of Virginia Tech until 2004. Since 1971 he has been involved with most aspects of fiber optics research. In 1990 he was awarded the R.W.Wood prize in recognition of pioneering studies of optical nonlinearities in fibers and the demonstration of polarization preserving fibers and in 2005 he received the IEEE/OSA John Tyndall Award for contributions to the fundamentals of the nonlinear properties of fibers. He was inducted as a foreign member of the Russian Academy of Science in 2009 and became a member of the National Academy of Engineering in 2012.

13:00–15:00
LTh3I • Innovative Metallic-Emitter Coupled Systems III
Presider: Alexander Poddubny; Ioffe Inst., Russia

LTh3I.1 • 13:00 Invited

Automated Optimization of Photonic Crystals for Broadband Slow Light and Ultra-High-Q Cavities, Vincenzo Savona[1], Momchil Minkov[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland.* Using an automated optimization procedure, we design ultra-high-Q photonic crystal cavities and slow-light waveguides, improving dramatically on previous best figures of merit. These structures, partly experimentally demonstrated, hold great promise for nanostructured hybrid devices.

LTh3I.2 • 13:30

Lasing Characteristics of Two Dimensional Surface Plasmon Lasers in an Active Meta-Material, Vasco T. Tenner[1], Michiel J A de Dood[1], Martin P van Exter[1]; [1]*Quantum Matter & Optics, Huygens-Kamerlingh Onnes Laboratorium, Universiteit Leiden, Netherlands.* We have studied surface-plasmons on metal hole arrays combined with gain and observe surface plasmon laser action. We will discuss the feedback mechanism, angular beam profile, and spatial emission profile of this surface plasmon laser.

FTh3A • Ultrafast Laser Applications I—Continued

FTh3A.2 • 13:45
Free Induction Decay in the Extreme Ultraviolet, Samuel Bengtsson[1], Esben W. Larsen[1], David kroon[1], Cord Arnold[1], Anne L'Huillier[1], Lars Rippe[1], Johan Mauritsson[1]; [1]*Lunds Universitet, Sweden.* We present an experimental study of controlled Free Induction Decay (FID) in the extreme ultraviolet regime excited by High-order Harmonics. The control is done by applying a delayed infrared pulse.

FTh3A.3 • 14:00
Observation of Dynamical Localization and Bloch Oscillations within Molecular Alignment of Nitrogen, andrei kamalov[1], Johannes Floss[2], Doug Broege[1], Ilya Averbukh[2], Philip H. Bucksbaum[1]; [1]*SLAC National Lab, USA;* [2]*Chemistry, Weizmann Inst. of Science, Israel.* Nitrogen gas is rotationally excited by a train of eight impulsive kicks. The resulting population alignment evolution exhibits two phenomena explained by analogy to the famous condensed matter effects of dynamical localization and Bloch oscillations.

FTh3A.4 • 14:15
The polarization of the SHG in single ZnS NWs, Hu Hongbo[1], Kai Wang[1], Bing Wang[1], Peixiang Lu[1]; [1]*Huazhong Univ. of Science and Technology, China.* We use the electrical-dipole approximation to study the polarization of SHG in single ZnS NWs. The polarization of the measured SHG signal varies with the ZnS crystal orientations and the polarization directions of pumping laser.

FTh3B • Integrated Photonics for Communications: Hybrid Integration on Silicon I—Continued

FTh3B.2 • 13:45 Invited WiO
Hybrid Long-wavelength VCSEL using High Contrast Metastructure on SOI, Connie J. Chang-Hasnain[1], James Ferrara[1]; [1]*Univ. of California Berkeley, USA.* An electrically-pumped III-V-silicon hybrid VCSEL using a high-contrast metastructure (HCM) reflector on SOI with CW output >1 mW, 1.46 K/mW thermal resistance, and 5 Gb/s direct modulation is presented. The grating can provide in-plane waveguide coupling.

FTh3B.3 • 14:15 Invited
High Bandwidth Transceivers Using Heterogeneous Integration on Silicon, Gregory Fish[1], Jon Roth[1], Anand Ramaswamy[1], Erik Norberg[1], Robert Guzzon[1], Jae Shin[1], Brian Koch[1], Sparacin Dan[1]; [1]*Aurrion, Inc., USA.* The heterogeneous integration of InP material into a silicon photonics wafer flow enables high bandwidth transceivers to be fabricated using established silicon foundry infrastructure for both fabrication and packaging.

FTh3C • Symposium on Applications of Low Noise Frequency Combs I—Continued

FTh3C.3 • 14:00 Invited
Exabit Optical Network Based on Optical Comb Distribution for High-Performance Datacenters: Challenges and Strategies, Takashi Inoue[1], Takayuki Kurosu[1], Kiyo Ishii[1], Haruhiko Kuwatsuka[1], Shu Namiki[1]; [1]*Natl Inst of Adv Industrial Sci & Tech, Japan.* A design concept of optical network enabling Exabit/s interconnect between 100,000 nodes for future high-performance datacenters is discussed, where distributed optical frequency comb plays an important role in realizing high-capacity and energy-efficient WDM transmission.

FTh3D • Quantum Communications II—Continued

FTh3D.3 • 14:00
Towards the spin-wave storage of entangled photons in a solid state quantum memory, Daniel Rieländer[1], Alessandro Seri[1], Margherita Mazzera[1], Hugues de Riedmatten[1,2]; [1]*ICFO – The Inst. of Photonic Science, Spain;* [2]*ICREA - Institució Catalana de Recerca i Estudis Avançats, Spain.* We will show our progress on storage of entangled heralded single photons in the spin state of a solid state quantum memory.

FTh3D.4 • 14:15
Quantum Hyperdense Coding, Trent M. Graham[1], Christopher Zeitler[1], Paul G. Kwiat[1]; [1]*Univ of Illinois at Urbana-Champaign, USA.* We use photons simultaneously entangled in polarization and temporal mode to implement hyperdense coding, a quantum-enhanced communication protocol that can transmit up to 2.81 bits of classical information for every 2-qubit photon received.

FTh3E • Optical Fiber Sensors III: Devices—Continued

FTh3E.3 • 13:45 WiO
Chirped Fiber Optical Current Sensor Based on Graded Terfenol-D Composite, Suha Lasassmeh[1], Edward Lynch[1], Chiu T. Law[1], Rani El-Hajjar[1]; [1]*Univ. of Wisconsin Milwaukee, USA.* This paper presents a magnetostriction-based optical current sensor with wide dynamic range. It consists of a fiber Bragg grating embedded in a magnetostrictive composite with graded particle size distribution converting magnetostrictive strain into frequency chirp in proportional to magnetic field.

FTh3E.4 • 14:00
Ultra-Thin Multi-Parameter Sensor Achieved with on-Fiber Plasmonic Interferometer, Zhijian Zhang[1], Yongyao Chen[1], Haijun Liu[3], Hyungdae Bae[1], Douglas A. Olson[2], Ashwani K. Gupta[1], Miao Yu[1]; [1]*Dept. of Mechanical Engineering, Univ. of Maryland, USA;* [2]*National Inst. of Standards and Technology, USA;* [3]*Dept. of Mechanical Engineering, Temple Univ., USA.* We demonstrate the multi-parameter sensing capability of an ultra-thin plasmonic interferometer fabricated on a fiber facet. High refractive index and temperature sensitivities are achieved.

FTh3E.5 • 14:15
All SMF Inline Mach-Zehnder Interferometer with Micro Cavity for Curvature Sensing, Sumit Dass[1], Jitendra Dash[1], Rajan Jha[1]; [1]*I.I.T. Bhubaneswar, India.* We propose cascaded taper based Mach-Zehnder interferometer with micro cavity as highly sensitive curvature sensor. Experimental results show that by changing the tapering parameters of second taper, curvature sensitivity of the system can be tailored.

FTh3F • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning I—Continued

FTh3F.3 • 13:45
Atomic-layer lithography of sub-10-nm plasmonic nanogaps on flat metallic surface, Dengxin Ji[1], Borui Chen[1], Xie Zeng[1], Tania Moein[1], Haomin Song[1], Nan Zhang[1], Qiaoqiang Gan[1], Alexander Cartwright[2]; [1]*State Univ. of New York at Buffalo, USA;* [2]*State Univ. of New York, USA.* We developed a novel atomic layer lithography procedure to fabricate large area flat metallic surfaces with sub-10-nm features, which is particularly useful for fabrication of nanostructures with strongly localized field enhancement.

FTh3F.4 • 14:00
Negative Index in a Lossy Chiral Metamaterial under First-Order Material Dispersion using a Drude Model, tarig algadey[1], Monish R. Chatterjee[1]; [1]*Univ. of Dayton, USA.* Using the Drude model for complex conductivity,phase and group velocities, and indices are calculated under first-order dispersion in chiral metamaterials. Conditions are derived for negative index, and the results compared with parametric analyses.

FTh3F.5 • 14:15
Circularly Polarized Light Detection with Hot Electrons in Chiral Plasmonic Metamaterials, Wei Li[1], Zachary J. Coppens[1], Lucas Vázquez[2], Wenyi Wang[3], Alexander O. Govorov[2], Jason Valentine[1]; [1]*Mechanical Engineering, Vanderbilt Univ., USA;* [2]*Dept. of Physics and Astronomy, Ohio Univ., USA;* [3]*Electrical Engineering, Vanderbilt Univ., USA.* We report on a circularly polarized light detector based on chiral plasmonic metamaterials and hot electron injection. The detector has the ability to distinguish left and right hand circularly polarized light without additional optical elements.

FTh3G • Computational Optical Sensing and Imaging II—Continued

FTh3G.3 • 14:00
High-Contrast 3D Surface Topographic Imaging With Near Wavelength-Limited Resolution Using Ptychography, Dennis F. Gardner[1], Elisabeth Shanblatt[1], Bosheng Zhang[1], Matthew Seaberg[1], Christina Porter[1], Robert Karl[1], Michael Tanksalvala[1], Margaret Murnane[1], Henry Kapteyn[1], Daniel Adams[1]; [1]*Univ. of Colorado at Boulder, USA.* We achieve high-contrast, 3D surface topographic imaging with a lateral resolution of 1.3λ and with 6Å axial precision using ptychographic coherent diffraction imaging and a high-harmonic source at 30nm.

FTh3G.4 • 14:15
Extracting Full Susceptibility Tensor Using Modified Optical Coherence Tomography, Yang Xu[1], Fredrick A. South[1], Yuan-Zhi Liu[1], Stephen A. Boppart[1], Paul S. Carney[1]; [1]*Univ of Illinois at Urbana-Champaign, USA.* We present a method of measuring the full susceptibility tensor map of samples using a modified high numerical aperture (NA) optical coherence tomography (OCT) system. This method promises high resolution, angle invariant results with significantly extended depth of field (DoF).

FTh3H • Fiber Lasers and Amplifiers—Continued

FTh3H.2 • 13:45
Analysis of Nonlinear Optical and Dynamic Gain Effects of Moderate-Power, Pulse-Position-Modulated, Erbium-Doped Fiber Amplifiers for Deep-Space Applications, Haomin Yao[1], Malcolm W. Wright[2], John R. Marciante[1]; [1]*The Inst. of Optics, Univ. of Rochester, USA;* [2]*Jet Propulsion Lab, California Inst. of Technology, USA.* Self-phase modulation and stimulated Raman scattering are analyzed and limit the usable data-format space. Output pulse energy variation and square-pulse distortion, as large as 28% and 21% respectively, primarily depend on symbol duration.

FTh3H.3 • 14:00
Observation of continuous evolution of the output state of polarization from a polarization–rotated, mode-locked soliton fiber laser, Guoqing Hu[1], Xin Zhao[1], Zijun Yao[1], Meng Zhang[1], Zheng Zheng[1,2]; [1]*School of Electronic and Information Engineering, Beihang Univ., China;* [2]*Collaborative Innovation Center of Geospatial Technology, China.* The output of a soliton fiber laser is observed to remain mode-locked and continuously evolve between orthogonal scalar states and vector soliton states, even as an intracavity polarizer is rotated over a range of 90°.

FTh3H.4 • 14:15
Numerical Study on Multimode-fiber-based Random Fiber Laser, Han Wu[1], Zinan Wang[1], Mengqiu Fan[1], Yunjiang Rao[1]; [1]*Univ. Electronic Sci. & Tech. of China, China.* We make a numerical study on the power performance of backward-pumped random fiber laser (RFL) based on short graded-index multimode fiber (MMF). Comparing with its SMF-based counterpart, the MMF-based RFL has the lower threshold and comparable slope efficiency.

LTh3I • Innovative Metallic-Emitter Coupled Systems III—Continued

LTh3I.3 • 14:00
Threshold Analysis in Monolayer Semiconductor Nanolaser by Surface Plasmon Enhancement, Xiang Meng[1], Richard Grote[1], Jerry Dadap[1], Richard Osgood[1]; [1]*Columbia Univ., USA.* We have examined the lasing threshold requirements for optically pumped surface plasmon based nanolasers with 2D materials as active medium, which is an excellent research tool as an on-chip nanoscale light source.

LTh3I.4 • 14:15
Controlling Electric and Magnetic Resonances for Ultra-Compact Nanoantennas with Switchable Directionality, Kan Yao[2], Yongmin Liu[1,2]; [1]*Dept. of Mechanical and Industrial Engineering, Northeastern Univ., USA;* [2]*Dept. of Electrical and Computer Engineering, Northeastern Univ., USA.* We design and demonstrate an ultra-compact nanoantenna composed of an asymmetric trimer. The structure can support a highly tunable magnetic resonance in addition to the electric resonance, resulting in switchable directionality and enhanced radiative emission.

FTh3A • Ultrafast Laser Applications I—Continued

FTh3A.5 • 14:30
Liquid Crystals as High Repetition Rate Targets for Ultra Intense Laser Systems, Patrick Poole[1], Christopher Willis[1], Ginevra Cochran[1], Matthew McMahon[1], Enam Chowdhury[1], C. David Andereck[1], Douglass Schumacher[1]; [1]*Ohio State Univ. , USA.* Liquid crystal film targets are presented with on-demand thickness control for use in experiments such as laser ion acceleration, where thickness manipulation is critical. Variation from 10 nm to 10 µm with a positional reproducibility better than 2 µm and repetition rate exceeding 0.3 Hz.

FTh3A.6 • 14:45
Approaching the Abbe Limit in the Extreme Ultraviolet: Ultrafast Imaging Using a Compact High Average Power High Harmonic Source, Michael Zürch[1], Jan Rothhardt[2,3], Steffen Hädrich[2,3], Stefan Demmler[2], Manuel Krebs[2], Jens Limpert[2,3], Andreas Tünnermann[2,4], Alexander Guggenmos[5,6], Ulf Kleineberg[5,6], Christian Spielmann[1,3]; [1]*Inst. of Optics and Quantum Electronics, Friedrich Schiller Univ. Jena, Germany;* [2]*Inst. of Applied Physics, Friedrich Schiller Univ. Jena, Germany;* [3]*Helmholtz Inst. Jena, Germany;* [4]*Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany;* [5]*Ludwig-Maximilians-Universität München, Germany;* [6]*Max-Planck-Institut für Quantenoptik, Germany.* We demonstrate high-resolution imaging below one wavelength in the extreme ultraviolet using high numerical aperture diffractive imaging. Our high-average power high harmonic source at 33nm wavelength provides sufficient flux for real-time imaging.

FTh3B • Integrated Photonics for Communications: Hybrid Integration on Silicon I—Continued

FTh3B.4 • 14:45
Low Power Compensation of Thermal Drift in Hybrid Silicon and Lithium Niobate Ring Resonators, Li Chen[1], Michael G. Wood[1], Ronald M. Reano[1]; [1]*Ohio State Univ. , USA.* We present active compensation of thermal drift of hybrid silicon and lithium niobate ring resonances. A capacitive geometry and low thermal sensitivity results in 17 °C temperature compensation using tuning power at the sub-nanowatt level.

FTh3C • Symposium on Applications of Low Noise Frequency Combs I—Continued

FTh3C.4 • 14:30 Invited
Digital Coherence W-band Radio-over-fiber System, Ken-ichi Kitayama[1], Nikolaos P. Diamantopoulos[1], Yuki Yoshida[1], Atsushi Kanno[2], Tetsuya Kawanishi[2,3]; [1]*Osaka Univ., Japan;* [2]*Electronic and Physical Systems, Waseda Univ., Japan;* [3]*National Inst. of Information and Communications Technology, Japan.* W-band RoF transmission system with converged MIMO DSP for compensating signal impairments both in optical fiber and free-space is presented, particularly focusing on MDM transmission in a low differential mode group delay two-mode fiber link.

FTh3D • Quantum Communications II—Continued

FTh3D.5 • 14:30
Exploring a Four-Qubit Hilbert Space Using Hyperentangled Photons, Aditya N. Sharma[1], Kevin McCusker[2], Julio Barreiro[3], Paul G. Kwiat[1]; [1]*Dept. of Physics, Univ. of Illinois at Urbana-Champaign, USA;* [2]*Center for Photonic Communication and Computing, Northwestern Unitersity, USA;* [3]*Dept. of Physics, Univ. of California at San Diego, USA.* We present an experimental realization of the Smolin state using hyperentangled photon pairs from spontaneous parametric downconversion, to our knowledge the first optical demonstration of bound entanglement that does not simulate mixture using random unitaries.

FTh3D.6 • 14:45
Multiplexing single-photon orbital angular momentum states in fiber - Limits to dephasing correction via dynamical decoupling, Manish Kumar Gupta[2,1], Jonathan P. Dowling[2,1]; [1]*Louisiana State Univ., USA;* [2]*Hearne Inst. for Theoretical Physics, USA.* We derive a decoherence model for OAM states of a photon in a multimode optical fiber and show that rate of decoherence is proportional to l^2, where l is the azimuthal mode order. We also show numerically that for lower values of l the decoherence can be minimized by using dynamical decoupling.

FTh3E • Optical Fiber Sensors III: Devices—Continued

FTh3E.6 • 14:30 Invited
Miniaturized Fiber Bragg Grating Interrogator based on an Arrayed Waveguide Grating in SOI platform, Andrea Trita[2], Eli Voet[3], Jan Vermeiren[4], Danae Delbeke[1], Pieter Dumon[1,5], Shibnath Pathak[1], Dries Van Thourhout[1]; [1]*Ghent Univ., INTEC, Belgium;* [2]*Rockley Photonics Inc., USA;* [3]*Com&Sens, Belgium;* [4]*Xenics nv, Belgium;* [5]*Luceda Photonics, Belgium.* We experimentally demonstrated a novel miniaturized Fiber-Bragg-Grating sensor interrogator, based on a tailored Arrayed-Waveguide-Grating (AWG) filter fabricated in the Silicon-on-Insulator (SOI) platform. The measured interrogator resolution is 10pm on a 50nm operational bandwidth.

15:00–15:30 Coffee Break, *Market Street & South Tower Foyers*

FTh3F • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning I—Continued

FTh3F.6 • 14:30
Perfect Absorption in Ultra-thin Uniform and Nanostructured Media, C. Martijn de Sterke[1], Björn C. P. Sturmberg[1], Lindsay C. Botten[2,3], Christopher G. Poulton[3], Kokou B. Dossou[3], Ross C. McPhedran[1]; [1]*Centre for Ultrahigh Bandwidth Devices for Optical Systems (CUDOS), School of Physics, Univ. of Sydney, Australia;* [2]*National Computational Infrastructure, Australian National Univ., Australia;* [3]*Centre for Ultrahigh Bandwidth Devices for Optical Systems (CUDOS), School of Mathematical and Physical Sciences, Univ. of Technology Sydney, Australia.* We show that perfect absorption can be achieved in ultra-thin gratings composed of weakly absorbing dielectric materials combined with a mirror. The structures can be fabricated using standard processing techniques.

FTh3F.7 • 14:45
Aperiodic Gap Plasmon Resonators for Unidirectional Launching and Shaping of Surface Plasmon Polaritons, Zeyu Lei[1], Tian Yang[1]; [1]*Shanghai Jiao Tong Univ., China.* We report a compact device for the efficient launching of unidirectional surface plasmon polaritons (SPPs). Unidirectional SPPs with focused, Bessel and Airy profiles have also been experimentally realized by adjusting the wavefront.

FTh3G • Computational Optical Sensing and Imaging II—Continued

FTh3G.5 • 14:30 WiO
From Frequency Domain Multi-Focus Fusion to Focus Slicing, Julia Alonso[1], José Ferrari[1]; [1]*Universidad de la Republica, Uruguay.* For optical systems under severe defocus, we propose a method to estimate the focus slices (i.e. in-focus region of each of the acquired images of a stack) from Fourier based all-in-focus reconstructed image. Experimental results are provided.

FTh3G.6 • 14:45
Multi-perspective Fluorescence Talbot Microscopy, Yangyang Sun[1], Shuo Pang[1]; [1]*CREOL, Univ. of Central Florida, USA.* We demonstrate a long imaging depth, multi-perspective fluorescence scanning microscopy based on Talbot effect generated from a microlens array. An object with two layers that are 155μm apart was reconstructed from different perspectives.

FTh3H • Fiber Lasers and Amplifiers—Continued

FTh3H.5 • 14:30 Invited
Er-Doped Semi-Guiding High-Aspect-Ratio Core (SHARC) Fiber Amplifier Generating 100 μJ, 1-nsec Pulses at 30 kHz, David A. Rockwell[1], Friedrich Strohkendl[1], Sean Moore[1], Vladimir Shkunov[1], Fabio Di Teodoro[1], John Marciante[2]; [1]*Raytheon Company, USA;* [2]*U. Rochester, USA.* We describe an Er:SHARC fiber amplifier generating 1-nsec pulses having peak powers approaching 100 kW at a 30 kHz repetition rate. Pulse energies of 0.9 mJ were achieved with a longer pulse length of 15 nsec.

LTh3I • Innovative Metallic-Emitter Coupled Systems III—Continued

LTh3I.5 • 14:30 Invited
***Ab Initio* Studies of Structure and Excited States of Organic-Based Semiconductors,** Jeffrey Neaton[2,1]; [1]*Molecular Foundry, Lawrence Berkeley National Lab, USA;* [2]*Dept. of Physics, Univ. of California, Berkeley, USA.* I will discuss the use of density functional theory and many-body perturbation theory – within the GW approximation and BSE approach – for understanding structure and excited-states of organic materials, e.g. acene crystals and halide perovskites.

15:00–15:30 Coffee Break, *Market Street & South Tower Foyers*

FiO | FiO | FiO | LS | FiO

15:30–17:30
FTh4A • Ultrafast Laser Applications II
Presider: Laszlo Veisz; Max-Planck-Institut fur Quantenoptik, Germany

FTh4A.1 • 15:30 Invited WiO
High Intensity Laser-driven X-ray Sources for High Energy Density Science, Félicie Albert[1]; [1]*Lawrence Livermore National Lab, USA.* We discuss betatron x-ray radiation from laser wakefield accelerators using femtosecond (blowout regime) and picosecond (self modulated and direct laser acceleration regimes) scale laser pulses. The source will have applications for high energy density science.

FTh4A.2 • 16:00
A 260 MW light source with 7 \mu m wavelength as a path to strong field science in the far infrared., Derrek Wilson[1], Adam M. Summers[1], Carlos Trallero-Herrero[1]; [1]*Kansas State Univ., USA.* We demonstrate a far infrared source (7 \mu m) with pulse duration of < 120 fs and pulse energies of 31 mJ. Additionally, we show a clear path to achieving GW level peak power.

15:30–17:30
FTh4B • Integrated Photonics for Communications: Hybrid Integration on Silicon II
Presider: Sasan Fathpour; Univ. of Central Florida, CREOL, USA

FTh4B.1 • 15:30
Detection of Optical Plasmons Using an Atomically-Thin Semiconductor, Kenneth M. Goodfellow[1], Chitraleema Chakraborty[1], Ryan Beams[1], Nick Vamivakas[1], Lukas Novotny[2]; [1]*Univ. of Rochester, USA;* [2]*ETH Zurich, Switzerland.* We demonstrate near-field electrical detection of silver nanowire plasmons with the atomically-thin semiconductor molybdenum disulfide. Our device exhibits plasmon-to-charge conversion efficiencies of 0.5 and plasmon reponsivities better than 250 mA/W.

FTh4B.2 • 15:45 Invited
Hybrid Photonic Integration, John Dallesasse[1], B Kesler[1], T O'Brien[1], G.L. Su[1], J Carlson[1]; [1]*Dept. of Electrical and Computer Engineering, Univ. of Illinois at Urbana-Champaign, USA.* Integration of compound semiconductors with CMOS provides a path for improving performance and increasing functionality. Methods for integrating photonic materials are examined, and the resulting thermal environment modeled. Integration of III-N materials is also discussed.

15:30–17:30
FTh4C • Symposium on Applications of Low Noise Frequency Combs II
Presider: Bill Kuo, Univ. of California San Diego, USA

FTh4C.1 • 15:30 Invited
Optical-to-RF Frequency Synthesis: Application Priorities for Ultra-low Phase Noise, David Howe[1], Archita Hati[1], Lora Nugent-Glandorf[1]; [1]*Time and Frequency Division, National Inst. of Standards and Technology , USA.* We describe operational challenges and progress of optical frequency-comb dividers (OFDs) that synthesize RF signals from the optical domain. Our priorities include: (1) ultra-low phase-noise, (2) continuous operation, and (3) broadly low Allan deviation.

FTh4C.2 • 16:00 Invited
Withdrawn.

15:30–17:15
LTh4D • Complex Dynamics
Presider: Aristide Dogariu, Univ. of Central Florida, CREOL, USA

LTh4D.1 • 15:30
Semiconductor microstructure optical resonators, Hongxing Dong[2], Liaoxin Sun[1], Yang Liu[2], Zhanghai Chen[1], Long Zhang[2]; [1]*Fudan Univ., China;* [2]*Shanghai Inst. of Optics and Fine Mechanics, China.* High quality ZnO microstructure optical cavities with different morphologies were fabricated. By using the spatially resolved spectroscopic technique, optical resonant modes were directly observed and further investigated systematically.

LTh4D.2 • 15:45
Coupled Opto-Electronic Oscillator with Three-Point Stabilization, Anthony Klee[1], Kristina Bagnell[1], Peter Delfyett[1]; [1]*Univ. of Central Florida, CREOL, USA.* We present a coupled opto-electronic oscillator architecture with independent stabilization of optical frequency and mode spacing. Decoupling the two parameters is accomplished by filtering the spectrum into three regions for generation of unique error signals.

LTh4D.3 • 16:00
Simulations of the Optical Bichromatic Force in Multilevel Systems, Leland Aldridge[1], Scott E. Galica[1], Edward E. Eyler[1]; [1]*Univ. of Connecticut, USA.* The optical bichromatic force (BCF) shows promise for improved laser slowing and cooling of molecules. We are investigating BCF dynamics in multilevel systems using numerical simulations, in conjunction with experimental tests on the CaF molecule.

15:30–17:30
FTh4E • Optical Fiber Sensors IV: Methods
Presider: Bruno Bureau; Universite de Rennes I, France

FTh4E.1 • 15:30 Invited
Distributed Acoustic Sensing (DAS): Theory and Applications, David Hill[1]; [1]*OptaSense, UK.* Exploiting the effect of Rayleigh backscatter in optical fibers, Distributed Acoustic Sensing (DAS) has emerged as a powerful and rapidly adopted sensing technology with a broad range of uses across a wide assortment of industries.

FTh4E.2 • 16:00
Athermal Compensation of Source Wavelength Drifts for Fiber-Optic Current Sensors, Georg M. Müller[1], Wei Quan[1], Miklós Lenner[1], Lin Yang[1], Andreas Frank[1], Klaus Bohnert[1]; [1]*ABB Corporate Research, Switzerland.* An athermal fiber-optic retarder introduces controlled wavelength dependent cross-coupling between the two orthogonal polarization states of a fiber-optic current sensor and thus compensates the wavelength dependence of the Faraday effect.

FiO

15:30–17:30
FTh4F • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning II
Presider: Debashis Chanda, Univ. of Central Florida, USA

FTh4F.1 • 15:30 Invited WiO
Ink Deposition of Quaternary Amorphous Oxide Semiconductors for Electronic and Optoelectronic Devices, Chun-Li Lo[1], Rebecca L. Peterson[1]; [1]*Univ. of Michigan, USA.* High-quality amorphous oxide thin films with band-edge absorption in the ultraviolet are deposited using a sol-gel ink process. We control optical and electrical properties of semiconducting zinc tin oxide by incorporating quaternary alloy elements.

FTh4F.2 • 16:00
2D Photonic-Crystal Waveguide Structures and 3D Periodic-Lattice-Based Microstructures by Pattern-Integrated Interference Lithography, Matthieu C. Leibovici[1], Thomas K. Gaylord[1]; [1]*Georgia Inst. of Technology , USA.* We report the fabrication of photonic-crystal waveguide structures by pattern-integrated interference lithography. Experiments are in excellent agreement with simulations. Preliminary results for three-dimensional microstructure fabrication are presented as well.

15:30–17:30
FTh4G • Computational Optical Sensing and Imaging III
Presider: Guoan Zheng; Univ. of Connecticut, USA

FTh4D.1 • 15:30
Adaptive Allocation of Measurement Time for Imaging Interferometry, Zachary DeSantis[1], James R. Fienup[1]; [1]*Univ. of Rochester, USA.* Imaging interferometry has a significant challenge balancing cost and measurement time. We propose a method for reducing the total measurement time, by adaptively measuring the Fourier domain, with a favorable impact on the image quality.

FTh4D.2 • 15:45
Self-interference digital polarization holography for three-dimensional incoherent imaging, Ziyi Zhu[1], Zhimin Zhi[1]; [1]*Dept. of Physics, Univ. of South Florida, USA.* We present a self-interference digital polarization holography method for 3-D imaging of an incoherent scene in a single shot. The 3-D imaging capability is quantitatively demonstrated with controllable time-multiplexed incoherent scenes.

FTh4D.3 • 16:00
Enhanced-resolution by Sparse Synthetic Aperture with Fresnel Elements (S-SAFE), Yuval Kashter[2], Yair Rivenson[3], Adrian Stern[1], Joseph Rosen[2]; [1]*Dept. of Electro-Optics Engineering, Ben gurion Univ., Israel;* [2]*Dept. of Electrical & Computer Engineering, Ben-Gurion Univ. of the Negev, Israel;* [3]*Faculty of Engineering, Bar-Ilan Univ., Israel.* We present an advanced configuration of an incoherent holographic imaging system with a partial synthetic aperture. The image resolution of the physical aperture-limited system is significantly enhanced although the synthetic aperture is sparse.

LS

15:30–17:15
LTh4H • Stable Laser Systems
Presider: Jill Scott, Idaho National Lab, USA

LTh4H.1 • 15:30
Frequency Stabilization of an External Cavity Diode Laser using Helium 2S-3P Saturated Absorption Transitions, Chia-Wei Chen[1], Jow-Tsong Shy[2], Pei-Ling Luo[2], Li-Bang Wang[2], Hsiang-Chen Chui[1]; [1]*National Cheng Kung Univ., Taiwan;* [2]*Physics, National Tsing Hua Univ., Taiwan.* We reported the frequency of an external cavity diode laser was locked on He-4 2S-3P hyperfine transitions in a RF-discharged helium cell using a 10-mW 389-nm laser. The S/N ratio and performance were investigated.

LTh4H.2 • 15:45
Collective State Atomic Clock: Experimental Investigation and Application to Spin-Squeezing, Renpeng Fang[1], May E. Kim[1], Resham Sarkar[1], Selim Shahriar[1]; [1]*Northwestern Univ., USA.* We describe our effort towards experimental demonstration of an N-atom collective state atomic clock which produces a root-N narrowing of Ramsey fringes, and the application thereof to the generation and efficient detection of spin squeezing.

LTh4H.3 • 16:00
Self-heterodyne Measurement of Mode Evolution in High-Power Diode Lasers, Jordan P. Leidner[1], John R. Marciante[1]; [1]*The Inst. of Optics, USA.* Self-heterodyne measurements of beat frequencies between broad-area laser lateral and longitudinal modes are spatially resolved to generate spatio-spectral mappings of mode beat frequencies. Evolution with power is used as evidence to indicate spatial coherence collapse.

15:30–17:30
LTh4I • Novel Laser Systems
Presider: Ken-ichi Kitayama; Osaka Univ., Japan

LTh4I.1 • 15:30
Final EDP Ti: Sapphire Amplifiers for New Generation of Ultra-High Power Laser Systems, Vladimir V. Chvykov[1], Mikhail Kalashnikov[1], Károly Osvay[1]; [1]*ELI-ALPS, Hungary.* We studied the concept of EDP amplification for the 10-100 PW level of the three ELI-pillars laser systems. The design of EDP – duty amplifiers required to achieve these parameters was done and will be reported.

LTh4I.2 • 15:45
Polarization of the Airy Beam, Sean M. Nomoto[1], A. Aadhi[2], Shashi Prahbakar[2], R. P. Singh[2], Reeta Vyas[1], Surendra Singh[1]; [1]*Univ. of Arkansas, USA;* [2]*Theoretical Physics Division, Physical Research Lab, India.* Evolution of the polarization profile of finite aperture Maxwell-Airy beams with propagation was studied experimentally. Existence of the cross polarization of the Airy beam is demonstrated.

LTh4I.3 • 16:00
Unveiling the OAM and Acceleration of Vortex and Airy Beams, Roy Shiloh[1], Yuval Tsur[1], Roei Remez[1], Yossi Lereah[1], Boris A. Malomed[1], Vladlen Shvedov[2], Cyril Hnatovsky[2], Wieslaw Krolikowski[2], Ady Arie[1]; [1]*Tel-Aviv Univ., Israel;* [2]*Australian National Univ., Australia.* The Astigmatic Airy beam is introduced, and accurate, closed-form expressions are derived using ray-tracing methods. These expressions are confirmed in experiment in an extraordinary optical system: the transmission electron microscope.

FTh4A • Ultrafast Laser Applications II—Continued

FTh4A.3 • 16:15
Improved Method of Pulse Width Stabilization for Picosecond Mode-locked Yb-doped Fiber Laser, Vladimir A. Lazarev[1], Dmitriy Shelestov[1], Kirill Koshelev[1], Alexey Pnev[1], Valery Karasik[1], Anatoly Grudinin[2]; [1]*Bauman Moscow State Technical Univ., Russia;* [2]*Fianium Ltd, UK.* We developed an improved method based on SHG technique for pulse width stabilization of picosecond Yb-doped fiber laser with absolute error less than 200 fs.

FTh4A.4 • 16:30
Angle Resolved Photoelectron Phase Shifts in Above Threshold Ionization, Adi Natan[1], Lucas J. Zipp[1,2], Philip H. Bucksbaum[1,2]; [1]*SLAC National Accelerator Lab, USA;* [2]*Physics, Stanford Univ., USA.* We observed angle resolved phase shifts from interfering ionization pathways in strong field two-color above threshold ionization spectrum of argon. 2D Phase maps are obtained for both tunneling ionization and multi-photon ionization regimes.

FTh4A.5 • 16:45
Towards Generation of Long and Continuous Plasma Channels in Air., Evgeny (Jenya) Papeer[1], Moti Botton [1], Daniel Gordon[2], Phillip Sprangle[2], Yair Ferber[1], Elad Schleifer[1], Elior Dekel[1], Arie Zigler[1], Zohar Henis[1]; [1]*Hebrew Univ., Israel;* [2]*NRL, USA.* We experimentally demonstrate concatenation of several filaments left in the wake of powerful femtosecond laser. Lifetime of plasma filaments is extended using an external nanoseconds laser thus allowing to generate long, continuous high density plasma channels in air.

FTh4B • Integrated Photonics for Communications: Hybrid Integration on Silicon II—Continued

FTh4B.3 • 16:15 Tutorial
Quantum Dot Lasers on Silicon by Direct Epitaxial Growth, Alwyn J. Seeds[1], Jiang Wu[1], Siming Chen[1], Mingchu Tang[1], Qi Jiang[1], Huiyun Liu[1]; [1]*Univ. College London, UK.* Although many silicon photonic devices have been demonstrated, efficient, electrically pumped on-chip light sources have not been realised due to the indirect bandgap of silicon. Recent achievements in direct growth of high performance III-V quantum dot lasers on Si offer a solution to this problem.

Alwyn Seeds holds the Ph.D. and D.Sc. degrees of the University of London. After working as a Staff Member at MIT Lincoln Laboratory he moved to University College London, where he is Professor of Opto-electronics and Head of the Photonics Group. He has published over 400 papers and filed some 20 patents on microwave and photonic devices and their systems applications. Professor Seeds has been elected a Fellow of the Royal Academy of Engineering (UK) and an IEEE Fellow (USA). He has served as the Vice-President for Technical Affairs of the IEEE Photonics Society (USA).

FTh4C • Symposium on Applications of Low Noise Frequency Combs II—Continued

FTh4C.3 • 16:30 Invited
Signal Processing using Optical Frequency Combs, Ronald D. Esman[1], Anthony Lenihan[1]; [1]*MITRE Corp, USA.* We will review the utilization of optical frequency combs for wideband signal processing and the impact this will have on microwave systems. We discuss the subsystem performance metrics and relate them to required comb characteristics.

LTh4D • Complex Dynamics—Continued

LTh4D.4 • 16:15
An Atom Gyroscope Using a 2D Tilted Magneto-Optical Trap, Raghav Simha[1], Erin Knutson[2], George Welch[3], Francesco A. Narducci[1]; [1]*Naval Air Systems Command, USA;* [2]*Physics, St. Mary's College of Maryland, USA;* [3]*Physics, Texas A&M Univ., USA.* We present atom interferometry measurements using a 2D tilted MOT atom source. The atoms' transit times through multiple continuous Raman beams form the atom optic light pulses. Prospects for a dual sensor will be discussed.

LTh4D.5 • 16:30 WiO
Global Discord of Three Quantum Dots in a Driven Cavity with Dissipation in the Steady State, Willa Rawlinson[1], Reeta Vyas[1]; [1]*Univ. of Arkansas, USA.* Global Discord is calculated for three identical quantum dots interacting with a quantized cavity field in presence of dissipation, detuning, and driving field in the steady state and correlations with output field behavior is explored.

LTh4D.6 • 16:45
Magnetic Gradiometer Using Simultaneous Measurements on Two Cold Atom Clouds, Sara DeSavage[1], Arvind Srinivasan[2], Danielle Braje[3], Jon Davis[1], Francesco A. Narducci[1]; [1]*Naval Air Systems Command, USA;* [2]*Physics, St. Mary's College of Maryland, USA;* [3]*Integrated Nanosystems, MIT Lincoln Labs, USA.* We present measurements of magnetic gradients using atom clouds. Atoms are collected in a 3D MOT and half the atoms are launched. Raman spectroscopy is performed, determining the magnetic field at each atom cloud.

FTh4E • Optical Fiber Sensors IV: Methods—Continued

FTh4E.3 • 16:15
Probing the Intrinsic Thermal Noise of Optical Fibers at Infrasonic Frequencies, Lingze Duan[1]; [1]*Univ. of Alabama in Huntsville, USA.* A Mach-Zehnder-Fabry-Perot-hybrid sensing scheme is proposed for probing the fundamental thermal noise of optical fiber in the infrasonic region. A feasibility analysis is presented and experimental realization is discussed.

FTh4E.4 • 16:30
High Resolution All Fiber Optical Coherence Domain Polarimetry, Abdelrahman Afifi[1], Mahmoud H. Ahmed[1]; [1]*Electronics and Communications Eng. Dept., Faculty of Eng., Ain shams Univ., Egypt.* An all fiber OCDP is constructed with a fiber loop mirror replacing free space mirrors. The measuring technique incorporates a μs scanning to determine the cross coherence function details at any point in the DUT.

FTh4E.5 • 16:45
Enhancement of Exposed Evanescent Field in a Photonic Crystal Fiber with Triangular Air Holes around the Core for Chemical Sensing, Wee Lit Ng[1], Din Chai Tee[1], Kwok Shien Yeo[1], Ghafour Amouzad Mahdiraji[1], Gong-Ru Lin[2], Faisal Rafiq Mahamd Adikan[1]; [1]*Univ. of Malaya, Malaysia;* [2]*National Taiwan Univ., Taiwan.* Sunny PCF is proposed and numerically investigated. By adding the sunny structure to a normal PCF (air-filling ratio of 0.8), the sensitivity at 1500nm is boosted up from 12.35% to 16.85% without significant confinement loss.

FTh4F • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning II—Continued

FTh4F.3 • 16:15
Plasmon-assisted Etching for Fabrication of Planar Optical Components, Qing Ding[1], Hao Chen[1], Abdul Bhuiya[1], Kimani C. Toussaint[1]; [1]*Univ of Illinois at Urbana-Champaign, USA*. Plasmon-assisted etching (PAE) of arrays of Au pillar-supported bowtie nanoantenna is demonstrated. As proof-of-concept, we use PAE to demonstrate table-top fabrication of a planar diffraction grating and a Fresnel zone plate.

FTh4F.4 • 16:30
Vertically Tapered Adiabatic Waveguide Mode Converters Fabricated with Digital Projection Photochemical Etching, Kaiyuan Wang[1], Chris Edwards[1], Xin Yu[1], Lonna Edwards[1], Shailendra Srivastava[1], Lynford L. Goddard[1]; [1]*Univ of Illinois at Urbana-Champaign, USA*. We combine conventional planar semiconductor processing with gray-scale topography created by digital projection photochemical etching to fabricate adiabatic waveguide mode converters. Applications include efficient coupling to fiber or between planes of multi-layer photonic integrated circuits.

FTh4F.5 • 16:45 WiO
Optically Resonant Silver C-shape Arrays Fabricated via Two Photon Photoreduction, Sahar Tabrizi[1], Yaoyu Cao[1], Benjamin Cumming[1], Baohua Jia[1], Min Gu[1]; [1]*Swinburne Univ. of technology, Australia*. We demonstrate single-step direct laser writing of silver c-shape arrays via highly sensitive two-photon photoreduction process.The periodic nanostructures present strong optical resonances in the near-infrared region. This method provides cost-effective fabrication of functional metamaterial device.

FTh4G • Computational Optical Sensing and Imaging III—Continued

FTh4D.4 • 16:15
Temporal Ghost Imaging, Piotr Ryczkowski[1], Margaux Barbier[1], Ari T. Friberg[2], John M. Dudley[3], Goëry Genty[1]; [1]*Optics Lab, Tampere Univ. of Technology, Finland;* [2]*Dept. of Physics and Mathematics, Univ. of Eastern Finland, Finland;* [3]*Institut FEMTO-ST, Université de Franche-Comté, France*. We report on the first experimental demonstration of time-domain ghost imaging using a temporally incoherent classical light source. Our results open novel perspectives for dynamic imaging of ultrafast signals with high resolution even in the presence of noise.

FTh4D.5 • 16:30
Stochastic Characterization of Optical Scattering Potentials, Milad Akhlaghi Bouzan[1], Aristide Dogariu[1]; [1]*CREOL, College of Optics and Photonics, Univ. of Central Florida, USA*. Enhanced fluctuations of integrated scattered intensity are used to measure characteristic scales of scattering potentials. The approach relies on controlling only statistical properties of the illumination and is robust against inherent perturbations.

FTh4D.6 • 16:45
Tunable Optical Masks for extended Depth of Field, Jorge Ojeda-Castaneda[1]; [1]*Univ. of Guanajuato, Mexico*. We discuss the concept of a vortex-pair and its use for implementing phase masks and tunable apodizers, which extend the depth of field. We apply these devices for designing nonconventional systems, with zero Petzval sum.

LTh4H • Stable Laser Systems—Continued

LTh4H.4 • 16:15
Simultaneous CW 1063.7 nm and 1070.8 nm dual wavelength Nd:$GdVO_4$ laser operation using two VBGs for gain control, Yu-Hua Hsieh[1], Ching-Nien Chen[1], Te-Yuan Chung[1]; [1]*National Central Univ., Taiwan*. Dual wavelength operation of a diode pumped Nd:$GdVO_4$ laser was constructed using two volume Bragg gratings (VBGs) as the output couplers. By tuning the temperature of both VBGs achieved stabilization dual wavelength laser output.

LTh4H.5 • 16:30 WiO
Study of White Noise Corner Frequency Location in Residual Phase Noise Measurement with Short and Long Cavity Lengths, Kristina Bagnell[1], Anthony Klee[1], Peter Delfyett[1]; [1]*CREOL - College of Optics and Photonics, USA*. We present an investigation of the white noise plateau in residual phase noise measurement of an optical frequency comb for short and long external laser cavity lengths.

LTh4H.6 • 16:45
Robust Optical Clocks Based on Alkaline-Earth Vapor Cells, Christopher J. Erickson[1], Jordan Armstrong[2], Nathan Lemke[3]; [1]*Space Vehicles, Air Force Research Lab, USA;* [2]*ATA Aerospace, USA;* [3]*Space Dynamics Lab, USA*. Alkaline-earth atoms offer narrow linewidth clock transitions that have been limited to lattice, MOT, and beam geometries due to material properties. We present compact vapor cell solutions for realizing clocks with these atoms.

LTh4I • Novel Laser Systems—Continued

LTh4I.4 • 16:15 WiO
Mode Profile of a Mid-IR Gas-filled Hollow-Core Photonic Crystal Fiber Laser, Neda Dadashzadeh[1], Kushan Weerasinghe[1], Andrew Jones[1], Benoit Debord[2], Frederic Gerome[2], Fetah Benabid[2], Brian Washburn[1], Kristan Corwin[1]; [1]*Kansas State Univ., USA;* [2]*Univ. of Limoges, XLIM Research Inst., France*. Beam profile measurements of an acetylene-filled hollow-core fiber laser have been performed for the first time, towards beam combining. The laser produces a beam with M^2 of 1.71±0.19.

LTh4I.5 • 16:30 WiO
Two-Photon Spectroscopy in Rb for an Optical Frequency Standard, Gretchen Phelps[1], Nathan Lemke[1], Chris Erickson[2], John Burke[2]; [1]*Space Dynamics Lab, USA;* [2]*Air Force Research Lab, USA*. We report on the development of an atomic clock for both ground and space applications, based upon the two-photon transition in Rb. Off-the-shelf components allow for a simple architecture that supports $7 \times 10^{-13} \tau^{-1/2}$ at 1 second.

LTh4I.6 • 16:45
Thin-Disk Pumped, High-Average-Power, 2.06-µm BiB_3O_6 Femtosecond Optical Parametric Oscillator, Travis Petersen[2,1], Jake Bromage[1]; [1]*Lab for Laser Energetics, USA;* [2]*Optics, Univ. of Rochester, USA*. A sync-pumped optical parametric oscillator using a 48-W, 1.1-ps, thin-disk–based pump laser designed to produce 0.5-µJ, sub-500-fs pulses at 7.08 MHz centered at 2060 nm is currently under construction.

FiO | FiO | LS | FiO

FTh4A • Ultrafast Laser Applications II—Continued

FTh4A.6 • 17:00
Temporal Lenses for Three-Dimensional Electron Pulse Compression, Liang Jie Wong[1,2], Byron Freelon[2], Timm Rohwer[2], Nuh Gedik[2], Steven Johnson[2]; [1]*Sg Inst. of Manufacturing Technol, Singapore;* [2]*MIT, USA*. We propose an all-optical method of compressing electron pulses to attosecond durations and sub-micrometer dimensions using ultrafast optical pulses. Applications range from ultrafast electron imaging to coherent terahertz sources.

FTh4A.7• 17:15
Development of Predictive Models of Absorption of High Power Laser Light by Optically-Thick Materials, Matthew Levy[1], Scott C. Wilks[2], Max Tabak[2], Stephen Libby[2], Siegfried Glenzer[3], Peter Norreys[1]; [1]*Univ. of Oxford, UK;* [2]*Lawrence Livermore National Lab, USA;* [3]*SLAC National Accelerator Lab, USA*. Key metrics for petawatt (10^{15} W) laser applications, such laser fusion, relate to the absorption *f*. In this paper, we show how to derive the theoretical extrema of *f*. We then show how to sweep out curves through this constrained parameter space.

FTh4B • Integrated Photonics for Communications: Hybrid Integration on Silicon II—Continued

FTh4B.4 • 17:00 WiO
Selective growth and coalescence of GaAs on Si (001) substrates using a round-hole nanopatterned SiO_2 mask, Yunrui He[1], Jun Wang[1], Haiyang Hu[1], Qi Wang[1], Yongqing Huang[1], Xiaomin Ren[1]; [1]*BUPT, China*. The epitaxy of GaAs on round-hole nanopatterned GaAs/Si substrates is studied. Faceted growth fronts and the tilt of GaAs pillars are observed. Experimental results show that the deposition selectivity is not sensitive to growth temperature.

FTh4B.5 • 17:15
Silicon-Integrated Graphene-Based THz Modulator, Martin Mittendorff[1], Shanshan Li[2], Thomas E. Murphy[1,2]; [1]*Inst. for Research in Electronics & Applied Physics, Univ. of Maryland, USA;* [2]*Dept. of Electrical & Computer Engineering, Univ. of Maryland, USA*. We present a broadband THz modulator based on a silicon waveguide with a graphene sheet on top. The Fermi energy, and therefore the intraband absorption in the graphene, is modulated via a back gate.

FTh4C • Symposium on Applications of Low Noise Frequency Combs II—Continued

FTh4C.4 • 17:00 Invited
Comb-locked Arbitrary Signal Synthesis, Radan Slavik[1], David S. Wu[2], David J. Richardson[1]; [1]*Univ. of Southampton, UK;* [2]*Albert Einstein Inst., Max Planck, Germany.* New route toward optical waveform generation based upon the coherent combination of multiple comb-locked semiconductor lasers operating at different wavelengths is investigated. Various challenges associated with this approach are addressed.

LTh4D • Complex Dynamcis—Continued

LTh4D.7 • 17:00
Realization of Inverse Saturable Absorption by Cascaded Second-Order Process for Stable Modelocking, Shyamal Mondal[1], Shouvik Mukherjee[2,1], Satya P. Singh[1], Prasanta K. Datta[1]; [1]*Indian Inst. of Technology Kharagpur, India;* [2]*Dept. of Physics and Astronomy, Univ. of Pittsburgh, USA*. Experimentally realized stable picosecond pulses from a cascaded second-order cw-mode-locked Nd:YVO_4 laser has been verified by a self-consistent-complex-beam propagation method with radially varying gain aperturing which accounts the stable pulsewidth and inverse saturation loss behavior.

FTh4E • Optical Fiber Sensors IV: Methods—Continued

FTh4E.6 • 17:00 Invited
Fibre Optic Radiation Sensor Systems for Particle Accelerators, Jochen Kuhnhenn[1]; [1]*Fraunhofer-Institut Naturwissenschaftlich Technische Trendanalysen, Germany.* Sensing radiation with optical fibers has become a valuable tool especially at accelerators over the last decade. This presentation will present principles, constraints and options to detect radiation via different effects induced in optical fibers.

Thank you for attending FiO/LS. Look for your post-conference survey via email and let us know your thoughts on the program.

FiO

FTh4F • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning II—Continued

FTh4F.6 • 17:00
Designing All-Dielectric Structures for Efficient Directional Scattering, Roxana Rezvani Naraghi[1,2], Sergey Sukhov[1], Aristide Dogariu[1]; *[1]CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA; [2]Dept. of Physics, Univ. of Central Florida, USA.* By structural design of wavelength-size all-dielectric spherical particles, one could control the scattering directivity. Besides, an inverse Mie procedure can be implemented for core-shells particle in order to find the refractive indices and particle size.

FTh4F.7 • 17:15
Designing Transparent Structural Color, Chia Wei Hsu[1,2], Owen D. Miller[2], Steven Johnson[2], Marin Soljacic[2]; *[1]Yale Univ., USA; [2]MIT, USA.* We design dielectric stacked-ring structures that are transparent under omnidirectional broadband illumination but scatter strongly with a directional narrowband light source. Such structures can be used as transparent projection screens.

FTh4G • Computational Optical Sensing and Imaging III—Continued

FTh4D.7 • 17:00 WiO
Sampling Rate Chosen to Ensure Unitary and Additive Properties for the 2D Non-separable Linear Canonical Transform, Liang Zhao[1], Inbarasan Muniraj[1], John J. Healy[1], John T. Sheridan[1]; *[1]Univ. College Dublin, Ireland.* The linear canonical transform can model a wide variety of paraxial optical systems. The continuous transform is additive & unitary, sampling rate chosen to ensure these two important group properties during discretization are summarized.

FTh4D.8 • 17:15
Trans-spectral Ghost Microscopy, Reuben Aspden[1], Nathan R. Gemmell[1], Peter Morris[1], Daniel S. Tasca[2], Lena Mertens[1], Michael G. Tanner[3], Robert A. Kirkwood[1], Alessandro Ruggeri[4], Alberto Tosi[4], Robert W. Boyd[5,6], Gerald S. Buller[3], Robert H. Hadfield[1], Miles J. Padgett[1]; *[1]Univ. of Glasgow, UK; [2] Universidade Federal do Rio de Janeiro, Brazil; [3]Heriot-Watt Univ., UK; [4]Informazione e Bioingegneria Politecnico di Milano,, Italy; [5]Univ. of Rochester, USA; [6]Univ. of Ottawa, Canada.* Low-light infrared imaging techniques suffer from high noise levels and cost. We demonstrate a ghost microscopy system where the object is probed using infrared photons whilst the image is developed with correlated visible photons.

LS

LTh4H • Stable Laser Systems—Continued

LTh4H.7 • 17:00
Multi-Pulsing Dynamics in Coupled-Cavity Soliton Fiber Laser, Ki Sang Lee[1], Kee Hwan Nam[1], Myeongsoo Kang[1]; *[1]Dept. of Physics, KAIST, Korea.* Dynamics of a coupled-cavity mode-locked soliton fiber laser is experimentally investigated at both the single-pulsing and multi-pulsing regimes. In particular, multi-pulsing dynamics can be widely controlled by tuning the cavity coupling strength and intra-cavity loss.

LTh4I • Novel Laser Systems—Continued

LTh4I.7 • 17:00
Linearly Tunable Single Frequency Nd: YVO_4 Laser Utilizing RTP as Electro-Optical Element, Xinrui Xu[1], Deying Chen[1], Rongwei Fan[1], Yufei Ma[1], Renpeng Yan[1], Xudong Li[1]; *[1]National Key Lab of Science and Technology on Tunable Laser, Harbin Inst. of Technology, China.* A linearly tunable single frequency Nd: YVO_4 laser is proposed. Single frequency tuning operation with a tuning range of 6.9 GHz at 1064 nm is achieved by tilting etalon and modulating voltage applied on RTP simultaneously.

LTh4I.8 • 17:15
Graphene/Polymer Composite Saturable Absorbers Based On Evanescent Wave Interaction Using Etched Fiber, Hyub Lee[1], Won Sik Kwon[1], Jin Hwan Kim[1], Daewon Kang[1], Kyungsoo Kim[1], Soohyun kim[1]; *[1]Korea Advanced Inst. of Science and Technology , Korea.* A graphene/polymer composite coated on a chemically etched fiber is used as a saturable absorber based on evanescent wave interaction for passive mode-locking of ultrafast fiber lasers.