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

- [AIM Photonics](https://aimphotonics.org)
- [OSA Industry Development Associates](https://www.osaindustrial.org)
- [Precision Optical Transceivers](https://www.precisionoptics.com)
- [Synopsys](https://www.synopsys.com)
- [Thorlabs](https://www.thorlabs.com)
- [Wiley](https://www.wiley.com)

Check the Mobile App for regular updates. Program updates and changes through 13 October may be found on the Conference Program Update Sheet distributed in the registration bags.
# Conference Schedule-at-a-Glance

Note: Dates and Times are subject to change. Check the Mobile App for regular updates. All times reflect Eastern time zone.

<table>
<thead>
<tr>
<th>Time Block</th>
<th>Monday 17 October</th>
<th>Tuesday 18 October</th>
<th>Wednesday 19 October</th>
<th>Thursday 20 October</th>
<th>Friday 21 October</th>
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</thead>
<tbody>
<tr>
<td><strong>GENERAL &amp; EXHIBITS</strong></td>
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<tr>
<td>Registration</td>
<td>15:00–20:00</td>
<td>07:00–17:00</td>
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<td>07:30–16:30</td>
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<tr>
<td>WORKinOPTICS.com Kiosk &amp; E-Center</td>
<td>15:00–20:00</td>
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<td>07:00–17:00</td>
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<tr>
<td>Speaker Preparation Room</td>
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<tr>
<td>Coffee Breaks</td>
<td>10:00–10:30</td>
<td>09:30–10:30</td>
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<tr>
<td>Exhibit Hall Open</td>
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<td>09:30–16:00</td>
<td>09:30–14:00</td>
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<tr>
<td>Unopposed Exhibit-only Time</td>
<td>09:30–10:30</td>
<td>09:30–10:00</td>
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<td>14:30–16:00</td>
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<tr>
<td>Glass Art Contest &amp; Auction</td>
<td>09:30–16:00</td>
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<tr>
<td>OSA Student Chapter Competition</td>
<td>14:00–16:00</td>
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<tr>
<td><strong>PROGRAMMING</strong></td>
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<tr>
<td>FiO/LS Technical Sessions</td>
<td>08:00–18:00</td>
<td>10:30–18:00</td>
<td>14:00–18:30</td>
<td>08:00–18:00</td>
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<tr>
<td>Laser Science Symposium on Undergraduate Research</td>
<td>12:15–18:00</td>
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<tr>
<td>Joint FiO/LS Plenary &amp; Awards Sessions</td>
<td>08:00–09:30</td>
<td>08:00–09:30</td>
<td>14:30–16:00</td>
<td>09:30–11:00</td>
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<tr>
<td>FiO Poster Sessions</td>
<td>08:00–09:30</td>
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<tr>
<td>OSA Light the Future Speaker Series featuring Michio Kaku and Nobel Laureates</td>
<td>11:00–12:30</td>
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<td>Postdeadline Paper Sessions</td>
<td>10:30–12:30</td>
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<tr>
<td><strong>SPECIAL EVENTS</strong></td>
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<tr>
<td>Women of Light, a Special Program for Women in Optics hosted by WiSTEE CONNECT</td>
<td>11:00–17:00</td>
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<tr>
<td>Make Optics Career Roundtable</td>
<td>17:00–18:00</td>
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<tr>
<td>Diversity &amp; Inclusion Reception: A Look at the LGBT Climate in Physics</td>
<td>17:00–18:00</td>
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<tr>
<td>FiO/LS Welcome Reception</td>
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<td>Osa Fellow Members Lunch</td>
<td>07:30–08:30</td>
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<tr>
<td>Optical Material Studies Technical Group Special Talk</td>
<td>12:00–13:15</td>
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<tr>
<td>Polarization Technical Group Special Talk</td>
<td>12:00–13:30</td>
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<td>OSA Friends and Family Event</td>
<td>13:45–16:00</td>
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<tr>
<td>Meet the OSA Editors’ Reception</td>
<td>15:30–16:30</td>
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<tr>
<td>Photonics Clambake 2016</td>
<td>17:30–20:30</td>
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<td>Optics &amp; Energy: Reflections on the Past and Lighting the Future</td>
<td>18:00–19:00</td>
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<td>OSA Student Member Party</td>
<td>19:00–22:00</td>
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<td>Optics Alumni Networking Reception</td>
<td>19:00–22:00</td>
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<td>AIM Photonics Northeast Supply Conference (NESCO)</td>
<td>08:00–17:00</td>
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<td>Environmental Sensing Technical Group Special Talk</td>
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<td>Meet the Editors of the APS Journals Reception</td>
<td>15:30–17:00</td>
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<td>OIDA Member and Exhibitor Appreciation Reception</td>
<td>16:00–17:00</td>
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<td>OSA Annual Business Meeting</td>
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<tr>
<td>DLS Annual Business Meeting</td>
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<tr>
<td>OSA 100 Year BASH</td>
<td>18:30–21:30</td>
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<tr>
<td>VIP Industry Leaders Networking Event</td>
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Welcome to Frontiers in Optics 2016

We are pleased that you have chosen to join us to celebrate The Optical Society’s centennial year as we return to the organization’s birthplace, Rochester, New York. The 2016 Frontiers in Optics (FiO) Conference, the 100th Annual meeting of The Optical Society, will encompass the breadth of optical science and engineering and provide 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 2016.

The technical program features nearly 900 invited, tutorial, and 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. This year’s program also features two renowned Plenary speakers. Lukas Novotny, ETH Zurich, Switzerland, will give the presentation, “Controlling Light-matter Interactions on the Nanometer Scale” during Wednesday’s Plenary session. Michal Lipson, Columbia University, USA, will discuss “Next Generation Silicon Photonics” at the Thursday Plenary session. Our Plenary session programming will also include the award presentations from two individuals receiving two of the highest honors for OSA and APS. Gerard Mourou, University of Michigan, USA, winner of the OSA 2016 Frederic Ives Medal/Jarus W. Quinn Prize, will give an address at the Wednesday Plenary session. Robert W. Boyd, recipient of the APS 2016 Arthur L. Schawlow Prize will present during Thursday’s Plenary session. In addition to these distinguished speakers, OSA will celebrate our 100th Anniversary with a continuation of the Light the Future Speaker series. This event will feature Michio Kaku, Futurist and theoretical Physicist, City College of New York, USA.

FiO is pleased to offer several special symposia – The Symposium on 100 Years of Optical Design, Fabrication, Testing and Instrumentation – A Historical Look Back (Tuesday, 18 October, 08:00–14:30); The Symposium on the 50th Anniversary of Low-Loss Optical Fibers (Tuesday, 18 October, 08:00–14:30); The Symposium on Mid-Infrared Fiber Sources (Thursday, 20 October, 08:00–14:30); and the Symposium on Integrated Quantum Optics (Friday, 21 October, 08:00–14:30); and the Symposium on Integrated Quantum Optics (Friday, 21 October, 14:30–17:30). 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 2016 include the following:

- OSA’s Science Educators’ Day will be held on Sunday, 16 October, from 13:30–16:30, in the Grand Ballroom of the Hyatt Regency Rochester. 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.
- The Conference Welcome Reception will be held on Monday, 17 October, from 18:30–20:30.
- OSA Students will be welcomed at the OSA Student Member Party Tuesday, 18 October from 19:00–22:00.
- Be sure to join us for the OSA 100 Year BASH on Wednesday, 19 October from 18:30–21:30.
- The Light the Future Speaker Series featuring a presentation by Michio Kaku will be held on Thursday, 20 October from 11:00–12:30.
- Late-breaking advances in optics will be presented on Friday, 21 October, in the FiO Postdeadline Paper Sessions, running from 10:30–12:30.
- The OSA Foundation is pleased to announce the 8th annual Emil Wolf Outstanding Student Paper Competition. One award winner will be selected from each of the seven FiO subsequences. 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).
- Wednesday and Thursday, 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!

We welcome you to FiO 2016 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!
Welcome to Laser Science 2016

The leadership of the Division of Laser Science (DLS) of the American Physical Society (APS) is pleased to welcome you to our 32nd annual meeting, Laser Science (LS) 2016, in Rochester, New York. We are grateful for the help of our colleagues and technical program Subcommittee Chairs, David Reis, Robert Alfano, Bo Zhen, Nick Vamivakas, Mohammad Hafezi, Carlos Baiz, Dirk Englund, and Christopher Milne, 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. 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 with over 100 Laser Science presentations, 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 Tuesday, 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. The technical sessions for the Laser Science meeting are organized around several broad themes: High Harmonic Generation from Solids to Gases; Multiphoton Effects and High Resolution Imaging; Advanced Nano-Photonic Lasers: Science and Application; Quantum Light Sources; Integrated Quantum Photonics; Nonreciprocal and Topological Photonic Devices; Nano-Plasmonics for Spectroscopy and Imaging; Advances in X-ray and XUV Laser Science and Applications; and General Laser Science. The DLS Business meeting will be held Wednesday, 19 October from 17:00–18:00. We welcome you to the Laser Science 2016 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!

Kevin J. Kubarych
University of Michigan, USA,
Laser Science Co-Chair

Edo Waks
University of Maryland, USA,
Laser Science Co-Chair
General Information

Conference Services

Registration
Galleria

Registration Hours

<table>
<thead>
<tr>
<th>Monday, 17 October</th>
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<td>Friday, 21 October</td>
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Speaker Preparation Room
Aqueduct C/D

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

<table>
<thead>
<tr>
<th>Monday, 17 October</th>
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Media Room
Aqueduct A/B

A staffed media room is available for credentialed members of the media. Badges for pre-registered reporters and reporter registration are in the media room along with media kits, internet connectivity and printer.

Media Room Hours

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<tr>
<th>Monday, 17 October</th>
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<td>Tuesday, 18 October</td>
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<td>Thursday, 20 October</td>
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E-Center
Empire Lobby

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

Exhibition
Empire Hall

Wednesday, 19 October, 09:30–16:00
Thursday, 20 October, 09:30–14:00

Exhibit Hours Exclusive

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<tr>
<th>Wednesday, 19 October</th>
<th>09:30–10:30 12:00–13:00 14:00–16:00</th>
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<tr>
<td>Thursday, 20 October</td>
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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.

Business Center
Hyatt Regency Rochester and Radisson Rochester Riverside

The Radisson Rochester Riverside Business Center is located in the hotel Lobby and features four computers for guest use as well as printers. Copying, and faxing services are offered through the Radisson Rochester Riverside Front Desk. These services are available 24 Hours a Day.

The Hyatt Regency Rochester’s in-house Business Center, operated by CMI Communications, offers one-stop shopping for all of your business needs, including e-mail and high-speed Internet access, secretarial/transcription services, photocopying, and faxing. Guests of the Hyatt Regency Rochester have extended access to the business center which is available 24 hours a day, 7 days a week.

Lost and Found

For Lost and Found please check first at the conference registration counter in the Galleria. 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.

Rochester Riverside Convention Center
Wifi information:
SSID: FiO2016
Password: OSA100proud

Radisson Rochester Riverside Wifi Information:
SSID: RadissonRochesterRiverside
Password: none

WORKinOPTICS.com Kiosk
Empire Lobby
WORKinOPTICS.com provides a state-of-the-art platform to efficiently connect employers and job seekers within the optics and photonics community.

Your next job opportunity or new hire is just a click away.

- Post your resume at no charge to reach top employers.
- OSA Industry Development Associates Members get 20 free job postings.

First Aid and Emergency Information
In the event of an emergency at the Rochester Riverside Convention Center, please dial “0” from any black courtesy phone.

Medical Facilities
Strong Memorial Hospital
601 Elmwood Avenue
Rochester, New York 14642
+1 585.275.2100

Rochester General Hospital
1425 Portland Avenue Rochester, New York 14621
+1 585.922.4000

Highland Hospital
1000 South Avenue Rochester, New York 14620
+1 585.473.2200

Park Ridge Hospital
1555 Long Pond Road Rochester, New York 14626
+1 585.723.7000

Sponsoring Society Membership Booths
Galleria

APS and OSA Society Booth Hours

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APS Booth
Galleria
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 Fluids, Physical Review Applied, Physical Review Accelerators and Beams, Physical Review Physics Education Research, and Physics. Please stop by our table near Registration to learn more about the prestigious Physical Review collection and Physical Review Fluids, our newest journal dedicated to publishing innovative research that will significantly advance the fundamental understanding of fluid dynamics.

OSA Booth
Galleria
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.

CAM Lounge
Empire 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

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OSA100 Exhibit
Empire Hall Booth #101 and Galleria

OSA is marking a century of sparking inspiration and smart innovation driven by 270,000 scientists, students, engineers and business leaders around the world. Visit the OSA100 Exhibit in the registration area to experience 100 iconic images from the history of optics, photonics and The Optical Society. A smaller version of the exhibit will also be featured at booth #101. To see the interactive version of the OSA100 Exhibit and learn more about OSA Centennial Activities, go to osa.org/100.

OSA100 Empire Hall Booth Hours

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<th>Date</th>
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OSA100 Galleria Booth Hours

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<td>Wednesday, 19 October</td>
<td>07:00–17:00</td>
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<tr>
<td>Thursday, 20 October</td>
<td>07:00–17:00</td>
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<tr>
<td>Friday, 21 October</td>
<td>07:30–16:30</td>
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Looking for Lunch? Food Trucks and Concessions!

We have planned some new exciting lunch options. On Tuesday, 18 October and Friday, 21 October a variety of food trucks will be available during lunch hours (cash and credit accepted) outside of the Rochester Riverside Convention Center. On Wednesday, 19 October, cash concessions will be available in the exhibit hall from 12:00–13:00, visit with the exhibitors and enjoy lunch (cash only please).

Free Lunch Provided by OSA

On Thursday, 20 October, join your FiO colleagues for a FREE lunch in the Exhibit Hall from 12:30–14:00. This is a great opportunity to meet the exhibitors who have contributed to our success over the last 100 years.
OSA Membership is an investment in your future—with professional benefits and vital connections that can last your entire career. That’s why 19,275 leaders in science, engineering and industry choose The Optical Society as their professional association.

As a Frontiers in Optics attendee, you can save 50% on a one-year, individual membership.* This special rate is available whether you’re joining for the first time or renewing for another year.

Stop by the OSA Booth in the lobby area to take up the offer. (Then visit the OSA Centennial Exhibit, which reflects on 100 years of innovations and inventions in optics.)

* Promotion applies to 1-year individual membership only.
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 2016 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. 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.

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 reference the FiO/LS mobile app.

Join the Social Conversation at FiO/LS 2016!
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 #FIO16 in your tweets. Stop by the OSA booth for more details. Join the conversation. Follow @Opticalsociety on Twitter. Use hashtag #FIO16. Celebrate 100 years of optics at #OSA100.

FiO/LS Mobile Application
Frontiers in Optics/Laser Science 2016 (FiO/LS 2016) has gone mobile again this year using CrowdCompass! We strongly encourage you to download our mobile guide to enhance your experience at FiO/LS 2016. 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’)
3. Search for OSA Events in the app stores.
# 2017 OSA Optics and Photonics Topical Meetings and Congresses

<table>
<thead>
<tr>
<th>Event Name</th>
<th>Dates</th>
<th>Submit by</th>
<th>Location/Website</th>
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<tbody>
<tr>
<td>OFC</td>
<td>19 - 23 March Los Angeles, California, USA ofcconference.org</td>
<td>11 October 2016</td>
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<tr>
<td>Optical Trapping Applications (OTA) Novel Techniques in Microscopy (NTM)</td>
<td>OSA Biophotonics Congress: Optics in the Life Sciences 2 - 5 April San Diego, California, USA osa.org/LifeSciencesOPC</td>
<td>29 November 2016</td>
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<tr>
<td>Bio-Optics: Design and Application (BODA) Optics and the Brain (BRAIN)</td>
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<td>OSA Quantum Information and Measurement (QIM) - IV: Quantum Technologies</td>
<td>5 - 7 April Paris, France osa.org/qim</td>
<td>6 December 2016</td>
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<tr>
<td>CLEO: 2017</td>
<td>14 - 19 May San Jose, California, USA cleoconference.org</td>
<td>14 December 2016</td>
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<tr>
<td>OSA Digital Holography and 3-D Imaging Topical Meeting</td>
<td>29 May - 1 June Jeju Island, South Korea osa.org/dh</td>
<td>24 January 2017</td>
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<tr>
<td>CLEO/Europe - EQEC</td>
<td>25 - 29 June Munich, Germany <a href="http://www.cleoeurope.org">www.cleoeurope.org</a></td>
<td>19 January 2017</td>
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<tr>
<td>European Conferences on Biomedical Optics</td>
<td>25 - 29 June Munich, Germany <a href="http://www.osa.org/ecbo">www.osa.org/ecbo</a></td>
<td>19 January 2017</td>
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<tr>
<td>3D Image Collection and Display Applied Industrial Optics (AIO)</td>
<td>OSA Imaging and Applied Optics Congress 26 - 29 June San Francisco, California osa.org/ImagingOPC</td>
<td>15 February 2017</td>
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<td>Computational Optical Sensing and Imaging (COSI)</td>
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<td>Imaging Systems and Applications (IS) Mathematics in Imaging</td>
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<tr>
<td>Propagation Through and Characterization of Atmospheric and Oceanic Phenomena (pcAOP)</td>
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## Submit your abstract by:

- **OFC**
- **OSA Biophotonics Congress**: Optics in the Life Sciences 2 - 5 April San Diego, California, USA osa.org/LifeSciencesOPC
- **OSA Design and Fabrication Congress** 9 - 13 July Denver, Colorado, USA osa.org/DesignFabOPC
- **OSA Nonlinear Optics Topical Meeting** 17 - 21 July Waikoloa, Hawaii, USA osa.org/nlo
- **OSA Advanced Photonics Congress** 24 - 27 July New Orleans, Louisiana, USA osa.org/PhotonicsOPC
- **CLEO/Pacific Rim** 31 July - 4 August Singapore, Singapore photonics2017.org
- **Frontiers in Optics/Laser Science** 17 - 21 September Washington, D.C., USA frontiersinoptics.com
- **Advanced Solid State Lasers Conference and Exhibition (ASSL)**
- **OSA Laser Congress** 1 - 5 October Nagoya, Aichi, Japan osa.org/assl
- **Solid State Lighting (SSL)**
- **OSA Light, Energy and the Environment Congress** 6 - 9 November Boulder, Colorado, USA osa.org/EnergyOPC
Conference Plenary Sessions and Awards Ceremony

Wednesday, 19 October, 08:00–09:30 and Thursday, 20 October, 08:00–09:30

Lilac 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:

**Wednesday, 19 October**

Welcome and Opening Remarks

**Controlling Light-matter Interactions on the Nanometer Scale**, Lukas Novotny, ETH Zürich, Switzerland

OSA Award and Medal Presentations

Ives Medal Address – Extreme Light: From Multiphoton Ionization to Light Materialization and Beyond, Gérard Mourou, IZEST, Ecole Polytechnique Palaiseau, France

Closing Remarks

**Thursday, 20 October**

Welcome

**Next Generation Silicon Photonics**, Michal Lipson, Columbia University, USA

OSA Fellow Member Recognition

APS Fellow Member Recognition

Schawlow Prize Lecture – Nonlinear Optics and Laser Science, Robert W. Boyd, University of Ottawa, Canada

Closing Remarks

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**Plenary Presentations**

**Controlling Light-matter Interactions on the Nanometer Scale**, Lukas Novotny, ETH Zürich, Switzerland

The past 20 years have brought exceptional control over light-matter interactions on the nanoscale. Today, localized optical fields are being probed with nanoscale materials and, vice versa, nanoscale materials are being controlled and manipulated with localized fields.

In this talk, Lukas Novotny will discuss both early and recent developments in near-field optical spectroscopy and optical nanomanipulation.

**About the Speaker**

Lukas Novotny is a Professor of Photonics at ETH Zürich. His research is focused on understanding and controlling light-matter interactions on the nanometer scale. Novotny did his PhD at ETH Zürich and from 1996-99 he was a postdoctoral fellow at the Pacific Northwest National Laboratory, working on new schemes of single molecule detection and nonlinear spectroscopy. In 1999 he joined the faculty of the Institute of Optics at the University of Rochester where he started one of the first research programs to focus on nano-optics. Novotny is the author of the textbook Principles of Nano-Optics, which is currently in its second edition. He is a Fellow of The Optical Society and the American Association for the Advancement of Science.

**Next Generation Silicon Photonics**, Michal Lipson, Columbia University, USA

In the past decade, silicon photonics has recently been shown as a platform for high-performance optical devices that can be monolithically integrated with state-of-the-art microelectronics.

The toolbox of integrated nanophotonics today is rich: from the ability to modulate, guide and amplify multiple wavelength sources at GHz bandwidths, to optomechanical MEMS and nonlinear devices.

In this talk, Michal Lipson will review the current challenges and recent achievements in the field of silicon photonics and present recent results. Using highly-confined photonic structures, her team has demonstrated ultra-compact passive and active silicon photonic components that enhance the electro-optical, mechanical and nonlinear properties of the material.

**About the Speaker**

Prof. Michal Lipson is the Eugene Higgins Professor at Columbia University. She completed her B.S., M.S. and Ph.D. degrees in Physics in the Technion in 1998. Following a Postdoctoral position in MIT in the Material Science department from 1998 to 2001, she joined the School of Electrical and Computer Engineering at Cornell University and was named the Given Foundation Professor of Engineering at the School of Electrical and Computer Engineering in 2012. In 2015 she joined the electrical engineering department at Columbia University. Lipson is one of the pioneers of the field of silicon photonics. She holds over 20 patents and is the author of over 200 technical papers. Prof. Lipson’s honors and awards include Macarthur Fellow, Blavatnik Award, IBM Faculty Award, and NSF Early Career Award. She is a Fellow of both the OSA and of IEEE. She was named by Thomson Reuters as a top 1% highly cited researcher in the field of Physics.
Awards Ceremony

APS and OSA will present awards and honors during the Plenary Session.

2016 Arthur L. Schawlow Prize in Laser Science

Nonlinear Optics and Laser Science, Robert W. Boyd, University of Ottawa, Canada

The interplay between nonlinear optics and the field of laser science will be reviewed. Topics to be stressed include the development of approaches for controlling the velocity of light, of quantum imaging methods, and composite nonlinear optical materials.

About the Speaker

Robert W. Boyd received the B.S. degree in physics in 1969 from Massachusetts Institute of Physics (MIT) and his Ph.D. in physics in 1977 from the University of California, Berkeley. He joined the faculty of the University of Rochester in 1977, and in 2001 became the M. Parker Greens Professor of Optics and Professor of Physics. In 2010, he became Professor of Physics and Canada Excellence Research Chair at the University of Ottawa. His research interests include studies of “slow” and “fast” light, orbital angular momentum of light, quantum communication, quantum imaging, nonlinear optical interactions and materials, and nanofabrication of photonic devices. He has written two books, co-edited two anthologies, published over 400 research papers (=29,000 citations, Google h-index 71), and been awarded nine patents. He is the 2009 recipient of the Willis E. Lamb Award for Laser Science and Quantum Optics, the 2010 recipient of a Humboldt Research Prize, and the 2014 recipient of the Quantum Electronics Award of the IEEE Photonics Society.

2016 Frederic Ives Medal / Jarus Quinn Prize

Extreme Light: From Multiphoton Ionization to Light Materialization and Beyond, Gérard Mourou, École Polytechnique, France

The laser provides a convenient way to generate formidable fields—enough to break atomic bonds, drive particles relativistically over short distances or generate high energy radiations. A new way to compress large energy pulses into the attosecond-zeptosecond range has emerged. X-Ray pulses in the exawatt regime would ensue opening unfathomable possibilities for nuclear physics, high energy physics, astrophysics and cosmology, showing that the best in laser physics is yet to come.

About the Speaker

Gérard Mourou was the founding Director of the Center for Ultrafast Optical Science at the University of Michigan. For forty years, Mourou has pioneered the field of ultrafast lasers and their applications in scientific, engineering and medical disciplines. He is also the founder of the Extreme Light Infrastructure (ELI) in Europe. With his student Donna Strickland he is the inventor of the chirped pulses amplification technique which allows ultrashort laser pulses to be amplified to petawatt optical powers, with the laser pulse being stretched out temporarily and spectrally before amplification. Mourou has received the Wood Prize from OSA, the Edgerton Prize from the SPIE, the Sarnoff Prize from the IEEE, and the 2004 IEEE/LEOS Quantum Electronics Award. He is a Fellow of OSA and IEEE, as well as a member of the U.S. National Academy of Engineering. Currently he is a distinguished professor emeritus at the University of Michigan, USA, and at the École Polytechnique in Palaiseau, France.

APS/Division of Laser Science Award

Arthur L. Schawlow Prize

Robert Boyd, Univ. of Ottawa, Canada

DLS sponsored APS Fellows:

Andrea Alu, Univ. of Texas, Austin, USA
Citation: For seminal contributions to electromagnetic theory and applications, nano optics, plasmonics, and metamaterials.

Hiroshi Amano, Nagoya Univ., Japan
Citation: For pioneering the materials science and device physics leading to the invention of blue light-emitting diodes with III nitride-based semiconductor heterostructures.

Hou-Ton Chen, Los Alamos National Laboratory, USA
Citation: For contributions to the development of active metamaterials and devices, and the development and understanding of few-layer metamaterials and metasurfaces, especially in the terahertz frequency range.

Zhingang Chen, San Francisco State Univ., USA
Citation: For seminal contributions on spatial solitons, photonic lattices, and beam shaping, and for promoting world-class research at an undergraduate institution.

Stefan Hell, Max Planck Institute, Germany
Citation: For pioneering contributions to the development and application of superresolved, far-field optical microscopy.

Mackillo Kira, Philipps Univ. Marburg, Germany
Citation: For contributions to theoretical semiconductor quantum optics.

Xiaogin Li, Univ. of Texas, Austin, USA
Citation: For contributions to quantum information, multidimensional coherent spectroscopy, nanophotonics based on AFM assembly, and spin dynamics in ferromagnetic nanostructures.
OSA Awards and Honors

OSA Fellowships
Irene Georgakoudi, Tufts University, USA
Elizabeth M. C. Hillman, Columbia University, USA
Cristina Masoller, Universitat Politecnica de Catalunya, Spain
David D. Smith, NASA Marshall Space Flight Center, USA
H. Philip Stahl, NASA Marshall Space Flight Center, USA
David Stork, Rambus Inc., USA
Andrey A. Sukhorukov, Australian National University, Australia
Mourad Zghal, University of Carthage, Tunisia

2016 Frederic Ives Medal/Jarus W. Quinn Prize
Gérard Mourou, École Polytechnique, France
For numerous pioneering contributions to the development of ultrafast and ultrahigh intensity laser science and for outstanding leadership of the international and commercial communities impacted by these technologies

Esther Hoffman Beller Medal
Bishnu P. Pal, Mahindra École Centrale, India
For over thirty-five years of guided wave photonics education, including the development of graduate and continuing education teaching programs and laboratories in optoelectronics and optical communications at IIT-Delhi, and for inspiring a generation of leading academic and industrial scientists

Max Born Award
Xiang Zhang, University of California, Berkeley, USA
For the experimental realization of major theoretical predictions in the field of metamaterials and graphene optics

Stephen D. Fantone Distinguished Service Award
G. Michael Morris, RPC Photronics Inc., USA
For extraordianary contributions to the OSA, including distinguished service as OSA President and a key role in the formation and leadership of the OSA Foundation

Paul F. Forman Team Engineering Excellence Award
Advanced LIGO Engineering Team
For innovative engineering creating the most sensitive measurement instrument ever built, leading to the first direct detection of gravitational waves.

Joseph Fraunhofer Award/Robert M. Burley Prize
Demetri Psaltis, École Polytechnique Fédérale de Lausanne, Switzerland
For pioneering contributions to the fields of photonics engineering and optofluidics.

Nick Holonyak, Jr. Award
Chennupati Jagadish, Australian National University, Australia
For pioneering work and sustained contributions to quantum-well, quantum-dot and nanowire optoelectronic devices and their integration

Emmett Leith Medal
Francis T.S. Yu, Pennsylvania State University, USA
For life-long important contributions to holography, white-light holography, partially coherent signal processing, optical correlators, and information optics.

Ellis R. Lippincott Award
Thomas Elsaesser, Max Born Institute, Germany
For seminal contributions to the understanding of the ultrafast coherent and incoherent vibrational dynamics of hydrogen bonds in liquids and biomolecules

Michael S. Feld Biophotonics Award
For leadership and pioneering contributions in the field of biophotonics, comprising the diverse use of label-free native fluorescence, Raman spectroscopy and optical imaging for cancer detection in tissues and cells

William F. Meggers Award
Brooks H. Pate, University of Virginia, USA
For the invention of the chirped-pulse Fourier transform microwave technique, which revolutionized rotational spectroscopy, leading to an explosion of novel spectroscopic, astrochemical, analytical, dynamical, and chemical kinetics applications

David Richardson Medal
Francisco J. Duarte, Interferometric Optics, USA
For seminal contributions to the physics and technology of multiple-prism arrays for narrow-linewidth tunable laser oscillators and laser pulse compression.

R. W. Wood Prize
Kishan Dholakia, University of St. Andrews, U.K.
For pioneering research into optical micromanipulation using shaped light for interdisciplinary photonics-based applications.

The Treasurer’s Award: An OSA Employee Recognition Program
The Treasurer’s Award, in recognition of the unique perspective our Treasurers have on the staff and their impact to the operations of the Society, will honor an employee who has made significant contributions to organizational excellence, who promotes and enacts innovative solutions or who exemplifies inspirational leadership.

Congratulations to the 2016 Treasurer’s Award Recipient:
Deborah Herrin, The Optical Society, USA
Awards and Special Recognitions

OSA Foundation Grant Recipients

The OSA Foundation would like to congratulate our 2016 grant recipients. Through the following programs we have been able to provide over 30 grants, scholarships and prizes to help students attending FiO.

You can help to inspire and support the next generation of science and engineering innovators by making a donation to the OSA Foundation. 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, visit www.osa.org/foundation, or stop by the OSA booth.

OSA Foundation Travel Grant Recipients

Fernando Arturo Araiza Sixtos, Faculty of Sciences, Mexico
Pegah Asgari, Zanjan Univ., Iran
Gabriel Castillo-Santiago, UNAM, Mexico
Jin-hui Chen, Nanjing Univ., China
Andrew Huzortey, Univ. of Cape Coast, Ghana
Jem Teresa John, Indian Inst. of Sciences, India
Ivan Kam, Instituto de Estudios Avanzados (IEAv), Universidade Federal de Sao Paulo, Brazil
Apurv Chaitanya Nellikka, Physical Research Laboratory, India
Yousef Pourvais, Univ. of Tehran, Iran
Nirmal Punjabi, Indian Inst. of Technology, Bombay, India
Zhuo Wang, Huazhong Univ. of Sciences & Technology, China
Jin-Min Wu, Beijing Inst. of Technology, Beijing Key Laboratory or Fractional Signals and Systems, China

OSA Foundation Boris P. Stoicheff Memorial Scholarship

Established in 2011 by the OSAF and the Canadian Association of Physicists Educational Trust Fund (CAPETF), this program pays tribute to Boris P. Stoicheff, an internationally renowned laser spectroscopist who also served as President of OSA (1976) and CAP (1983-84). This $3,000 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 the 2016 award recipient:
Christopher Pugh, Univ. of Waterloo, Canada

OSA Foundation Emil Wolf Outstanding Student Paper Competition

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

Congratulations to our finalists competing at FiO:

FiO 1: Optical Design and Instrumentation
Wenzhe Li, Clemson Univ., USA
Maria Papaioannou, Univ. of Southampton, UK
Piotr Tyczkowski, Tampere Univ. of Technology, Finland
Di Xu, Univ. of Rochester, USA

FiO 2: Optical Sciences
Zhe Guang, Georgia Inst. of Technology, USA
Nihal Jhajj, Univ. of Maryland, USA
Roman Khakimov, Australian National Univ., USA
Bethany Little, Univ. of Rochester, USA

FiO 3: Optics in Biology and Medicine
William Eldridge, Duke Univ., USA
Aleks Klimas, George Washington Univ., USA

FiO 4: Fiber Optics and Optical Communications
Krysta Boccuzzi, Univ. of Rochester, USA
Zhanwei Liu, Cornell Univ., USA
Samantha Nowierski, Northwestern Univ., USA

FiO 5: Integrated Photonics
Clément Javerzac-Galy, Ecole Polytechnique Federale De Lausanne, Switzerland
Moritz Merklein, Centre for Ultrahigh Bandwidth Devices for Optical Systems (CUDOS), The Univ. of Sydney, Australia
Mengjie Yu, Cornell Univ., USA

FiO 6: Quantum Electronics
Lior Cohen, Hebrew Univ. of Jerusalem, Israel
Rick Leijssen, FOM Inst. AMOLF, the Netherlands
Christian Reimer, INRS-EMT, Canada

FiO 7: Vision and Color
Amanda Bares, Cornell Univ., USA
Michelle Victoria, Univ. of Illinois at Urbana-Champaign, USA
Tao Jin, Univ. of Waterloo, Canada

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:

Mahbub Alam, Georgia Inst. of Technology, USA
Surekha Barkur, Manipal University, India
Gabriel Castillo, Universidad Nacional Autonoma de Mexico, Mexico
Xiaobo Han, Huazhong Univ. of Science and Technology, China
Tong Lin, National Univ. of Singapore, Singapore
Sara Magdi, American Univ. in Cairo, Egypt
Emerson Melo, Univ. of Sao Paulo, Brazil
Patrick Stockton, Colorado State Univ., USA
Denise Valente, Univ. College Dublin, Ireland
Hengyun Zhou, Harvard Univ., USA
OSA Foundation Jean Bennett Memorial Student Travel Grant

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

Congratulations to our 2016 grant recipient:
Roxana Rezvani Naraghi, University of Central Florida, USA

OSA Foundation Robert S. Hilbert Memorial Student Travel Grant

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

Congratulations to our 2016 grant recipients:
Jin-hui Chen, Nanjing University, China
Ahmed Dorrah, University of Toronto, Canada
Denise Valente, University College Dublin, Ireland

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 Tuesday, 18 October from 08:00-10:00 in the Highland Room E. The winner will be announced at the DLS business meeting Wednesday.

The following presentations will be given during this special session:
Giulio Vampa, Univ. of Ottawa, Canada, Identifying and Using Recollision-based High Harmonics from Bulk Semiconductors
Christoph Heyl, Lund Univ., Sweden, Power-scaling Attosecond Sources Using Universal Scaling Principles for Nonlinear Optical Processes in Gases
Mohammad Mirhosseini, California Inst. of Technology, USA, Quantum Information with Structured Light
Sylvain Ravets, Joint Quantum Institute, USA, Development of Tools for Quantum Engineering Using Individual Atoms: Optical Nanofibers and Controlled Rydberg Interactions
Special Symposia

**Symposium on 100 Years of Optical Design, Fabrication, Testing, and Instrumentation - A Historical Look Back**

Tuesday, 18 October, 08:00–10:00 (Part I), 10:30–12:00 (Part II), 13:30–14:30 (Part III)

Grand Ballroom A (Radisson)

Symposium Organizer: Julie Bentley, Univ. of Rochester, USA

This symposium celebrates 100 years of advances in optical design, optical fabrication and testing, and instrumentation by taking a historical look back. Topics to be discussed include the development of optical design software, the optical design of telescopes at NASA, the evolution of optical design and metrology at Tropel, a look into optical manufacturing at Kodak, the history of the Steward Mirror Lab, APOMA, and COM, and the ever changing landscape of optical metrology and optical instrumentation.

**Invited Speakers:**

John Bruning, Retired, USA, History of Optical Design and Metrology at Tropel

Joseph Howard, NASA, USA, Large-data Center Interconnect: Emerging Technologies and Scaling Challenges

John Grievenkamp, The Univ. of Arizona, USA, Optics Goes to the Movies

Dae Wook Kim, Univ. of Arizona, USA, 30 Years of Mirror Making at the Richard F. Caris Mirror Lab

John Schoen, US Dept. of Defense, USA, History of the Center for Optics Manufacturing

Jim Sydor, Sydor Optics, USA, APOMA: Past & Present

Ed White, Consultant, USA, History of Optical Manufacturing at Kodak

Robert Wiederhold, Optimax Systems, Inc., USA, The History of Optical Fabrication in Rochester NY

Jim Wyant, Univ. of Arizona, USA, Short History of Interferometric Optical Metrology

**Symposium on 50th Anniversary of Low-Loss Optical Fibers**

Tuesday, 18 October, 08:00–10:00 (Part I), 10:30–12:00 (Part II), 13:30–15:30 (Part III)

Grand Ballroom B (Radisson)

Symposium Organizer: Alan F. Evans, Corning, USA

Optical fibers have changed our society by connecting the world. This fundamental global transformation occurred due to the advent of low-loss optical fiber for high-bandwidth transmission of optical data. This symposium celebrates the 50th anniversary of Charles K. Kao’s seminal paper unfolding the alluring possibilities and opportunities of low-loss silica fiber. The presentations in this symposium will focus on the history of the development of silica fiber technologies, highlight significant milestones and advances to emerge from this paradigm shift in the way light is transmitted, and describe recent developments of low-loss fibers with advanced designs and materials.

**Invited Speakers:**

John Ballato, Clemson Univ., USA, back to the Future - Why Boring Old Materials and Designs are the Answer to Next Generation Optical Fibers

Richard Epworth, Retired, UK, The Birth of Optical Fiber Communications

Yoel Fink, MIT, USA, Realizing a Moore’s Law for Fibers

Randy Giles, Nokia Bell Labs, USA, Origins of the Erbium-Doped Fiber Amplifier

Takemi Hasegawa, Sumitomo Electric Industries Ltd., Japan, Advances in Ultra-low Loss Silica Fibers

Don Keck, Retired, USA, Glass and Light: Enabling the Information Age

Ming Jun Li, Corning Inc., USA, Recent Development in Optical Fibers for High Capacity Transmission Systems

John MacChesney, John B. MacChesney Optical Materials, USA, AT&T’s Contributions to Fiber Optics

Stojan Radic, Univ. of California San Diego, Transmitting Beyond The Fictitious Nonlinear Capacity Limit

David Richardson, Univ. of Southampton, UK, Recent Advances in Microstructured Optical Fibers and their Applications

Robert Tkach, Nokia Bell Labs, USA, High-Capacity Optical Communications – Can We Guess the Future from the Past?

**Laser Science Symposium on Undergraduate Research**

Tuesday, 18 October, 12:15–18:00

Highland Room A

Organizer: Harold Metcalf, Stony Brook Univ., USA

The Symposium on Undergraduate Research has been a feature of the annual meeting of the Division of Laser Science of the American Physical Society (APS-DLS) for more than ten years, and has showcased the research work of approximately 400 students during that time. Students’ presentations often describe their work during the previous summer. The Symposium has been supported by the DLS, OSA, and the NSF, along with several corporate sponsors. The NSF has played a vital role by providing the research opportunities for many of the students through its REU programs, as well as by direct support of the event.
A couple strongly to matter. Recent advances in understanding the complex phenomenology of multiple scattering offer unique opportunities for retrieving structural information and for controlling the propagation of light. At photonic mesoscales, fascinating interaction and confinement phenomena occur across different temporal and spatial scales. This symposium will gather international experts to discuss the experimental and theoretical progress in unveiling the properties of light propagating through and emitted in disordered media as well as a range of novel phenomena related to light-matter interaction.

Invited Speakers:

Girish Agarwal, Oklahoma State Univ., USA, Long Range Light Matter Interactions at Hyperbolic Meta Surface

Hui Cao, Yale Univ., USA, Control of Optical Intensity Distribution inside a Disordered Waveguide

Mathias Fink, Ecole Sup Physique Chimie Industrielles, France, Wave Control and Holography with Time Transformations

Allard Mosk, Universiteit Twente, Netherlands, Open Channels in Scattering Media: See the Light Inside

Silvia Vignolini, Cambridge Univ., UK, Cellulose Bio-inspired Hierarchical Structures

Symposium on Mesoscopic Optics of Disordered Media

Wednesday, 19 October, 10:30–12:00 (Part I), 13:00–14:00 (Part II)
Grand Ballroom D (Radisson)

Organizers: Aristide Dogariu, CREOL, Univ. of Florida, USA; Remi Carminati, ESPCI ParisTech, France; and Juan Jose Saenz, Donostia International Physics Center, Spain

In extreme environments, electromagnetic fields couple strongly to matter. Recent advances in understanding the complex phenomenology of multiple scattering offer unique opportunities for retrieving structural information and for controlling the propagation of light. At photonic mesoscales, fascinating interaction and confinement phenomena occur across different temporal and spatial scales. This symposium will gather international experts to discuss the experimental and theoretical progress in unveiling the properties of light propagating through and emitted in disordered media as well as a range of novel phenomena related to light-matter interaction.

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Silvia Vignolini, Cambridge Univ., UK, Cellulose Bio-inspired Hierarchical Structures

A Tribute to Steve Jacobs

Wednesday, 19 October, 10:30–12:00 (Part I), 13:00–14:00 (Part II)
Highland Room C

Organizer: Julie Bentley, Univ. of Rochester, USA

The Stephen D. Jacobs Symposium has been organized to honor the late Dr. Stephen D. Jacobs’s contributions to the fields of optical materials, liquid crystals, optics manufacturing and educational outreach. Steve spent his entire career at the University of Rochester with appointments at the Laboratory for Laser Energetics (LLE), Institute of Optics, Materials Science and Chemical Engineering departments. His research included topics such as phosphate laser glass, frequency conversion crystals, liquid crystal laser optics, optical finishing of glass, ceramics and crystals, magnetorheological finishing (MRF), cholesteric liquid crystal flakes for display applications, and laser damage in multilayer dielectric coatings. In addition to his significant technical contributions Steve also had a passion for educational outreach. He volunteered as the educational outreach chair for the OSA-Rochester Section for over 15 years during which time he developed and organized the Optics Suitcase program that has been instrumental in introducing hundreds of thousands of young children to the fields of optics and materials science throughout the US and globally in over 40 countries. Steve Jacobs touched many lives, we are honored to have this special symposium in memory of our great colleague, friend and mentor.

Invited Speakers:

Tanya Kosc, Univ. of Rochester, USA, Steve Jacobs: The Optics Outreach Innovator

John Lambropoulos, Univ. of Rochester, USA, Nanomechanics in Optical Manufacturing

Ken Marshall, Univ. of Rochester, USA, Thirty-five Years of Liquid Crystal Research at LLE: From Laser Fusion to Electronic Paper

Kathleen Richardson, UCF-CREOL, USA, Optical Glass Science – The How and Why We Got Here

Aric Shorey, Corning Inc., USA, Materials Development in Magnetorheological Finishing: The Work of Dr. Stephen Jacobs

Symposium on Mid-Infrared Fiber Sources

Thursday, 20 October, 14:00–16:00 (Part I), 16:30–18:30 (Part II)
Grand Ballroom A (Radisson)

Organizer: Morten Ibsen, Univ. of Southhampton, UK

Optical sources in the mid-infrared wavelength range have become key for enabling applications in remote sensing, biomedical, materials processing, homeland security. Specific applications in metrology, tomography, and isotope separation are enabled by optical access to the molecular fingerprint region. To date, mid-infrared fiber sources span the performance space from ultrafast pulses to kilowatts of power, from single-frequency to supercontinuum bandwidths, and cover spectral bands that cannot be addressed by other sources (e.g., QCLs). This symposium will focus on recent developments in mid-infrared fiber sources and related technologies, with the most advanced progress in the field including materials, devices, and applications.

Invited Speakers:

Caroline Amiot, Tampere Univ. of Technology, Finland, Mid-IR Source for Ultra-broadband Cavity Enhanced Spectroscopy

Martin Bernier, Université Laval, Canada, All-fiber Sources Operating in the Mid-infrared

Stuart Jackson, Macquarie Univ., Australia, Power Scaling Concepts for Mid-infrared Fibre Lasers Using Fluoride Glass

Khahn Kieu, Univ. of Arizona, USA, Mid-IR Ultrafast Fibre Laser Sources

Christian Rosenberg Petersen, DTU, Denmark, Generation and Applications of High Average Power Mid-IR Supercontinuum in Chalcogenide Fibres

Angela Seddon, Univ. of Nottingham, UK, Medical Applications of Mid-IR Fibre Laser Technologies
Brandon Shaw, Naval Research Labs, USA, Highly Nonlinear Fibre for Applications in the Mid-IR
Thibaut Sylvestre, Univ. of Franche-Comté, France, Tutorial: Mid-IR Wavelength Conversion in Tapered Chalcogenide Fibres

Symposium on 100 Years of Vision at OSA: Most Cited Vision Papers in OSA Journals
Thursday, 20 October 2016, 14:00–16:00
Highland Room E
Organizer: Susana Marcos, Consejo Sup Investigaciones Cientificas, Spain

Vision Science has been an active community at OSA, and a large percentage of publications on vision have been among the most top cited in OSA Journals (JOSA, JOSA A, Applied Optics, Optics Letters, Optics Express and Biomedical Optics Express, among others). The symposium highlights some classic vision science papers and their impact on today's research in the field. Selected themes range from the sensitivity of the eye and motion perception to wavefront sensing in the eye.

Invited Speakers:
Edward H. Adelson, MIT, USA, Motion, Early Vision, and the Plenoptic Function
Denis Pelli, New York Univ., USA, Visual Sensitivity and Object Recognition
Andrew Beau Watson, NASA, USA, Fourier, Gabor, Reichardt, Hilbert: Guides on the Path to a Model of Human Motion Perception
David Williams, Univ. of Rochester, USA, Emerging Ocular Applications of Wavefront Correction

Symposium on Integrated Photonic Manufacturing
Friday, 21 October, 08:00–10:00 (Part I), 13:30–14:30 (Part II)
Highland Room A
Symposium Organizer: Stefan Preble, Rochester Inst. of Technology, USA

This symposium gathers experts from academia, industry and foundries to discuss the progress that has been made and the challenges that remain to realize commercially successful integrated photonic manufacturing platforms.

Invited Speakers:
Roel Baets, Universiteit Gent, Belgium, Silicon Photonics Platforms: To Standardize or to Diversify?
Keren Bergman, Columbia Univ., USA, Manufacturing Silicon Photonics for High-performance Datacom Systems
Peter de Dobbeleare, Luxtera, USA, Silicon Photonics: Applications and High Volume Manufacturing Platform
Michael Liehr, AIM Photonics, USA, AIM Photonics - Manufacturing Challenges for Photonic Integrated Circuits
Sylvie Menez, CEA-LETI, France, Providing Silicon-Photonic Transceivers with an Efficient Laser Source: Where does “III-V/Silicon Heterogeneous Integration” Stand?
Peter O’Brien, Tyndall Institute, Ireland, Development of Integrated Photonic Packaging Standards and Foundry Capabilities

Symposium on Integrated Quantum Optics
Friday, 21 October, 14:30 - 15:30 (Part I); 16:00–17:30 (Part II)
Highland Room A
Symposium Organizer: Stefan Preble, Rochester Inst. of Technology, USA

Quantum optics technologies have the potential to revolutionize computing, communication and sensing systems. Chip-scale implementations have resulted in rapid progress by integrating high quality photon sources, circuits and single photon detectors together. This symposium will focus on recent developments and the progress that is being made towards the realization of complex, chip-scale, quantum information systems.

Invited Speakers:
Benjamin Eggleton, Univ. of Sydney, Australia, Multiplexing of Integrated Single Photon Sources
Dirk Englund, MIT, USA, Quantum Information Processing Using Programmable Silicon Photonic Integrated Circuits
Jeremy O’Brien, Univ. of Briston, UK, Title to be Announced
Christine Silberhorn, Universitat Paderborn, Germany, Quantum Information Processing with Photon Temporal Modes
Jelena Vuckovic, Stanford Univ., USA, Quantum Nanophotonics: From Inverse Design to Implementations
Special Events

Science Educators Day (EDAY) 2016
Sunday, 16 October, 13:30–16:30
Grand Ballroom A-C, Hyatt Regency Rochester

The Optical Society Foundation (OSAF) in partnership with the American Association of Physics Teachers (AAPT) and The Optical Society (OSA) Rochester Local Section are hosting a special community outreach program and training for K-12 educators! This session will focus on light and color through fun, hands-on, and even *edible* science experiences.

- Learn about the components of white light with a “Rainbow Peephole,” how some animals see patterns invisible to the human eye with “Magic Stripes,” and how materials can change color with the “Magic Patch.”
- Learn about color absorption and reflection as we predict the colors of M&M’s under different colors of light and as we observe how light travels through colored gummy bears.
- Learn about color transmission as we observe the world through filters made of Jell-O.
- Participants will walk away with a variety of resources for their students and multiple lesson plans appropriate for K-12.

Student Leadership Conference (Invitation only)
Monday, 17 October, 07:00–17:00
Grand Ballroom, Holiday Inn Rochester Downtown

The OSA Student Leadership Conference (SLC) at FiO/LS brings together chapter officers from around the globe each year to network amongst their peers and to learn more about successful chapter management and careers in optics and photonics. This year’s event will feature professional development, chapter management and education outreach programming.

Women of Light, a Special Program for Women in Optics hosted by WiSTEE CONNECT
Monday, 17 October, 11:00–17:00
Grand Ballroom F-G, Hyatt Regency Rochester

WiSTEE Connect is an organization which serves to connect female students, faculty members, and engineers in Science, Technology, Engineering, and Entrepreneurship (STEE) from regional universities and private companies in upstate New York. The vision of WiSTEE Connect is to promote women leadership in STEE and assist women involved in these areas to gain regional and/or global connections and recognition. This organization helps to bridge the gap between science and entrepreneurship while providing a forum through which women in these fields may learn, connect, and lead.

The overall goal of the “Women of Light” special session is to shine light upon women’s careers in science, technology, engineering, mathematics, and entrepreneurship, recruit women across career ranks and disciplines, and build a sustainable community of women in both academia and industry from which career growth, mobility, and leadership opportunities may be sought out.

Diversity and Inclusion Program and Reception: A Look at the LGBT Climate in Physics
Monday, 17 October, 17:00–18:00
Grand Ballroom A-B, Hyatt Regency Rochester

Speaker: Ramon Barthelemy, American Institute of Physics Statistical Research Center, USA

Please join Barthelemy as he shares highlights from the 2016 American Physical Society’s (APS) LGBT Climate in Physics Report. Following the presentation join your colleagues for a networking reception to discuss ways the optics and photonics community can improve diversity and inclusion. We encourage you to attend this program to learn what OSA is doing to improve the experience of underrepresented members and support your colleagues as we continue this important conversation. First 50 attendees will receive a printed copy of APS’s LGBT Report.

Make Optics Career Roundtable
Monday, 17 October 2016, 17:00–18:00
Grand Ballroom E, Hyatt Regency Rochester

Hosted by the OSA Optical Fabrication and Testing Technical Group, this event will provide students and recent graduates with the opportunity to connect with experienced professionals working in academia, industry and government roles. Contact TGactivities@osa.org to register for this career roundtable event.

FiO/LS Welcome Reception
Monday, 17 October, 18:30–20:30
Galleria, Riverside Court, and Empire Lobby

Get the FiO/LS 2016 conference off to a great start by attending the Welcome Reception. Meet with colleagues from around the world and enjoy light hors d’oeuvres. This event is complimentary for FiO/LS Technical attendees only. Non-technical attendees and guest tickets are available for $75 USD each.

Sponsored by
Optics in Digital Systems Technical Group Networking Breakfast
Tuesday, 18 October 2016, 07:30–08:30
Genesee Suite G, Radisson Rochester Riverside

Members of the OSA Optics in Digital System Technical Group are invited to join us for a networking breakfast on Tuesday morning. The event will provide an opportunity to connect with fellow attendees who share an interest in this field and to learn more about this technical group. An RSVP is required for this technical group event as breakfast will be provided. Contact TGactivities@osa.org to register, pending availability.

Polarization Technical Group Special Talks
Tuesday, 18 October, 12:00–13:30
Genesee Suite G, Radisson Rochester Riverside

Organized by the OSA Polarization Technical Group, this event will feature a series of special talks by three high impact speakers working in this field. Join us to hear about our speakers’ recent research and discuss advances in the field of polarization over lunch. An RSVP is required for this technical group event as lunch will be provided. Contact TGactivities@osa.org to register, pending availability.

Optical Material Studies Technical Group Special Talk
Tuesday, 18 October 2016, 12:00–13:30
Grand Ballroom D, Radisson Riverside Rochester

Join the OSA Optical Material Studies Technical Group for a special talk focused on photonics and optical materials. Dr. Michal Lipson of Columbia University will be the featured speaker. An RSVP is required for this technical group event as lunch will be provided. Contact TGactivities@osa.org to register, pending availability.

OSA Fellow Members Lunch
(Advance Registration Required)
Tuesday, 18 October, 12:00–13:15
Grand Ballroom A-C, Hyatt Regency Rochester

OSA Fellow Members are invited to join their colleagues for lunch. Advance registration is required.

OSA Members, Family and Friends Tour – Susan B. Anthony Museum & House
(Advance Registration Required)
Tuesday, 18 October, 13:45–16:00

OSA members and their families are welcome to attend a 90-minute tour of the National Susan B. Anthony Museum & House, which is the home of the legendary American women’s rights leader during the most politically active period of her life. The home was the headquarters of the National American Woman Suffrage Association when Susan B. Anthony was its president. Come learn how she and fellow suffragists changed history for women’s rights.

Shuttle transportation will depart from the Rochester Convention Center at 13:45 and guests will return at 16:00.

Meet the OSA Editors’ Reception
Tuesday, 18 October, 15:30–16:30
Empire Lobby

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

Photonics Clambake 2016
(Ticket Required)
Tuesday, 18 October, 17:30–20:30
Grand Ballroom, Hyatt Regency Rochester

The Photonics Clambake is a melting pot of optics & photonics professionals who gather to enjoy one of the industry’s premier networking events while relaxing with refreshing beverages, great food and lots of clams.

Reservations and payments must be made in advance, no payments will be accepted at the door.

Questions? Contact Mike Naselaris of Sydor Optics, Inc. at miken@sydor.com or +1.585.271.7300.

Optics & Energy: Reflections on the Past and Lighting the Future
Tuesday, 18 October, 18:00–19:00
Genesee Suite F, Radisson Riverside Rochester

Join the OSA Optics for Energy Technical Group for this special event highlighting the major milestones of the optics and energy partnership through the last century. Visionaries in the field will be invited to share their thoughts and provide insight into the future of energy-related research and applications. Brief presentations will be followed by informal discussions and networking over refreshments.

OSA Student Member Party
Tuesday, 18 October, 19:00–22:00
Grand Ballroom, Holiday Inn Rochester Downtown

OSA Student Members who are full technical registrants of FiO/LS are invited to attend the OSA Student Member Party. This birthday party will celebrate the next 100 years of leaders in the society with food, drinks and entertainment.
Optics Alumni Networking Reception
Tuesday, 18 October, 19:00–22:00
Riverside Ballroom and Lounge, Radisson Riverside Rochester

The Institute of Optics, University of Rochester; The College of Optical Sciences, University of Arizona; The College of Optics & Photonics, University of Central Florida; Rochester Institute of Technology; and Stanford Photonics Research Center, Stanford University, are honored to host our alumni and invited friends for a reception in conjunction with OSA FiO. Remarks from Optics Leaders will be featured at 8 PM, including Xi-Cheng Zhang, Thomas Koch, Bahaa Saleh and Thomas Baer.

Invitation only; registration is required.

AIM Photonics Northeast Supply Conference (NESCO)
Wednesday, 19 October, 08:00–17:00
Hyatt Regency Rochester, Grand Ballroom Salons A-D

The AIM Photonics Northeast Supply Conference (NESCO) provides a stage for established Photonics supply chain companies, new and emerging innovators, industry leaders, strategic investors, and venture capitalists to discuss the needs and requirements of the industry's future growth. Participants will gain insights into technology, capital, partnership, and collaboration strategies necessary for mutual success.

Who should attend?
- Entrepreneurs involved or interested in Photonics innovation
- Emerging Optics and Photonics companies seeking to network with technology partners and investors
- Investment professionals from the angel, venture, corporate and institutional communities
- R&D, purchasing, supply chain managers, and manufacturing senior executives from the Photonics industry

Questions? Please contact Frank Tolic at ftolic@sunypoly.edu

Glass Art Contest & Auction
Wednesday, 19 October, 09:30–16:00
Thursday, 20 October, 09:30–14:00
Empire Hall

Hosted by the OSA Rochester Section and the OSA Foundation

Optical fabricators and glass artists will showcase their unique approaches to the design and manufacture of glass artwork. Pieces will be displayed in the Frontiers in Optics Exhibition Hall, 19–20 October. All attendees are invited to vote for their favorite piece in the contest, and several of the pieces are available for auction. Proceeds will go to the OSA Rochester Section to support the Optics Suitecase and the OSA Foundation to support the Explore Optics Kit.

Environmental Sensing Technical Group Special Talk
Wednesday, 19 October, 12:00–13:00
Genesee Suite G, Radisson Hotel Rochester Riverside

Join the OSA Environmental Sensing Technical Group for a special talk focused on open-path sensing and the application of UAVs in environmental sensing. Dr. Azer Yalin of Colorado State University will be the featured speaker. An RSVP is required for this technical group event as lunch will be provided. Contact TGactivities@osa.org to register, pending availability.

Student Chapter Competition
Wednesday, 19 October, 14:00–16:00
Empire Hall

OSA challenges its student chapters to an annual competition where they showcase their unique and innovative skills with youth education outreach demonstrations. Each competing chapter will use the OSA Foundation & LASER Classroom Explore Optics Kit and any easily obtained items to create a new demonstration that is not already a part of these kits. Competitors will have their sights set on three cash prizes of up to $500, so it’s a show you don’t want to miss.

Meet the APS Journal Editors Reception
Wednesday, 19 October, 15:30–17:00
Riverside Court

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.

OIDA Member and Exhibitor Appreciation Reception
(OIDA Members and Exhibitors Only)
Wednesday, 19 October, 16:00–17:00
Empire Hall

Sponsored by

Exhibitors, finish up your first day and come relax and mingle with your colleagues. 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 oida@osa.org or +1.202.416.1474 for more information.
Division of Laser Science Annual Business Meeting  
Wednesday, 19 October, 17:00–18:00  
Genesee Suite F, Radisson Rochester Riverside

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 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. The Carl E. Anderson Dissertation award will also be presented at this meeting.

OSA Annual Business Meeting  
Wednesday, 19 October, 17:00–7:45  
Regency Ballroom C, Hyatt Regency Rochester

Learn more about OSA and join the OSA Board of Directors for the Society’s annual business meeting. An update on the Society’s 2015 activities will be presented and the results of the Board of Directors election will be announced.

OSA 100 Year BASH  
Wednesday, 19 October, 18:30–21:30  
The Sibley Building, 228 East Main Street, Rochester, New York

In celebration of the OSA Centennial, join OSA in acknowledging the innovators and inventions that inspire the future. This reception is sure to be a high point in a year of celebration. We’ve waited a century for this, and we want you to be a part of it!

Entry is free for registered attendees of Frontiers in Optics.

OSA Members who are not planning to attend as a Technical registrant can register for the free Exhibit Hall Only option and receive complimentary entry to the party.

Nonmembers who are not planning to attend as a Technical registrant can register for the free Exhibit Hall Only option then select the option to purchase a BASH ticket for $100 USD.

Additional guest BASH tickets are available for $100 USD each.

OSA Light the Future Speaker Series  
featuring Michio Kaku and Nobel Laureates  
Thursday, 20 October, 11:00–12:30  
Lilac Ballroom

This event will feature Michio Kaku, futurist and theoretical physicist, City College of New York, with Sir Peter L. Knight, emeritus professor, Imperial College, London, OSA Fellow, 2004 President.

Kaku’s talk “Optics of the Future: Exploring the Universe and the Brain” will be followed by a discussion featuring a panel of Nobel Laureates including Roy Glauber, Nicolaas Bloembergen, Robert F. Curl, John L. Hall, W.E. Moerner, William D. Phillips and David J. Wineland.

VIP Industry Leaders Networking Event:  
Connecting Corporate Executives, Young Professionals & Students  
Thursday, 20 October, 12:30–14:00  
Grand Ballroom C, Hyatt Regency Rochester

This session brings together Industry Executives to share their business experience with Young Professionals, Recent Graduates and Students – how they started their careers, lessons learned and using their degree in an executive position. Informal networking during lunch is followed by a transition to “speed meetings” – brief, small-group visits with each executive to discuss industry trends or career topics.

Sponsored by GoFoton
Exhibition Information

Visit the Frontiers in Optics 2016 Exhibit in Empire Hall and get a glimpse of the latest optical innovations! The FiO 2016 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
Wednesday, 19 October, 09:30–16:00
Thursday, 20 October 09:30–14:00
Empire Hall

Exhibit Hall Unopposed Exhibit-Only Times

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Joint FiO/LS Poster Sessions
Wednesday, 19 October 14:30–16:00
Thursday, 20 October 09:30–11:00
Empire Hall

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 390 posters scheduled for presentation.

E-Posters

As a new feature of the 2016 FiO/LS Meeting, we have offered selected presenters the opportunity to present their paper as an E-poster. Like a conventional poster, an e-poster will convey an author’s introduction, motivation, results, and conclusions, on one screen. However, e-posters will provide the author with the option to digitally bring up supplemental details for deeper discussion. E-posters will be presented in the Exhibit Hall (Empire Hall) during the two Joint Poster sessions. Each author selected for an E-poster will be given 45 minutes to present an E-poster. The remaining 45 minutes, the author will present their traditional poster within their designated poster slot. Please find a schedule of presentation times below.

Joint Poster Session I E-Poster Presentation Times

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Joint Poster Session II E-Poster Presentation Times

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FiO 2016 Participating Companies:
(as of August 29, 2016)

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<td>Precision Optical Transceivers, Inc.</td>
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<td>RPC Photonics</td>
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<td>SPIE: The Intl Society for Optics</td>
<td>Springer Nature</td>
<td>Sydor Optics, Inc.</td>
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<td>Synopsys, Inc.</td>
<td>Syntec Optics</td>
<td>The Institute of Optics, University of Rochester</td>
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<td>Thorlabs</td>
<td>Wordingham Technologies</td>
<td>Wuhan National Lab for Optoelectronics</td>
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<td>Xiamen Freeform Optical Technology Co., Ltd.</td>
<td>Xonox Technology GmbH</td>
<td>Zygo Corporation</td>
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<td>Toptica Photonics, Inc.</td>
<td>TRIOPTICS USA</td>
<td>UltraFast Innovations</td>
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<tr>
<td>United Lens Co, Inc.</td>
<td>University of Arizona, College of Optics</td>
<td>University of Central Florida, CREOL</td>
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<td>Wiley</td>
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</table>
FiO/LS Committee

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

Frontiers in Optics General Chairs
Scott Carney, University of Illinois at Urbana-Champaign, USA
Urs Utzinger, University of Arizona, USA

Frontiers in Optics Program Chairs
Chris Dainty, University College London, UK
Tom Brown, University of Rochester, USA
Ling Fu, Wuhan National Lab for Optoelectronics, China

Frontiers in Optics Subcommittees

FiO 1: Optical Design and Instrumentation
Julie Bentley, University of Rochester, USA, Subcommittee Chair
Rob Bates, FiveFocal LLC, USA
Dewen Chang, Beijing Institute of Technology, China
Jessica DeGroote Nelson, Optimax, USA
Groot Gregory, Synopsys, USA
John Koshel, University of Arizona, USA
Byoungho Lee, Seoul National University, South Korea
Rongguang Liang, University of Arizona, USA
Xinye Lou, Microsoft, USA
Mike Marcus, Lumetrics, USA
Simon Thibault, Laval University, Canada
Qiwen Zhan, University of Dayton, USA

FiO 2: Optical Sciences
Jake Bromage, University of Rochester, USA, Subcommittee Chair
Cameron Geddes, Lawrence Berkeley National Lab, USA, Subcommittee Chair
Selçuk Aktürk, Istanbul Technical University, Turkey
Judith Dawes, Macquarie University, Australia
Greg Gbur, UNC Charlotte, USA
Cristina Hernandez-Gomez, STFC Rutherford Appleton Laboratory, UK
Igor Jovanovic, Pennsylvania State University, USA
Carlos Lopez Mariscal, Naval Research Laboratory, USA
Jie Qiao, Rochester Institute of Technology, USA
Shivanand, Intel, USA
Laura Sinclair, NIST, USA
Laszlo Veisz, Max Planck Institute for Quantum Optics, Germany

FiO 3: Optics in Biology and Medicine
Elizabeth Hillman, Columbia University, USA, Subcommittee Chair
J. Quincy Brown, Tulane University, USA
Irene Georgakoudi, Tufts University, USA
Christine Hendon, Columbia University, USA
Martin Leahy, National University of Ireland Galway, Ireland
Jonathan (Teng-Chieh) Liu, University of Washington, USA
Junle Qu, Shenzhen University, China
Gang Zheng, University of Toronto, Canada

FiO 4: Fiber Optics and Optical Communications
John Marcicante, University of Rochester, USA, Subcommittee Chair
Goéry Genty, Univ. of Tempere, Finland
John Ballato, Clemson University, USA
James Dailey, Vencore Labs, USA
Iyad Dajani, Air Force Research Lab., USA
Fabrizio Di Pasquale, Scuola Superiore Sant’Anna, Italy
Diego Grosz, Instituto Balseiro, Argentina
Morten Ibsen, Univ. of Southampton, UK
Bill (Ping Piu) Kuo, University of California San Diego, USA
Drew Maywar, RIT, USA
Armando Pinto, Aveiro University, Portugal

FiO 5: Integrated Photonics
Stefan Preble, Rochester Institute of Technology, USA, Subcommittee Chair
Paul Barclay, University of Calgary, Canada

FiO 6: Quantum Electronics
Alexander V. Sergienko, Boston University, USA, Subcommittee Chair
Antonio Badolato, University of Rochester, USA
Sara Ducci, University of Paris VII, France
Alexander Gaeta, Columbia University, USA
Nobuyuki Imoto, Osaka University, Japan
Jian-Wei Pan, University of Erlangen Nuremberg, Germany

FiO 7: Vision and Color
Susana Marcos, Consejo Sup Investigaciones Científicas, Spain, Subcommittee Chair
Melanie Campbell, University of Waterloo, Canada
Stacy Choi, Ohio State University, USA
Ding Neal, Advanced Medical Optics, USA
Ram Sabesan, University of California Berkeley, USA
Frank Schaeffel, University of Tubingen, Germany
Duje Tadin, University of Rochester, USA
Brian Vohsen, University College Dublin, Ireland
Vicki Volbrecht, University of Colorado, USA
Yudong Zhang, Institute of Optics and Electronics, Chinese Academy of Sciences, China
Laser Science Committee

Laser Science Co-Chairs
Kevin J. Kubarych, University of Michigan, USA
Edo Waks, University of Maryland, USA

Laser Science Subcommittee Chairs

1. High Harmonic Generation from Solids to Gases
   David Reis, Stanford Univ., USA, Subcommittee Chair

2. Multiphoton Effects and High Resolution Imaging
   Robert Alfano, CCNY, USA, Subcommittee Chair

3. Advanced Nano-Photonic Lasers: Science and Application
   Bo Zhen, MIT, USA, Subcommittee Chair

4. Quantum Light Sources
   Nick Vamivakas, University of Rochester, USA, Subcommittee Chair

5. Integrated Quantum Photonics
   Dirk Englund, Columbia University, USA, Subcommittee Chair

6. Nonreciprocal and Topological Photonic Devices
   Mohammad Hafezi, University of Maryland, USA, Subcommittee Chair

7. Nano-Plasmonics for Spectroscopy and Imaging
   Carlos Baiz, University of Texas, Austin, USA, Subcommittee Chair

8. Advances in X-ray and XUV Laser Science and Applications
   Christopher Milne, Paul Scherer Inst, USA, Subcommittee Chair

Explanation of Session Codes

FTu1A.4

Meeting Name
F = Frontier in Optics (FiO)
L = Laser Science (LS)
J = Joint

Series Number
1 = First Series of Sessions
2 = Second Series of Sessions

Day of the Week
M = Monday
Tu = Tuesday
W = Wednesday
Th = Thursday

Number
(presentation order within the session)

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, 16 October

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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<tbody>
<tr>
<td>13:30–16:30</td>
<td><strong>Science Educator's Day</strong>, Hyatt Regency Rochester, Grand Ballroom A-C</td>
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## Monday, 17 October

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<tr>
<th>Time</th>
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<th>Location</th>
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<tbody>
<tr>
<td>07:00–17:00</td>
<td><strong>OSA Annual Student Chapter Leadership (Invitation only)</strong>, Holiday Inn Hotel Rochester, Grand Ballroom</td>
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<tr>
<td>11:00–17:00</td>
<td><strong>Women of Light, a Special Program for Women in Optics hosted by WiSTEE CONNECT</strong>, Hyatt Regency Rochester, Grand Ballroom F-G</td>
<td></td>
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<tr>
<td>15:00–20:00</td>
<td><strong>Registration</strong>, Galleria</td>
<td></td>
</tr>
<tr>
<td>17:00–18:00</td>
<td><strong>Diversity &amp; Inclusion Program and Reception: A Look at the LGBT Climate in Physics</strong>, Hyatt Regency Rochester, Grand Ballroom A-B</td>
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<tr>
<td>17:00–18:00</td>
<td><strong>Make Optics Career Roundtable</strong>, Hyatt Regency Rochester, Grand Ballroom E</td>
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<tr>
<td>18:30–20:30</td>
<td><strong>FiO/LS Welcome Reception</strong>, Galleria, Riverside Court, and Empire Lobby</td>
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## Agenda of Sessions — Tuesday, 18 October

<table>
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<tr>
<th>Time</th>
<th>Grand Ballroom A (Radisson)</th>
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<th>Grand Ballroom C (Radisson)</th>
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<td>Registration, Galleria</td>
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<tr>
<td>07:30–08:30</td>
<td>Optics in Digital Systems Technical Group Networking Breakfast, Radisson Rochester, Riverside, Genesee Suite G</td>
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<tr>
<td>08:00–10:00</td>
<td>FTu1A • Symposium on 100 Years Optical Fabrication I (ends at 14:30)</td>
<td>FTu1B • Symposium on 50th Anniversary of Low-Loss Optical Fibers I</td>
<td>FTu1C • Laser-Plasma Interactions and Acceleration</td>
<td>FTu1D • Silicon Photonics I</td>
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<tr>
<td>10:00–10:30</td>
<td>Coffee Break, West Corridor and Skyway Lobby (Radisson)</td>
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<tr>
<td>10:30–12:00</td>
<td>FTu2A • Symposium on 100 Years Optical Fabrication II (ends at 14:30)</td>
<td>FTu2B • Symposium on 50th Anniversary of Low-Loss Optical Fibers II</td>
<td>FTu2C • Laser-Matter Interactions</td>
<td>FTu2D • Silicon Photonics II</td>
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<tr>
<td>12:00–13:30</td>
<td>Lunch Break (on your own)</td>
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<tr>
<td>12:00–13:30</td>
<td>Polarization Technical Group Special Talks, Radisson Rochester Riverside, Genesee Suite G</td>
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<tr>
<td>12:00–13:15</td>
<td>OSA Fellow Members Lunch (Advance Registration Required), Hyatt Regency Rochester, Grand Ballroom, A-C</td>
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<tr>
<td>12:00–13:30</td>
<td>Optical Material Studies Technical Group Special Talk, Radisson Riverside Rochester, Grand Ballroom B</td>
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<tr>
<td>12:15–14:55</td>
<td>LTu2J • Laser Science Symposium on Undergraduate Research Poster Session, Riverside Court</td>
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<tr>
<td>13:30–15:30</td>
<td>FTu3A • Symposium on 100 Years Optical Fabrication III (ends at 14:30)</td>
<td>FTu3B • Symposium on 50th Anniversary of Low-Loss Optical Fibers III</td>
<td>FTu3C • Ultrafast and THz Sources</td>
<td>FTu3D • Plasmonic and Photonic Crystal Devices</td>
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<td></td>
<td>FTu4A • Tutorial: Bill Casserly (begins at 14:45)</td>
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<tr>
<td>13:45–16:00</td>
<td>OSA Members, Family and Friends Tour – Susan B. Anthony Museum &amp; House, Shuttle transportation will depart from the Hyatt Regency Rochester at 13:45</td>
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<tr>
<td>15:30–16:30</td>
<td>Meet the OSA Editors’ Reception, Empire Lobby</td>
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<tr>
<td>16:00–18:00</td>
<td>FTu5A • Optics in Consumer Electronics (ends at 17:30)</td>
<td>FTu5B • Laser Material Processing</td>
<td>FTu5C • Frequency Combs and High Harmonic Generation</td>
<td>FTu5D • Mid-Infrared Integrated Photonics (ends at 17:45)</td>
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<tr>
<td>17:30–20:30</td>
<td>Photonics Clambake 2016 (ticket required), Hyatt Regency Rochester, Grand Ballroom</td>
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<tr>
<td>18:00–19:00</td>
<td>Optics &amp; Energy: Reflections on the Past and Lighting the Future, Radisson Rochester Riverside, Genesee Suite F</td>
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<tr>
<td>19:00–22:00</td>
<td>OSA Student Member Party, Holiday Inn Hotel Rochester, Grand Ballroom</td>
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<tr>
<td>19:00–22:00</td>
<td>Optics Alumni Networking Reception, Radisson Rochester Riverside, Riverview Ballroom and Lounge</td>
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### Key to Shading
- Frontiers in Optics
- Laser Science
- Joint
### Agenda of Sessions

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<tr>
<td>Registration, Galleria</td>
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<tr>
<td>LTu1E ♦ Carl E. Anderson Award for Outstanding Doctoral Dissertation Session</td>
<td>FTu1F ♦ Three-Dimensional Optical Design</td>
<td>FTu1G ♦ Quantum Effects in Metamaterials</td>
<td>LTu1H ♦ Nanophotonics I</td>
<td>FTu1i ♦ Novel Light Generation and Manipulation in Fiber Devices I</td>
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<td>Coffee Break, West Corridor and Skyway Lobby (Radisson)</td>
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<tr>
<td>LTu2E ♦ X-ray and XUV I</td>
<td>FTu2F ♦ Resolution and Measuring Limits</td>
<td>FTu2G ♦ Optics and Photonics of Disordered Systems</td>
<td>LTu2H ♦ Multiphoton Effects I (ends at 11:30)</td>
<td>FTu2I ♦ Novel Fiber Devices</td>
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<tr>
<td>Lunch Break (on your own)</td>
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<tr>
<td>LTu3E ♦ Laser Science Symposium on Undergraduate Research I (15:00–16:30)</td>
<td>FTu3F ♦ Optical Properties of Materials</td>
<td>FTu3G ♦ Integrated Quantum Optics</td>
<td>LTu3H ♦ Quantum Light Sources I (ends at 15:00)</td>
<td>FTu3l ♦ Novel Light Generation and Manipulation in Fiber Devices II</td>
</tr>
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<tr>
<td>LTu5E ♦ Laser Science Symposium on Undergraduate Research II (starts at 16:45)</td>
<td>LTu5F ♦ X-ray and XUV II</td>
<td>FTu5G ♦ Nonlinear Optics in Micro/Nano-Optical Structures I</td>
<td>FTu5H ♦ Nano-Plasmonics for Spectroscopy</td>
<td>FTu5l ♦ Novel Light Generation and Manipulation in Fiber Devices III</td>
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FiO/LS 2016 • 16–21 October 2016

29
# Agenda of Sessions — Wednesday, 19 October

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<thead>
<tr>
<th>Time</th>
<th>Grand Ballroom A (Radisson)</th>
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<td>Registration, Galleria</td>
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<tr>
<td>08:00–09:30</td>
<td>JW1A • Joint Plenary Session, Lilac Ballroom</td>
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<tr>
<td>08:00–17:00</td>
<td>AIM Photonics Northeast Supply Conference (NESCO), Hyatt Regency Rochester, Grand Ballroom A-D</td>
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<tr>
<td>09:30–16:00</td>
<td>Exhibit Hall Open, Empire Hall</td>
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<tr>
<td>09:30–16:00</td>
<td>Glass Art Contest, Empire Hall</td>
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<tr>
<td>09:30–10:30</td>
<td>Unopposed Exhibit Only Time and Coffee Break, Empire Hall</td>
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<tr>
<td>10:30–12:00</td>
<td>FW2A • Novel Design Concepts for Eye Correction and Vision Simulators I</td>
<td>FW2B • Quantum Communications I</td>
<td>FW2C • Biomedical Optics</td>
<td>FW2D • Symposium on Mesoscopic Optics of Disordered Media I</td>
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<tr>
<td>12:00–13:00</td>
<td>Lunch Break (on your own) and Unopposed Exhibit Only Time, Empire Hall</td>
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<tr>
<td>12:00–13:00</td>
<td>Environmental Sensing Technical Group Special Talk, Genesee Suite G, Radisson Hotel Rochester Riverside</td>
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<tr>
<td>13:00–14:30</td>
<td>FW3A • Novel Design Concepts for Eye Correction and Vision Simulators II</td>
<td>FW3B • Quantum Communications II</td>
<td>FW3C • Diffuse Imaging and Optical Properties</td>
<td>FW3D • Symposium on Mesoscopic Optics of Disordered Media II (ends at 14:00)</td>
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<tr>
<td>14:00–16:00</td>
<td>Student Chaper Competition, Empire Hall</td>
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<td>14:30–15:00</td>
<td>Coffee Break, Empire Hall</td>
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<tr>
<td>14:30–16:00</td>
<td>JW4A • Joint Poster Session I and Unopposed Exhibit Only Time, Empire Hall (see page 23 for specific e-poster viewing times)</td>
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<tr>
<td>15:30–17:00</td>
<td>Meet the Editors of the APS Journals, Riverside Court</td>
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<tr>
<td>16:00–17:00</td>
<td>OIDA Members and Exhibitor Appreciation Reception (OIDA members and exhibitors only), Empire Hall</td>
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<tr>
<td>16:00–18:00</td>
<td>FW5A • Understanding Myopia Development (ends at 17:30)</td>
<td>FW5B • High Power Fiber Lasers and Beam Combining (ends at 18:15)</td>
<td>FW5C • Optical Coherence Tomography</td>
<td>FW5D • Integrated Photonics</td>
</tr>
<tr>
<td>17:00–17:45</td>
<td>OSA Annual Business Meeting, Hyatt Regency Rochester, Regency Ballroom C</td>
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<tr>
<td>17:00–18:00</td>
<td>APS Division of Laser Science Annual Business Meeting, Radisson Hotel Rochester Riverside, Genesee Suite F</td>
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<tr>
<td>18:30–21:30</td>
<td>OSA 100 Year BASH, The Sibley Building, 228 East Main Street, Rochester, New York</td>
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<td>FW2E • Exotic States and Applications I</td>
</tr>
<tr>
<td>FW2F • Optical Fibers for Space Projects</td>
<td>FW2G • Symposium: Tribute to Steve Jacobs I</td>
<td>FW2H • Adaptive Optics and Inferometry</td>
<td>LW2I • Integrated Quantum Photonics I (ends at 12:30)</td>
<td></td>
</tr>
<tr>
<td>Unopposed Exhibit Only Time and Coffee Break, Empire Hall</td>
<td>Lunch Break (on your own) and Unopposed Exhibit Only Time, Empire Hall</td>
<td>Environmental Sensing Technical Group Special Talk, Genesee Suite G, Radisson Hotel Rochester Riverside</td>
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<tr>
<td>FW3A • Novel Design Concepts for Eye Correction and Vision Simulators II</td>
<td>FW3B • Quantum Communications II</td>
<td>FW3C • Diffuse Imaging and Optical Propertiesv</td>
<td>FW3D • Symposium on Mesoscopic Optics of Disordered Media II</td>
<td>FW3E • Plasmonics</td>
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<tr>
<td>FW3F • Quantum Entanglement</td>
<td>FW3G • Symposium: Tribute to Steve Jacobs II (ends at 14:00)</td>
<td>FW3H • Optical Design and GRIN Materials</td>
<td>LW3I • Multiphoton Effects II</td>
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<tr>
<td>Student Chaper Competition, Empire Hall</td>
<td>Coffee Break, Empire Hall</td>
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<tr>
<td>JW4A • Joint Poster Session I and Unopposed Exhibit Only Time, Empire Hall (see page 23 for specific e-poster viewing times)</td>
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<td>Meet the Editors of the APS Journals, Riverside Court</td>
<td>OIDA Members and Exhibitor Appreciation Reception (OIDA members and exhibitors only), Empire Hall</td>
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<tr>
<td>FW5A • Understanding Myopia Development (ends at 17:30)</td>
<td>FW5B • High Power Fiber Lasers and Beam Combining (ends at 18:15)</td>
<td>FW5C • Optical Coherence Tomography</td>
<td>FW5D • Integrated Photonics</td>
<td>FW5E • Ultrafast Lasers and Applications</td>
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<tr>
<td>FW5F • Nonlinear Optics in Micro/Nano-Optical Structures II</td>
<td>FW5G • Optical Fabrication and Metrology</td>
<td>FW5H • Freeform Design and Metrology</td>
<td>LW5I • Integrated Quantum Photonics II</td>
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<tr>
<td>OSA Annual Business Meeting, Hyatt Regency Rochester, Regency Ballroom C</td>
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<td>APS Division of Laser Science Annual Business Meeting, Radisson Hotel Rochester Riverside, Genesee Suite F</td>
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<tr>
<td>OSA 100 Year BASH, The Sibley Building, 228 East Main Street, Rochester, New York</td>
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## Agenda of Sessions — Thursday, 20 October

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<tr>
<th>Time</th>
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<td>07:00–17:00</td>
<td>Registration, Galleria</td>
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<tr>
<td>08:00–09:30</td>
<td>JTh1A • Joint Plenary Session, Lilac Ballroom</td>
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<td>09:30–14:00</td>
<td>Exhibits Open, Empire Hall</td>
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<td>09:30–14:00</td>
<td>Glass Art Contest, Empire Hall</td>
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<td>Coffee Break, Empire Hall</td>
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<td>09:30–11:00</td>
<td>JTh2A • Joint Poster Session II and Unopposed Exhibit Only Time, Empire Hall (see page 23 for specific e-poster viewing times)</td>
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<tr>
<td>11:00–12:30</td>
<td>JTh3A • OSA Light the Future Speaker Series featuring Michio Kaku and Nobel Laureates, Lilac Ballroom</td>
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<td>12:30–14:00</td>
<td>Free Lunch (provided by OSA), Exhibit Hall, Empire Hall</td>
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<tr>
<td>12:30–14:00</td>
<td>VIP Industry Leaders Networking Event: Connecting Corporate Executives, Young Professionals &amp; Students, Hyatt Regency Rochester, Grand Ballroom B-C</td>
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<td>14:00–16:00</td>
<td>FTh4A • Symposium on Mid-Infrared Fiber Sources I</td>
<td>FTh4B • Optical Vortices</td>
<td>FTh4C • Computational Imaging I</td>
<td>FTh4D • Optics Meets Neuroscience I</td>
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<tr>
<td>16:00–16:30</td>
<td>Coffee Break, West Corridor and Skyway Lobby (Radisson)</td>
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<tr>
<td>16:30–18:30</td>
<td>FTh5A • Symposium on Mid-Infrared Fiber Sources II</td>
<td>FTh5B • Optical Vortices, Polarization and Mode Shaping</td>
<td>FTh5C • Computational Imaging II</td>
<td>FTh5D • Optics Meets Neuroscience II</td>
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### Key to Shading
- **Frontiers in Optics**
- **Laser Science**
- **Joint**
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<th>Highland Room A</th>
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<td>FTh4E • High Capacity Optical Communications and Data Centers I</td>
<td>FTh4F • Quantum Communication and Networking I</td>
<td>FTh4G • Integrated Nonlinear Optics I</td>
<td>FTh4H • Probing Ocular Biomechanics with Imaging Techniques / Novel Applications of Femtosecond Lasers in Ophthalmology</td>
<td>FTh4I • Symposium on 100 Years of Vision at OSA: Most Cited Vision Papers in OSA Journals</td>
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<tr>
<td>FTh5E • High Capacity Optical Communications and Data Centers II</td>
<td>FTh5F • Quantum Communication and Networking II</td>
<td>FTh5G • Integrated Nonlinear Optics II</td>
<td>LTh5H • Topological Photonics I</td>
<td>LTh5I • High Harmonic Generation</td>
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## Agenda of Sessions — Friday, 21 October

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<tr>
<td>08:00–10:00</td>
<td>FF1A • Imaging and Therapy Inside the Human Body</td>
<td>FF1B • Optical Fiber Sensors I</td>
<td>FF1C • Quantum Information Processing in Integrated Systems</td>
<td>FF1D • Quantum Optical Technologies</td>
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<td>10:00–10:30</td>
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<td>Coffee Break, West Corridor and Skyway Lobby (Radisson)</td>
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<tr>
<td>10:30–12:30</td>
<td>FF2A • Postdeadline Session I</td>
<td>FF2B • Postdeadline Session II</td>
<td>FF2C • Postdeadline Session III</td>
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<td>12:30–13:30</td>
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<td>Lunch (on your own)</td>
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<tr>
<td>13:30–15:30</td>
<td>FF3A • Advanced Microscopy Methods and Applications</td>
<td>FF3B • Optical Fiber Sensors II</td>
<td>FF3C • Quantum Electronics I</td>
<td>FF3D • Quantum Optical measurement and Quantum Technologies I</td>
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<td>Coffee Break, West Corridor and Skyway Lobby (Radisson)</td>
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<tr>
<td>16:00–18:00</td>
<td>FF4A • In-vivo Spectroscopy, Metabolism and Raman</td>
<td>FF4B • Optical Manipulation, Processing and Applications</td>
<td>FF4C • Quantum Electronics II</td>
<td>FF4D • Quantum Optical Measurement and Quantum Technologies II</td>
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<tr>
<td>FF1E • Symposium on Integrated Photonic Manufacturing I</td>
<td>FF1F • Strongly Confined Nanoscale Waveguides, Photonic Crystals and Resonator Devices</td>
<td>FF1G • Wavefront Sensing and Phase Retrieval (begins at 08:30)</td>
<td>FF1H • General Optical Sciences I</td>
<td>LF1I • Nanophotonics II</td>
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<td>LF2D • General Laser Science I</td>
<td>LF2E • General Laser Science II</td>
<td>LF2F • Quantum Light Sources II</td>
<td>LF2G • General Laser Science III (begins at 10:45)</td>
<td>LF2H • High Harmonic Generation II</td>
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<td>Lunch (on your own)</td>
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<tr>
<td>FF3E • Symposium on Integrated Photonic Manufacturing II (ends at 14:30)</td>
<td>FF3F • Ultrafast Dynamics and laser Ion Acceleration</td>
<td>FF3G • Polarization Control and Measurements</td>
<td>FF3H • General Optical Sciences II</td>
<td>LF3I • X-ray and XUV III</td>
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<tr>
<td>FF4A • Symposium on Integrated Quantum Optics I (begins at 14:30)</td>
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<tr>
<td>FF5E • Symposium on Integrated Quantum Optics II (ends at 17:30)</td>
<td>FF5F • Hybrid Integration (ends at 18:15)</td>
<td>FF5G • Beams and Optical Coherence</td>
<td>FF5H • Exotic States and Applications II</td>
<td>LFSI • Topological Photonics II</td>
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</table>
Optical Designs of NASA Telescopes, Joseph M. How ard; 1 NASA Goddard Space Flight Center, USA. A brief historical summary of NASA’s space telescopes is presented with an emphasis on their science applications and resulting optical design forms.

The Birth of Optical Fiber Communications, Richard Ep worth; 1 Retired, UK. Fifty years ago the optical fiber revolution began with the pioneering publication “Dielectric-fibre surface waveguides for optical frequencies”, the work of a small team at a British research laboratory. This is their story.

Glass and Light: Enabling the Information Age, Donald B. Keck; 1 Consultant, USA. Forty-six years ago, a technological syzygy of four inventions/breakthroughs – including Corning’s low-loss optical fiber – created the Information Age. We’ll revisit that remarkable milestone, and the world-changing impact of optical telecommunications.

Optical Designs of NASA Telescopes, Joseph M. Howard; 1 NASA Goddard Space Flight Center, USA. A brief historical summary of NASA’s space telescopes is presented with an emphasis on their science applications and resulting optical design forms.

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Biography: Wim Leemans is the Director of the Accelerator Technology and Applied Physics (ATAP) Division and Director of the BELLA (Berkeley Lab Laser Accelerator) Center at LBNL. He obtained his Ph.D. from UCLA and joined LBNL in 1991. His main research focuses on the development of laser driven plasma accelerators and applications. He has received numerous awards including most recently the 2009 E.O. Lawrence Award from the DOE, the Advanced Accelerator Concepts Award in 2012, the 2014 DOE Secretary’s Achievement Award for the BELLA Project and is a Fellow of the APS, IEEE, and AAAS.

Join the conversation. Follow @Opticalsociety on Twitter. Use hashtag #FIO16 and #OSA100
between electrons and their holes dominate crystals we find that “generalized recollisions” can benefit many applications. We present a method of switching the spatial coherence of a laser for multimodality microscopy.


Reconfigurable Photonics Metasurfaces, Nikolay I. Zheludev, ORC, Univ. of Southampton, UK; CDFT/TPPSMS, Nanyang Technological Univ., Singapore. The balance of forces at the nanoscale offers the opportunity to develop reconfigurable metamaterials in which thermal, electromagnetic Coulomb, Lorentz and Ampère forces can be used to control their optical properties.

Ni-TaN Nanocomposite Absorber For Next-Generation Extreme Ultraviolet Lithography, Darrick Hay, Patrick Bagge, Ian Khaw, Lei Sun, Obert Wood, Yulu Chen, Ryoung-Han Kim, Zhengping Qi, Zhimin Shi, Department of Physics, Univ. of South Florida, USA; GlobalFoundries Inc., USA. We present a scaling framework for nonlinear light-matter interactions, applicable to attosecond pulse generation and other nonlinear phenomena as e.g. filamentation.

Spatial Coherence Engineering of Lasers, Hui Cao, Yale Univ., USA. We develop lasers with low spatial coherence to achieve speckle-free imaging. We also invent a fast and efficient method of switching the spatial coherence of a laser for multimodality microscopy.

Photonic Hypercrystals, Evgenii E. Narimanov, Purdue Univ., USA. Photonic hypercrystals form a new universality class of artificial optical media. These hyperbolic metamaterials with a periodic spatial variation of permittivity on subwavelength scale, combine the features of metamaterials and photonic crystals.

Ni-TaN nano-composite absorber is studied for next-generation EUV lithography. We show that the performance is insensitive to the size and location of nano-particles, and that such an absorber can greatly reduce HV bias.
Precision Optics and Metrology at Tropel, John H. Bruning; Retired, Corning, USA. This talk is a personal perspective on the evolution of precision optics and metrology at Tropel in Rochester, highlighting early applications of computers, lasers and microlithography, and their impact on microelectronics, photonics and healthcare.

FTu1A.3 • 09:00
Invited
Precision Optics and Metrology at Tropel, John H. Bruning; Retired, Corning, USA.

Bell Lab’s Seminal Testing to of Optical Fiber Systems: Past, Present and Future, John MacChesney; 1 John B. MacChesney Optical Materials, USA. Bell labs invents and produces low-loss optical fibers for ATR transmission networks. MSB has been widely used. Bell labs are the continuing leaders in the area of WDM and high-capacity transmission systems.

FTu1B.3 • 09:00
Invited

Measuring Ultralow Emittance of Laser-Driven Electron Beams with Spectroscopic Imaging of Inverse-Compton-Scattered X-rays, Grigory Golovin1, Sudeep Banerjee1, Cheng Liu1, Shouyuan Chen1, Jun Zhang1, Boahe Zhao1, Ping Zhang1, Matthew Veale1, Matthew Wilson1, Paul Seller1, Donald P Umstadter2, 1 UNL, USA; 2 STFC, UK. We report the first measurement of laser-wakefield-accelerated electron beam transverse emittance, as well as its evolution, performed via a novel technique employing spectroscopic imaging of inverse-Compton scattered x-rays.

FTu1C.3 • 09:00

Experimental observation of multiphoton Thomson scattering, Wenchao Yan1, Grigory Golovin1, Colton Fruhling1, Daniel Haden1, Ping Zhang1, Jun Zhang1, Boahe Zhao1, Cheng Liu1, Shouyuan Chen1, Sudeep Banerjee1, Donald P. Umstadter2, 1 Univ. of Nebraska Lincoln, USA. High power laser light is used to study Thomson scattering in the highly multiphoton regime. The experimental results are consistent with ultra-high field strengths and the scattering of close to 10^3 laser photons per electron.

FTu1C.2 • 08:45

Single Recollision Event with High Ponderomotive Energy, T. J. Hammond1, 2 JAS Labs, U. Ottawa, USA. We use the interplay of nonlinear optics and spatio-temporal coupling to synthesize a sub-cycle pulse. It generates isolated attosecond pulses, tunable in energy by the carrier envelope phase over an octave in the extreme ultraviolet.

FTu1C.4 • 09:15

Apodized Grating for Silicon Tunable Delay Lines, Lingjun Jiang1, Stephen Anderson1, Young H. Kim1, Weimin Zhou1, Zhaoan R. Huang1, Renselaer Polytechnic Inst., USA; 2 Sensors & Electron Devices Directorate, US Army Research Laboratory, USA. We investigated three designs of apodized silicon grating waveguides for delay line applications. A tunable delay of 140 ps/mm for wavelength tuning and 130 ps/mm/V for voltage tuning has been achieved in our best design.

FTu1C.5 • 09:15

Apodized Grating for Silicon Tunable Delay Lines, Lingjun Jiang1, Stephen Anderson1, Young H. Kim1, Weimin Zhou1, Zhaoan R. Huang1, Renselaer Polytechnic Inst., USA; 2 Sensors & Electron Devices Directorate, US Army Research Laboratory, USA. We investigated three designs of apodized silicon grating waveguides for delay line applications. A tunable delay of 140 ps/mm for wavelength tuning and 130 ps/mm/V for voltage tuning has been achieved in our best design.

FTu1D.3 • 08:45

60.5 dB Silicon Mach-Zehnder Interferometer using Self-Optimising Beam-Splitters, Callum M. Wilkes1, Xiaogang Qiang1, Jianwei Wang1, Raffaele Santagati1, Stefano Paesani1, Xiaojun Zhu1, Pete Shadbolt2, Terry Rudolph2, David Miller2, Mark G. Thompson1, Jeremy L. O’Brien1, 1 CQI, Univ. of Bristol, UK; 2 Sun Yat-Sen Univ., China; 3 Imperial College, London, UK; 4 Stanford Univ., USA. We demonstrate an ultra-high extinction MZI on a reconfigurable silicon photonic chip, using a self-optimising approach to adjust variable beam-splitters. This result paves the way for large-scale integrated photonic quantum information applications.

FTu1D.4 • 09:00

Subwavelength Grating Athermal Mach-Zehnder Silicon Photonics Interferometer With Enhanced Fabrication Error Tolerance and Wide Spectral Range, Peng Xing1, Jaime P. Viegas1, Masdar Inst. of Science and Tech, United Arab Emirates. We present an experimental validation of a broadband athermal Mach-Zehnder interferometer with subwavelength grating waveguide in one of the arms to increase its fabrication error tolerance, while achieving less than 10 pm/K thermal sensitivity.
We investigate structured photons as carriers of quantum information. We describe our implementation of quantum cryptography with orbital angular momentum, and present our implementation of quantum cryptography states tomography for structured light fields. The ranges of bicontinuity for three-dimensional, periodic structures made by multi-beam interference are reported, along with their volume fractions and surface areas. Corresponding results for sphere-based models are presented for comparison.

FTu1F.4 • 09:15
Characteristics of Three-Dimensional Bicontinuous Periodic Structures Produced by Multi-Beam Interference, Shruthi Kumara Vadivel1, Matthieu Lebovici1, Thomas K. Gaylord1, Georgia Inst. of Technology, USA. The ranges of bicontinuity for three-dimensional, periodic structures made by multi-beam interference are reported, along with their volume fractions and surface areas. Corresponding results for sphere-based models are presented for comparison.

FTu1F.3 • 08:45
Invited
Inverse Methods and the Design of Sub-wavelength Scattering Elements for Super-resolution, Michael A. Fiddy1, Univ. of North Carolina at Charlotte, USA. Subwavelength-scale scatterers convert evanescent into propagating waves. Nonlinear inverse scattering algorithms may reveal these processes leading to superresolved images but they may be replaced by propagating through designed optical structures.

FTu1G.3 • 09:00
Trapped Ultracold Atoms Make Perfect Quantum Metamaterials, Pankaj K. Jha1,2, Michael Meijer1, Jeongmin Kim1, Chihhui Wu1, Yuan Wang1, Yuri Rostovtsev1, Xiang Zhang1, Univ. of California, Berkeley, USA; 2Univ. of North Texas, USA. We introduce a novel platform for quantum metamaterial by engineering the electromagnetic response of ultracold atoms loaded in an artificial crystal of light. Our proposal opens the door for applications at single-photon level with metamaterials.

FTu1G.4 • 09:15
Engineering a Giant Nonlinear Optical Response for a Meta-Surface on an Epsilon-Near-Zero Material, Mohammad Z. Alam1, Israel de Leon1,2, Sebastian A. Schub1, Jeremy Upham1, Robert W. Boyd1, Univ. of Ottawa, Canada; 2Tecnológico de Monterrey, Mexico. A meta-surface of plasmonic antennas on a thin epsilon-near-zero substrate exhibits a broadband nonlinear response with |n_r| values up to eight orders of magnitude larger than that of silica glass and |Δn|>3.0.

FTu1H.3 • 09:00
Invited
Title to be Announced, Steven G. Johnson1, Massachusetts Inst. of Technology, USA. Abstract not available.

FTu1H • Nanophotonics I—Continued

FTu1I.4 • 09:15
Intracavity Dissipative Four-Wave Mixing at Different Dispersion Regimes of an Ultrafast Fiber Laser, Sinem Yilmaz1,2, Hakan S. Sayın2, Fatih Öner Ilday1,3, Jörg Neumann4,5, Dietmar Kracht4,1; 1Physics department, Bilkent Univ., Turkey. We investigated a system which generates ultra-high repetition rate of 100 GHz stable pulse trains for different dispersion regimes in combination of a high-finesse Fabry Perot filter inside the laser setup.
Optics Goes to the Movies, John Greivenkamp; 'Univ. of Arizona, USA. The Museum of Optics at the Univ. of Arizona has acquired a number of movies that provide interesting windows into the history of optical design and fabrication. Portions of several of these movies will be shown.

Origins of the Erbium-Doped Fiber Amplifier, Randy Giles; 'Nokia Bell Labs, USA. Optical amplification in lightwave systems became practical with the invention of the Erbium-doped Fiber Amplifier (EDFA) in the late 1980s. This talk will trace the early work on the erbium-doped fiber and the enabling technologies that took the EDFA from lab experiments to its wide deployment resulting in a dramatic bandwidth expansion of commercial lightwave systems.

We present an experiment where two independent laser-plasma accelerators were coupled by an active plasma lens. Electron beam trapping in the second stage was verified by an 100 MeV energy gain.

Silicon Photonic Switches for Datacenters, Ming C. Wu, Tae Joon Seok, Sangyoon Han; 'Univ. of California Berkeley, USA. Silicon photonics offers unprecedented capability to integrate large-scale optical switches on a chip. We review the current state-of-the-art of silicon photonic switches, and describe our large-scale (64x64) switches with microsecond switching time.
Lahaye set up that developed toward this goal. Reports on the progress made on two different compensating for their weaknesses. This paper strengths of multiple approaches while hopefully searching Laboratory, USA.

Fredrik K. Fatemi2, Daniel Barredo1, Thierry Soljacic3, Steve L. Rolston1, Luis A. Oropeza1, and Alexandre Barraudi1,2,3,1, Jonathan E. Hoffman1, Antoine Browaeys1, and Thierry Soljacic1,2,3,1, Joint Quantum Inst., USA; 2ORC, Univ. of South Australia; 3Naval Research Laboratory, USA. Robust hybrid quantum systems have been imagined to combine the strengths of multiple approaches while hopefully compensating for their weaknesses. This paper reports on the progress made on two different setups that are developed toward this goal.

FTu1F • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning—Continued

Using Near IR Scattering Nanoparticles to Improve Transparent Solar Cell Efficiency, Duncan C. Wheeler1, Yichen Shen1, and Martin Soljačić1; 1Physics, MIT, USA. We use near IR scattering nanoparticles and a wavelength selective mirror to create a light trapping effect. When used with a transparent solar cell, theoretical calculations show that efficiency can double without decreasing transparency.

Reversibly tunable hydrophilic nano/microporous polymer photonic crystal, Dengqin Ji1, Alexander Cartwright1, Tim Thomay1, Chi Zhou1, Qiaoqiang Gan1, and Duncan C. Wheeler1; 1Physics, MIT, USA. We report a low cost fabrication method to finely manipulate the pore size of nano/microporous materials and demonstrate its application for reversible color tuning of porous polymer photonic crystals based on atmosphere humidity condensation.

FTu1G • Quantum Effects in Metamaterials—Continued

Gain Optical Nonlinearities and Non-volatile Switching in Photonic Metamaterials, Nikolay I. Zheludev1,2; 1CDPT/ITP/SPMS, Nanyang Technological Univ., Singapore; 2ORC, Univ. of Southampton, UK. Extremely large nonlinearities can be obtained in all-dielectric and plasmonic metamaterials through the exploitation of optomechanical and thermal response of the nanostructures, that can be additionally enhanced by the use of superconductors.

Lasing Using Bound States in the Continuum, Ashok Kodigala1,2, Aku J. Antikainen1,2, and Thomas Lettvin1; 1Univ. of California, San Diego, USA. We have designed a high quality factor cavity that is based on a bound state in the continuum and harnessed its properties to demonstrate a novel type of surface emitting laser in the c-band (~1550nm).
The Richard F. Caris Mirror Lab at the Univ. of Arizona has made lightweight honeycomb mirrors for some of the world’s largest telescopes. Its 30 years of mirror making history, enabling a series of iconic telescopes, is presented.

### History of the Center for Optics Manufacturing, 30 Years of Mirror Making at the Richard F. Caris Mirror Lab

**Invited**

Hubert M. Martin, Dae Wook Kim, Roberta Graziani, John Hill, Gotfried85, Richard Caris, Chao, John M. Schrader, Hui Zheng, Wei, Brian, Richard Caris, Lasers, Mike, John, and many others.

The Center for Optics Manufacturing (COM) at the Univ. of Rochester was a U.S. Army Center of Excellence from 1990–2004 as a focal point for development, demonstration, and implementation of manufacturing technology.

### Recent Development in Optical Fibers for High Capacity Transmission Systems

**Invited**

Ming-Jun Li, John M. Schrader, Hui Zheng, Wei, Brian, Richard Caris, Lasers, Mike, John, and many others.

We present recent development in optical fibers for long haul and short reach applications. We discuss new single mode and multimode fibers for increasing system capacity and next generation fibers for space division multiplexing.

### Time-resolved Holographic Imaging of Femtosecond Laser-induced Damage Process in Dielectric Thin Films

**Invited**

Anis Melnikaitis, Dviras Melnikaitis, Nerys, Balys, and many others.

We report single nanoparticle detection using silicon nitride two-dimensional coupled-resonator optical-waveguides (CROWs). Our experiments based on light-scattering imaging show real-time binding of 100nm-radius particles using 2×2 microring CROWs.
than P. Marangos polythiophene (P3HT) film.

stable intense laser pulse at 1800 nm which was energy range using HHG from a 1.5 cycle CEP supercontinuum in the 150 – 450 eV photon range for Absorption Spectroscopy, HHG Generated Soft X-ray Supercontinuum for Single Tailored Spatial Projective Measurement, Brahm L. Miseikis, S. Jarosch, D.A. Wood

Imperial College London, Israel; 2Physics, Queens College and Graduate Center of CUNY, USA.

We introduce a new technique for estimating the distance between two point sources. We present progress towards an experimental demonstration of the advantages of this technique over the more traditional Image Plane Counting.

Simultaneous fluorescent and quantitative phase imaging through spatial frequency projections, Patrick A. Stockton, Randy Bartels, Jeffrey J. Field, Colorado State University, USA. We introduce a new imaging technique to simultaneously image fluorescence and phase with a single element detector. This is accomplished by taking advantage of modulation transfer and Fourier optics to reconstruct the fluorescence and phase.

Retrieving Inter-Segment Piston Error Using Broadband Light, Scott Paine, James R. Fienup, University of Rochester, USA. Traditional phase retrieval methods fail to retrieve piston errors greater than 0.5 waves in segmented systems because of 2-pi ambiguities. We present and characterize an algorithm that uses broadband light to determine such piston errors.

Anderson Localization in the Deep Subwavelength Regime, Hanan H. Herzig Sheinfux, Guy Bartal, Mordechai Segev, Technion Institute of Technology, Israel; 3Physics, Queens College and Graduate Center of CUNY, USA. We experimentally demonstrate, for the first time, that localization of visible light can occur in deep subwavelength disordered multilayers with ~15 nm layer thicknesses. Transmission is shown to be sensitive to 2 nm thickness variations.

An in vivo Two-Photon Fluorescence Approach to Quantify the Blood-Brain Barrier Permeability for Drug Delivery in Brain, Lingyan Shi, Columbia University, USA. A new method was developed to quantify the blood-brain barrier (BBB) solute permeability postnatal rat brain and adult by using two-photon imaging system in vivo.

A new method was developed to quantify the blood-brain barrier (BBB) solute permeability postnatal rat brain and adult by using two-photon imaging system in vivo.

CO₂ Laser Structuring of Semiconductor-core Glass Fibers, Michael Fokine, Thomas Hawkins, Maxwell Jones, John Ballato, Ursula J. Gibson, Norges Teknikalaboratoriet, Norway; 2Clemson Univ., USA; 3KTH Royal Inst. of Technology, Sweden; 4Nufern, Inc, USA. A scanning CO₂ laser system is used to process semiconductor core glass fibers. The conditions can be tuned to melt the core and soften the glass, producing resonators, tapers and bends.

Self-Cleaning of Femtosecond-Pulsed Beams in Graded-Index Multimode Fiber, Zhanwei Liu, Logan G. Wright, Demetrios Christodoulides, Frank W. Wise, Cornell Univ., USA; 2Univ. of Central Florida, USA. We observe a nonlinear self-cleaning process in multimode fiber. Experiments and simulations show this effect is caused by Kerr nonlinear interactions between the modes. Several important applications will be discussed.

Composite Material Hollow Anti-resonant Fiber Nd-3, Logan G. Wright, Demetrios Christodoulides, Frank W. Wise, Cornell Univ., USA; 2Univ. of Central Florida, USA. We observe a nonlinear self-cleaning process in multimode fiber. Experiments and simulations show this effect is caused by Kerr nonlinear interactions between the modes. Several important applications will be discussed.

Self-Cleaning of Femtosecond-Pulsed Beams in Graded-Index Multimode Fiber, Zhanwei Liu, Logan G. Wright, Demetrios Christodoulides, Frank W. Wise, Cornell Univ., USA; 2Univ. of Central Florida, USA. We observe a nonlinear self-cleaning process in multimode fiber. Experiments and simulations show this effect is caused by Kerr nonlinear interactions between the modes. Several important applications will be discussed.
FTu2A • Symposium on 100 Years of Optical Design, Fabrication, Testing, and Instrumentation - A Historical Look Back II–Continued

FTu2B • Symposium on the 50th Anniversary of Low-Loss Optical Fibers II–Continued

FTu2C • Laser-Matter Interactions–Continued

FTu2D • Silicon Photonics II–Continued

**APOMA: Past & Present, James M. Sydor1,2; Sydor Optics Inc; USA; 2Sydor Technologies, USA.**

The future holds. Visit apoma.org for more info.

**FiO/LS 2016 • 16–21 October 2016**

**APOMA: Past & Present, James M. Sydor1,2; Sydor Optics Inc; USA; 2Sydor Technologies, USA.**

APOMA: Past & Present, James M. Sydor1,2; Sydor Optics Inc; USA; 2Sydor Technologies, USA. Overview and updates related to APOMA (American Precision Optics Manufacturers Association) including why APOMA was formed, the history of APOMA, past accomplishments, current events and what the future holds. Visit apoma.org for more info.

12:00–13:30 Lunch Break (on your own)

13:30–15:30 Poster Session, Riverside Court

13:45–16:00 OSAs Members, Family and Friends Tour – Susan B. Anthony Museum & House, Shuttle transportation will depart from the Hyatt Regency Rochester at 13:45
experiments, as demonstrated recently, Nature opens the way to performing coherent control. FEL FERMI is nearly transform limited. This longitudinal coherence, whereas the seeded FELs based on SASE have poor

**FTu2E.3 • 11:30**

**Invited**

Exploiting the Longitudinal Coherence of FERMI: Coherent Control with Multicolor FEL Pulses, Kevin Prince, 1 Int’l Centre for Theoretical Physics, Italy. FELs based on SASE have poor longitudinal coherence, whereas the seeded FEL FERMI is nearly transform limited. This opens the way to performing coherent control experiments, as demonstrated recently. Nature Photonics 10 (2016) 176.

**FTu2F.4 • 11:15**

Weak Value Measurements with Pulse Recycling, Courtney Byard1, Trent Graham2, Andrew Jordan1, Paul Kwiat1; 1Univ. of Illinois at UC, USA; 2Physics and Astronomy, 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 3.2.

**FTu2F.5 • 11:30**

Common Path Heterodyne Interferometer for Single Nanoparticle Detection in Fluids, Sarah Kurmulis1, Lukas Novotny2; 1Photons Laboratory, ETH Zurich, Switzerland. Sensitivity of interferometric detection of nanoparticles is limited by path length fluctuations. We present a common path heterodyne interferometer using a vibrating plate that allows stable and sensitive sizing of single nanoparticles in solution.

**FTu2F.6 • 11:45**

Fault-tolerant and finite-error localization for point emitters within the diffraction limit, Zong Sheng Tang1, Kadir Durak1, Alexander Ling1; 1Center for Quantum Technologies, Singapore Inst. of Technology, Singapore. We implement a finite-error estimator for determining the separation between two incoherent point sources even with small separation. This technique has good tolerance to error, making it an interesting consideration for high resolution instruments.

**FTu2F.7 • 12:00**

Using Polarized Light to Investigate Shell Structure of Sea Dwelling Organisms, Joshua A. Jones1, Enrique J. Galvez1, Rebecca A. Mettler1, Anthony J. D’Addario1, Carne Burgess1, Brian Regan2, Samantha Spano2, Ben Cvrch3; 1Coldgate Univ., USA. We present our work on using polarized light to investigate the structure of nacre in three shelled species: bivalve, cephalopod and gastropods. Data were collected using imaging polarimetry of monochromatic light passing through thin samples.

**FTu2G.3 • 11:15**

Replica Symmetry Breaking in Random Lasers Based on Colloidal Rh-6G and Specially Designed TiO$_2$ Nanoparticles, Pablo I. Pincheira1, Andrea Silva2, Sandra Carrerio2, Serge Few0, Andre de Lima Moura1,2, Ernesto Raposo1, Anderson Gomes1, Cid B. de Araujo1,2; 1Universidade Federal de Alagoas, Brazil; 2Deartmento de Física, Universidade Federal de Pernambuco, Brazil; 3Univ. of Yaounde I, Yaoundé, Cameroon. Replica symmetry break and a photonic paramagnetic to spin-glass phase transition in a random laser based on ethanol solution of Rhodamine 6G and specially designed amorphous TiO$_2$ nanoparticles is demonstrated.

**FTu2G.4 • 11:30**

Multiple Most-Likely Path Solutions for Continuously Monitored, Driven Qubits, Philippe Lewalle1, Areeya Chantasri1, Andrew Jordan1; 1Univ. of Rochester, USA. We examine most-likely paths for continuously monitored pure-state qubits, obtained as an extremum of a stochastic path integral. By considering the evolution of the Lagrange Manifold, we locate multiple-path solutions, analogous to optical caustics.

**FTu2G.5 • 11:45**

Using Polarized Light to Investigate Shell Structure of Sea Dwelling Organisms, Joshua A. Jones1, Enrique J. Galvez1, Rebecca A. Mettler1, Anthony J. D’Addario1, Carne Burgess1, Brian Regan2, Samantha Spano2, Ben Cvrch3; 1Coldgate Univ., USA. We present our work on using polarized light to investigate the structure of nacre in three shelled species: bivalve, cephalopod and gastropods. Data were collected using imaging polarimetry of monochromatic light passing through thin samples.

**FTu2G.6 • 12:00**

The Reflectivity Measurement of a Dynamically Formed Fiber Bragg Grating Inside an Yb-doped Fiber, Ivan A. Lobach1,2, Roman V. Drobyshev1, Andrei A. Fotiadis2, Sergey I. Kablukov1, Sergey A. Babkin1; 1Inst. of Automation and Electrometry, Russian Federation; 2Electromagnetism and Telecommunication department, Univ. of Mons, Belgium. A new kind of long-period fiber grating that contains dissipative fiber types is fabricated and demonstrated. This dissipative-fiber long-period fiber grating (DF-LPFG) is shown to exhibit good resonant attenuation and an acceptable insertion loss.

**FTu2I.4 • 11:15**

Maskless photolithography using a photon sieve on an optical fiber tip, Raquel Flores1, Ricardo Janeiro1, Dionísio Pereira1, Jaime Viegas1; 1Masdar Inst., United Arab Emirates. A photon sieve inscribed on a single mode optical fiber tip by focused ion beam milling is demonstrated for maskless lithography of a photosresist with a 405 nm wavelength laser.
13:30–14:30
FTu3A • Symposium on 100 Years of Optical Design, Fabrication, Testing, and Instrumentation - A Historical Look
Back III
Presider: Dae Wook Kim, Univ. of Arizona, USA

FTu3A.1 • 13:30
Invited
History of Optics Manufacturing in Rochester, New York, Jim VanKouwenberg1, Robert Wiederhold1, Optmax Systems Inc, USA. Optics manufacturing has a long history in Rochester with interesting stories of how companies developed and spun off other companies. This paper presents an historical overview as well as a few examples using current businesses.

FTu3A.2 • 14:00
Invited
Title to be Announced, Edward White1; 2CDGM Glass Company USA, USA. Abstract not available.

13:30–15:30
FTu3B • Symposium on the 50th Anniversary of Low-Loss Optical Fibers III
Presider: Alan Evans; Corning Incorporated, USA

FTu3B.1 • 13:30
Invited
Recent Advances in Microstructured Optical Fibers and their Applications, David Richardson1, 2Univ. of Southampton, UK. I review recent advances in microstructured fiber technology (in particular exploiting either multiple spatial cores/channels, and/or a hollow core) to deliver significant improvements in both conventional and emerging applications in communications, lasers and sensing.

FTu3B.2 • 14:00
Invited
Transmitting Beyond The Fictitious Nonlinear Capacity Limit, Stogan Radic1, 2Univ. of California San Diego, USA. With introduction of low-loss fibers, it appears that the transmission capacity is limited by Kerr response. We discuss the genesis of this misconception and describe the physics that does not recognize “nonlinear Shannon limit”.

13:30–15:30
FTu3C • Ultrafast Sources and Applications
Presider: Jie Qiao, Rochester Inst. of Technology, USA

FTu3C.1 • 13:30
Invited
Towards Attosecond Measurement in Complex Molecules and the Condensed Phase, Jonathan P. Marangos1, 2Imperial College London, UK. The challenge of measuring ultrafast electron dynamics will be explained. Recent progress on soft X-ray sources based upon XFELs and HHG and their application to time resolved absorption spectroscopy and related techniques will be described.

FTu3C.2 • 14:00
Invited
Ultracompact Field-Effect Plasmonic Modulator, Kaifeng Shi1, Zhaolin Lu1; 2Rochester Inst. of Technology, USA. We present an ultra-compact electro-absorption (EA) plasmonic modulator based on the field effect inside a metal-insulator-conductive oxide (MIC) structure. The modulator has an effective length of only 800nm, and can potentially work at high speed.

FTu3C.3 • 14:15
Dynamics of Large Femtosecond Filament Arrays: Possibilities, Limitations, and Trade-offs, Wiktor Wolaski1, Natalia M. Litchinitser1; 2Univ. at Buffalo, USA. We show that the dynamics of multifilament array propagation is affected by relative phase of the generating beams, number of filaments, separation between them, and initial power. We find the optimal parameters ensuring high array stability.

Biography: Jon Marangos graduated with a BSc in Physics from Imperial College in 1982 and a PhD in 1986. Currently he holds the Lockyer Chair in Physics at Imperial College and is an OSA Fellow. Recently he has been looking at the problems of controlling the electron dynamics driven in complex systems by strong laser fields and in developing high power sub-femtosecond light sources. He is involved in free electron laser science having led the UK New Light Source Project from 2008-2010 and is an active participant in experiments at X-ray FELs in USA, Japan and Europe.

13:30–15:45
FTu3D • Plasmonic and Photonic Crystal Devices
Presider: Jeurg Leuthold; ETH Zurich, Switzerland

FTu3D.1 • 13:30
Invited
Physical Scaling Laws of Nanophotonics, Ke Liu1, Shuai Sun1, Arka Majumdar1; 2Univ. of California San Diego, USA. We show that nanophotonic device performance scales non-monotonically with critical length and define the metric [Speed / (Energy/bit x Footprint)] to assess the quality of link performance based-on both optical and electrical tradeoffs.

FTu3D.2 • 14:00
Invited
On-Chip Plasmonic Spectrometer, Yuval Tsur1, Ady Arie1; 2Tel Aviv Univ., Israel. The first on-chip spectrometer utilizing propagating surface plasmon polatants, is demonstrated. It can enable compact Raman spectroscopy, and harnesses the plasmonic field-enhancement to potentially improve micro-particle spectroscopy.
15:00–16:30  
LTu3E • Laser Science Symposium on Undergraduate Research I  
Presider: Hal Metcalf, SUNY, Stony Brook, USA  
See the program distributed with registration materials for complete information.
Biography: Bill is a key contributor to the advancement of computer-aided illumination engineering, particularly in the development of practical and effective optimization capabilities for illumination systems. Bill is a SPIE Fellow, holds 48 US patents, and teaches illumination design courses. Bill has authored numerous papers and a chapter on illumination engineering in the Optical Society of America’s Handbook of Optics. At the 2006 and 2010 International Optical Design Conferences, Dr. Casserly submitted the winning solution for the Illumination Design Problem.
High-order hyper-Rayleigh scattering in BBO nanocrystals with dimensions of ~8 nm. The samples excitation was performed at 2000 nm, emission up to the fifth harmonic, i.e., 400 nm was detected.

We report on the high-order hyper-Rayleigh emission in BBO nanocrystals with five harmonic, i.e., 400 nm was detected. Rayleigh emission in BBO nanocrystals with

We study the symmetry of CO2 in the lambda point in liquid CO2. The polarization of the vibration transitions is measured by both conventional optical and infrared

We implement it on a reconfigurable Silicon QRNG, without necessary embedding into a chip, achieving heralding efficiencies of ~96%.

We also demonstrate a Bayesian approach for practical and robust implementation of the quantum phase estimation algorithm. We implement it on a reconfigurable Silicon QRNG, demonstrating its importance for future quantum applications.

We implement it on a reconfigurable Silicon QRNG, demonstrating its importance for future quantum applications. We demonstrate the most advanced chip enabling four photon generation and manipulation for heralding tunable two-photon states.

High-performance photon sources have been realized to produce entangled states and by balancing the losses in the resonator we achieved heralding efficiencies of ~96%.

We report on the high-order hyper-Rayleigh scattering in BBO nanocrystals with dimensions of ~8 nm. The samples excitation was performed at 2000 nm, emission up to the fifth harmonic, i.e., 400 nm was detected.
Active control of the vacuum field in nanomechanical photonic crystal structures, Michele Cotrufo1, Midolo Leonardo1, Maurangelo Petruzzella1, Zarko Zobenica1, Frank W. M. van Otten1, Andrea Fiore1; 1COBRA Research Inst., Eindhoven Univ. of Technology, Netherlands. We investigate a photonic-crystal-based nano-opto-electro-mechanical system which allows controlling the spatial localization of the vacuum electromagnetic field. Large modulations of the optical Q-factor are predicted and experimentally demonstrated.

Figure of Merit for planar plasmonic waveguides with a Kerr nonlinearity, C. Martijn de Sterke1, Guangyuan Li1, Stefano Palomba1; 1Univ. of Sydney, Australia. We illustrate the use of a Figure of Merit for nonlinear plasmonic waveguides with a set of one-dimensional geometries for which the fields are known analytically, bringing out the physical requirements for optimizing such structures.

Reminder:
FiO/LS 2016 Program now available in mobile formats!
Visit www.frontiersinoptics.com for more information.
Controlling Dipole Orientation Near A Dielectric Interface Via Substrate and Buffer Layer, Xuan Long Ho, Po-Jui Chen, Wei Yen Woon, Jonathon David White; Department of Photonics Engineering, Yuan Ze Univ., Taiwan; Department of Physics, National Central Univ., Taiwan. Fluorescence lifetime of Rhodamine 6G on an air-dielectric interface increased by a factor of three as thickness of a PMMA layer increased suggesting a change in dipole orientation from isotropic to perpendicular.

Rogue-soliton generation via Anderson localisation, Mohammed F. Saleh, Claudio Conti, Fabio Biancalana; Department of Physics, Univ. Sapienza, Inst. for Complex Systems (ISC-CNR), Italy. We offer a new explanation of how rogue-solitons generated during the modulation instability process in optical fibres are formed. Our novel point of view is based on Anderson localisation effect assisted by an optical-event horizon.

Microwave Beam Steering System with Simultaneous Spectral Bandpass Filtering Using Optical True Time Delay, Wenjing Xu; Beijing Univ. of Posts and Telecomm., China. A novel microwave beam steering system with spectral filtering using optical true time delay is proposed. 90 degrees beam steering with four elements and spectral filtering with 26-dB passband-to-stopband contrast ratio are simultaneously obtained.
addressing size, weight and power constraints. Optical design is a key enabler for such requirements while addressing size, weight and power constraints.

- **Human Centric Optical Design Enabling Next Generation Wearable Displays**, Bernard Kress1, Microsoft Corporation, USA. High resolution over large FOV with accurate 3D cues are key to the ultimate AR/VR experience. Human centric optical design is a key enabler for such requirements while addressing size, weight and power constrains.

- **Retro-reflective Characteristics of Transparent Screen for Head Mounted Projection Displays**, Shaib R. Soomro1, Hakan Urey1; 1Optical Microsystems Laboratory, Electrical engineering department, Koc Univ., Turkey. Retro-reflective features of microbeads based transparent screen are explored. Analytical expression of reflection cone is formulated and experimentally validated. Screen luminance for different viewing conditions is calculated when used with HMPD.

- **Flexible holographic 3D display with wide viewing angle**, Zhiyang Zhang1, Qiming Zhang1, Juan Liu1, Yongtian Wang1, Min Gu1, 1Beijing Inst. of Technology, China; 2Royal Melbourne Inst. of Technology, Australia. A flexible 3D holographic display has been designed based on the high refractive index materials on a flexible substrate. The dramatically increased viewing angle of the curved hologram is numerically demonstrated.
16:45–18:00  LTuSE • Laser Science Symposium on Undergraduate Research II
Presider: Hal Metcalf, SUNY, Stony Brook, USA
See the program distributed with registration materials for complete information.

**Highland Room A**

**Highland Room B**

16:00–18:00  LTuSF • X-ray and XUV II
Presider: Jonathan P. Maranos; Imperial College London, UK

16:00–18:00  LTuSF.1 • 16:00  Invited
Shrinking the Synchrotron: Tabletop Extreme Ultraviolet Absorption of Transition Metal Complexes, Josh Vura-Weis1, 2, Erika R. Warren3, Stephen R. Leone1, 1Department of Chemistry, LIU, USA. High-harmonic extreme ultraviolet spectroscopy is shown to be sensitive to the electronic structure of molecular transition metal complexes, distinguishing the oxidation state, spin state, and ligand field, and metal identity of coordination systems.

16:00–18:00  LTuSF.2 • 16:30  Invited
Transient Wave Mixing Spectroscopy Using High Order Harmonic Attosecond Pulses and Few-cycle NIR Laser, Wei Cao1, 2, Wei Cao1, 2, Erika R. Warren3, Stephen R. Leone1, 1Department of Chemistry, LIU, USA. We demonstrate the wave mixing process between weak extreme ultraviolet(XUV) attosecond pulses and strong near-infrared (NIR) few-cycle laser pulses in gas phase atoms. It offers a means for ultrafast nonlinear XUV spectroscopy.

**Highland Room C**

**Highland Room D**

16:00–18:00  FTuSG • Nonlinear Optics in Micro/Nano-Optical Structures I
Presider: Anatoly Zagayt; King’s College London, UK

16:00–18:00  FTuSG.1 • 16:00  Invited
Hybrid Silicon Photonic Circuits for Chip-Scale Quantum Optics, Hong Tang1, 1Yale Univ., USA. We will present the heterogeneous integration of active nanostructured materials on silicon chips for low-loss waveguiding and the exploitation of hybrid photonic circuits for efficient light conversion, manipulation and detection on silicon platform.

16:00–18:00  FTuSG.2 • 16:30  Invited
Photonic Quantum Networks, Ian A. Walmsley1, 2, Joshua Nunn1, 2, Brian J. Smith1, 2, Steve Kolihammer1, 2, Dylan Saunders1, 2, Stefanie Bar1, 1Jelmer Renema3, 1Patrick Ledingham1, Andreas Eckstein1, 2, Benjamin Brecht1, Amir Feizpour1, Helen Chrzanowski1, 2Univ. of Oxford, UK. Photonic networks offer the promise for delivering robust quantum information processing technologies, from sensor arrays to quantum simulators. New sources, detectors and memories illustrate progress towards building scalable quantum network.

16:00–18:00  FTuSH • Nano-Plasmonics for Spectroscopy
Presider: Kevin Kubarych; Univ. of Michigan, USA

16:00–18:00  FTuSH.1 • 16:00  Invited
Ultrafast Microscopy of Plasmonic Modes of Ag Nanocrystals Grown on Si Substrates, Hrvoje Petek1, 1Univ. of Pittsburgh, USA. We investigate the plasmonic modes of Ag nanocrystals grown in situ on Si(001) substrate by time-resolved photoelectron emission microscopy. Spectromicroscopic measurements reveal high-order plasmonic modes of Ag nanowires and Ag/Si interface.

16:00–18:00  FTuSH.2 • 16:30  Invited
Nanoscale Characterization and Control of Functional Materials Using Near-field Spectroscopy, Joanna M. Atkin1, 1Univ. of North Carolina - Chapel Hill, USA. Scattering-based near-field spectroscopy allows for measurements of nanometer heterogeneity in a wide variety of materials. I will discuss the use of near-field spectroscopy to probe the functional properties of nanostructured electronic materials.

**Highland Room E**

16:00–18:00  FTuSI • Novel Light Generation and Manipulation in Fiber Devices III
Presider: Gilberto Brambilla; Univ. of Southampton, UK

16:00–18:00  FTuSI.1 • 16:00  Invited
Polarization Effects in Optical Fibers For Distributed Sensing, Andrea Galtarossa1, 1Luca Palmieri1, 1Universita degli Studi di Padova, Italy. We show that the analysis of the state of polarization of Rayleigh backscattered light may be useful in developing distributed polarization sensitive optical fiber sensors able to measure mechanical parameters, electric current and magnetic field.

**Tuesday, 18 October**
**FiO/LS 2016 • 16–21 October 2016**

**Tuesday, 18 October**

**FiO**

Grand Ballroom A (Radisson)  
Grand Ballroom B (Radisson)  
Grand Ballroom C (Radisson)  
Grand Ballroom D (Radisson)

**FiTu5A • Optics in Consumer Electronics—Continued**

**FiTu5A.4 • 17:00**  
Efficient Structured Light Generator, Tasso R. Sales, Amherst, USA; Michael Morris, RPC Photonics Inc, USA. We describe a refractive micro-structure that generates a pseudorandom structured light pattern for gesture recognition and 3D sensing applications. The optical element provides wide field-of-view, high efficiency, and no zero order.

**FiTu5B • Laser Material Processing—Continued**

**FiTu5B.4 • 17:00**  
Graphene Oxide Thin Films for Functional Photonic Devices, Baohua Jia, Xiaorui Zheng, Han Lin, Yunyi Yang, Scott Fraser, Swinburne Univ of Technology, Australia. Using direct laser printing technology, we present functional photonic devices made from graphene oxide films demonstrating their great potentials as an emerging integratable platform for ultrafast, light weight and flexible photonic applications.

**FiTu5C • Frequency Combs and High Harmonic Generation—Continued**

**FiTu5C.4 • 17:00**  

**FiTu5D • Mid-Infrared Integrated Photonics—Continued**

**FiTu5D.4 • 17:00**  
Antimonid Based Mid-Infrared Detectors and Focal Plane Arrays, Sanjay Krishna, Center for High Technology Materials, USA. The use of “unipolar barrier engineering” to realize high performance infrared detectors and focal plane arrays will be discussed. A metamaterial detector structure will be demonstrated using Type II superlattices.

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**FiTu5A.5 • 17:15**  
Holographic Light Management in Photovoltaic Systems, Raymond K. Kostuk, Juan Russo, Jose Castro, Deming Zhang, Shelby Vorndran, Univ of Arizona, USA; Luminis, USA; Seagate Technology, USA; Panduit, USA. In this paper the application of holographic optical elements for photovoltaic energy conversion is reviewed including broadband concentrators and spectrum splitting systems with volume and computer generated holograms.

**FiTu5B.5 • 17:30**  
Flexible Laser Scribed Biomimetic Supercapacitors, Litty Thakkekara, Dan Li, Ling Gu, Min Gu, Swinburne Univ.

**FiTu5C.5 • 17:30**  
Generation of Low-Phase-Noise Millimeter Waves in a Wide Frequency Range by Using a Frequency Comb based on Electro-Optics-Modulators, Atsushi Ishizawa, Tadashi Ni-shikawa, Takahiro Goto, Kenichi Hitachi, Tetsuomi Sogawa, Hideki Gotoh, NTT Basic Research Laboratories, Japan. Using an electro-optics-modulator-based optical frequency comb at telecommunications wavelengths, we have successfully demonstrated that phase noise in a commercially available signal generator from 6 to 72 GHz can be dramatically reduced.

**FiTu5D.5 • 17:30**  
Mid-infrared ultra high Q factors in fluoride crystalline microresonators, Clement Javersac-Galy, Caroline Lecaplan, Michael L. Gorodetsky, Tobias J. Kippenberg, Ecole Polytechnique Federale de Lausanne, Switzerland; Russian Quantum Center, Russian Federation; Faculty of Physics, M. V. Lomonosov Moscow State Univ., Russian Federation. Using an uncoated chalcogenide tapered fiber as high ideality coupler, we demonstrate ultra-high quality factors deep in the mid-infrared with crystalline microresonators. Due to low multiphonon absorption we obtain the highest mid-IR optical finesse.
Frontiers of X-ray Science Developed with LTu5E • Laser Science Symposium

Tetsuo Katayama

an XFEL Facility SACLA, Japan; 2Japan Synchrotron Radiation Research Institute (JASRI), Advanced Light Source and Photon Science, USA. Japan. I will present latest status and perspective on a Japanese XFEL facility SACLA, including recent relocation of the SCSS test accelerator to the SACLA facility. I will focus on the challenges for reaching ultimately atomic resolution in X-ray imaging of single-particles, with the goal of overcoming the technical issues. We report the control over the spontaneous emission of energy-tunable quantum emitters embedded in passive waveguide circuits, realized by coupling Stark-tunable quantum dots to electromechanically-compliant photonic crystal molecules.

Measurement of photon-pair generation in waveguide arrays with specialized poling, Francesco Lenzini,1 James Titchener,1 Paul Fisher,1 Andreas Boes,1 Alexander Poddubny1, Sachin Kasture,2 Ben Haylock,3 Matteo Villa,1 Aman Mitchell1, Alexander S. Saintiev,1 Andrey A. Sukhorukov,1 Mirko Lobino1, Gradh University, Australia; 2The Australian National University, Australia; 3RMIT University, Australia; 4ITMO University, Russian Federation; 5Ioffe Physical-Technical Institute of the Russian Academy of Science, Russian Federation. We present the realization of an inhomogeneously poled nonlinear waveguide array for the generation of photon pairs. The device is characterized by coincidence counting and a novel method based on reversed sum-frequency generation measurements.

High Efficiency Superconducting Single-Photon Detectors Evanescently Coupled to Laser-Written Waveguides, Rubayet Al Maruf,1 Christopher Haapamäki1, Michal Bajcsy1, Inst. for Quantum Computing, Department of Electrical and Computer Engineering, Canada. SNSPDs evanescently coupled to silicon waveguides can have low system efficiency due to mode mismatch issue. We propose to improve this by substituting the silicon waveguides with silica waveguides, such as fibers or laser-written waveguides.

Ultrafast Methods for Investigating Structure and Dynamics of Biological Systems, Carlos Baiz,1 Univ. of Texas at Austin, USA. We describe a suite of ultrafast IR spectroscopy tools and molecular models designed to probe biological interfaces, including membrane protein structure, and interfacial environments surrounding the lipid bilayer.

Generation of Radially and Azimuthally Polarized Beams using All-Fiber Couplers, Shankar Pidishetty1,2, Gilberto Brambilla1, Siddharth Ramachandran2, Balaji Srinivasan1,3, Optoelectronics Research Centre, Univ. of Southampton, UK; 2Electrical and Computer Engineering Department, Boston Univ., USA; 3Department of Electrical Engineering, Indian Inst. of Technology Madras, India. We demonstrate the generation of radially and azimuthally polarized beams using an all-fiber fused coupler fabricated using single mode fiber (SMF) and air-core fiber. The generated beams exhibit high stability with ~85% power coupling efficiency.

Ultra-Long DFB Fiber Bragg Grating for Stimulated Brillouin Scattering in Standard Fiber, Sébastien Loranger1, Victor Lambin2,3, Raman Kashyap1,2, Ecole Polytechnique de Montréal, Canada; 2Electrical Engineering Department, Polytechnique Montréal, Canada. We demonstrate stimulated Brillouin scattering (SBS) in a standard fiber using ultra-long distributed feedback (DFB) fiber Bragg gratings (FGB). This is the first observation of SBS in standard fiber with a DFB.
FTu5B.6 • 17:45
An investigation of light behaviour in the multilayer photopolymer during holographic recording, Ra’ed A. Malallah1, Haoyu Li1, Inbarasan Muniraj1, John T. Sheridan1;1Univ. College Dublin, Ireland. We show the calculation for photopolymerization process using the multilayer technique by varying the dye concentration. The 3D Nonlocal Photopolymerization Driven Diffusion model is applied to calculate the resulting absorption and polymerization.

FTu5C.6 • 17:45
Testing QED with Ramsey-Comb spectroscopy in the deep-UV range, Sandrine Galtier1, Robert K. Altmann1, Laura S. Dreissen1, Kjeld S. Eikema1;1Vrije Universiteit Amsterdam, Netherlands. By combining upconversion of amplified frequency comb laser pulses with Ramsey-spectroscopy, we developed deep-UV Ramsey-Comb excitation, leading to highly accurate two-photon spectroscopy in krypton, and molecular hydrogen for testing QED.

17:30–20:30 Photonics Clambake 2016, (ticket required), Hyatt Regency Rochester, Grand Ballroom

18:00–19:00 Optics & Energy: Reflections on the Past and Lighting the Future, Radisson Rochester Riverside, Genesee Suite F

19:00–22:00 OSA Student Member Party, Holiday Inn Hotel Rochester, Grand Ballroom

19:00–22:00 Optics Alumni Networking Reception, Radisson Rochester Riverside, Riverview Ballroom and Lounge
17:30–20:30 Photonics Clambake 2016, (ticket required), Hyatt Regency Rochester, Grand Ballroom

18:00–19:00 Optics & Energy: Reflections on the Past and Lighting the Future, Radisson Rochester Riverside, Genesee Suite F

19:00–22:00 OSA Student Member Party, Holiday Inn Hotel Rochester, Grand Ballroom

19:00–22:00 Optics Alumni Networking Reception, Radisson Rochester Riverside, Riverview Ballroom and Lounge
**Grand Ballroom A (Radisson)**

**07:00–18:00** Registration, Galleria

**08:00–09:30** JW1A • Joint Plenary Session, Lilac Ballroom

**08:00–17:00** AIM Photonics Northeast Supply Conference (NESCO), Hyatt Regency Rochester, Grand Ballroom A-D

**09:30–16:00** Exhibit Hall Open, Empire Hall

**09:30–16:00** Glass Art Contest, Empire Hall

**09:30–10:30** Unopposed Exhibit Time and Coffee Break, Empire Ballroom

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**Grand Ballroom B (Radisson)**

**10:30–12:00** FW2A • Novel Design Concepts for Eye Correction and Vision Simulators I
Presider: Brian Vohnsen, Univ. College Dublin, Ireland

FW2A.1 • 10:30 **Invited**
Myopia Control Off-Axis Correction Lenses, Earl Smith; 'Univ. of Houston, USA. The defocus-sensitive mechanisms that regulate ocular growth operate in a regionally selective manner. Optical manipulations of peripheral vision can influence growth, potentially slowing myopia progression, without altering central vision.

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**Grand Ballroom C (Radisson)**

**10:30–12:00** FW2B • Quantum Communications I
Presider: Rainer Steinwandt; Florida Atlantic Univ., USA

FW2B.1 • 10:30 **Invited**
The Interplay between Cryptography and Quantum Technology - Challenges and Opportunities, Rainer Steinwandt; 'Florida Atlantic Univ., USA. Quantum technology has substantial potential for cryptography. This talk discusses cryptanalytic implications – how common hardness assumptions are invalidated and security models deserve to be revisited – and how quantum technology can transcend limitations of classical cryptography.

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**Grand Ballroom D (Radisson)**

**10:30–12:00** FW2C • Biomedical Optics
Presider: Mike Marcus, Lumetrics, USA

FW2C.1 • 10:30 **Invited**
3D High-definition Wide Field-of-view Optical Coherence Microscopy Advancing Real-time in-vivo Cellular Imaging, Cristina Canavesi, Andrea Cogliati, Adam Hayes, Patrice Tankam, Anand Santhanam, Kevin Rolland-Thompson, Jannick P. Rolland; 'LighTopTech Corp., USA; 'Electrical and Computer Engineering, Univ. of Rochester, USA; 'The Inst. of Optics, Univ. of Rochester, USA; 'Radiation Oncology, Univ. of California, USA; 'Synopsys Inc., USA. In-vivo imaging requires micron-scale resolution in 3D, ~1 mm depth of imaging and large field-of-view (≥1 mm). Optical coherence microscopy breaks the cellular lateral resolution limit of optical coherence tomography, enabling advances in biotech.

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**10:30–12:00** FW2D • Symposium on Mesoscopic Optics of Disordered Media I
Presider: Aristide Dogariu, CREOL, Univ. of Florida, USA

FW2D.1 • 10:30 **Invited**
Control of Optical Intensity Distribution inside a Disordered Waveguide, Hui Cao, R. Sarma, Yaron Bromberg, Alexey Yamilov, Sasa Petrenko; 'Yale Univ., USA; 'Dept. of Physics, Missouri Univ. of Science & Technology, USA. We use the adaptive wavefront shaping technique to vary the total energy inside a disordered silicon waveguide, and change the energy density distribution across the sample by selective coupling to high or low transmission eigenchannels.
07:00–18:00 Registration, Galleria

08:00–09:30 JW1A • Joint Plenary Session, Lilac Ballroom

08:00–17:00 AIM Photonics Northeast Supply Conference (NESCO), Hyatt Regency Rochester, Grand Ballroom A-D

09:30–16:00 Exhibit Hall Open, Empire Hall

09:30–16:00 Glass Art Contest, Empire Hall

09:30–10:30 Unopposed Exhibit Time and Coffee Break, Empire Ballroom

10:30–12:00 FW2E • Exotic States and Applications I
Presider: Shivanand, Purdue Univ., USA

FW2E.1 • 10:30 Invited
Exotic States of Light for Microscopy, Monika A. Ritsch-Marte1, 2; Medical Univ. of Innsbruck, Austria. Using tailored optical wavefronts or “exotic” optical beams in a microscope leads to a wealth of opportunities to modify the imaging performance. Advantages and problematic issues of recent approaches and general trade-offs will be discussed.

10:30–12:00 FW2F • Optical Fibers for Space Projects
Presider: Morten Ibsen; Univ. of Southampton, UK

FW2F.1 • 10:30 Tutorial
Recent Advances in Radiation Hardened Fiber-Based Technologies, Sylvain Girard1, Youcef Querdane1, Thierry Robin1, Benoit Cadier1, Aziz Bokkenter1; Laboratoire Hubert Curien, Université Saint Etienne, France; Photonics Division, Photonics Division, IXBlue, France. Several recent techniques are presented allowing to increase the radiation tolerance of fibers and fiber-based sensors to the harsh radiation constraints associated with space, high energy physics or nuclear power plants.

10:30–12:00 FW2G • A Tribute to Steve Jacobs I
Presider: Jonathan Zuegel, Univ. of Rochester, USA

FW2G.1 • 10:30 Invited
Optical Glass Science – the How and Why We Got There, Kathleen A. Richardson1; Univ. of Central Florida, CREOL, USA. Optical glasses play a critical role in photonic systems and components. Know-how in glass manufacturing and characterization realized at LLE in the early 1980’s led by Steve Jacobs, continue to yield advancement throughout our community.

10:30–12:00 FW2H • Adaptive Optics and Interferometry
Presider: Christina Schwartz, Univ. of Rochester, USA

FW2H.1 • 10:30
Wavefront Shaping For Measurements Through Diffusing Phase Boundaries, Nektarios Koukourakis1, Bob Fregin1, Jörg König1, Lars Buettner2, Jürgen Czarske1; IFW, Germany. We show that aberrations introduced by diffusing phase boundaries can be compensated by using guide-stars. Flow field measurements based on image correlation through rough phase boundaries are presented.

10:30–12:30 LW2I • Integrated Quantum Photonics I
Presider: To be Announced

LW2I.1 • 10:30 Invited
Quantum Silicon Photonics: Photon sources and Circuits, Stefan F. Preble1, Jeffrey A. Steidle1, Michael Fant01, Christopher C. Tison1, Gregory A. Howland2, Edwin Hach1, Paul Alsing2, Rochester Inst. of Technology, USA; Air Force Research Laboratory, USA. We report high performance ring resonator photon sources and the integration of the sources into quantum photonic circuits. We also discuss ring resonators as a building block for compact, reconfigurable, linear quantum optical circuits.

(continued on page 61)
FW2A.2 • 11:00 Invited
New Technologies to Increase the Range of Vision of Intraocular Lenses, Aixa Alarcon1, Marrie H. van der Moor1, Carmen Canovas1, Henk Weeber1, Patricia Piers1; 1Abbott Medical Optics Inc, Netherlands. Traditional methods to increase depth of focus result in the reduction of distance vision and increased side-effects. We present how the combination of different technologies can significantly improve depth of focus and visual performance.

FW2B.2 • 11:00
Hyperdense Coding with Single Photons, Alexander Hill1, Trent Graham1, Paul Kwiat1; 1Univ. of Illinois (UIUC), USA. We present current progress on an experimental implementation of quantum hyperdense coding, a quantum communication protocol which is capable of transmitting up to 2.58 bits per hyperentangled photon pair.

FW2C.2 • 11:00
Tomographic Coaxial Scanning Microscopy Using a Conical Lens (Axicon), Boris Y. Zeldovich1, Bahaa E. Saleh1; 1Univ. of Central Florida, CREOL, USA. A new form of tomographic coaxial scanning microscopy is proposed by replacing the standard lens in confocal microscopy with a conical lens (axicon) that generates pencil-like illumination and detection along lines through the object.

FW2D.2 • 11:00 Invited
Wave Control and Holography with Time Transformations, Mathias Fink1; 1Ecole Sup Physique Chimie Industrielles, France. Because time and space play a similar role in wave propagation, wave control can be achieved or by manipulating spatial boundaries or by manipulating time boundaries. Here we emphasize the role of time boundaries manipulation. We show that sudden changes of the medium properties generate instant wave sources that emerge instantaneously from the entire wavefield and can be used to control wavefield and to revisit the holographic principles.
FW2E • 11:00  
Topological Darkness of Tamm Plasmons for High-Sensitivity Singular-Phase Optical Detection, Svetlana V. Borsikina1, Jonathan Tong2, Yoichiro Tsurimaki1, Victor N. Borsikin2, Alexander Semenov1, Mykola I. Ayzatskiy1, Yuri P. Machekhin1, Gang Chen1, Maitreyi Jayaseelan1; 1Univ. of Rochester, USA; 2Kharkiv Inst. of Physics and Technology, Ukraine; 3Inst. for Single Crystals

Biography: Sylvain Girard got his PhD degree from Saint-Etienne University (UJM), France in 2003. He joined CEA in 2004 and became a senior member of technical staff. He was in charge of vulnerability and radiation hardening studies of photonics for the Laser Megajoule. In 2012, Sylvain joined UJM as Full Professor to work on the development of predictive models for the behavior of optical materials and components under irradiation. He has co-authored more than 140 journal papers and is the recipient of the 2013 IEEE NPSS Early Achievement Award and the 2014 IEEE Nicolas Brillouin Award.

FW2E • 11:15  
Creating ‘Optics’ for Singular Atom Optics with Spinor Bose–Einstein Condensates, Martin J. Booth1,2; 1Univ. of Oxford, UK; 2SAOT, Univ. of Erlangen Nurnberg, Germany

Biography: Sylvain Girard got his PhD degree from Saint-Etienne University (UJM), France in 2003. He joined CEA in 2004 and became a senior member of technical staff. He was in charge of vulnerability and radiation hardening studies of photonics for the Laser Megajoule. In 2012, Sylvain joined UJM as Full Professor to work on the development of predictive models for the behavior of optical materials and components under irradiation. He has co-authored more than 140 journal papers and is the recipient of the 2013 IEEE NPSS Early Achievement Award and the 2014 IEEE Nicolas Brillouin Award.

FW2F • 10:45  
Advances in Adaptive Optics for Microscopy and Nanoscopy, Martin J. Booth1; 1Univ. of Oxford, UK; 2SAOT, Univ. of Erlangen Nurnberg, Germany

Adaptive optics has been widely applied to microscopes to compensate specimen-induced aberrations. We report on recent developments extending these techniques to more challenging methods, including to super-resolution microscopes, or nanoscopy.

FW2F • 11:00  
Small Diameter Polarization Maintaining Photonic Crystal Fiber for Spaceborne Miniaturized Gyroscoopes, Cai Wei1, Jing Jin1, Jingming Song1, Wei Li2, Wenyong Luo1, Ningfang Song1, Chunxi Zhang1; 1Beihang Univ., China; 2FiberHome Telecommunication Technologies CO., Ltd., China.

An optimized small diameter polarization maintaining photonic crystal fiber (PM-PCF) is proposed. Radiation response of the PM-PCF and the performance of a 300-m mini coil demonstrate that the fiber is suitable for spaceborne gyroscopes.

FW2F • 11:15  
Title to be Announced, Alexander L. Gaeta1; Columbia Univ., USA. Abstract not available.
FW2A • Novel Design Concepts for Eye Correction and Vision Simulators I—Continued

FW2A.3 • 11:30
Temporal multiplexing and simulation of multifocal intraocular lenses, Vyas Akond1, Carlos Dorronsoro2, Enrique Gamboa3, Maria Vinas1, Daniel Pascual1, Sara Assal1, Susana Marcos1; Consejo Sup Investigaciones Científicas, Spain. Tunable lenses can simulate multifocal intraocular lenses through temporal multiplexing. The effect of sampling, response time of tunable lens and choice of the through-focus optical quality metric in evaluating the temporal profile are investigated.

FW2A.4 • 11:45
Light Sword Lens as Effective Method of Presbyopia Compensation, Krzysztof Petelczyński1, Karol Kakarenko1,2, Andrzej Kolodziejczyk1,2, Zbigniew Jaroszewicz2, Marek T. Rekas1, Alejandro Mira-Agudelo1, John Fredy Barrera1, Rodrigo Heras1; Faculty of Physics, Warsaw Univ of Tech, Poland; Inst of Applied Optics, Poland; National Inst. of Telecommunications, Poland; Facultad de Ciencias Exactas y Naturales, Universidad de Antioquia UdeA, Colombia; Ophthalmology Department, Military Inst. of Medicine, Poland. The monocular vision tests of 34 presbyopic patients was performed for defocused BCDVA vision, stenopia and Light Sword Lens correction. We show that visual acuity in the LSL case is better than others while contrast sensitivity matches normal vision.

FW2B • Quantum Communications I—Continued

FW2B.4 • 11:30
Observation of Intrinsic Spin-Orbit Interaction of Light in Few-Mode Optical Fiber, Dashiel L. Vitullo1, Cody C. Leany2, Patrick Gregg3, Roger Smith1, Dileeep V. Reddy1, Siddharth Ramachandran1, Michael G. Raymer1; Univ. of Oregon, USA; Electrical & Computer Engineering, Boston Univ., USA; Physics, College of Wooster, USA. Interaction between spin and intrinsic orbital angular momentum of light in a straight few-mode fiber is observed to generate rotation for both polarization and spatial profiles, in agreement with recent prediction.

FW2B.5 • 11:45
Experimentally Demonstrating Quantum Data Locking with a Quantum Enigma Machine, Daniel Lum1, Michael Allman1, Thomas Gerrits2, Varun Verma1, Cosmo Lupo3, Seth Lloyd4, Saé Woo Nam1; Univ. of Rochester, USA; National Inst. of Standards and Technology, USA; Massachusetts Inst. of Technology, USA. We present an experimental demonstration of quantum data locking as a quantum enigma machine that encrypts 6 bits per photon with less than 6 bits per photon of encryption key while remaining information-theoretically secure.

FW2C • Biomedical Optics—Continued

FW2C.4 • 11:30
Synthetic holographic phase imaging in confocal microscopy and applications, Martin Schnell1,2, Sam Buerskien1, Paulo Sarriugarte1, Maria Jesus Perez-Roldan1, Rainer Hilkenbrand3, F. Scott Carney4,5; CIC nanoGUNE Consolider, Spain; Beckman Inst. for Advanced Science and Technology, Univ. of Illinois Urbana-Champaign, USA; Department of Electrical and Computer Engineering, Univ. of Illinois Urbana-Champaign, USA; CIC nanoGUNE Consolider and EHU/UPV, Spain; IKERBASQUE, Basque Foundation for Science, Spain. We present synthetic optical holography for amplitude and phase-resolved confocal imaging. We apply our technique to optical topography mapping and numerical refocusing of out-of-focus confocal data.

FW2C.5 • 11:45
Sensing pH in a Microfluidic Channel with a Lab-on-a-Chip Fluorescence Spectrometer, Jiajie Chen1, Ruoyu Wang2, Abhishek Renganathan1, Anurag Rattan1, Varun Verma1, Siddharth Ramachandran1, Michael G. Raymer1,2,3, P. Scott Carney2,3; CIC nanoGUNE Consolider, Spain; Beckman Inst. for Advanced Science and Technology, Univ. of Illinois Urbana-Champaign, USA; CIC nanoGUNE Consolider and EHU/UPV, Spain; IKERBASQUE, Basque Foundation for Science, Spain; Electrical and Computer Engineering, Univ. of Illinois Urbana-Champaign, USA; Department of Electrical and Computer Engineering, Univ. of Illinois Urbana-Champaign, USA. We present a smartphone unit for measuring pH. The dye-mixed sample is input to a microfluidic chip and inserted into the unit. The smartphone image sensor records the fluorescence spectrum, and an app determines pH.

FW2D • Symposium on Mesoscopic Optics of Disordered Media I—Continued

FW2D.3 • 11:30 (Invited)
Open Channels in Scattering Media: See the Light Inside, Allard Mosk1; Debye Inst. for Nanomaterials Science, Universiteit Utrecht, Netherlands. Open channels are remarkable solutions of the wave equation that carry light through a thick scattering sample. We measure the energy density and frequency width of open channels and use them as a sensitive probe of the scattering strength.
FW2E • Exotic States and Applications I—Continued

FW2E.4 • 11:30
Dark Matter Optics, Humberto Michinel1, Angel Paredes1; 1Universidad de Vigo, Spain. We explain galactic offsets in the Abell 3827 cluster by considering Dark Matter as a coherent condensate of ultra-light axions forming solitons, which display interference properties similar to those observed in nonlinear optics.

FW2E.5 • 11:45
Measuring Exotic Looped Trajectories of Light, Omar S. Magana Loaiza1, Israel de Leon2,3, Mohammad Mirhosseini1, Brian McIntyre1, Brandon Rodenburg1, Robert W. Boyd1,2; 1Univ. of Rochester, USA; 2Department of Physics and Max Planck Centre for Extreme and Quantum Photonics, Univ. of Ottawa, Canada; 3School of Physics and Astronomy, Rochester Inst. of Technology, USA. The probability of a photon to follow looped trajectories in a three-slit interferometer is extremely small and difficult to measure. We unveil the underlying physics and implications behind these trajectories and present their first observation.

FW2F • Optical Fibers for Space Projects—Continued

FW2F.3 • 11:30
Miniaturized Interferometric Fiber Optical Gyroscopes for Space Application, Jing Jin1, Cai Wei1, Song Jingming1, Xiaoan Xu1, Ningfang Song1, Chunxi Zhang1; 1Beihang Univ., China. The configurations of miniaturized interferometric fiber optical gyroscopes (IFOG), miniaturized components, high reliability techniques and performance test results of typical IFOG products are introduced in this paper.

FW2G • A Tribute to Steve Jacobs I—Continued

FW2G.3 • 11:30
Steve Jacobs: The Optics Outreach Innovator, Tanya Z. Kosci1; 1Univ. of Rochester, USA; 2Laboratory for Laser Energetics, USA. Steve Jacobs’ achievements extended to the often overlooked realm of education and outreach when he developed the innovative, interactive Optics Suitcase. Initially conceived for local middle schools, the Optics Suitcase has expanded worldwide.

FW2H • Adaptive Optics and Interferometry—Continued

FW2H.5 • 11:45
Cost-Effective Adaptive Optics with the Digital Light Ophthalmoscope, Matthew S. Muller1, Ann E. Elsner2,1; 1Aeon Imaging, LLC, USA; 2School of Optometry, Indiana Univ., USA. A novel adaptive optics system for imaging the retina is presented. The system uses a digital light projector and rolling shutter detector, permitting real-time adjustments to the confocal aperture and a compact and cost-effective layout.

LW2I • Integrated Quantum Photonics I—Continued

LW2I.3 • 11:30
Experimental Photonic Quantum State Transfer and Self-guided Tomography, Alberto Pernuzzo1, Andreas Boes1, Robert Chapman1, Zixin Huang1, Akib Karim1, Inna Krasnokutska1, Jean-Luc Tambasco1; 1Quantum Photonics Laboratory, Royal Melbourne Inst. of Technology, Australia. Integrated optics offers an attractive platform for generating, manipulating and detecting quantum states of light. We report on the experimental realization of the perfect state transfer protocol and the self-guided quantum tomography.

LW2I.4 • 12:00
High Performances Integrated Single Photon Sources, Pascale Senellart1; 1CNRS, Centre for Nanoscience and Nanotechnology – C2N – CNRS UMR9001, Site de Marcoussis, Route de Nozay, France. Resonantly-excited quantum dots inserted in an electrically controlled pillar cavity are shown to produce single photons with a purity and indistinguishability exceeding 99% and a brightness 20 times higher than SPDC based single-photon sources.

12:00–13:00 Lunch Break (on your own)

12:00–13:00 Environmental Sensing Technical Group Special Talk, Genesee Suite G, Radisson Hotel Rochester Riverside
FW3A.1 • 13:00  
**Invited**  
**SimVis: See-through Simulation of Presbyopic Corrections**, Carlos Dorronsoro1, Akswayth Radakrishnan1, Jose Ramon Alonso-Sanz1, Daniel Pascual1, Enrique Gambra1, Vyas Akondi1, Susana Marcos1; 1INSTITUTO DE OPTICA - CSIC, Spain. We developed a see-through portable binocular visual simulator capable of simulating presbyopic corrections. Subjects performed visual tests with 17 corrections (bifocal, trifocal, monovision). Perceived quality differed across patients/corrections.

FW3B.1 • 13:00  
**Tutorial**  
**Quantum-crypto Systems in the Commercial Service Network**, Jeong-sik Cho2, Sean Kwak1; 1Univ. of Southampton, UK; 2Quantum Tech Lab, SK Telecom, Korea. Quantum-crypto system has to evolve to provide customers with substantial benefits such as low-cost, compactness and scalability as well as robustness, high service availability.

FW3C.1 • 13:00  
**Invited**  
**Bedside Mapping of Human Brain Function with High Density Diffuse Optical Tomography**, Adam T. Eggебrecht1; 1Washington Univ. in St Louis, USA. I will present our custom high density optical imaging system and analytical pipelines that enable optical mapping of human brain function in the intensive care unit, the operating room, and in sensitive populations including children with autism.

FW3D.1 • 13:00  
**Invited**  
**Long Range Light Matter Interactions at Hyperbolic Meta Surface**, Girish Agarwal1; 1Oklahoma State Univ., USA. We show how long range light matter interactions can be realized at hyperbolic metasurfaces. We concentrate on the dipole-dipole interactions which are important for energy transfer studies and in quantum entanglement between qubits at metasurfaces.
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<tr>
<td>13:00–14:30</td>
<td>FW3E • Plasmonics</td>
<td>Plasmonics has emerged as a solution for monolithic integration of THz bandwidth photonic components at the microscale. In this talk we review recent advances in the field of optical communications and the microwave photonics enabled by plasmonics.</td>
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<td>13:00–14:30</td>
<td>FW3F • Quantum Entanglement</td>
<td>We create the first entangled state of more than two particles entangled in greater than two dimensions. Our state consists of three photons entangled in $3 \times 3 \times 2$ dimensions of their orbital angular momentum.</td>
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<td>13:00–14:30</td>
<td>FW3G • A Tribute to Steve Jacob II</td>
<td>Nanomechanics in Optical Manufacturing. Nanomechanics addresses nm-level material properties, including fracture, mechanical-chemical interactions, and deformation. Nanomechanics applies to optical manufacturing from grinding, to finishing, to polishing, including magnetoreheological finishing (MRF), as all these material removal mechanisms essentially break atomic bonds.</td>
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<td>13:00–14:30</td>
<td>FW3H • Optical Design and GRIN Materials</td>
<td>Tolerance Eigenmode Analysis of Optical Systems. We describe a tolerance eigenmode analysis for optical systems. This analysis indicates, in order of importance, the combinations of aberrations that will be induced by tolerances, thus allowing better tolerance assignment and compensator selection.</td>
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<td>13:00–14:00</td>
<td>LW3I • Multiphoton Effects II</td>
<td>Non-linear wavelength extension of Fibre Laser Systems. Spectral and temporal versatility is achieved using compact master oscillator power fibre amplifier schemes to drive nonlinear processes both fibre integrated and in bulk allowing power scaled operation throughout the visible and mid infra-red.</td>
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FW3A • Novel Design Concepts for Eye Correction and Vision Simulators II—Continued

FW3A.2 • 13:30 Surface-changing Accommodating Intraocular Lens for Presbyopia Correction, Andres De La Hoz1, Eduardo Martinez-Enriquez2, Carlos Dorrorsoro1, Nandor Bekesi1, Nicolas Alejandro1, Hrebesh Subhash1, Daniel Pascual1, Susana Marcos1; C3IC - Inst. of Optics, Spain. An AIOL design that changes the shape of its surfaces thru application of equatorial forces is proposed. Its viability is evaluated using mechanical and optical simulations, and experimental measurements of focal length and surface shape change.

FW3A.3 • 13:45 Retinal-simulating phantom produced by chemically amplified photolithography, Denise V. dos Santos1, Brian Vohnsen1; Univ. College Dublin, Ireland. To emulate photoreceptors for an eye model, an array of dielectric cylinders in a uniform matrix has been developed by photolithography. Preparation details and sample analysis are discussed in this work.

FW3A.4 • 14:00 Measuring Temporal Integration in Human Vision with Single Photons, Michelle M. Victora1, Rebecca M. Holmes1, Ranxio Frances Wang1, Paul Kwiat1; Univ. of Illinois at Urbana-Champaign, USA. We discuss techniques using a heralded single-photon source to study the lower limit of human vision, specifically measuring temporal integration using multi-photon trials, and report preliminary results at the few-photon level.

FW3B • Quantum Communications II—Continued

FW3B.2 • 13:30 All-optical synchronization for quantum networks, Bruno Fedrici1, Luti A. Ngah1, Florian Kaiser1, Olivier Albert1, Laurent Labonte1, Virginia D’Auna1, Sebastien Tanzielli1; Lab. de Physique de la Matiere Condensee, France. We report an all-optical realization of a quantum relay experiment at a telecom wavelength. Our synchronization scheme is validated by a two-photon interference visibility greater than 99% at the relay station.

FW3C • Diffuse Imaging and Optical Properties—Continued

FW3C.2 • 13:30 Invited Diffuse Optics for Monitoring Bone Healing and Cancer Treatments, Regine Choe1; Univ. of Rochester, USA. Diffuse optical and correlation tomography have a great potential to monitor and predict treatment efficacy. We demonstrate feasibility for chemotherapy on breast cancer and tissue engineering based treatments for bone healing using murine models.

FW3D • Symposium on Mesoscopic Optics of Disordered Media II—Continued

FW3D.2 • 13:30 Invited Cellulose Bio-inspired Hierarchical Structures, Silvia Vignolini1; Cambridge Univ., UK. In this talk the route for the fabrication of complex bio-mimetic cellulose-based photonic structures will be presented and the optical properties of artificial structures will be analysed and compared with the natural ones.
FW3E.3 • Plasmons—Continued

FW3E.2 • 13:30 Invited

Novel Applications of Plasmonic Bowtie Nanoantennas in the Presence of Enhanced Local Heating, Kimani C. Toussaint1, EHU and DIPC, Spain; 4Department of Physics, kaev4, Gennady Shvets, USA; 3Materials Physics Center CSIC-UPV/Technology, Univ. of Illinois Urbana-Champaign, USA; 5Materials Development in Magnetorheological Finishing (MRF) has been substantial over the past few decades. In this presentation, we will review the considerable contributions from Dr. Stephen Jacobs.

FW3E.3 • 14:00

Real-space mapping of chiral antennas and metasurfaces, Martin Schnell1,2, Paulo Sarnagarte1, Tomas Neuman1, Alexander B. Khani2, Gernandy Shvets1, Javier Aizpurua3, Erich Neumann4, and Paolo Sarri5, 1Laboratory for Laser Energetics, Univ. of Rochester, USA; 2US Army Research Laboratory, USA. The materials development in Magnetorheological Finishing (MRF) has been substantial over the past few decades. In this presentation, we will review the considerable contributions from Dr. Stephen Jacobs.

FW3E.4 • 14:40

Achromatic Design of Gradient Index Lenses using Ternary Blends, Guy Beadie1, Joseph N. Mait1, Richard A. Flynn2, Predrag Milojkovic3, 1US Naval Research Laboratory, USA; 2US Army Research Laboratory, USA; 3Laser Pulses, A Tribute to Steve Wasilewski, 1Univ of Texas at Austin, USA; 2US Army Research Laboratory, USA. Optical elements that enable tailored modulation of their refractive index during exposure to laser pulses can help better control beam characteristics. Our approach is based on activation of defect centers in large-bandgap materials.

FW3F • Quantum Entanglement—Continued

FW3F.3 • 13:30

Einstein-Podolsky-Rosen Position-Momentum Entanglement in a Quantum Memory Setup, Michal Dabrowski1, Michal Parniak1, Radoslaw Chrapkiewicz2, Wojciech Wasilewski3, 1Faculty of Physics, Univ. of Warsaw, Poland. Raman scattering emissive multimode quantum memory setup is presented. The memory enables storage of photonic position-momentum entanglement, demonstrating a time-delayed Einstein-Podolsky-Rosen paradox.

FW3F.4 • 13:45

Measuring Non-Commuting Observables of a Single Photon via Sequential Weak Values Evaluation, Marco Gramigna1, 1Physical Metrology, INRIM, Italy. First experimental realization of a sequential weak value evaluation of two incompatible observable of a single photon.

FW3F.5 • 14:00

Few-photon induced transient entanglement in multi-qubit bi-directional chiral waveguide QED, Imran M. Mirza1, John C. Schotland1, 1Univ of Michigan, USA. We study transient entanglement generation and control in multiple-qubit bi-directional chiral waveguide QED utilizing single or two-photon Gaussian wavepackets. Particularly, we show how chirality can enhance the maximum generated multi-qubit entanglement.

FW3G • A Tribute to Steve Jacob II—Continued

FW3G.2 • 13:30 Invited

Materials Development in Magnetorheological Finishing: The work of Dr. Stephen Jacobs, Aric B. Shoery1, 1Corning Incorporated, USA. The materials development in Magnetorheological Finishing (MRF) has been substantial over the past few decades. In this presentation, we will review the considerable contributions from Dr. Stephen Jacobs.

FW3G.3 • 13:30

Few-photon induced transient entanglement in multi-qubit bi-directional chiral waveguide QED, Imran M. Mirza1, John C. Schotland1, 1Univ of Michigan, USA. We study transient entanglement generation and control in multiple-qubit bi-directional chiral waveguide QED utilizing single or two-photon Gaussian wavepackets. Particularly, we show how chirality can enhance the maximum generated multi-qubit entanglement.

FW3H • Optical Design and GRIN Materials—Continued

FW3H.2 • 13:30

Implementation of a Scattering Method for Rough Surfaces in a Raytracing Software linked with a CAD (Computer-Aided Design) Toolbox, Florian Loosien1, Carsten Backhaus1, Norbert Lindlein1, Jochen Zeiter2, Jörg Franke1, 1Inst. of Optics, Information and Photonics (IOIP), Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany; 2Inst. for Factory Automation and Production Systems (FAPS), Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany. The design and simulation of printed polymer optical waveguides is a new approach in the field of raytracing techniques, to link the CAD routines with the simulation process of the waveguides via raytracing methods.

FW3H.3 • 13:45

Is the Maxwell-Shafer fish eye lens able to form super-resolved images?, Miguel A. Alonso1, 1Univ. of Rochester, USA. The Maxwell-Shafer fish eye lens (a so-called absolute system) are studied theoretically to determine if it can form super-resolved images or obeys the diffraction limit. A modal analysis shows that the latter is true.

FW3H.4 • 14:00

Achromatic Design of Gradient Index Lenses using Ternary Blends, Guy Beadie1, Joseph N. Mait1, Richard A. Flynn2, Predrag Milojkovic3, 1US Naval Research Laboratory, USA; 2US Army Research Laboratory, USA; 3Laser Pulses, A Tribute to Steve Wasilewski, 1Univ of Texas at Austin, USA; 2US Army Research Laboratory, USA. Optical elements that enable tailored modulation of their refractive index during exposure to laser pulses can help better control beam characteristics. Our approach is based on activation of defect centers in large-bandgap materials.
<table>
<thead>
<tr>
<th>Grand Ballroom A (Radisson)</th>
<th>Grand Ballroom B (Radisson)</th>
<th>Grand Ballroom C (Radisson)</th>
<th>Grand Ballroom D (Radisson)</th>
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<tr>
<td>FW3A • Novel Design Concepts for Eye Correction and Vision Simulators II—Continued</td>
<td>FW3B • Quantum Communications II—Continued</td>
<td>FW3C • Diffuse Imaging and Optical Properties—Continued</td>
<td>FW3D • Symposium on Mesoscopic Optics of Disordered Media II—Continued</td>
</tr>
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</table>

**FW3B.4 • 14:15**
Withdrawn.

**FW3C.4 • 14:15**
Development of an advanced model for determining the optical properties below and beyond 600 to 1000 nm wavelength range from frequency domain diffuse reflectance, Yu-Wen Chen¹, Chien-Chih Chen¹, Po-Jung Huang¹, Sheng-Hao Tseng¹, Department of Photonics, National Cheng-Kung Univ., Taiwan; Advanced Optoelectronic Technology Center, National Cheng-Kung Univ., Taiwan. We developed an artificial neural networks trained by frequency domain-based Monte Carlo simulation, which could work with a least-square optimized algorithm to recover an extensive range (below and beyond 600-1000nm) of sample’s optical properties.

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**14:00–16:00** Student Chaper Competition, *Empire Hall*

**14:30–15:00** Coffee Break, *Empire Hall*

**14:30–16:00** JW4A • Joint Poster Session I and Unopposed Exhibit Time, *Empire Hall* (see page 23 for specific e-poster viewing times)

**15:30–17:00** Meet the Editors of the APS Journals Reception, *Riverside Court*

**16:00–17:00** OIDA Members and Exhibitor Appreciation Reception (OiDA members and exhibitors only), *Empire Hall*
### Highland Room A

**FW3E • Plasmonics—Continued**

Deep Subwavelength and Broadband Light Delivery using an All-Fiber Plasmonic Nanotip-Enhanced Near-Field Probe, Alessandro Tuniz, Mario Chemnitz, Jan Delith, Stefan Weidlich, Markus Schmidt; Inst. of Photonic Technology, Germany; Heraeus Quarzglas GmbH & Co. KG, Quarzstr. 8, Germany; Abbe School of Photonics and Faculty of Physics, Germany. We experimentally demonstrate a monolithic nanowire-enhanced fiber-based plasmonic nanoprobe for broadband excitation (550-730 nm) of short range surface plasmons and delivery of subwavelength radiation to a gold nanotip with sub-100 nm apex radius.

### Highland Room B

**FW3F • Quantum Entanglement—Continued**

Generation of Path-Entangled Photons Using an Arrayed Waveguide Grating, Nobuyuki Matsuda, Hideki Nishi, Peter Karkut, Tai Tsuchizawa, Koji Yamada, William J. Munro, Kaoru Shimizu, Hiroki Takesue; NTT Nanophotonics Center, Japan; NTT Basic Research Laboratories, Japan; NTT Device Technology Laboratories, Japan. We demonstrate the on-chip generation of path-entangled photon pairs using an arrayed-waveguide grating with nonlinear input waveguides. The scheme can be extended to the generation of high-dimensional entanglement.

### Highland Room C

**FW3G • A Tribute to Steve Jacob II—Continued**

Design and Fabrication of Gradient-Index Optical Elements for Beam Shaping, James R. Leger, Mint Kunkel, Glen Douglass, Simon Gross; Univ. of Minnesota Twin Cities, USA; Physics and Astronomy, Macquarie Univ., Australia. We describe a new method of generalized beam shaping based on gradient index optics in waveguides. Phase retrieval is used in the design and femtosecond laser writing is used in the fabrication of the waveguides.

### Highland Room D

**FW3H • Optical Design and GRIN Materials—Continued**

**FW3H.5 • 14:15**

### Highland Room E

**LW3I • Multiphoton Effects II—Continued**

### Schedule

<table>
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<tr>
<th>Time</th>
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<tr>
<td>14:00–16:00</td>
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<tr>
<td>16:00–17:00</td>
<td>OIDA Members and Exhibitor Appreciation Reception (OiDA members and exhibitors only), Empire Hall</td>
</tr>
</tbody>
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Wednesday, 19 October

JW4A.1 Simulating Phase-Only Pupil Plane Masks for Laser Suppression, Jacob H. Wirth1, Abbie Watnik2, Garrath Ruane3, Grover A. Swartzlander2, 1Rochester Inst. of Technology, USA; 2U.S. Naval Research Laboratory, USA. A phase-only pupil plane mask is tested to protect sensors from powerful coherent radiation. Masks are simulated to reduce the peak irradiance of the point spread function while images are reconstructed in post-processing.

JW4A.2 Scalable and Gray-Coded Optical M-ary QAM Using QPSK Modulators with Binary Electronic Driving Signals, Naj A. Alakayik1, Lim Nguyen1, 1Electronic and Computer Engineering, Univ. of Nebraska Lincoln, USA. We present a novel square M-ary QAM transmitter using QPSK modulators driven by binary electronic signals. The proposed configuration generates Gray-coded symbol constellations and is scalable for high order optical M-ary QAM.

JW4A.3 Proposal for Generation of Hybrid Entangled States in Waveguide Using Polarization Converter, Divya Bharadwaj1, Krishna Thyagarajan1, 1Indian Inst. of Technology, Delhi, India. In this paper we describe a scheme for generation of hybrid entangled states in waveguides by frequency doubling and then generating photon pairs using type-II spontaneous parametric down conversion process and the electro optic effect in a domain engineered KTP channel waveguide.

JW4A.4 Effect of Nonlinearity on the Formation of Spatial Optical Rogue Waves, Akbar Safat1, Robert Fickler1, Miles J. Padgett2, Robert W. Boyd3, 1Univ. of Ottawa, Canada; 2Univ. of Glasgow, UK; 3The Inst. of Optics, Univ. of Rochester, USA. Randomness plays a crucial role in the formation of optical seas. We observe that when the random phase shift is not strong enough, nonlinear propagation has a significant effect on the formation of rogue waves.

JW4A.5 On the Microscopic Origins of Optical Magnetism - Insight from Mie Theory, Mengren Man1, Kevin J. Webb1, 1Purdue Univ., USA. We identify the microscopic origins for optical magnetism in dielectric materials. Features in the homogenized permeability are found to correspond to the magnetic dipole resonance of individual particles, which will have far-reaching impacts.

JW4A.6 Asymmetric Transport of Light through All-dielectric Structured Media, Roxana Rezvani Naragh1,2, Sergey Sukhov1, Anıstea Dogaru1, 1Univ. of Central Florida, CREOL, USA; 2Department of Physics, Univ. of Central Florida, USA. Asymmetric transmission of light usually requires chiral materials or grating-like structures that make them sensitive to all parameters of incident light. Here we show asymmetric transport of light that is broadband and polarization-insensitive.

JW4A.7 Estimation of atom loading efficiency into a hollow core fiber, Taehyun Yoon1,2, Michal Bajczyk1, 1Inst. for Quantum Computing, Univ. of Waterloo, Canada; 2Department of Electrical and Computer Engineering, Univ. of Waterloo, Canada. We simulate the motion of Cs atoms in a dipole potential created by a red detuned laser diverging from a hollow core photonic crystal fiber (HCPCF) and estimate the loading efficiency into the fiber.

JW4A.8 Generation of variable sized “perfect” vortex and its effect in parametric down conversion process, Jabir M. V1, Apurv Chaitanya Nel-Ilkka1, A. Aadhi1, Gautam K. Samanta2, 1Electrical and Computer Engineering, Univ. of Ottawa, Canada; 2Department of Electrical Engineering, NIT Rourkela, India. We report a novel scheme to generate variable sized “perfect” vortices, having radius and order as mutually independent parameters, and prove that angular spectrum of down-converted photons does not depend on OAM of pump vortices.

JW4A.9 Experimental Observation of Second Harmonic Generation in polymeric Carbon Dioxide, Amaryta Sengupta1, Choong-Shik Yoo2, 1Indian Inst. of Technology Delhi, India; 2Washington State Univ., USA. Close to 20% efficiency of second harmonic generation is observed in polymeric CO2 synthesized under novel conditions. This polymeric phase of CO2 retains its non-linear optical properties over a broad range of pressures and temperatures. This presentation will be presented as an E-Poster on Screen 2 from 15:15–16:00.

JW4A.10 Diffraction Compensation of Finite Beams in Hyperbolic Metamaterials, Jishu C. Panani1, Alessandro Alberucci1,2, Allan Boardman1, Gaetano Assanto1, 1Univ. of Porto, Portugal; 2Tampere Univ. of Technology, Finland; 3Univ. of Salford, UK. The propagation of finite size beams in a hyperbolic metamaterial is modeled as a moving particle of negative mass. We show the occurrence of anomalous diffraction, diffraction compensation and profile recovery for any input excitation.

JW4A.11 Modeling the Evolution of Spatial Entanglement with non-Gaussian Beams, Matthew Reichert1, Xiaoyi Bao2, 1Purdue Univ., USA. We study the dynamics of spatial entanglement during propagation and experimentally observe its migration between amplitude and phase. To accommodate non-Gaussian biphotons, we generalize the “beam quality factor” M² from classical laser theory.

JW4A.12 Nonperturbative Nonlinear Optics in Liquid Crystals, Alessandro Alberucci1, Fernando Piccardi1, Nina Kravets1, Oleksandr Buchnev1, Jisha C. Panani1, Gaetano Assanto1, 1Univ. of Porto, Portugal; 2Tampere Univ. of Technology, Finland; 3Univ. of Southampton, UK; 4Univ. of Rome (‘‘Tor Vergata’’), Italy. We show that reorientational nematic liquid crystals are an ideal workbench for the investigation of non-perturbative nonlinear optical effects and report light self-steering, power-controlled negative refraction and spontaneous symmetry breaking.

JW4A.13 Imaging Moving Objects Hidden in Arbitrarily Heavily Scattering Media, Qiaoxu Luo1, Jason A. Newman1, Kevin J. Webb1, 1Purdue Univ., USA. We show an image of a moving object (pi-shaped mask) embedded in heavily scattering media using a coherent imaging approach. Spatial speckle intensity correlation measurements in relation to object position are used to reconstruct the pi-shaped mask.

JW4A.14 Towards the generation of entangled photon pairs using a tapered fiber coupler, Lambert Giner1,2, Xinru Cheng1,2, Chams Baker1, 1Fleron Flëscher1, 1Princeton Univ., USA. We simulate the motion of Cs atoms in a dipole potential created by a red detuned laser diverging from a hollow core photonic crystal fiber (HCPCF) and estimate the loading efficiency into the fiber.

JW4A.15 A Statistical Analysis of Spatial and Spectral Control with Binary Irregular Nanostructures, Yu-Chun Hsieh1, Kevin J. Webb1, 1Purdue Univ., USA. We study the degrees of freedom from a 2-D binary nanostructured material, as they impact the achievable spectral and spatial control. This statistical analysis provides design strategies for applications.

JW4A.16 Phase Sensitive Amplification in Metastable Helium at Room Temperature, Jaseban Lugani1, Chitrani Banerjee1, Marie-Aude Maynard1, Pascal Neveu1, Ram Soorani1, Ruinanlan Ghoosh1, Fabien Bretenaker1, Fabienne Goldfarb1, Laborgatoire Arme Canon, France; 2Shiv Nadar Univ., India. We have performed phase sensitive amplification (PSA) in metastable helium. The maximum and minimum gain behaviors and their values compared to the gain for the Phase Insensitive Amplification (PIA) correspond to a very pure PSA.

JW4A.17 Mode Amplification and Nonlinear Mode Conversion in Few Mode Fibers, Abdennahmen Trichili1, Mourad Zghal2, Luca Palmieri3, Marco Santagustinia1, 1Engineering School of Comm of Tunis, Tunisia; 2Dipartimento di Ingegneria dell’Informazione, Università di Padova, Italy. We demonstrate phase sensitive and insensitive amplification and nonlinear mode conversion in few mode fibers by studying the four wave mixing effect.

JW4A.18 Spectral narrowing in the propagation of unchirped pulses in two-core fibers, Neostor Lozano-Crisostomo1,2, Julio Cesar Garcia Melgarejo1,2, Miguel Torres Cisneros1, Daniel Alberto May Arriaga1, Javier Sanchez Mondragon1, 1Departamento de Óptica, Instituto Nacional de Astrofisica, Optica y Electricidad, Mexico; 2Universidad Autonoma de Coahulla, Mexico; 3Centro de Investigaciones en Óptica, Mexico; 4Departamento de Electrónica, Universidad de Guanajuato, Mexico. We demonstrate spectral narrowing in the propagation of an initial unchirped optical pulse through a two-core fiber (TCF). Our results show that the linear coupling between both TCF cores induces that spectral narrowing.

JW4A.19 Characterizing a 10×10 OAM propagation matrix of few-mode fiber by a dual-interference pattern method, Guoxuan Zhu1, Yuxuan Li1, Yijie Chen1, Yuxuan Weng1, Yanfeng Zhang1, Hui Chen1, Siyuan Yu2, Sun Ye-sen Chen1, China. A dual-interference pattern method is proposed for measuring OAM spiral spectrum, including amplitude and phase information. With this method, we characterize the output field of a few-mode fiber and obtain its 10×10 OAM propagation matrix.

JW4A.20 Portable Multiplexer Supporting Three Spatially Multiplexed Optical Channels, Syed H. Murshi1, Saud Alans1, Guilherme Cavalcante1, Bilas Chowdhury1, Rayan Enaya2, 1Florida Inst. of Technology, USA. Design of the input end of a portable spatial multiplexer supporting three spatially multiplexed optical channels over a multimode fiber is presented. Screen projection of the output beam and its intensity profile is also reported.
Empire Hall

JW4A • Joint Poster Session I—Continued

JW4A.41
Tailoring light by 3D direct laser-writing of supercontinuum phase elements, Shilomi Lightman1,2, Raz Gvishi1, Ady Aria1,2, NRC, Israel; 1Electrical Engineering, Tel-Aviv Univ., Israel. We demonstrate experimentally phase modulation of light beams by fabricating arbitrary microstructures using a 3D-Direct Laser writing method. This approach produces complex structured light beams, in a compact, stable and cost effective manner.

JW4A.42
Square Holey Cladding Dielectric THz Waveguides for Chip-to-Chip Communication, Nafiseh Afkarian1, Naixin Yang1,2, Timothy LaFave1, Rashaunda Henderson1, Kenneth K. O’1, Duncan MacFarlane1, 1Electrical Engineering, Southern Methodist Univ., USA; 2Electrical Engineering, Univ. of Texas at Dallas, USA. The development of a square holey cladding dielectric waveguide for chip-to-chip THz communication is presented. Designed to operate in the range of 180-360GHz, measured and simulated mode profiles of fabricated waveguides are in good agreement.

JW4A.43
Image Processing Applied to Photon Sparse Data, Lena Mertens1, Shlomi of micron-scale phase elements, Tailoring light by 3D direct laser-writing JW4A.41

JW4A.45
Multiplexing three-dimensional optically encrypted data, Alejandro Velez1,2, Roberto Torroba1, John Fredy Barrera1, 1ClO, Argent-ina; 2Instituto de Fisica, Universidad de Antio-quia, Colombia; 1Facultad de Ingenieria, UNLP, Argentina. We introduce a multiplexing method for three-dimensional data experimentally encrypted using a joint transform correlator. Encrypted data are individually filtered and added forming a multiplexed package. Each object is retrieved using a key object.

JW4A.46
Observation of two state behavior in the Supercontinuum Generation induced by insability in Saturable Nonlinear Media, Kangaraja Nithyanandan1, Porsezan Kuppusamy1, 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.

JW4A.47
Nonuniform Laguerre-Gaussian Correlated Partially Coherent Beam, Jiayi Yu1,2, Soochow Univ., China. A new kind of partially coherent beam called a nonuniform Laguerre-Gaussian correlated partially coherent beam have been introduced. It is found that the intensity distribution exhibits self-focusing, self-shifting and self-splitting effect.

JW4A.48
Scattered-Light Analysis of Birefringent Coatings for Distributed Polarization Rotators, Katelynn Sharma1,2, Thomas Germer1, Christopher Smith1, Jonathan Zuegel1,2, Pomona College, USA. We experimentally and theoretically examine methods for increasing the image acquisition speed in CCD-based thermoreflectance measurements by increasing the sampling rate, for signal amplitudes both above and below the quantization limit.

JW4A.49
E-Poster
Lensless Measurements of Optical Field Correlations, Katelinn Sharma1,2, Thomas G. Brown1, Miguel Alonso1, University of Rochester, USA. We investigate a method to measure spatial coherence that uses no lenses in the measurement. Three variations of this method are compared, and we find one using three amplitude masks to be the most robust. This presentation will be presented as an E-Poster on Screen 2 from 14:30-15:15.

JW4A.50
A simple wavefront re-construction optical elements combination, Hai Lin1,2, Shanghai Insit of Optics & Fine Mechanics, China. A simple wavefront re-construction optical element is designed. It uses uniaxial optical crystals to re-arrange a beam with transverse inhomogeneous intensity profile but homogeneous state-of-polarization.

JW4A.51
Withdrawn.

JW4A.52
Thermal Imaging Microscope and Applica- tions to Microelectronic Devices, Ki Soo Chang1,2, Korea Basic Science Inst., Korea. We demonstrate a thermal imaging microscope system that measures the temperature distribution over the surface of microelectronic devices. It enables hot spot detection and thermal analysis of microelectronics devices.

JW4A.53
Additive random noise in generalized phase-shifting algorithms, Gastón Ayubi1,2,3, Jose A. Fer- ner1,2, Universidad de la Republica, Uruguay. The purpose of the present work is study the phase extraction from interferograms with additive random noise, and deduce the conditions to be satisfied for minimizing the phase-retrieval error. Simulations are presented.

JW4A.54
Microsphere Stabilized Plane-Parallel Resona- tors Fabricated via Convective Assembly, Jose A. Rivero1, Tom Galvin3, James G. Eiden1, UIUC, USA. An array of microspheres, situated near one mirror of a critically-stable cavity, stabilize the cavity at positions occupied by the spheres. Each microcavity in the resulting array exhibits strong mode confinement and unique spectral characteristics.

JW4A.55
Increasing the Speed of CCD-Based Ther- moreflectance Imaging: Theory and Ex- periment, Mark Hallman1,2, Kyle Allison1,3, Janice A. Hudgings1,2, Physics and Astronomy, Pomona College, USA. We experimentally and theoretically examine methods for increasing the image acquisition speed in CCD-based thermoreflectance measurements by increasing the sampling rate, for signal amplitudes both above and below the quantization limit.

JW4A.56
Discussions on advantages of ghost imag- ing compared to traditional optical imag- ing, Wei Tao Liu1,2, College of Science, NUDT, China. Ghost imaging promises higher spatial resolution, higher robustness against harsh environment, higher detection sensitivity, and more options in system designing due to the controllability of the source. Our results on this will be reported.

JW4A.57
The Origin of Asymmetric Transmission in Chiral Photonic Crystals, Nikhil Parappurath1, Filippo Alpeggiani1,3, Koubus Kuipers1, Ewald Verhagen1,2, FOM Inst. AMOLF, Netherlands. We present a fundamental limit to asymmetric transmission (AT) in strongly chiral photonic crystals. We develop a theory that fully predicts AT from eigenmode properties, and show that near-unity AT can be reached in suitable designs.

JW4A.58
Accurate Determination of Inner Diameter for X-Ray Mono-Capillary Optics, Kwon Sun Chon1, Yoshiharu Namba2, Catholic Univ. of Daegu, Korea; 2Chubu Univ., Japan. Small inner diameter of a mono-capillary optics was previously measured by using synchrotron beamline which provided images of high resolution. The measurement accuracy was 0.67 μm, and diameters along the axis direction were also measured.

JW4A.59
Partially polarized speckle of light scattered from depolarizing media, Gabriel Soriano1, Myriam Zerad1,2, Claude Amra1,2, Institut Fresnel, Aix-Marseille Université, France; 1Institut Fresnel, CNRS, France. The spatial distribution of the time-averaged intensity is theoretically and numerically studied when light of arbitrary partial polarization state is strongly scattered from a depolarizing medium.

JW4A.60
A Simple Method to Measure the Complex Refractive Index of Conducting Media, Fernando Arturo Araiza Sixtos1,2, Maximino Avenda-ño-Alejo1,2, CCADET-UNAM, Mexico; 1Facultad de Ciencias, Mexico. A simple method to measure the refractive index of metals considering the Fresnel coefficients for reflectance and expanding in Taylor’s series is proposed. We present measurements, which could be in agreement with other optical methods.

JW4A.61
Determination of width of subapertures in Lattice design for stitching interferometer of aspheric surfaces, Junzheng Peng1, Xiang Li1, Xiaoli Liu1, Yingjie Yu2, Xiang Peng1, Shenzhen Univ., China; 2Shanghai Univ., China. Determination of the width of subapertures is a key issue in stitching interferometer of aspheric surface. This paper proposed a method to solve this problem based on the slope resolution capability of interferometer.
Resting-State Functional Connectivity Mea-
surement in the Mouse Brain using a Low Cost Photoacoustic Computed Tomography. Ali Haniri1, Parsa Omid1, Mohamadreza Nasi-
navanlaki1, BME, Wayne state Univ., USA. We use photoacoustic technology to noninvasively image Resting-State Functional Connectivity (RSFC) in the mouse brain, with a high frame rate, large field of view and high spatial resolu-
tion at different depths.

High Numerical Aperture Meta-lenses at Vis-
ible Wavelengths, Mohammadreza Khosansani-
nejadi1, Wei-Ting Chen1, Alexander Zhu2, Jaewon Oh1,2, C. Roques-Carmes1, Ishan Mishra1, Fedrico Capasso1, John A Paulson School of Engineering and Applied Science, Harvard Univ., USA; 2Univ. of Waterloo, Cana-
da. We present a compact hyper-spectrometer using only planar metasurface lenses and a CMOS camera. Spectral resolutions as small as approximately 300 pm (detector-limited) and an overall working range exceeding 130nm at visible wavelengths are achieved.

Undergraduate Laboratory on Polarization Using Poincaré Beams, Joshua A. Jones1, Anthony J D’Addario1, Enrique J. Galvez1, Col-
gate Univ., USA. Gaussian and higher order Laguerre-Gauss mode beams are combined to form Poincaré beams having spatially varying polarization. We developed a new lab using Poincaré beams as an exercise to teach states of polarization.

Multifilter Phase Imaging with Partially Coher-
ent Light: Nonparaxial Case, Yijun Bao1, Thom-
as K. Gaylord1, Georgia Inst. of Technology, USA. The existing quantitative phase imaging method Multifilter Phase Imaging with Partially Coherent light (MFI-PCI) has been extended to nonparaxial case. Its improved accuracy has been verified using simulations and microlens experimental measurements.

Light Scattering Spectroscopy of Nanosilica Particles Aggregating in Single, Freely Sus-
pected Micrometer-Sized Evaporating Drop-
let, Maniwa P. Wziont1, Justice Archer2, Daniel Jakubczyk1, Gennady Derkachov1, Krystyna Kolwas1, Maciej Kolwas1, Inst. of Physics Pol-
ish Academy of Sciences, Poland. The light scattering spectroscopy of single, micrometer-
sized evaporating droplet was developed. We report a well-pronounced change in the visible spectrum of the nanosilica suspension corresponding to different stages of aggregate formation.

Compact hyper-spectrometer based on meta-
surfaces at visible wavelengths, Alexander Y. Zhu1, Wei-Ting Chen1, Mohammadreza Kho-
sansanijad1, Jaewon Oh1,2, Rober Devlin1, Ishan Mishra1, Fedrico Capasso1, John A Paulson School of Engineering and Applied Science, Harvard Univ., USA; 2Univ. of Waterloo, Canada. We present a compact hyper-spectrometer using only planar metasurface lenses and a CMOS camera. Spectral resolutions as small as approximately 300 pm (detector-limited) and an overall working range exceeding 130nm at visible wavelengths are achieved.

Diffraction at the grating and appearance of “spirits” from the view of radiooptics, Vasily Kazakov1, Oleg Moskalents1, Nadezhda Firino-
va1; St. Petersburg State Univ. of Aerospace Instrumentation, Russian Federation. Diffraction at the grating from the view of radiooptics is considered. The properties of spectrum in different diffraction orders are examined. The mathematical justification for appearance of “spirits” at diffraction on the grating is proposed.

Negative Index in Chiral Metamaterials under Conductive Loss and First-Order Material Dispersion Using Lorentzian, Condon and Drude Models, Monish R. Chatterjee1, Tang Aligayde1, Univ. of Dayton, USA. Emergence of negative index (NIM) in chiral materials with conductive loss using standard dispersive models is reported. Positive and negative phase and group indices are realized as expected for NIM behavior for sidebands with opposite polarities.

High-output-power third-harmonic genera-
tion at 355nm based on La:CaB6O12 (LCB) crystal in yz plane, Liu Wang1, Inst. of Semicon-
ductors, China. Third-harmonic generation based on LCB crystal was investigated in yz plane. The maximum output power at 355 nm was 11.5W. The angular bandwidth and tem-
perture bandwidth were measured, which are larger than the previous reports also.

Experimental study of the vortex phase induced-change of the polarization structure of a radially polarized beam, Lisa Guo1, Yongjian Cai1, Fei Wang1, Xianlong Liu1, Lin Liu1, School of Physical Science and Technol-
ogy and Collaborative Innovation Center of Suzhou Nano Science and Technology, So-
zhou Univ., China; School of Electronic Information, GuangDong Polytechnic Normal Univ., China. We carried out the theoretical and experimental study on the propagation of a focused radially polarized vortex beam. It is found that the state of polarization of such beam rotates and changes on propagation.

Nonlinear dynamics, bifurcation maps, signal encryption and decryption using acousto-
optic chaos under a variable aperture il-
lumination, Monish R. Chatterjee1, Suman Chappara1; Univ. of Dayton, USA. Bregg cell nonlinear dynamics and bifurcation properties under first-order feedback with variable aperture are examined. Chaotic encryption and recovery of low-bandwidth signals, and optimal performance are evaluated for fixed and variable apertures.

Revival of Hanbury Brown-Twiss Effect and Its Application on Single-Arm Ghost Imaging Based on Discrete Chaotic Light, Liming Li1, Peilong Hong1, Guoquan Zhang1, Nankai Univ., China; Nanjing Univ. of Science and Technol-
y, School of Science, China. Based on a discrete chaotic light source, we demonstrated the revival effect of second-order spatial correlation pattern with multiple bunching peaks, which can be used to achieve ghost imaging in a single-arm configuration.

In-line system for intensity and topological charge characterization of optical vorti-
ces, Edgar Rueda1, Jorge Gomez2, Dafine Amaya3, Alberto Lencina1; Universidad de Antioquia, Colombia; Politecnico Colombiano Jaime Isaza Cadavid, Colombia; Centro de investigaciones opticas, Argentina; Universidad Nacional del Centro de la Provincia de Buenos Aires, Laboratorio de analisis de suelos, Argen-
tina. An in-line system to recover simultaneously topological charge and intensity of an optical vortex is presented. It is based on adding a Fresnel lens to a vortex-producing lens. The need of an interferometer is eliminated.

Optical Vortex Microscope-Analytical Model and its Experimental Verification, Agnieszka Popiolek-Masajada1, Jan Masajada1, Lukasz Plocinczak1, Wroclaw Univ. of Technology, Poland. Model of the microscopic optical system in which the optical vortex is embedded within the Gaussian beam and focused to the sample plane is considered. The analytical solutions are verified in the experimental setup.

Blueshift in the Near Band Edge Emission and in the Optical Band Gap of Sr Doped ZnO Films, Vandana Mash1, Anchal Sivas-
tava1, Univ. of Lucknow, Lucknow, India. A blueshift in the near band edge emission in the strontium doped zinc oxide thin films deposited by sol-gel method is observed. The nanocrystalline films show an enhancement in the optical band gap by 6.6%.

Imaging Darkness, Adam Selym1, Thomas W. Clark1, Neal Radwell1, Sonia Franke-Ar-
old1; Univ. of Glasgow, UK. We present a technique for reconstructing bright and dark light sculptures. The method is based on recording fluorescence from a thermal rubidium gas directly or after atomic depletion respectively.

Persistence and fidelity of phase singularities in optical random waves, Lorenzo De Angelis1, Filippo Alpeggiani1, Andrea Di Falco1, L. Kuppe-
r1s1; Center for Nanophotonics, AMOLF, Nether-
lands; 2SUPA, School of Physics and Astronomy, Univ. of St Andrews, UK. As the wavelength is varied, phase singularities in random waves are created, diffuse and annihilate. With near-field experiments we map their trajectories as a function of wavelength and study correlations between creation and annihilation events.
Wednesday, 19 October

JW4A.83 E-Poster
Formation of LiPPS in nanocomposites of Poly (ethylene terephthalate)/Expanded Graphite by using UV nanosecond laser pulses, René I. Rodrigues Beltran1, Margarita Hernandez2, Tiberio A. Ezquerra3, Anna Szmyczynski4, Sandra Paszkiewicz5, Zbigniew Rosielski6, Marta Castellis6, Pablo Moreno7, Esther Reboliar7, Universidad de Salamanca, Spain; Instituto de Estructura de la Materia (IEM-CSIC), Spain; West Pomeranian Univ. of Technology, Poland; Instituto de Química Física Rocasolano (IGIR-CSIC), Spain. We report the formation of Laser Induced Periodic Surface Structures in Poly(ethylene terephthalate) and Poly(ethylene terephthalate)/Expanded Graphite films. Some physical properties of the surfaces improve in the presence of these nanostructures. This presentation will be presented as an E-Poster on Screen 5 from 14:20-15:15.

JW4A.84 A 10-GHz Optical Frequency Comb from a SCOWA-Based Mode-Locked Laser with 600-Hz Optical Mode Linewidth, Kristina Bagnell1, Anthony Klee1, Peter Delfyett1, Univ. of Central Florida, USA. We present a harmonically mode-locked 10-GHz repetition rate with high saturation power SCOWA gain, with a long external fiber cavity and intracavity etalon for supermode suppression, with optical mode linewidth of 600 Hz.

JW4A.85 Optical Nonlocal nonlinear properties in [EMIM][BF4], Izshav Sevrenso Carnilo1, Edgar Alvarado Méndez1, Monica Tejo Durán1, DI-CIS, Universidad de Guanajuato, Mexico. We used the nonlocal nonlinear model by the characterization of ionics liquid [EMIM][BF4] by the z-scan technique to nonlinear refraction and nonlinear absorption curves. Numerical and experimental results show ionic liquid as nonlocal medium.

JW4A.86 Spectral Analysis of Bragg and non-Bragg Orders in Dynamic Holography using Photorefractive Materials, Aakash Kota1, Ujjta Abeywickrema2, Partha P. Banerjee1, Univ. of Dayton, USA. Interaction of Bragg and non-Bragg orders in a photorefractive material during two-beam coupling is studied by numerically solving the coupled differential equations for the angular plane wave spectra of all interacting orders.

JW4A.87 Quantitative Measurement of the Average Orbital Angular Momentum of Light with a Cylindrical Lens, Samuel Alperin1, Robert Niederberger1, Juliet T. Gopinath1, Mark Siemens1, Univ. of Denver, USA; Physics, Univ. of Colorado, USA; Electrical, Computer, and Energy Engineering, Univ. of Colorado, USA. We show that the average orbital angular momentum (OAM) of twisted light can be measured with a single stationary cylindrical lens and camera. Our method can be calibrated absolutely and measure arbitrary (non-integer) average OAM.

JW4A.88 Diffraction Gratings Prepared by HR-LiPPS for New Surface Plasmon-Polariton Photodetectors and Sensors, Iaroslav Grinitskyi1, Sergey Mamkyrin1, Mykhaylo Dudychko1, Tatiana Borodina1, Nataliya Makshin1, Leonardo Orazi1, UNIMORE, Italy; V. E. lashkaryov Inst. of Semiconductor Physics, National Academy of Sciences of Ukraine, Ukraine; National Technical Univ. of Ukraine “Kiev Polytechnic Inst.”, Ukraine, National Academy of Sciences of Ukraine, F. O. Ovcharenko Inst. of Biocollidal Chemistry, Ukraine. New method based on HR-LiPPS for diffraction grating on preliminary fabricated p-n junction on Si substrate are suggested. This allows to produce surface plasmonic photodetectors based on periodically corrugated thin metal plasmon-carrying films.

JW4A.89 Raman spectroscopy for CVD monolayer graph: Fermi levels depending on different substrates material, Solveyga Azbte1, Alauda Denisilwan2, Mikhail Khodzhet1, Univ. ITMO, Russian Federation. Energies of Fermi level of monolayer graphite on quartz, polyethylene terephthalate (PET) and Si were calculated using Raman spectroscopy data. The dependence of Fermi level energy on refractive index of the substrate was shown.

JW4A.90 Anisoplanatic Electrooptic Magnetic Image Propagation through Narrow or Extended Phase Turbulence using Altitude-Dependent Structure Parameter, Monish R. Chatterjee1, Ali Mohamed1, Univ. of Dayton, USA. The effects of turbulence on anisoplanatic imaging are often modeled through the use of a sequence of phase screens distributed along the optical path. We implement the split-step wave algorithm to examine turbulence-corrupted images.

JW4A.91 Self-Healing of Laguerre-Gauss Beams Described by Superposition of Conical-Like Traveling Waves, Jorge A. Ugalde-Ontiveros1, Alfonso Jiménez-Najera1, Job Mendoza-Hernández2, Marcelo D. Iturbe-castillo1, Sabino Chavez-Cerda3, Inst. Nat Astrofísica Optica Electronica, Mexico; Centro de Investigaciones en Optica, Mexico; Departamento de Fisica, CINVESTAV, Mexico; Facultad de Ciencias Fisico-Matematicas, Benemérita Universidad Autónoma de Puebla, Mexico. We demonstrate that propagation of Laguerre-Gaussian beams has not been fully understood since some observed phenomena with them cannot be explained without the use of transverse traveling wave features similar to those of Bessel beams.

JW4A.92 Magnetic response of split nanoplate type metamaterial at near infrared frequency, Nishant Shankhwar1, Ravindra K. Sinha1, Yogita Kalra1, CSIR-CSIO, India; Department of Applied Physics, Delhi Technological Univ., India. In this paper, we present the design of a split nanoplate type metamaterial which shows strong magnetic resonance at infrared frequency. Its operation is similar to that of split ring resonator (SRR) but is easier to fabricate at nanoscale.

JW4A.93 Electro-optic dual-comb vibrometer, Vicente D. Durán1, Elena L. Telezhen1, Victor Torres-Company1, Chalmers Univ. of Technology, Sweden. We use an ultrashort-electro-optic dual comb interferometer to perform single-point vibrometry on the sub-nanometer second time scale. We resolve the vibration of an ultrasound speaker driven at 50 kHz, achieving a sub-nanometer axial resolution.

JW4A.94 New algorithm of adaptive focusing of laser beam developed on conservation laws of propagation, V. A. Trofimov1, Artem Kottov1, Tatiana Lyask1, M. V. Lomonosov Moscow State Univ., Russia. Federal Region. We propose a new algorithm of adaptive focusing of laser beam by using the conservation laws of optical radiation propagation in linear and non-linear medium.

JW4A.95 Withdrawn.

JW4A.96 A Point Spread Function for Fourier Telescopy, William T. Rhodes1, Florida Atlantic Univ., USA. A spatial frequency domain point spread function for Fourier telescope imaging is defined and its properties discussed. The function is given by the inverse Fourier transform of the object illumination intensity distribution.

JW4A.97 A system to control the energy of a high power laser system and its application to x-ray generation at ultra-high intensity, Baobun Zhao1, Wenchao Yan1, Ying Zhang1, Sudheep Banerjee1, Gregor Golovin1, Colton Fruehing1, Daniel Hadjen1, Jun Zhang1, Cheng Liu1, Shouyuan Chen1, Donald P. Umstadter1, Univ. of Nebraska Lincoln, USA. We demonstrate a system to control the output energy of a high-energy, ultrashort pulse laser system by an order-of-magnitude. This technique is used to control the brightness of an Inverse-Compton x-ray source.

JW4A.98 Generation and Switching of Phase Vortices in Cylindrical Vector Beams, C Hari Krishna1, Sourabh Roy1, Physics, National Inst. of Technology Warangal, India. Cylindrical vector beams are generated using a two mode optical fiber. Vortex and anti-vortex are observed in interferograms formed by helical and plane wavefronts. Switching between them is achieved by changing input polarization state.

JW4A.99 Local and nonlocal nonlinear response of Ag nanocubes in solution as a function of size and concentration, Emma V. Garcia Ramirez1, Jorge Alejandro Reyes Esqueda1, Dayi Ramirez Martinez1, Sergio Sabinas Hernandez2, Gabriela Diaz Guerrero1, Univ Nacional Autonoma de Mexico, Mexico. Cubic silver nanoparticles were analyzed by z-scan technique in the resonant and non-resonant regimes. These results were done with picosecond pulse as function of the size and concentration of the samples.

JW4A.100 Robust Statistical Parity-Time Symmetric Lasers in Fiber Cavities, Ali Kazemi Jahromi1, Absar U. Hassan2, Ayman Abouraddy2, Demetrios Christodoulides2, Univ. of Central Florida, CREOL, USA. We demonstrate that many features of PT-symmetric lasing, such as the lower predicted lasing threshold and PT-symmetric phase transition, are sufficiently robust to be observed in a long fiber cavity (>1 km) despite random phase fluctuations.

JW4A.101 Transparent Perfect Mirror via Non-Hermitian Optical Properties, Emma V. Garcia Ramirez1, Jorge Alejandro Reyes Esqueda1, Roberto Lopez Pere1, Enrique Vigueras-Santiago1, Dayi Ramirez Martinez1, Univ Nacional Autonoma de Mexico, Mexico; Universidad Autonoma del Estado de Mexico, Mexico. We study photoluminescence properties of direct-gap of ZnO films for different grain size and we obtained lasing threshold. The crystalline structure, surface morphology and optical properties of the thin films have been investigated.

FiO/LS 2016 • 16–21 October 2016
We propose a novel method of Zagreb, Croatia.

We demonstrate this by calculating the speed delay to the mode indices of higher beam orders. We reported this dependence of light’s orbital order and radial order.

Perez-Hernandez 4, M.F. Ciappina obtained this extension by using driven pulses. Inst. of Quantum Optics, Germany.

More than five decades have passed since the first laser was demonstrated, it still continues to amaze and delight with its power and applications. An outreach program was organized to teach optics using laser light.

We report the dependence of light’s speed delay to the mode indices of higher beam orders. We demonstrated this by calculating the speed delay to the mode indices of higher beam orders. We proposed an algorithm of two-dimensional correlation analysis between blood glucose and optical scattering for noninvasive blood glucose measurement with optical coherence tomography (OCT).

We propose a method to determine the measureable range of DOCT velocity. We demonstrate DOCT velocity unwrapping of datasets with peak velocity up to 14.5 cm/s. This technique significantly extends the measureable range of DOCT velocity.

This presentation will be presented as an E-Poster on Screen 1 from 15:15–16:00.

JW4A.105 Laser Quest: A Laser-Based Education and Outreach Program - Coupling Practice with Content (URACE), Sumit Ghat1;2, Physics, Andhra Vidyalaya College, India; 1Physics, Andhra Vidyalaya College - Osmania Univ, India. More than five decades have passed since the first laser was demonstrated, it still continues to amaze and delight with its power and applications. An outreach program was organized to teach optics using laser light.

JW4A.104 Extended the high-order harmonic generation cutoff by means of self-phase-modulated chirped pulses, E. Neya1, F. Videla1, J.A. Perez-Hernandez1, M.F. Ciappina1, 2Centro de Investigaciones Energeticas de La Plata, Argentina; 3Departamento de Ciencias Básicas, Facultad de Ingeniería Universitaria Nacional de La Plata, Argentina; 4National Inst. of Physics, Philipppines; 5Max Planck Institute of Quantum Optics, Germany. We report the dependence of light’s speed delay to the mode indices of higher beam orders. We demonstrated this by calculating the speed delay to the mode indices of higher beam orders. We proposed an algorithm of two-dimensional correlation analysis between blood glucose and optical scattering for noninvasive blood glucose measurement with optical coherence tomography (OCT).

We propose a novel method of Zagreb, Croatia.

We demonstrate this by calculating the speed delay to the mode indices of higher beam orders. We reported this dependence of light’s orbital order and radial order.

JW4A.106 Alternative Fusing Algorithm for High Speed Gabor Domain Optical Coherence Microscopy, Panomsak Meemron1, Fornheip Pongchalee1, Joewone Widjaja1, Jannick P. Rolland2; School of Physics, Suranaree Univ. of Technology, Thailand; 1Inst. of Optics, Univ. of Rochester, USA. An alternative Gabor-based fusing algorithm that improves the processing speed of the GD-OCM is presented. The fusion is performed in spectral domain and hence could enable hardware-based fusion, which is promising for real time GD-OCM.

This presentation will be presented as an E-Poster on Screen 1 from 15:15–16:00.

JW4A.107 Indirect Zinc Phthalocyanine excitation due to nonradiative quantum dots coupling, Guillermo A. Alves1,2, Arnaldo F. Reis1,3, J.A. Ribeiro1,2, E. Neyra1,2, F. Videla1,3, J.A. Perez-Hernandez1, M.F. Ciappina1, 2Centro de Investigaciones Energeticas de La Plata, Argentina; 3Departamento de Ciencias Básicas, Facultad de Ingeniería Universitaria Nacional de La Plata, Argentina; 4National Inst. of Physics, Philippines; 5Max Planck Institute of Quantum Optics, Germany. In this work we propose a new approach to extend the cutoff in high-order harmonic generation (HHG) spectra beyond the well established limits. We achieved this extension by using driven pulses obtained by means of self-phase-modulation (SPM).

JW4A.108 High-throughput Characterization of Nanoparticle Stability Using Near-field Optical Trapping, Perry Schen1, David Erickson1,2, Cor nell Univ, USA. We show high-throughput measurements of the interactions between nanoparticles and surfaces, characterizing colloidal stability based on fluctuations in scattered light during interaction with a guidewave on particles with <100 nm diameters.

JW4A.109 Exploiting Optical Asymmetry for Frequency-controlled Guiding of Particles with Light, Ognjen Ilic1, Ido Kaminer1, Yoav Lahini1, Hvojoe Buljan2, Marin Soljacic1; Massachusetts Inst. of Technology, USA; 2Department of Physics, Univ. of Zagreb, Croatia. We propose a novel method to guide particles that is controllable by the frequency of light. With detailed simulations, we demonstrate exceptional degree of control, independent of the direction of the light beam and insensitive to scattering.

JW4A.110 Beam Shaping through Turbid Media by Feedback-based Wavefront Shaping, Jin-Long Pu, Lipeng Wan1, Ziyang Chen1, Huling Huang1; 1College of Information Science and Engineering, Huazhao Univ, China. We demonstrate that the focusing of light into desired patterns through turbid media can be realized using feedback-based wavefront shaping. The desired focused patterns, such as a triangle-shape beam, are obtained.

JW4A.111 Superresolution Second Harmonic Generation Microscopy based on Point-scanning Structured Illumination, Szu-Yu Chen1, Chia-Hua Yeh1, Cheng-Zn Tan1; 1National Central Univ, Taiwan. Since fluorescence-based superresolution techniques can’t be applied to second harmonic generation microscopy (SHG,M), a system combining structured illumination and SHG was introduced to get a 1:41 resolution improvement factor in the chicken tendon.

JW4A.112 Raman Spectral Histopathology of Breast Cancer Recession Margins, Dustin W. Shipp1, Kenny Kong1, Emad Rahka1, Ian Ellis1, Ioan Nottingher1; School of Physics and Astronomy, Univ. of Nottingham, UK; Department of Pathology, Nottingham Univ. Hospitals NHS Trust, UK; School of Molecular Medical Sciences, Univ. of Nottingham, UK. We demonstrate a Raman spectroscopy system that maps tumors in thick pieces of breast tissue immediately following excision. Diagnostic accuracy is high with the potential to increase with more database samples.

JW4A.113 Conditions Leading to Eryptosis in Erythrocytes: A Raman Tweezers Study, Surekha Bankur1, Aseeefalli Bankapur1, Santhosh Chidangi1; 1Department of Atomic and Molecular Physics, Manipal Univ, India. Raman tweezers was used to study erythropoiesis in erythrocytes induced by different reasons. Our study shows that, though the main cause of eryptosis may be oxidative stress, the consequences of different stresses may be different.

JW4A.114 Self-trapping of Light Through Red Blood Cell Suspensions, Rekha Gautam1, Joshua Lamstein1, Anna Bezyadzina1, Zhigang Chen1; 1San Francisco State Univ, USA. We observe self-trapping and deep penetration of a laser beam in human red blood cell (RBC) suspensions under isotonic, hypotonic, and hypertonic conditions, in spite of the intrinsic absorption and scattering loss due to RBCs.

JW4A.115 Two-dimensional correlation between blood glucose and optical scattering for noninvasive blood glucose sensing with optical coherence tomography, Ya Su1, Huiqing Liu1, X. Steve Yao1;2, Changjiang Wei1, Zhihong Li1; 3Hebei Univ., China; 2General Photonics Corporation, USA; 1Suzhou Optoring Co. Ltd, China. We propose an algorithm of using two-dimensional correlation analysis between blood glucose and optical scattering coefficient of skin tissues for the noninvasive blood glucose measurement with optical coherence tomography (OCT).

JW4A.116 Quantification of Fluorescence Enhancement Due to Dielectrophoresis and the Plasmonic Effect Using Time-Resolved Fluorescence, Ivan T. Lima1, Logreeshan Velmanickam1, Michael Fondakowski1, Dharmameet Narawatna1; 1Department of Electrical and Computer Engineering, North Dakota State Univ, USA; 2Department of Mechanical Engineering, North Dakota State Univ, USA. We used time-resolved fluorescence to show that dielectrophoresis can increases the fluorescence emission due to the plasmonic effect near nanostructured metallic electrodes by a factor of 3, which can significantly reduce the detection sensitivity.

JW4A.117 Filtering Doppler OCT Improves Unwrapping and Extends Range of Microscopic Fluid Velocity Measurements, Yong Xu1, Donald Dargatz1, Jason Smid1, Adam Zysk1, Daniel Teh1, Stephen Boppart1;2, P. Scott Carney1;2; 1 Univ of Illinois at Urbana-Champaign, USA; 2Diagnostic Photonics, Inc, USA. Using the modified Robust Phase Tracker algorithm for denoising, we demonstrate DOCT velocity unwrapping of datasets with peak velocity up to 14.5 cm/s. This technique significantly extends the measureable range of DOCT velocity.

JW4A.118 Deep-Tissue Optical Imaging and Photoactivation Activities at Biophotonics@Tyndall, Stefan Andersson-Engels1;3, Monireh Salasi Mousavi1, Haichun Liu1, Andreas Walther1, Lars Rippe1, Stefan Kröll1;3, Lund Univ, Sweden, 1Tyndall National Inst., Univ. College Cork, Ireland; 2Biomedical Engineering, National Univ. of Singapore, Singapore. Activities for deep tissue imaging and photoactivation will be presented. When Biophotonics@Tyndall acts based on upconverting nanoparticles and ultrasound optical tomography will be pursued. Data from collaborative research will be given.

JW4A.119 Study of Photodynamic Therapy applied to the treatment and fluorescence-based diagnosis of infiltrative Basal Cell Carcinoma including gold nanoparticles, Felix Fanjul-Velez1, Jose L. Arze-Diego1, TEIES, Univ. of Cantabria, Spain. Photodynamic Therapy dosimetry is an unresolved issue for treatment effectiveness, particularly when using nanoparticles. In this work the treatment and fluorescence-based diagnosis is analyzed when applied to infiltrative Basal Cell Carcinoma.
JW4A.121 Super-Resolved Microscopy with Spatial Frequency-Modulated Imaging, Keith Wernsing1, Jeffrey J. Field1, Randy Bartels1, Colorado State Univ., USA. We present a super-resolved imaging technique for real and virtual state interactions, which measures object spatial frequency projections at bandwidths exceeding the diffraction limit by a factor of approximately twice the interaction nonlinearity.

JW4A.122 Withdrawn.

JW4A.123 Surface Plasmon-enhanced Super-resolution Imaging Using Silver Nanoislands, Taehwng Son1, Yougjin Oh1, Wonju Lee1, Donghyun Kim1, Yongseok Kim1. Korea. Surface plasmon-enhanced super-resolution imaging has been studied using silver nanoislands. The size of localized near-field was in the range of 100-150nm, which affects the resolution. Fluorescent actin filament of 774 nm was imaged.

JW4A.124 Driving force that controls a protein reaction for optogenetics, Masahide Terazima1, Chemistry, Kyoto Univ., Japan. Driving force of a photo-reaction of a photosensor protein were investigated by a time-resolved transient grating method. The result indicates that the enhanced fluctuation of the conformation is a key factor.

JW4A.125 Magnetic field enhancement in dielectric island assisted by metal nanoisland arrays, Jeong-Geun Yoon1, Sun-Je Kim1, Joosook Kim1, Byoungho Lee1, Seoul National Univ., Korea. In this paper, we propose a structure that consists of a dielectric island and a metal nanoisland array. In numerical simulation, the proposed structure shows a huge magnetic field enhancement up to a factor of 61.

JW4A.126 Single CdTe Nanowire Optical Correlator, Chenguang Xin1, Limin Tong1, Zhejiang Univ., China. Based on second harmonic generation in a 800-nm diameter CdTe nanowire, we demonstrated an optical correlator for femto-second pulse measurement. Benefited from the high optical nonlinearity, pulse energy goes down to several femtojoules per pulse.

JW4A.127 Grating Design for 3-D Interconnections of Waveguides in Overlaid Chips Using the RCWA-EIS Method, Congshan Wan1, Thomas K. Gaylord1, Munnahad S. Bakir1, Georgia Inst. of Technology, USA. The rigorous coupled-wave analysis-equivalent-index-slab (RCWA-EIS) method is used to determine the diffraction efficiencies of gratings for 3-D coupling between overlaid chips. The simulation results are validated by FDTD calculations.

JW4A.128 Fresnel coefficients of a two-dimensional atomic crystal, Michele Merano1, Universita degli Studi di Padova, Italy. I compare the slab model and the surface conductivity model of graphene to interpret the most remarkable experiments in graphene optics. Only the surface conductivity model is able to explain the overall experimental data.

JW4A.129 Optical control with large-scale assembly of highly aligned silver nanowires, Yunsheng Fang1, Yuqinpeng Wu1, Jun Zhou1, Qing Yang1, Bin Hu1, Wuhan National Laboratory for Optoelectronics, Huazhong Univ. of Science and Technology, China. College of Optical Science and Engineering, Zhejiang Univ., China. Large-scale aligned silver nanowires arrays was obtained using controlled capillary printing technology. Optical simulations were conducted to gain the single silver nanowire and nanowires arrays optical behaviors.

JW4A.130 Bragg Grating Encrusted Metal Clad Ridge Waveguide as an Highly Sensitive & Compact Bio-Sensor, Nazarab Saha1, Anu Kumar1, Indian Inst. of Technology, Dehli, India. It is shown that the RI sensitivity of a Bragg grating based ridge waveguide can be increased significantly by including a thin metal layer between the core and substrate.

JW4A.131 Transverse electric surface mode in atomically thin Boron-Nitride, Michele Merano1, Universita degli Studi di Padova, Italy. Atomi- cally thin Boron-Nitride is predicted to support a transverse electric non-radiating surface mode in the visible spectrum. This mode has a spatial confinement of 15 microns and an intensity-propagation distance greater than 2 cm.

JW4A.132 E-Poster Gain-Assisted Surface Plasmon Polaritons: Time Domain Analysis with Experimentally Fitted Organic Dye Models, Sharmaa Azzam1, Nikita Arnold1, Ludmila Prokopieva1, Drzysluk Kudyshev1, A. Kudyshev1, Purdue Univ., USA; Johannes Kepler Univ., Austria; Novosibirsk State Univ., Russian Federation. Kinetic parameters of a six-level model are obtained by matching the experimental data for a fluorescent dye to study loss-compensation in the surface plasmon-polariton propagating along a silver film covered with a gain layer. This presentation will be presented as an E-Poster on Screen 5 from 15:15-16:00.

JW4A.133 Withdrawn.

JW4A.134 Silicon On-chip Nanobeam Bandstop Filters for the Parallel Multiplexing of Integrated 1D Photonic Crystal Nanobeam Cavity Sensors Array, Daqian Yang1, Beijing Univ. of Posts and Telecom., China. We propose a novel method for the dense integration of nanoscale 1D photonic crystal (1D-PC) sensors array, which can be interrogated simultaneously between a single input and output port. The footprint is ultra-compact of 4.5μm×50μm.

JW4A.135 Analysis of various ZnR plasmonic nanostructures and their effect on the absorption of organic solar cells, Sara Al Menabawy1, Qiaoqiao Gao, Mohamed Swilam1, American Univ. in Cairo, Egypt; Electrical Engineering, Univ. at Buffalo, The State University of New York, USA. We incorporated ZnR nanoparticles, nanocubes and nanoshells in organic solar cell and theoretically demonstrated broadband absorption enhancement due to high scattering and near field enhancement. Their extinction cross sections are also analyzed.

JW4A.136 Study of Energy Transfer between Quantum Dots and a Two-Dimensional Semiconduc- tor, Kenneth M. Goodfellow1, Chitraleka Chakroborty1, Kelly Sowers1, Pradeep Waduge1, Meni Waruni1, Todd Krauss1, Kristina Driscoll1, A. Nick Vamivakas1, Univ. of Rochester, USA; Northeastern Univ., USA; Rochester Inst. of Technology, USA. We explore the efficiency transfer of energy between colloidal quantum dots with a cadmium selenide core and cadmium sulfide shell and monolayer molybdenum diselenide (MoSe2), separating them by thin layers of hexagonal boron nitride (h-BN).

JW4A.137 Plasmonic Nanoantenna Array with Single-Chip Integrated Metal-Orgaic Framework for Infrared Absorption Gas Sensing, Xinjuan Chong1, Ki-Jun Jeong Kim1, Erwen Li1, Yunying Zhang1, Paul Ochodnicki1, Chih-Hung Chang1, Alan X. Wang1, Oregon State Univ., USA; National Energy Technology Lab, USA. Plasmonics devices are usually not suitable for gas spectroscopy due to the limited enhancement length. Here, we demonstrate a plasmonic nanopatch array coated with metal-organic framework for CO2 sensing, with enhancement factor over 1100 times.

JW4A.138 Light extraction efficiency enhancement of organic light-emitting diodes fabricated on silicon network substrate, Dong B. Yu1, National Chung Cheng Univ., Taiwan. This research focuses on the improvement of internal light out-coupling of organic light emitting diodes (OLED) with enhancement factor about 2.25 times compared with a conventional OLED.

JW4A.139 Withdrawn.

JW4A.140 Surface-lattice resonances in 2d arrays of spheres: multipolar couplings and normal modes, Sylvia Sweedcko1, John E. Sipe1, Univ. of Toronto, Canada. We present a multipolar model of the surface - lattice resonances in arrays of spheres. We show the importance of couplings between multipoles of different polarity and characterize the dispersion of multipolar modes.

JW4A.141 Plasmon enhanced whispering gallery mode sensor using Nanostructure, Seunghun Lee1, Hyerin Song1, Tae Young Kang1, Soohee Hwang1, Taerim Yoon1, Heesang Ahn1, Kyoung Kim1, NanoBioPhotonics Lab, Korea. Whispering gallery mode optical sensor has detected sub-micron sized molecules by monitoring the resonance peak shift. We described ‘plasmonic enhanced’ whispering gallery mode sensor using nanostructure and it confirmed by computer simulations.

JW4A.142 Mid-IR Resonant Cavity Detectors, Trevor A. O’Loughlin1, Gregory Savich1,2, Daniel Sidor1, Brendan Marozas1, Gary Wicks1, Terry Golding1, Keith Jamison1, Leis Fredin1, Bert Fowler1, Weerasinge Priyanthi1, Inst. of Optics, USA; Air Force Research Laboratory, USA; USA; ‘Materials Science, Univ. of Rochester, USA; ‘Amethyst Research, Inc., USA. Resonant cavity detectors have been grown by MBE. They offer a low noise, narrow response detector in the mid-infrared region, with possible applications in spectroscopy, gas sensing, and optical communications.

JW4A.143 Spontaneous emission studies of blue and green InGaN-based laser diode struc- ture, Gyu-Jae Jeong1, Sung-Nam Lee1, Koya Polytechnic Univ., Korea. Blue/green LEDs represented higher efficiency droop than blue/green LEDs under the same injection current density. Because of same epi-structures, we suggested that efficiency droop may be due to the difference of heat dissipation structure.
Design of a Wavefront Control Type Compact Silicon Wavelength Selective Switch, Fumi Nakamura1, Kyoysuke Muramatsu1, Hiroyuki Tsuda1; 1Electronics and Electrical Engineering, Keio Univ., Japan. A 200-GHz channel spacing, 16-channel, 1+2 wavefront control type silicon wavelength-selective switch is designed, which have two-step etched rib structure to reduce loss in the boundary parts between the slab and the arrayed-waveguide.

Phase-Resolved Characterization of Reflective Infrared Nanostructured Half- and Quarter-Wave Plates, Carol L. Baumbauer1, 2; 1Electrical and Computer Engineering, Montana State Univ., USA; 2School of Chemical Engineering and Materials Science, Montana State Univ., USA. Fabrication and characterization of both half- and quarter-wave plates operating in reflection at infrared wavelengths is presented. The phase delay between TE/TM polarization components can be controlled by the subwavelength grating fill factor.

Strong coupling of hybrid and plasmonic resonances in liquid core plasmonic microcavities, Sheng Liu1, Xiang Wu1, Fu’dan Univ., China. A novel thin wall fluidic plasmonic micro-cavity resonator is proposed and fabricated to manipulate coupling between various types of resonant modes by changing its wall thickness and refractive index of the liquid in the core.

Full Particulars of Surface Plasma Polariton Dispersion Relation in Multi-Layered Media, Huseyn S. Tekin1, M. Ismail Aksun1, 2; Koc Univ., Turkey. We show that the wavevector and frequency of surface plasmon polaritons (SPPs) can simultaneously have complex values, providing better resolution/confineement. We analyze SPPs in layered media and provide the complete description of their dispersion.

Design of SOI Rib Slot Waveguide with Enhanced Evanescent Field for Optical Sensing, Satyajeet Kumar1, Ravi K. Vardhan1, Bishnu P. Pa1; 1Physics Department, Indian Inst. of Technology, Delhi, India; 2School of Natural Science, Mahindra Ecole Centrale, India. We propose a novel SOI rib horizontal slot waveguide geometry to achieve larger than 10% enhancement in evanescent field vis-à-vis a conventional horizontal slot waveguide and hence yielding higher sensitivity in its environment sensing applications.

Thermo-optic Tuning of Silicon Photon Multi-mode Waveguide for Post-Fabrication Optimization, Christina P. Chen1, Brian Souhan2, Richard M. Osgood1, Keren Bergman1; 1Columbia Univ., USA; 2West Point, USA. We examine the effect of thermo-optically varying the effective mode index of an asymmetric y-junction that multiplexes three modes. This work aims to optimize multiplex mode operation, thereby improving performance.

Generation and Characterization of Breath Solitons in an On-Chip Microresonator, Chenguang Xiao1, Jose Jaramillo-Villegas1, Yi Xuan2; 1Massachusetts Inst. of Technology, Cambridge, MA; 2University of New Brunswick, Fredericton, New Brunswick, Canada. We show the generation of breath solitons and characterization of the spectral dynamics in an on-chip SiN microresonator. The breath soliton exhibits asymmetric breathing with respect to the center of the spectrum.

Large Area Lithography-Free Metamaterial Thermophotovoltaic Emitters with Oxygen Tolerance, Zachary Coppen1, Ivan Kravchenko1, Jason Valentine1; 1Vanderbilt Univ., USA; 2Oak Ridge National Laboratory, USA. We present a large-area metamaterial thermal emitter that is fabricated using facile, lithography-free techniques. The device shows stable, selective emission after exposure to 1173 K for 22 hours in oxidizing and inert atmospheres.

Electric and magnetic hotspots in the Silicon Bow-tie nanocavity, Reena Reena1, Yvette Karia1, Rathini K. Sinha1, 2; 1CSR-CSIR, India; 2Delhi Technological Univ., India. We report enhancement of electric and magnetic fields in the silicon bow-tie nanocavity at visible wavelength. For our design, electric and magnetic resonances have been optically induced at the wavelength of 620 nm.

Enhanced nonlinear-optical response of composites based on plasmonic nanoparticles, Jiayu Zhang1, 2, 3; 1Tong Liao1, 2, 3, 4; 2University of Electronic Science and Technology of China, China; 3Chinese Academy of Science, State Key Laboratory of Transient Optics and Photonics, China. We demonstrate phase-sensitive amplification based on pump-degenerate four-wave mixing in highly nonlinear low-loss waveguides. A net gain of 6 dB (including propagation loss) is achieved, with an extinction ratio of 16 dB.

New Architectures for Photonic Doppler Velocimetry: High Velocities at Lower Cost, Levi Neukirch1, Amy M. Tainter1, Dale Tupa1, Philip J. Rae1, David B. Hollkamp1; 1Baylor College of Medicine, TX, USA; 2Physics Division, Los Alamos National Laboratory, USA; 3Explosive Science and Shock Physics Division, Los Alamos National Laboratory, USA. We make use of the Doppler effect to measure velocities in dynamic experiments, but Doppler shifts of ≈1.3 GHz/km/s demand exquisite digitization requirements and costs. We discuss methods leveraging frequency down-mixing to reduce digitization requirements and costs.

Electric and magnetic hotspots in the Silicon Bow-tie nanocavity, Reena Reena1, Yvette Karia1, Rathini K. Sinha1, 2; 1CSR-CSIR, India; 2Delhi Technological Univ., India. We report enhancement of electric and magnetic fields in the silicon bow-tie nanocavity at visible wavelength. For our design, electric and magnetic resonances have been optically induced at the wavelength of 620 nm.

Enhanced nonlinear-optical response of composites based on plasmonic nanoparticles, Jiayu Zhang1, 2, 3; 1Tong Liao1, 2, 3, 4; 2University of Electronic Science and Technology of China, China; 3Chinese Academy of Science, State Key Laboratory of Transient Optics and Photonics, China. We demonstrate phase-sensitive amplification based on pump-degenerate four-wave mixing in highly nonlinear low-loss waveguides. A net gain of 6 dB (including propagation loss) is achieved, with an extinction ratio of 16 dB.

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Design, development and operation of an amplitude modulator fabricated by laser writing in Lithium Niobate, Gustavo Torchia1, 2; 1D. Presti1, 2; A. Facciszewski1, V. Guareppi1; 1Centro de Investigaciones Opticas, Argentina; 2Departamento de Ciencia y Tecnologia, Universidad Nacional de Quilmes, Argentina. We present the design and development of a Mach Zehnder interferometer (MZI) fabricated in Lithium Niobate by means of fs laser writing. The main MZI working characteristics, as amplitude modulator, are also presented and discussed.
JW4A.162 Perfect Light Absorption in Ultra-thin Silicon Optical Nanocavity and its Application for Color Filters, Seyed Sadreddin Mirkhajefeyan1, Ting S. Liu2, Junpeng Guo2; 1Department of Electrical and Computer Engineering, The Univ. of Alabama in Huntsville, USA; 2Center for Integrated Nanotechnologies, Sandia National Laboratories, Albuquerque, USA. We investigated perfect light absorption in silicon optical nanocavity comprising of ultrathin aluminum and silicon films deposited on an aluminum surface. The thickness of the silicon film cavity is 1/18 of the perfect absorption wavelength.

JW4A.163 Optimized Mid-Infrared Thermal Emitters for Applications in Aircraft Countermeasures, Simon Lorenzo1, Chenglong You2, Georgios Veronis2,3, Jonathan Dowling1,2; 1Louisiana State Univ., USA; 2Heanne Inst. for Theoretical Physics and Department of Physics and Astronomy, Louisiana State Univ., USA; 3Center for Computation and Technology, Louisiana State Univ., USA; 4School of Electrical Engineering and Computer Science, Louisiana State Univ., USA. An optimized apodized photonic crystal structure is capable of near-blackbody and broad angle thermal emission at aircraft engine temperatures over the three to five micron wavelength.

JW4A.164 Feedback-induced Bistability of an Optically Levitated Nanoparticle: A Fokker-Planck Treatment, Wenchao Ge1, Brandon Rodenberg2, Mishkatul Bhattacharya3; 1Rochester Inst. of Technology, USA. The Fokker-Planck equation for an optically levitated nanoparticle with feedback damping is investigated. We recover previous theoretical and experimental works in the low-damping regime and predict a bimodal distribution in the overdamped regime.

JW4A.165 Bistable mode of THG at non-zero amplitudes of incident waves, V. A. Trofimov1, Pavel Sidorenkov2, Igor Kuchik1; 1M. V. Lomonosov Moscow State Univ, Russian Federation. We demonstrate and compare the numerical and analytical solutions of THG problem in the case of non-zero input intensity. Also we consider the solution on the boundaries of areas.

JW4A.166 Phase-contrast ghost imaging using an orbital angular momentum phase-filter, Peter A. Morris1, Reuben Aspden2, Ruiqing He1, Gian Chen2, Miles J. Padgett1; 1University of Glasgow, UK; 2Nanjing Univ. of Science and Technology, China. Position and orbital angular momentum correlations are used to image phase-objects. Using a non-local phase-filter, ghost images show isotropic edge-enhancement allowing imaging using significantly fewer photons than standard phase-contrast imaging.

JW4A.167 Modeling Structural Features of Single-Mode, O-Switched Pulse Ensembles, Graham Martin1, Troy J. Siemens1, John R. Thompson1; 1Virginia Military Inst., USA. Stochastic, single-mode, rate equations are solved to generate pulse ensembles for comparison with experiments. Structural features of the ensembles depend on the switching time for cavity losses and the statistical characteristics of noise sources.

JW4A.168 Photonic Microwave Generation Using a VCSEL Subjected to Orthogonal Optical Injection, Salim Ourari1, Tianyao Huang2, Hong Lin1; 1Bates College, USA. We have generated tunable photonic microwave signals ranging from 6 to 62 GHz in a vertical-cavity-surface-emitting laser operating with three transverse modes by using period one dynamics and dual-beam injection separately.

JW4A.169 A Novel Observation of Optical Bistability in Oppositely Directed Coupler, Kanagaraj Nithyanandan1, A.K. Shafeeqe Ali1, Porseian Kuppusamy1; 1Pondicherry Univ., India. We observe that the oppositely directed coupled possesses Bistability. This property arises due to effective feedback mechanism as a result of opposite directionality of the phase velocity and energy flow in the negative index materials.

JW4A.170 Light Slowing Down and Chirped Soliton Formation in a Medium with Gold Nanorods, V. A. Trofimov1, Tatiana Lysak1; 1M. V. Lomonosov Moscow State Univ., Russia. We show a possibility for light slowing down accompanied by a novel type soliton – chirped soliton – formation at a femtosecond pulse propagation in a medium with gold nanorods under the nanorods reshaping and negative phase-amplitude grating.

JW4A.171 Cavity QED with Collective Excitations of Warm, 3-Level Atoms, Garrett Hickman1, Todd B. Pittman, James D. Dranson1; 1University of Maryland, Baltimore County, USA. We derive a simplified Hamiltonian describing an ensemble of three-level room-temperature atoms in a two-mode cavity. If one transition is driven with a single photon, the ensemble behaves as if it was a single atom.

JW4A.172 Conservative Classical and Quantum Resolution Limits for Incoherent Imaging, Mark Keating1; 1National Univ. of Singapore, Singapore. We propose classical and quantum limits to the resolution of two incoherent sources from the perspective of minimax estimation. Our limits are valid for any biased or unbiased estimator and numerically demonstrated to be approachable.

JW4A.173 Qubit-Detuning Impacted Entanglement Mediated by the Surface Plasmon, Fan Zhang1, Dongxing Zhao2, Ying Gu1, Hongyi Chen1, He Hao1, Qihuang Gong1,2; 1Peking Univ., China; 2Collaborative Innovation Center of Extreme Optics, Shaxi Univ., China. We have theoretically demonstrated the influence of qubit entanglement induced by the detunings among two qubits and surface plasmons in a hybrid qubits-metallic nanoparticle system. Enhancement appears when nanoparticle is placed between qubits.

JW4A.174 Rapid Delay Modulation of Biphotons, Ogaga D. Odiele1, Joseph M. Lukens2,3, Jose A. Jaramillo-Villegas1; 4Poojaal Imany1, Carsten Langrock2, Martin M. Fejer1, Daniel E. Leard1, Andrew M. Weiner2; 1Purdue Univ., USA; 2Oak Ridge National Laboratory, USA; 3Universidad Tecnologica de Pereira, Colombia; 4Stanford Univ., USA. We demonstrate delay modulation of entangled photons over a full 32-ns span, utilizing pump frequency tuning and ultralong fiber Bragg gratings. Electro-optic modulators enable time-bin switching rates as fast as 2.5 MHz.

JW4A.175 Two-photon Absorption Induced Emission of InAs/GaAs Quantum Dots, Xian Hu1,2, Dorel Guzun3,4, Morgan E. Ware1,2; 1Virginia Tech; 2Purdue Univ., USA; 3National Univ. of Singapore, Singapore; 4National University of Singapore. We reported on the optical frequency response of a two-photon absorption induced emission of MBE grown undoped InAs/GaAs quantum dots (QDs) is investigated by power dependent photoluminescence and two-photon photoluminescence excitation study with excitation energy near the QDs half-bandgap.

JW4A.176 Withdrawn.

JW4A.177 Withdrawn.
Controlling Mandel’s Q-parameter in Disordered Lattices via Excitation-Symmetry Breaking, Hasan E. Kondakci1, Robert Keil1, Armando Perez-Leija2, Alexander Zaeemitz, Ayman Abboureddy3, Demetrios Christodoulides1, Bahaa E. Saleh3, CREOL, Univ. of Central Florida, USA; Inst. of Applied Physics, Friedrich-Schiller-Universität Jena, Germany; Institute for Experimental Physics, Universität Innsbruck, Austria. We experimentally demonstrate deterministic control of Mandel’s Q-parameter in off-diagonal disordered lattices while the mean photon number remains fixed. We achieve this by gradually breaking the excitation symmetry of the chiral mode pairs.

Quantum resources for optical phase estimation, Jaspreet Sahota1, Nicolas Quesada1, Daniel F. James1, Univ. of Toronto, Canada; Physik, Université de Sherbrooke, Canada. We determine how phase sensitivity depends on quantum entanglement (particle entanglement and mode entanglement) by employing the particle description (first quantization) and the mode description (second quantization) of bosonic probe states.

Electronic nature of new Ir(III)-complexes: linear spectroscopic and nonlinear optical properties, Salimeh Tofghi1, Peng Zhao1, Mykhailo Bondar2, Ryan O’Donnell3, Jianmin Shi1, David Hagan1, Eric Van Stryland1, CREOL Univ. of Central Florida, USA; Inst. of Physics NASU, Ukraine; US Army Research Laboratory, USA. Linear photophysical properties and two-photon absorption spectra of new Ir(III)-complexes in liquid media are presented. The excited-state potential surface of new compounds was revealed by steady-state and time resolved spectroscopic data.

Analytical Description of Nonlinear Refraction Index Measurements with the DAF sigma Technique, Anderson M. Amaral1, Hans A. Mejia2, Edision L. Falcao-Filho3, Cel B. de Araujo4, Universidade Federal de Pernambuco, Brazil; Departamento de Fisica, Universidade Federal do Piauí, Brazil. We obtained analytical expressions for the far-field beam width due to elliptical and astigmatic beams propagating inside Kerr media, and performed experiments with CS2 and silica. A good agreement between theory and experiment was found.

Evolution of Averaged Speckle Pattern, Xiaojun Cheng1,2, CUNY Queens College, USA; Graduate Center, CUNY, USA. We show that intensity maxima in speckle patterns averaged over a frequency interval diffuse with a diffusion coefficient decreasing linearly with the width of the frequency interval, providing a method in imaging for dynamic samples.

Nonlinear Modal Interactions in PT-Symmetric Lasers, Li1,2, Rami El-Ganany3,4, College of Staten Island, CUNY, USA; The Graduate Center, CUNY, USA; Department of Physics and Hemes Center for Quantum Phenomena, Michigan Technological Univ., USA. We discuss nonlinear modal interactions in PT-symmetric laser systems under steady state conditions, and we demonstrate several gain clamping scenarios in both the PT-symmetric and PT-broken phases.

Dynamic Ferroelectricity of Trojan Electrons on Face-Centered Square Lattice, Matt Kinsky1, Utah State Univ., USA. We show that hydrogen atoms placed on the face-centered two-dimensional square lattice and excited to Trojan electron states exhibit dynamic ferroelectric order when all Trojan Wave Packets move coherently in phase on circular orbits.

Experimental and Numerical Study on Stimulated Raman Scattering in As2S3, As5Ss, Microstructured Optical Fiber, Weiqing Gao1,2, Xue Li1, Qiang Xu2, Xiangcai Chen3, Chenquan Ni4, Li Chen5, Zhengqiang Wen1, Tonglei Cheng1, Xiaojie Xue, Takenobu Suzuki6, Yasutake Ohishi7, Research Center for Advanced Photon Technology, Toyota Technological Inst., Japan; School of Electronic Science & Applied Physics, Hefei Univ. of Technology, China. We demonstrate the stimulated Raman scattering effect in As2S3, As5Ss microstructured optical fiber. The first-order Stokes wave is obtained with the conversion efficiency of 15.0 dB. The simulated results agree well with the experiments.

Calculation of Power Spectral Density in Passively Modelocked Lasers with Slow Saturable Absorbers, Shaoqiang Wang1, Curtis R. Menyuk1, Computer Science and Electrical Engineering, Univ. of Maryland, Baltimore County, USA. We calculate the power spectral density for a passively modelocked fiber laser with a semiconductor saturable absorber using spectral methods. We obtained frequency sidebands that agrees with experimental observations.

Observation of Ince-Gaussian beams and their polarizations properties, Sean M. Noza1,2, Univ. of North Carolina at Charlotte, USA; Department of Chemistry, National Univ., USA; Department of Chemistry, Rice Univ., USA; Department of Materials Science and NanoEngineering, Rice Univ., USA. We report an ultrafast two-color pump-probe experiment measuring transient differential refraction of trions in monolayer MoS2. We explain our results using a model based on a set of rate equations.

Self-healing optical beams with snake-like and spiral paths in free space, Ahmed Dorrahi1, Michel Zamboni-Rached2, Mo Mojahedi1, Univ. of Toronto, Canada; Electrical Engineering, State Univ. of Campinas, Brazil. We experimentally demonstrate a class of non-diffracting beams, known as Frozen Waves, whose central spot can be made to follow an arbitrary off-axis curved path. These beams can be utilized in material processing and optical trapping applications.

Quantum Multiple Phase Estimation Using Balanced Multi-mode Entangled States, Lu Zhang1, Kam-fai C. Chan1, Pramode K. Verma1, Univ. of Oklahoma, USA. We present a generalized entangled state that can approach the Heisenberg limit in quantum metrology. We prove the entangled squeezed vacuum state can achieve a higher precision than entangled (squeezed) coherent state and NOON state.

Electron spin interaction with the angular momentum of the electromagnetic field, Charles Paillard1,2, Brahmi Dkhil3, Reeta Vyas1, Laurent Bellache1, Surendra Singh1,1, Laurent Bellache1, Surendra Singh1,1, Université Pari-Saclay, France. Consequences of the recently introduced interaction between the electron spin and the angular momentum of the electromagnetic field for atomic and optical physics are discussed.

We experimentally demonstrate deterministic control of Mandel’s Q-parameter in off-diagonal disordered lattices while the mean photon number remains fixed. We achieve this by gradually breaking the excitation symmetry of the chiral mode pairs.

We show that intensity maxima in speckle patterns averaged over a frequency interval diffuse with a diffusion coefficient decreasing linearly with the width of the frequency interval, providing a method in imaging for dynamic samples.

We discuss nonlinear modal interactions in PT-symmetric laser systems under steady state conditions, and we demonstrate several gain clamping scenarios in both the PT-symmetric and PT-broken phases.

We calculate the power spectral density for a passively modelocked fiber laser with a semiconductor saturable absorber using spectral methods. We obtained frequency sidebands that agrees with experimental observations.

We experimentally demonstrate a class of non-diffracting beams, known as Frozen Waves, whose central spot can be made to follow an arbitrary off-axis curved path. These beams can be utilized in material processing and optical trapping applications.

We present a generalized entangled state that can approach the Heisenberg limit in quantum metrology. We prove the entangled squeezed vacuum state can achieve a higher precision than entangled (squeezed) coherent state and NOON state.

We experimentally demonstrate deterministic control of Mandel’s Q-parameter in off-diagonal disordered lattices while the mean photon number remains fixed. We achieve this by gradually breaking the excitation symmetry of the chiral mode pairs.
Wednesday, 19 October

16:00–17:30
FW5A • Understanding Myopia Development
Presider: Frank Schaeffel, Eberhard-Karls_ Universitat Tubingen, Germany and Earl Smith, Univ. of Houston, USA

16:00–18:15
FW5B • High-Power Fiber Lasers and Beam Combining
Presider: Iyad Dajani; US Air Force Research Laboratory, USA

16:00–18:00
FW5C • Optical Coherence Tomography
Presider: Jerome Mertz, Boston Univ., USA

16:00–18:00
FW5D • Integrated Photonics
Presider: Michael Fanto, Rochester Inst. of Technology, USA

FW5A.1 • 16:00
Invited
Control of Myopia Progression in Children: Inside and Outside, Donald O. Mutti 1; 1Ohio State Univ. Optometry, USA. Positive results using peripheral myopia-based optical therapies have motivated their evaluation in longer-term clinical trials. This presentation will review these studies and whether time outdoors alters risk of myopia onset and progression rate.

FW5B.1 • 16:00
Invited
Coherent Beam Combining and Nonlinear Suppression of Multi-Kilowatt All-Fiber Amplifiers, Angel Flores 1, Iyad Dajani 1, Nader N. Naderi 1, Brian Anderson 1; 1US Air Force Research Laboratory, USA. We present multi-kW power scaling results of narrow line Yb-doped fiber amplifiers. Nonlinear suppression is attained through pseudo-random modulation. Subsequently, 5 pseudo-random modulated kW amplifiers were coherently combined into a 5kW beam.

FW5C.1 • 16:00
Invited
Live Imaging of Reproductive and Developmental Events in Mouse Model with Optical Coherence Tomography, Irina Larina 1; 1Baylor College of Medicine, USA. Toward understanding of mammalian reproduction and early embryonic development, we are working on development of imaging tools based on structural and functional optical coherence tomography in mouse models.

FW5D.1 • 16:00
Invited
Nanophotonics Technology and Applications, Yeshaiahu Fainman 1; 1Univ. of California, San Diego, USA. We discuss integration of a photonic information processing system onto a single chip focusing on nanoscale engineered optical nonlinearities and metal-dielectric-semiconductor nanostructures and compositions to construct nanoemitters.

FW5A.2 • 16:30
Invited
Myopia Development in Guinea Pigs, Sally A. McFadden 1, Guang Zeng 1; 1Univ. of Newcastle, Australia. Myopia is induced when growing eyes are exposed to hyperopic defocus or reduced vision. The associated changes and factors that influence the development of myopia in the guinea pig eye are described.

FW5B.2 • 16:30
Invited
Singlemode Raman Lasing in Graded-Index Fiber Pumped by High-Power 915-nm Laser Diode, Ekaterina A. Zlobina 1, Sergey I. Kablukov 2, Alexey A. Wolf 2, Alexander V. Dostovalov 2, Sergey A. Babin 2; 1Inst. of Automation and Electrometry, Russian Federation, 2Novosibirsk State Univ., Russia. Raman lasing in graded-index fibers pumped by a multimode 915-nm laser diode enables single-transverse-mode output due to special FBG inscribed by femtosecond technique. 954-nm output power of >10 W with narrow spectrum has been obtained.

FW5C.2 • 16:30
Invited
Monitoring and Guidance of Arrhythmia Therapy with Optics, Christine P. Hendon 1; 1Columbia University, USA. In this talk, I will describe my laboratory’s efforts towards translation of optical coherence tomography and near infrared spectroscopy for monitoring and guidance of arrhythmia therapy.

FW5D.2 • 16:30
Supra-octave-spanning single-mode and single-polarization operation in nanophotonic waveguides, Jeff Chiles 1, Sasan Fathpour 1; 1Univ. of Central Florida, USA. Nanophotonic anchored-membrane waveguides utilizing a semi-infinite and asymmetric geometry are fabricated and shown to exhibit single-mode and single-polarization operation over a record span exceeding 1.27 octaves.
FW5E.1 • 16:00 Tutorial
High Power Fiber-laser Based High Harmonic Sources for Nanoscale Imaging and Spectroscopy, Jan Rothhardt1, Steffen Hädrich1, Robert Klas1, Gertnet Tadese1, Stefan Demmler1,2, Maxim Tschernajew1,2, Jens Limpert1,2, Andreas Tunnermann1,2, Helmholtz Inst. Jena, Germany; 1Inst. of Applied Physics, Friedrich-Schiller-Univ. Jena, Germany; 2Fraunhofer Institute Jena. His group is applying table-top XUV sources to ultrafast nanoscale imaging and coherent high photon flux XUV and soft X-ray microscopy.

FW5F.1 • 16:00 Invited
Optical Antenna Spontaneous Emission: How Much Faster Than Stimulated Emission?, Eli Yablonovitch1,2, University of California Berkeley, USA. With optical antennas, spontaneous light emission becomes faster than stimulated emission, but the enhancement is limited by optical losses through the “anomalous skin effect”. Maintaining 50% efficiency, a 10x speedup beyond stimulated emission should be possible.

FW5G.1 • 16:00 Invited
Optical Fabrication Science & Technology for High Energy Laser Optics, Tayyab I. Suratwala1,2, Lawrence Livermore National Laboratory, USA. Optical fabrication Science & Technology (specifically sub-surface damage, surface figure, & roughness) and its impact on fabricating economical high quality, laser damage resistant optics for use in high energy, high power lasers are reviewed.

FW5H.1 • 16:00 Invited
Compact Freeform Offner-Chrisp Imaging Spectrometer, Jacob Reimers1,2, Kevin P. Thompson1,2, Kevin L. Whiteaker1,2, Kevin L. Whiteaker1,2, Billy Beaucamp1,2, Phillip Charlton1,2, Eric M. Schiesser1,2, Aydan Aksoylar1,2, Meri, USA; 2ECCE, Boston Univ., USA. We introduce a class of pictorial irradiance patterns that freeform optics can render sharply despite the blurring effect of extended light sources; show how to solve for the freeform geometry; and demonstrate a fabricated lens.

FW5I.1 • 16:30 Invited
Compact Freeform Offner-Chrisp Imaging Spectrometer, Jacob Reimers1,2, Kevin P. Thompson1,2, Kevin L. Whiteaker1,2, Billy Beaucamp1,2, Phillip Charlton1,2, Eric M. Schiesser1,2, Aydan Aksoylar1,2, Meri, USA; 2ECCE, Boston Univ., USA. We present the development of nanophotonic resonators for quantum frequency conversion, including efficient, low-noise conversion of single-photon-level signals and progress towards use with quantum dot single-photon-sources.
FW5A • Understanding Myopia Development—Continued

Wednesday, 19 October

Monday, 18 October

Tuesday, 19 October

Perez-Merino to myopia progression. This permits modelling of cone contribution all meridians except nasal, where the optic nerve head has no

and younger subjects are well fit by an exponential model in

Investigaciones Cientificas, Spain; 2School of Veterinary, Uni-

deral, Spain; 3Univ. of Newcastle, Australia.

We quantified anterior segment geometry in both

corneas, longer anterior chamber depth and steeper anterior lens.

Changes in anterior segment 3-D geometry in normal

and myopic guinea pig eyes, Susana Marcos, Pablo Pérez-Merino, Miriam Velasco-Ocana, Eduardo Martínez-Enriquez, Luis Revuelta, Sally A. McFadden, 1Consejo Sup Investigaciones Científicas, Spain; 2School of Veterinary, University Complutense de Madrid, Spain; 3Univ. of Newcastle, Australia. We quantified anterior segment geometry in both control and lens-treated eyes of a guinea pig model in vivo using custom-developed OCT. Myopic eyes showed longer axial lengths, thinner corneas, longer anterior chamber depth and steeper anterior lens.

FW5A.4 • 17:00

Power Scaling and Coherent Beam Combination of a

New-Linewidth, Monolithic Two-Tone Fiber amplifi-

er, Nader N. Naderi1, Angel Flores1, Brian Anderson1, Kenneth Rowland1, Izad Dajani1, UW Air Force Research Laboratory, USA. Power scaling results of a phase modulated two-tone fiber amplifier at clock rate of 2.5GHz are presented. Coherent beam combination performance of the two-tone amplifier yielded ~90% combining efficiency with no sign of linewidth broadening.

FW5A.4 • 17:15

Changes in anterior segment 3-D geometry in normal

and myopic guinea pig eyes, Susana Marcos1, Pablo Pérez-Merino2, Miriam Velasco-Ocana2, Eduardo Martínez-Enriquez1, Luis Revuelta1, Sally A. McFadden1, 1Consejo Sup Investigaciones Científicas, Spain; 2School of Veterinary, University Complutense de Madrid, Spain; 3Univ. of Newcastle, Australia. We quantified anterior segment geometry in both control and lens-treated eyes of a guinea pig model in vivo using custom-developed OCT. Myopic eyes showed longer axial lengths, thinner corneas, longer anterior chamber depth and steeper anterior lens.

FW5A.3 • 17:00

Brillouin Gain Spectroscopy on LMA Yb-Doped Photonic Bandgap Fiber, Cody Mart1,2, Benjamim Ward, Benjamin Pulford1, Izad Dajani1, Liang Dong1, Khant Kieu1, 1Univ. of Arizona, College of Optical Sciences, USA; 2Directed Energy Directorate, Air Force Research Laboratory, USA. We interrogate stimulated Brillouin scattering in large mode area photonic bandgap fiber. Theoretical and experimental studies reveal a gain less than 0.7 cm/W, which represents a significant reduction over commercial Yb-doped LMA step-index fibers.

FW5A • Understanding Myopia

Development—Continued

FW5B • High-Power Fiber Lasers and Beam

Combining—Continued

FW5B.3 • 16:45

900W Single-mode CW Power From an 60µm-core

Ytterbium-doped All-solid Photonic Bandgap Fiber Laser, Fan Ting Kong1, Guancheng Gu1, Thomas Hawkins1, Maxwell Jones1, Joshua Parsons1, Monica Kalichevsky-Dong1, Benjamin Pulford1, Izad Dajani1, Liang Dong1, 1Clemson Univ., USA; 2Nufenn, USA; 3Air Force Research Laboratory, USA. ~900W single-mode power was obtained from an Yb-doped, ~60µm-core all-silicon photonic bandgap fiber with multiple-cladding-resonant design, with 90% efficiency vs. launched pump. This is a record single-mode power from a micro-structured fiber laser.

FW5B • High-Power Fiber Lasers and Beam

Combining—Continued

FW5B.4 • 17:00

Brillouin Gain Spectroscopy on LMA Yb-Doped Photonic Bandgap Fiber, Cody Mart1,2, Benjamin Ward, Benjamin Pulford1, Izad Dajani1, Liang Dong1, Khant Kieu1, 1Univ. of Arizona, College of Optical Sciences, USA; 2Directed Energy Directorate, Air Force Research Laboratory, USA; 3Department of Physics, USA Air Force Academy, USA; 4Clemson Univ., Center for Optical Materials and Engineering Technology, USA. We interrogate stimulated Brillouin scattering in large mode area photonic bandgap fiber. Theoretical and experimental studies reveal a gain less than 0.7 cm/W, which represents a significant reduction over commercial Yb-doped LMA step-index fibers.

FW5B.5 • 17:15

Power Scaling and Coherent Beam Combination of a

New-Linewidth, Monolithic Two-Tone Fiber amplifi-

er, Nader N. Naderi1, Angel Flores1, Brian Anderson1, Kenneth Rowland1, Izad Dajani1, US Air Force Research Laboratory, USA. Power scaling results of a phase modulated two-tone fiber amplifier at clock rate of 2.5GHz are presented. Coherent beam combination performance of the two-tone amplifier yielded ~90% combining efficiency with no sign of linewidth broadening.

FW5C • Optical Coherence Tomography—

Continued

FW5C • Optical Coherence Tomography—

Continued

FW5C.3 • 17:00

Long-range, wide-field, functional optical coherence
tomography imaging for clinical otology in live patients and healthy normals, Dan MacDougall1, Joshua Farrell1, Nicholas Juhas1, Manohar Bance1, Jeremy Brown1, Robert Adamson1, Dalhousie Univ., Canada. We present results from a real-time, phase-sensitive swept-source OCT system used for middle ear imaging in live patients with co-registered functional Doppler vibraphraphy. This is the first system to successfully produce such images in vivo.

FW5C.4 • 17:15

Broadband Swept-Source Laser in 1.1 to 1.3 µm with InAs Quantum Dot Gain Chip Devices, Ruizhe Yao1, Nicholas Weir1, Chi-Sen Lee1, Zihao Wang2, Stefan F. Preble1, Wei Guo1, 1Univ. of Massachusetts Lowell, USA; 2Microsystems Engineering, Rochester Inst. of Technology, USA. We have demonstrated mode-hopping-free broadband swept-source laser with ~100 nm wavelength tuning range centered at 1.2 µm by using novel InAs quantum dot (QD) gain chip devices.

FW5D • Integrated Photonics—Continued

FW5D.3 • 16:45

On-Chip Optical Neuromorphic Computing, Yichen Shen1, Marin Soljacic1, Nicholas Harris1, Dirk. Englund2, 1Massachusetts Inst. of Technology, USA. We propose a nanophotonic system that do the neural network computing in optical domain. Our system is able to give equivalent learning performance, while potentially achieve much better speed and efficiency than conventional computer.

FW5D.4 • 17:00

Towards an Integrated Quantum Photonics Platform on GaAs, Sven Höfling1, 1Univ. of St. Andrews, UK. Integrated quantum photonics promises a chip-scale implementation of quantum circuits. We discuss recent progress towards the realization of a platform on GaAs, including single photon sources, detectors and other key elements towards a functional platform.
Measuring ultrafast lighthouse effect in femtosecond pulses, Zhe Guang

Using the STRIPED FISH Technology, USA.

Using the STRIPED FISH Technology, USA.

FW5E.3 • 17:00
Harmonic Generation in Graphene and Carbon Nanotubes,Marco Taucer, T. J. Hammond, Giulio Vampa, Nicolas Thiene, Bruno Schmidt, Charles-Andre Couture, François Légérè, Paul Corkum

FW5E.4 • 17:15
Amplification and Compression of Femtosecond Pulses by Fiber Parabolic Pre-Shaping, Walter P. Fu, Yuxing Tang, Timothy S. McComb, Tyson L. Lowder, Frank W. Wise, Cornell Univ., USA, nLIGHT Corporation, USA.

FW5E.5 • 17:15
Generation of non-classical light via self-induced transparency in mercury-filled hollow core photonic crystal fibers, Ulrich Vogl, Florian Sedlmeir, Nicolas Joly, Christoph Marquardt, Gerd Leuchs, MPI for the Science of Light, Germany. We successfully demonstrate squeezing of nanosecond pulses via self-induced transparency in a system of mercury vapor confined in a hollow core kagomé-style fiber.

FW5E.6 • 16:45
A 12 decades goniometric instrument for the comprehensive characterization of the spectral properties of thin-film filters, Michel Lequime, Simonia Lukiatyte, Myriam Zerrad, Claude Amra, Institut Fresnel - UMR 7249, France. This paper describes an innovative instrument that allows to measure the optical features of a thin-film filter (transmission, reflection, blocking, steepness, scattering) with 12 decades detection range and sub-nanometer spectral resolution.

FW5F.3 • 17:00
Superconducting Nanowire Single-photon Detector with Spot-size Converter on Si platform, Tatsuruu Hiraki, Tsuzuki Yamamoto, Hiroyuki Shibata, Shinya Matsuo, NTT Device Technology labs., Japan, NTT Nanophotonics Center, Japan, Kitami Inst. of Technology, Japan. We have integrated an SNSPD with a spot-size converter on the Si photonics platform. A system detection efficiency of 32% and a dark count rate of 96 Hz are achieved with a fiber coupled module.

FW5F.4 • 17:15
Optical Differentiation Wavefront Sensing for Freeform Optics Metrology, Tie Qiao, Zachary Mulhalan, Christophe Dorrer, Rochester Inst. of Technology, USA, Aktivate LLC, USA. High resolution, high dynamic range optical differentiation wavefront sensor using binary pixelated filters has been developed for the metrology of freeform optics. Wavefront reconstruction precision and accuracy will be presented.

FW5G.3 • 16:45
A 12 decades goniometric instrument for the comprehensive characterization of the spectral properties of thin-film filters, Michel Lequime, Simonia Lukiatyte, Myriam Zerrad, Claude Amra, Institut Fresnel - UMR 7249, France. This paper describes an innovative instrument that allows to measure the optical features of a thin-film filter (transmission, reflection, blocking, steepness, scattering) with 12 decades detection range and sub-nanometer spectral resolution.

FW5H.3 • 17:00
Optical Metrology Systems Spanning the Full Spectral Properties of Thin-Film Filters, Dae Wook Kim, Innocent Uwimana, Shiyan Ren, Charles-Andre Couture, Paul Corkum, Univ. of Arizona, USA. We present a collection of unique, collaborative optical metrology systems that are fully capable of measuring the extensive spectrum of low-to-mid to high spatial frequencies, corresponding to surface shape information.

FW5H.4 • 17:15
Scanning Customized Swept-source Optical Coherence Tomography (SS-OCT) for the Metrology of Freeform Optical Surfaces, Di Xu, Jianing Yao, Nan Zhao, Jannick P. Rolland, The Inst. of Optics, Univ. of Rochester, USA, Changshun Inst. of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences, China. A high-precision SS-OCT system with custom scanning configuration was developed for the point cloud metrology of freeform optical surfaces. Capabilities were demonstrated on an Alvarez surface and a measurement precision of z/20 was achieved.

FW5I.3 • 17:00
Invited Advances in Silicon Quantum Photonics, D. Bonneau, J.W. Silverstone, J. Wang, P. Sibson, R. Santagati, C. Erven, J.L. O’Brien, M.G. Thompson, Univ. of Bristol, UK. Silicon quantum photonics has emerged as a promising approach to realising complex and compact quantum circuits for applications in communication and computation. Highlights include chip-to-chip quantum communications, programmable quantum circuits and chip-based quantum simulations.
FW5B.6 • 17:30
Optimization of Coaxial Tm/Ho-Doped Fiber Lasers, Krysta Bocciuzzi¹, G. A. Newburgh¹, John R. Marciante¹; Univ. of Rochester, USA. Simulations of a novel coaxial fiber having a Ho-doped core surrounded by a Tm-doped ring resulted in 52% laser efficiency. The conventional method, a Tm fiber laser pumping a Ho fiber laser yielded a maximum 43% efficiency.

FW5C.5 • 17:30
Invited
Double-clad Fiber Couplers: Novel Devices for Multimodal Imaging., Caroline Boudoux¹; Engineering Physics, École Polytechnique Montréal, Canada. Innovation in double-clad fiber couplers allow for efficient separation (or combination) of coherent and diffuse light, which makes them ideally suited to perform multimodal endoscopic optical imaging.

FW5D.5 • 17:30
Orbital Angular Momentum Multiplexing using Low-Cost VCSELs for Datacenter Applications, Mehdi Nouri¹, Hiva Shahoie¹, Timothy Laffave², Solyman Ashrafi¹, Duncan MacFarlane¹; Electrical Engineering, Southern Methodist Univ., USA. Development of 428 Gb/s free space data communications link based on OAM multiplexing using 850nm VCSELs is presented. Passive optical mode sorters are used for MUX (transmit) and DeMUX (receive).

FW5B.7 • 17:45
All-fiber Combining Concepts in the Wavelength Range Around 2 µm, Hakan S. Sayin¹, Katharina Hausmann¹, Christoph Ottenhues¹, Ökan Işık¹, Michael Sterinke¹, Saniye S. Yılmaz¹,², Samir Lammini¹, Jörg Neumann¹, Fatih Ömer Ilday¹, Dietmar Kracht¹; Laser Zentrum Hannover e.V., Germany; Department of Physics, Bilkent Univ., Turkey; Laser Development, Lisa Laser OHG, Germany. We investigated combining in the 2 µm wavelength range. Tapered fused bundles enabled multi-mode combining, while coupling of single-mode sources to a truly single mode fiber was performed employing cascades of wavelength division multiplexers.

FW5D.6 • 17:45
Wavelength Selective External Cavity Laser Using an InAs Quantum Dot Gain Chip and an Arrayed-Waveguide Grating for T-band Optical Communication, Yudai Okuno¹, Yasunori Tomomatsu¹, Yoshinori Sawado¹, Katsumi Yoshizawa¹, Hideaki Shibutani¹, Hiroaki Tsuda¹; Keio Univ., Japan; Koshinokogaku Corporation, Japan; Pioneer Micro Technology Corporation, Japan. The wavelength selective external cavity laser using an InAs quantum dot gain chip and an arrayed-waveguide grating for T-band communication is proposed and the output wavelength can be tuned from 1041.8 nm to 1090.5 nm.
Prospects for Multi-kJ Plasma Amplifiers, Peter A. Narrey1,2, James Sadler1, Raoul M. Trines1, Robert Bingham1, Muhammad Kasm1, Luke Ceulemans1, Naren Ratan1, 1Department of Physics, Univ. of Oxford, UK; 2Central Laser Facility, STFC Rutherford Appleton Laboratory, UK. Plasma amplifiers potentially offer a route to low cost, high efficiency, multi-kJ laser pulses. I will describe numerical simulations underpinning careful experiment design and pulses. I will describe numerical simulations underpinning careful experiment design and interpretation to optimize this process at the Univ. of Rochester.

17:00–17:15 Direct Compressive Imaging of Joint Quantum States with Strong Projections, Samuel H. Knani1, Daniel Lum1, James Schneeloch1, John Howell1, 1Univ. of Rochester, USA; 2Air Force Research Laboratory, USA. We are performing an experiment to incorporate compressive sensing into a direct measurement protocol to measure general transverse joint-states using strong projections. We present simulation results of a 256 × 256 system using 9% sampling.

17:15–17:30 Combin-Like Frequency-Bin Entangled Photon Pair Generation in Silicon Nitride Microring Resonators, Jose A. Jaramillo-Villegas1,2, Poolad Imam1, Ogaga D. Odele1, Xiaoxiao Xue1, Yi Xuan1, Kyoung-Hun Han1, Daniel E. Leard1, Minghao Qi1, Andrew M. Weiner1, 1Purdue Univ., USA; 2Universidad Tecnologica de Pereira, Colombia. We report a comb-like frequency-bin entangled photon pair source with a high coincidence to accidental ratio in a silicon nitride microring resonator. We measured a Schmidt number of 4.0, thus verifying high degree of time-frequency entanglement.

17:30–17:45 Multifunctional Optics Testing Using Wavefront Technology, Johannes Prud1, Christian Brock1, Ralf Dorn1, 1Optocraft Metrology GmbH, Germany. Consumer optics require multifunctional and high performance test equipment. Latest developments and examples are described and how multifunctional optics testing can be realized on basis of wave-front sensing combined with other techniques.

17:45–17:55 Achromatic Resonances in an Optical Microcavity, Soroosh Shabahang1, H. Esat Kondakci1, Massimo L. Villinger1, Joshua Perlestein1, Ayman Abouraddy1, 1Univ. of Central Florida, CREOL, USA; 2Materials Science and Engineering, Univ. of Central Florida, USA. Achromatic transmission is demonstrated by angularly-multiplexed phase-matching. A 0.7-nm-wide resonance is broadened to 60nm, spanning multiple cavity FSRs, by assigning each wavelength to an appropriate incidence angle.

17:55–18:15 Windshield Metrology: Simultaneous Measurement of Wedge Angle and Layer Thickness, Michael A. Marcus1, 1Lumetrics, Inc, USA. An interferometric apparatus to simultaneously measure layer thickness and wedge angle profiles in multilayer windshields is described along with its measurement reproducibility. A hand-held probe simplifies alignment to the windshield surface.

18:15–18:30 Zernike Coefficient Measurement Using Geometric Phase Shifting Interferometer, Chittur S. Narayanmurthy1, 1Indian Inst. of Space Sci & Tech, India. Geometric phase shifting radial shearing interferometer method is used to determine Zernike Co-efficients of Kolmogorov type turbulence affected wavefront with detailed comparison with SHWS data.

18:30–21:30 OSA 100 Year BASH, The Sibley Building, 228 East Main Street, Rochester, New York
Spatial Squeezing in Bright Twin Light

Ahmad Darudi1, Pegah Asgari1; 1Zanjan Univ., Iran2Physics, Univ. of Oklahoma, USA.

Optical surface profilometry using Fresnel diffraction from a 2D array of reflective phase-steps, Pegah Asgari1, Yousef Pourvais2, Ahmad Darudi1; 1Zanjan Univ., Iran2Physics, Univ. of Tehran, Iran. In this paper, a novel method is presented for optical surface profilometry, based on phase-step diffractometry. The technique combines the advantages of Hartmann and Fizeau methods and is tolerant with environmental noises.

Spatial Squeezing in Bright Twin Light

JTh2A.1
Optical surface profilometry using Fresnel diffraction from a 2D array of reflective phase-steps, Pegah Asgari, Yousef Pourvais, Ahmad Darudi; 1Zanjan Univ., Iran2Physics, Univ. of Tehran, Iran. In this paper, a novel method is presented for optical surface profilometry, based on phase-step diffractometry. The technique combines the advantages of Hartmann and Fizeau methods and is tolerant with environmental noises.

Spatial Squeezing in Bright Twin Light

JTh2A.2
Spatial Squeezing in Bright Twin Light Beams using a CCD Camera, Ashok Kumar, Hayden Nunley1, Alberto Marino; 1The Univ. of Oklahoma, USA. We report the direct measurement of 2 dB of spatial squeezing with an EMCCD camera. We use bright twin beams of light generated through four-wave mixing in a double-lambda configuration in Rb atomic vapor.

Spatial Squeezing in Bright Twin Light

JTh2A.3
Stimulated Low-Frequency Raman Scattering, Anna Kudryavtseva, Nikolaiy V. Tcherniega, Konstantin I. Zemskov; P.N. Lebedev Physical Inst., Russian Federation. Stimulated low-frequency Raman scattering, caused by laser pulses interaction with acoustic vibrations of nanoparticles, has been studied in the wide range of nanoobjects both in high-ordered and random materials, in inorganic and organic substances.

Spatial Squeezing in Bright Twin Light

JTh2A.4
Constant intensity waves and transmission through non-Hermitian disordered media, Konstantinos Makris, Andre Brandstötter, Phillip Ambichl, Ziad Musslimani, Stefan Rotter; Univ. of Crete, Greece; 1Inst. for Theoretical Physics, Vienna Univ. of Technology, Austria; 2Mathematics, Florida State Univ., USA. By using the concept of constant-intensity waves, we show that perfect transmission through the disordered media is possible. Such scattering states can exist in non-Hermitian scattering landscapes with suitably engineered gain-loss distributions.

Spatial Squeezing in Bright Twin Light

JTh2A.5
Zero Rabi Flopping in the presence of a Field, Julio Cesar Garcia Melgarrego, Edgar Samuel Arroyo Rivera, Ricardo Martinez Martínez, José Alfredo Ramirez Flores, Javier Sanchez Mondragon; 1Inst Nac Astrofisica Optica Electronica, Mexico; 2Universidad Autónoma de Coahuila, Mexico. The idle role of the photonic dark state of the X-Cavity JCM is quite an interesting feature because arises from dipole orientation. We discuss the zero Rabi flopping in its presence and discuss its evidence.

Spatial Squeezing in Bright Twin Light

JTh2A.6
Plasmonic Effect of Low-Dimensional Electron Gas in Core-Shell Nanowires, Kiana Montazer, Zhishun Wang, Bahram Nabet, 1Drexel Univ., USA. We analyze the plasmonic effect of core-shell nanowires explaining how metallic layers and low-dimensional electron gas formed at the heterojunction of the core and the shell affect the optical cavity and mode generations.

Spatial Squeezing in Bright Twin Light

JTh2A.7
An Experimental study of Odd-Order Dispersion Effects in Propagation of Long-Range Surface Plasmon Polaritons Using a Hong-Ou-Mandel Interferometer, Naoto Namekata, Ryo Kobayashi, Takahide Sakaidani, Shuichiro Inoue; 1Nihon Univ., Japan. Higher-order dispersion effects on long-range surface-plasmon-polariton waveguide have been investigated using a quantum interferometer. We observed degradation of the quantum indistinguishability which originated from the odd-order dispersions.

Spatial Squeezing in Bright Twin Light

JTh2A.8
Withdrawn.

Spatial Squeezing in Bright Twin Light

JTh2A.9
Ambient-condition growth of high-pressure phase centrosymmetric crystalline KDP microstructures for efficient optical second harmonic generation, Y. Ren1,2, Zhihuan Wang1,2, Zhihuan Wang1,2, Y. Ren1,2; 1National Inst of Optics & fine Mechanics, USA; 2Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN) and Advanced Materials and BioEngineering Research (AMBER) Centre, Trinity College Dublin, Ireland. WS, and MoS2 mono- and few-layer films were fabricated by vapor phase sulfurization or chemical vapor deposition method. The nonlinear absorption (saturable absorption, two-photon absorption) properties in VIS to NIR range were investigated.

Spatial Squeezing in Bright Twin Light

JTh2A.10
Nonlinear absorption in WS2 and MoS2 mono- and few-layer films, Saifeng Zhang, Yuanxin Li1, Niall McEvoy1, Jun Wang; 1Shanghai Inst of Optics & fine Mechanics, USA; 2Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN) and Advanced Materials and BioEngineering Research (AMBER) Centre, Trinity College Dublin, Ireland. The theory of Bloembergen and Pershan for the light waves at the boundary of nonlinear media is extended to a nonlinear two-dimensional atomic crystal. A comparison with experimental results is reported.
JTh2A.12

JTh2A.13
Effect of Purcell Enhancement on Internal Quantum Efficiency of InGaN Green Light-Emitting Diode Structures, Han-Youl Ryu, Guen-Hwan Ryu, Young-Hwan Choi; Inha Univ., Korea. We theoretically investigate the modification of internal quantum efficiency (IQE) in InGaN green flip-chip LED structures as a result of the Purcell effect that is found to be quite advantageous for improving the IQE InGaN green LEDs.

JTh2A.14
Non-local angular double-slit light diffraction with thermal light, Lu Gao, J.P. Zhao, Omar S. Magaña-Loaiza, Seyed Mohammad Hashemi Rafsanjani, Mohammad Mirhosseini, Ygu Zhou, Robert W. Boyd; School of Science, Univ. of Geosciences (Beijing), China; The Inst. of Optics, Univ. of Rochester, USA. We report an experimental observation of ghost diffraction with non-local angular double-slit by making use of thermal light QAM correlation measurement. Correlated angular interference patterns of the distributed angular double-slit are measured.

JTh2A.15
The Effect of Misaligned Modal Loss on Entangled Qubits, Brian T. Kirby, Michael Brodsky; US Army Research Laboratory, USA. Quantum Networks require the ability to distribute entanglement to remote nodes, which could be degraded by the mode dependent loss in transmission channels. We offer an elegant way to account for the mode loss impact.

JTh2A.16
Effect of Spin Squeezing Followed by Anti-Squeezing in a Collective State Atomic Clock, Resham Sarkar, Minchuan Zhou, Renpeng Fang, Selim Shahnazi; Northwestern Univ., USA. Two-axes counter-twist (TACT) spin-squeezing can significantly reduce the quantum projection noise in an ensemble of two-level atoms. Here, we investigate the effect of TACT followed by an anti-TACT pulse in a collective state atomic clock.

JTh2A.17
Entanglement Constraints with Quantum Background Parties, Xiao-Feng Qian, Miguel A. Alonsè, Joseph H. Eberly; Univ. of Rochester, USA. We include the usually neglected unidentified non-interacting quantum background in the analysis of open system dynamics. A set of generic inequalities of entanglement dynamics is discovered and their novel geometric representations are presented.

JTh2A.18
Control of spatial distribution of entangled photons by the spatial structure of classical pump beam, Jabir M. V., N. Aparv Chatanya, Goutam K. Samanta; Physical Research Laboratory, India; Indain Inst. of Technology, India. We control the spatial distribution of entangled photons generated through SPDC process by manipulating spatial structure of classical pump beam. Using vortex pump beam, we show that the entangled photons have doughnut spatial pattern.

JTh2A.19
Wideband Suppression of Local Density of States in Random Waveguides, Xiaojun Cheng; CUNY-Queens College, USA; Graduate Center of CUNY, USA. We find the local density of states inside quasi-1D random waveguide is increasingly suppressed in the middle of the sample over a wide frequency range with increasing sample length and decreasing waveguide cross section.

JTh2A.20
Revivals in the Jaynes-Cummings model in terms of characteristic functions, Hudson Pimenta, Daniel F. James; Univ. of Toronto, USA. Through the periodicity of characteristic functions, we find that atomic population revivals in the Jaynes-Cummings model are replicas of each other that have experienced dispersion akin to that of free particles in quantum mechanics.

JTh2A.21
The cross-cavity micromaser, Julio Cesar Garcia Melgarejo, Nestor Lozano-Cristosomo, Jose Alfredo Ramirez Flores, Ricardo Martinez Martinez, Javier Sanchez Mondragon; Inst Nac Astrofisica Optica Electronica, Mexico; Universidad Autonoma de Coahuila, Mexico. The experimental and QED dynamics of a JCM micromaser relies on the JCM fully solvability. We discuss an analogous case, an X-cavity, where a new quantum feature produced by the X-cavity has not been accounted.

JTh2A.22
The cross-cavity photon dark state, Julio Cesar Garcia Melgarejo, Edgar Samuel Arroyo Rivera, Daniel Alberto May Arroya, Miguel Torres Cisneros, Javier Sanchez Mondragon; Inst Nac Astrofisica Optica Electronica, Mexico; Universidad Autonoma de Coahuila, Mexico; Centro de Investigaciones en Optica, A. C., Mexico; Universidad de Guanajuato, Mexico. The photonic dark state of the X-Cavity JCM is one of the interesting joint features of the orthogonal single cavity modes pair. We test its quantum nature by introducing a second Two Level Atom.

JTh2A.23
Choice of the Detection Location in a Three-Party Measurement-Device-Independent Quantum Key Distribution System, Yucheng Qiao, Zhenyu Li, Ziyang Chen, Bin Luo, Xiang Peng, Hong Guo; Peking Univ., China; Beijing Univ of Posts and Telecommunications, China. We propose a method of choosing the detection location for a three-party measurement-device-independent quantum key distribution system, which can simplify the parameter optimization problem for practical applications.

JTh2A.24
Highly-sensitive detection of the lattice distortion in single bent ZnO nanowires by second-harmonic generation microscopy, Xiaobo Han, Kai Wang, Peixiang Lu; HUST, China. A high detection sensitivity of -0.001 nm on the bending distortion is obtained by measuring the SHG polarmetric patterns. The twisting distortion can also be detected by observing the extraordinary non-axisymmetrical SHG polarmetric patterns.

JTh2A.25
Optical Image Cloning based on Electro-magnetically Induced Absorption, Shamaila Manzoor, Ulices F. Apolinario, Luis E. Pimenta, Daniel F. James; Queen Mary, University of London, UK; Center for Quantum Photonics, H. Wills Physics Laboratory and Department of Electrical and Electronic Engineering, Univ. of Bristol, UK. We include the usually neglected unidentified non-interacting quantum background in the analysis of open system dynamics. A set of generic inequalities of entanglement dynamics is discovered and their novel geometric representations are presented.

JTh2A.26
Nondegenerate Nonlinear Refraction in Semiconductors, Peng Zhao, Matthew Rechert, David Hagan, Eric Van Stryland; CREOL Univ. of Central Florida, USA; Princeton Univ., USA. The dispersion of nondegenerate nonlinear refraction in semiconductors is measured using our beam-deflection method. With high nondegeneracy, n₂ is significantly enhanced over degenerate case, and rapidly sign to negative near the bandgap.

JTh2A.27
Withdrawn.

JTh2A.28
Caustic and wavefronts produced by arbitrary reflecting surfaces, Maximo Avendano Alejo, Universidad Nacional Autonoma de Mexico, Mexico. We provide a simple formulas for reflected caustics and wavefronts through smooth surfaces considering an incident plane wavefront propagating along the optical axis, having a wide potential of non-imaging optical systems for solar concentrators.

JTh2A.29
Numerical Algorithm for Finding Optimal Experimental Setup for Arbitrary Unitary Operator, Sushovit Adhikari, Jonathan Dowling, Louisiana State Univ., USA. A numerical algorithm to generate an optimal experimental setup for arbitrary unitary matrix has been developed. Given an unitary operator, the algorithm designs the experiment with the least number of beam splitters used.

JTh2A.30
Optimal Architectures for Single Photon Metrology, Margarite L. LaBorde, Jonathan P. Olson, Keith R. Motes, Patrick Birchal, Nick M. Studer, Todd Moulder, Peter R. Rohde, Jonathan Dowling; Heanne Inst. for Theoretical Physics and Department of Physics & Astronomy, Louisiana State Univ., USA; Department of Physics and Astronomy, Macquarie Univ., Australia; Centre for Quantum Photonics, H. Wills Physics Laboratory and Department of Electrical and Electronic Engineering, Univ. of Bristol, UK; Centre for Quantum Computation and Intelligent Systems, Faculty of Engineering & Information Technology, Univ. of Technology, Australia. Passive linear optics are utilized to determine an interferometer with single-photon inputs capable of high phase sensitivity. This structure was optimized to maximize phase sensitivity and furthermore to explicitly compute this sensitivity.

JTh2A.31
Dark gap polariton solitons in a one-dimensional periodic potential, Ting-Wei Chen, Szu-Cheng Cheng; Chinese Culture Univ., Taiwan. The dark polariton solitons are investigated in a 1D periodic potential. The effective-mass approximation is used to obtain the numerical dark solitons in the zone center and edge under a diversity of potential depths and pump powers.
Highly Efficient Self-Q-Switched Erbium-Doped Fiber Laser Operating at High Output Powers, Luis F. Samano Aguilar1, Juan C. Hernandez Garcia1,2, Julian Motes Estudillo Ayala1, Roberto Rojas Laguna1, Olivier Pottiez1, Jose David Filoteo Razo1, Jesus Pablo Lautero Cruz1, Daniel Jauregui Vazquez1, Universidad De Guanajuato, Mexico;2CONACYT, Mexico; (CIO), Mexico. Ring self-Q-switched Erb:Yb1 fiber laser operated at 1565 nm is presented. The configuration has a high efficient (~62%), high output power (10 W) and short pulses generation (ns), allowing a stable multiple pulsing regime.

Optical reversible gate based on lithium niobate based Mach–Zehnder Interferometers, Chander kanta1, Anjali Amphawan2,3,4, DIT Univ., India, 5School of Computing, Universiti Utara Malaysia, Malaysia, 6Massachusetts Inst. of Technology, USA. In this paper, basic reversible logic gate (Peres gate) using the lithium niobate based Mach-Zehnder interferometer is proposed. The results are obtained by using beam propagation method and MATLAB simulations.

Atom-photon interface using the higher order modes of an ultrathin optical fiber, Thomas Nieudde1, Jinjin Du1, Sile Nic Chormaic1, Okinawa Inst. of Science and Technology Graduate School, Japan. We create an atom-photon interface using the higher order modes (HOM) of an ultrathin optical fiber. We explore interactions between HOMs and a cold atomic ensemble, with aim to transfer and store orbital angular momentum.

High power phase-locked four cores fiber laser, Liu YeHui1, Wang Yibo1, Liao Lei1, Li Haiqing1, Peng jinggang1, Yang Iyun1, Li Jinyan1, Huazhong Univ. of Science&Technology, China. We demonstrate a high power 4 cores Yb-doped fiber amplifier which is operated in an in-phase supermode and does not need other mode selection mechanisms. The maximum output power is 9.75 W.

Highly Efficient Self-Q-Switched Erbium-Doped Fiber Laser Operating at High Output Powers, Luis F. Samano Aguilar1, Juan C. Hernandez Garcia1,2, Julian Motes Estudillo Ayala1, Roberto Rojas Laguna1, Olivier Pottiez1, Jose David Filoteo Razo1, Jesus Pablo Lautero Cruz1, Daniel Jauregui Vazquez1, Universidad De Guanajuato, Mexico;2CONACYT, Mexico; (CIO), Mexico. Ring self-Q-switched Erb:Yb1 fiber laser operated at 1565 nm is presented. The configuration has a high efficient (~62%), high output power (10 W) and short pulses generation (ns), allowing a stable multiple pulsing regime.

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Highly Efficient Self-Q-Switched Erbium-Doped Fiber Laser Operating at High Output Powers, Luis F. Samano Aguilar1, Juan C. Hernandez Garcia1,2, Julian Motes Estudillo Ayala1, Roberto Rojas Laguna1, Olivier Pottiez1, Jose David Filoteo Razo1, Jesus Pablo Lautero Cruz1, Daniel Jauregui Vazquez1, Universidad De Guanajuato, Mexico;2CONACYT, Mexico; (CIO), Mexico. Ring self-Q-switched Erb:Yb1 fiber laser operated at 1565 nm is presented. The configuration has a high efficient (~62%), high output power (10 W) and short pulses generation (ns), allowing a stable multiple pulsing regime.
JTh2A.53 Optical Fiber SPR Sensor for Simultaneous Determination of Cu(II) and Pb(II) Ions Using Molecular Imprinting, Anand M. Shrivastav1, Suthi P. Usha1, Banish D. Gupta1; Indian Inst. of Technology, Delhi, India. Fabrication and characterization of SPR based fiber optic sensor for detection of copper and lead ions using molecular imprinting in the operating range of 0-10 mg/L and 0.100 µg/L for Cu(II) and Pb(II) ions are reported.

JTh2A.54 Measurement of Back-reflection and Back-scattering Noise in High Sensitivity Photonic Crystal Fiber-optic Gyroscope, Teng Fei1, Jing Jin1, Zichen Zhang1, Chunli Zhang1; Beihang Univ., USA. The incoherent back-reflected and backscattered light in PCF IFOG was investigated. A more accurate noise model for PCF IFOG which takes incoherent back-reflection and backscattering noise into account was proposed and verified by experiments.

JTh2A.55 Projective Measurement of the Lagueure-Gaussian Spectrum, Seyed Mohammad Hashemi Rafsanjani1, Omar S. Magana Loaiza1, Seyed Mohammad Hashemi Rafsanjani1, Robert W. Boyd1; Univ. of Rochester, USA. We propose a protocol for measuring the radial index of Laguerre-Gaussian modes, and provide evidence of lossless and unitary transformation of these modes into a Gaussian mode.

JTh2A.56 Hybrid Wireless Communication Networks: Integrating Free-Space Optics and WiFi, Spencer T. Liverman1, Qixue Wang1, Yu-Jung Chu1, Arun Natarajan1, Thinh Nguyen1, Alan X. Wang1; Oregon State Univ., USA. We describe WFO: A hybrid free-space optical and radio frequency system, which will provide downlink speeds of up to 60Mbps over a distance of three meters using light emitting diodes while maintaining a high level of mobility via a WiFi uplink.

JTh2A.57 E-Poster Spatial Frequency Modulated Imaging (SPIFI) in Amplitude with a Spatial Light Modulator, Michael D. Young1, Jeffrey J. Field1, Randy Bartels1, Jeff Squire1; Colorado School of Mines, USA; Colorado State Univ., USA. Previous work has demonstrated modulated imaging with binary masks. We present a new microscope that provides continuous modulation with a spatial light modulator, which can modulate through multiple methods: amplitude, phase, polarization, etc. This presentation will be presented as an E-Poster on Screen 4 from 10:15–11:00.

JTh2A.58 Withdraw.

JTh2A.59 Evaluation Of Transverse Aberration By Spatial Modulators, Maria Elizabeth Perecino1; INAOE, Mexico. The evaluation process of concave surfaces, some methods used are Hartmann and Ronchi test, which use spatial modulators. This paper presented the comparison between them evaluations along the spatial modulators. This paper presented the comparison between them evaluations along the spatial modulators.

JTh2A.60 Withdraw.

JTh2A.61 Withdraw.

JTh2A.62 Relationship Between Hermite-Gaussian and Ince-Gaussian Laser Beams, Allison Hine1, Jessica P. Conn1, Arkansas Tech Univ., USA. We generate Ince-Gaussian (IG) laser beams from Hermite-Gaussian (HG) laser beams using an astigmatic mode converter (AMC). The relationship between the HG order, IG order and ellipticity, and the rotation of the AMC is discussed.

JTh2A.63 Photon sieve on an optical fiber tip for improved light coupling into a submicron silicon waveguide, Ricardo Janeiro1, Raquel Flores1, Pabitra Dahal1, Jaime Viegas1, Masdar Inst., United Arab Emirates. The superior performance over a commercial tapered fiber for light coupling at 1550 nm into a silicon waveguide has been demonstrated using a photon sieve fabricated by focused ion beam on an optical fiber tip.

JTh2A.64 E-Poster Pico-watt radiant flux detection by smartphone, Youngkee Jung1, Jyll-Joon K. Doh1, Euwon Bae1; graduate student, USA; Mechanical engineering, Purdue Univ., USA. We present a smartphone based analytical device for detecting sub nano-watt level of radiant flux. A 3D printed optical cradle and a new algorithm to improve SNR level is suggested. This presentation will be presented as an E-Poster on Screen 5 from 10:15–11:00.

JTh2A.65 Twist phase-induced changes of the polarization degree and state of a stochastic electromagnetic beam, Lin Liu1; Soochow Univ., China. A radially polarized partially coherent twist beam propagating in uniaxial crystal have been explored based on the unified theory of coherence and polarization. The twist factor and the anisotropy induced the change of the statistical properties.

JTh2A.66 Employing the Ichikawa-Takeda’s Method Applied to Irradiance Transport Equation (ITE): Filtering and Tilt Grid Analysis, Jesús A. Arriaga Hernández1, Alejandro Cornejo Rodríguez1, Elizabeth Perecino Zacarías1, Ferran S. Granados2; INAOE, Mexico. From Irradiance Transport Equation, derived by Teague [1]. A detailed analysis was realized to the Ichikawa [2], arrangement for lens testing, the aspects studied were filters shape, period and tilt of ruling used experimentally.

JTh2A.67 Reconstruction of refractive index profile of photonic crystal fiber using intensity-based optical diffraction tomography, Jem Teresa John1, Ram M. Vasu1, Rajan Kanhirodan1; Indian Inst. of Science, India. An iterative Gauss-Newton algorithm which uses normal derivative of intensity (without estimating phase) as the measurement, to reconstruct the cross-sectional refractive index profile of a photonic crystal fiber.

JTh2A.68 Refraction-compensating algorithm for a 3D glass structure exhibiting multiple 2D images, Hyuj Haryama1, Hirokazu Nakayama1, Atsushi Shiraki1, Takashi Kakue1, Tomoyoshi Shimobaba1, Tomoyoshi Ito1; Graduate School of Engineering, Chiba Univ., Japan; Center for Computational Astrophysics, National Astronomical Observatory of Japan, Japan; Institute of Management and Information Technologies, Chiba Univ., Japan. The 3D structure designed by our algorithm exhibits multiple 2D images to different directions. However, refraction at the curved surface of glasses causes the deterioration in the image quality. We proposed a refraction-compensating algorithm.

JTh2A.69 Experimental Validation of Nodal Aberration Theory with a Customized Ritchey–Chrétien Telescope, Nan Zhao1, Kevin P. Thompson1, Jun Zhu2, Michael Pomerantz1, Jannick P. Rolland1; The Inst. of Optics, Univ. of Rochester, USA; Changchun Inst. of Optics, Physics Mechanics and Physics, Chinese Academy of Sciences, China; Synopsys, Inc., USA; Tsinghua Univ., China; Department of Mechanical Engineering, University of Rochester, USA. To experimentally validate Nodal Aberration Theory, third order spherical, coma, and astigmatism are investigated in a custom Ritchey–Chrétien telescope with precisely engineered test equipment. Multiple 2D images exhibiting multiple 2D images to different directions. However, refraction at the curved surface of glasses causes the deterioration in the image quality. We proposed a refraction-compensating algorithm.

JTh2A.70 Laser-induced localized photothermal conversion of vanadium into vanadium oxides, Giwan Seo1, Jong-Bum Yoo1, Shin ho Kim1, Bong-Jun Kim1, Kyoung Suk Yu1; Korea Advanced Inst. of Science & Tech, Korea; Coberex Co. Ltd., Korea. A method to evaluate the shape of fast plano-convex cylindrical lenses is presented, by using null bi-Ronchi type screens, which allows to have uniform patterns at detection’s plane inside the caustic region. This presentation will be presented as an E-Poster on Screen 4 from 09:30–10:15.

JTh2A.71 Withdraw.

JTh2A.72 Analysis of Hollow Core De-multiplexer for Spatially Multiplexed Systems, Syed H. Murshid1, Gregory L. Lovel1; Florida Inst. of Technology, USA. Analysis and simulated results of hollow core, all optical de-multiplexer architecture is presented that tests the coupling efficiency of the structure as the bevel angle of the device is varied for common optical indices.

JTh2A.73 A design approach of the image mapper for the image mapping spectrometer (IMS), Xiaoming Ding1, Yan Yuan1, Lijuan Su1; Beihang Univ., China. A design approach of the image mapper used in the image mapping spectrometer (IMS) is introduced to reduce the cross talk and improve the quality of the reconstructed images and spectral information.

JTh2A.74 E-Poster Testing cylindrical lenses placing a CCD sensor inside the caustic region, Gabriel Castillo-Santiago1, Maximino Avendaño-Alejo1; CCADET-UNAM, Mexico; Facultad de Ingeniería, UNAM, Mexico. A method to evaluate the shape of fast plano-convex cylindrical lenses is presented, by using null bi-Ronchi type screens, which allows to have uniform patterns at detection’s plane inside the caustic region. This presentation will be presented as an E-Poster on Screen 4 from 09:30–10:15.
JTh2A.75
Quasicylindrical waves at dielectric interfaces, Oliver Higbee, Choon H. Gan, Geoff R. Nash, College of Engineering, Mathematics and Physical Sciences, Univ. of Exeter, UK; Seagate, UK. The contribution of quasicylindrical waves to beam collimation is investigated at a dielectric interface. A subwavelength aperture surrounded by 1D resonant nanogrooves is patterned into a dielectric stack and its far field radiation pattern measured.

JTh2A.76
Quantitative analysis of stainless steel corrosion by reflective digital holographic microscopy, Youssef Pouvar, Pagah Aryan, Pedram Abdolah, Ali-Reza Moradi, Ramin Khamedi, Ahmad Danadi, Zanjani Univ, Iran (the Islamic Republic of); Physics, Univ. of Tehran, Iran (the Islamic Republic of). Using digital holographic microscopy technique, we suggest a novel quantitative criterion to distinguish between intergranular and transgranular corrosion in stainless steels. The method can be used to study several other metallurgical phenomena.

JTh2A.77
A New Photoanisotropy-copies-based Pattern Recognition System, Barbara N. Kilonadi, George Kakkuridez, Irena Kobulashvili; Laboratory of Holographic Recording and Processing of Information, Georgian Technical Univ, Inst of Cybernetics, Georgia. A new pattern recognition method is suggested based on determining the parameters of the integral polarization ellipse at the Fraunhofer diffraction of noncircularly polarized light on the photoanisotropic copy of the object image.

JTh2A.78
Dynamic surface profiling with synthetic holographic confocal microscopy, Martin Schnell, P. Scott Carney, Rainer Hillenbrand; CIC nanoGUNE Consolider, Spain; Becker Inst. for Advanced Science and Technology, Univ. of Illinois Urbana-Champaign, USA; Department of Electrical and Computer Engineering, Univ. of Illinois Urbana-Champaign, USA; CIC nanoGUNE Consolider and EUHU/UPV, Spain; IKERBASQUE, Basque Foundation for Science, Spain. We present vibration mode mapping of a micrometer sized cantilever with confocal microscopy which is based on the combination of synthetic optical holography with fast light detection. This presentation will be presented as an E-Poster on Screen 3 from 09:30–10:15.

JTh2A.79
Enhancement in Light-Matter Interaction within Atomic MoS2 Monolayers on Nanocavities, Corey Janisch, Haejin Song, Channing Zhou, Zhong Lin, Ana Laura Elias, Dangxin Ji, Mauricio Terrones, Qiaqiang Gan, Zhieun Lee; The Pennsylvania State Univ, USA; Univ at Buffalo, USA. We report a fundamental strategy to enhance light-matter interaction of atomically-thin films based on strong interference in planar nanocavities, which is validated experimentally by absorption and photoluminescence enhancement of MoS2 monolayers.

JTh2A.80
3D Printed Long Period Grating Filters, Victor Lambin Izezi, Jean-Sebastien Boisvert, Sebastien Loranger, Raman Kashyap; Polytechnique Montreal, Canada. We have created affordable tunable optical fiber filters using 3D printed periodic structures acting as long period fiber gratings.

JTh2A.81
Scattering in PT and RT Symmetric Multimode Waveguides: Generalized Conservation Laws Beyond 1D, Li Ge; Konstantinos Makris, Demetrios Christodoulides, Liang Feng, College of Staten Island, CUNY, USA; The Graduate Center, CUNY, USA; Crete Center for Quantum Complexity and Nanotechnology, Univ. of Crete, Greece; College of Optics and Photonics - CREOL, Univ. of Central Florida, USA; Department of Electrical Engineering, The State Univ. of New York at Buffalo, USA. We derive generalized conservation laws for light propagating in a multimode system with Parity-Time (PT) or Rotation-Time (RT) symmetry. These conservation laws can be expressed as scalar equalities for generalized transmittance and reflectance.

JTh2A.82
Introducing a Novel Active Learning Technique: Flipping Optics Classroom, Sumit Ghosh, Physics, Andhra Vidyalaya College, Osmania Univ, India. A higher order thinking, self-regulated methodology – Flipped classroom has been employed for teaching optics to the undergraduate students. Qualitative analysis on the efficacy of this model within the Indian context has been presented.

JTh2A.83
 Invisible Structures as Particular Solutions of Devaney-Wolf Theorem on Non-Radiating Sources, Giuseppe Labate, Ljudiška Mateković-vit's; Politecnico di Torino, Italy. Starting from Devaney-Wolf theorem on non-radiating sources, a general theory for invisible structures is presented, compactly deriving non-scattering devices based on Directional Invisibility, Plasmonic Cloaking, Mantle Cloaking and Arapole modes.

JTh2A.84
Raman – EDS Coupling for identification of unknown substances in Archaeology applied to the Turin Shroud, Jean-Pierre Lautié; Laude Consulting, France. Coupled Raman and Energy Dispersive Spectra show a substance fully compatible with oxidative ring cleavage products of the heme of blood, namely biliverdin-derived compounds. A weak line is tentatively attributed to amide I of proteins.

JTh2A.85
Coherent Frequency Combs for Dual-Comb Spectroscopy Spanning 3 to 5.2 μm, Daniel Maser, Gabriel Ycas, Flavio Cruz, Scott Diddams; National Inst. of Standards & Tech, USA; Physics, Univ of Colorado Boulder, USA; Instituto de Fisica Gleb Wataghin, Universidade Estadual de Campinas, Brazil. A tunable mid-infrared frequency comb was created via difference frequency generation. Pulses between 1 and 1.5 μm were mixed to make idlers of 3.5-2 μm. Two such combs were heterodyned at 5 μm to show their coherence and potential for spectroscopy.

JTh2A.86
Mimicking explosive heating profiles: feedback controlled sub-second laser heating using a three-color NIR pyrometer, Benjamin R. Anderson, Patrick Price, Ray Gunawardena, Hergen Eilers; Washington State Univ., USA. We develop a feedback controlled sub-second laser heating system to subject materials to temperature profiles mimicking those inside of explosive fireballs.

JTh2A.87
Measurements of the Temperature Dependence of the Optical Anisotropy Parameter of Cr2O3 Precursors Due to Irreversible Phase Changes During Subsecond Laser Heating, Benjamin R. Anderson, Ray Gunawardena, Hergen Eilers; Washington State Univ., USA. We measure the subsecond heating-induced spectroscopic changes of Cr2O3 precursors and find that Cr2O3 is a promising candidate for an ex-situ temperature sensor.

JTh2A.88
Ultrafast intramolecular charge transfer dynamics in low band gap leadindigo based copolymers, Newaymedhin A. Tegegne; University of Stellenbosch, South Africa. Ultrafast Charge transfer dynamics of a low band gap copolymer in solution was studied by fs-transient absorption spectroscopy. Intramolecular charge transfer characteristics (ICT) were observed. The inter system conversion time to ICT state was 13ps.

JTh2A.89
Clausius-Mossotti Lorentz-Lorenz relations and retardation effects for two-dimensional crystals, Michele Merano, Luca Dell’Anna, Universita degli Studi di Padova, Italy. We model a single-layer two-dimensional atomic crystal as a distribution of electric dipoles on a regular lattice. We evidence a manifestation of retardation-field effects in the optical response of these crystals.

JTh2A.90
Spectroscopic Changes of Cr3+ Doped Al2O3 Precursors Due to Infrared Phase Changes During Subsecond Laser Heating, Benjamin R. Anderson, Ray Gunawardena, Patrick Price, Hergen Eilers; Washington State Univ., USA. We measure the subsecond laser-heating-induced spectroscopic changes of Cr2O3 precursors and find that Cr2O3 is a promising candidate for an ex-situ temperature sensor.

JTh2A.91
Optical properties of heterogeneous systems with Ag nanoparticles, legen Baryshvskiy, Valentina Skoboeva, Valentina Smyntyna, Nikolay Malushkin, Klara Vereges; Odessa Nationa lI. I. Mechnikov Univ, Ukraine; Research Inst. of Photonics, Odessa National I. I. Mechnikov Univ, Ukraine. The optical properties of heterogeneous systems, including organic (dye) and inorganic (Ag and CuS) compounds were studied. The effect of Ag nanoparticles influence on molecular structuring and on luminescence intensity of quantum dots was found.

JTh2A.92
Tailoring Accelerating Beams with Wigner Distribution Function, Yuanyi Wen, Yujie Chen, Guoxuan Zhu, Yanfeng Zhang, Hui Chen, Siyuan Yu; Sun Yat-sen Univ., China. We proposed a Wigner distribution function to construct accelerating beams along both 2D and 3D curves. We unify previous caustic methods in real space and Fourier space, and also introduce a class of 3D caustics.
We theoretically dem...
JTh2A.114  Aluminum nitride microring resonator for efficient frequency comb doubling, Hoa Joong Jung1, Xiang Guo2, Na Zhu2, Scott Papp1, Scott Diddams3, Hong Tang1, 92 Yale Univ, USA; 1NIST, USA. We demonstrate efficient frequency comb doubling of input IR mode locked fiber comb with a high-Q phase matched AIN microring resonator. The sinusoidal phase dependent interference is well matched with theory.

JTh2A.115  Withdrawn.

JTh2A.116  Improving the signal-to-noise ratio of ghost imaging with thermal light background by narrow band optical filtering, Dongyue Yang1, Junhui Li1, Guohua Wu1, Bin Luo2, Longfei Yin2, Hong Guo1, 92 School of Electronic Engineering and Computer Science, and Center for Quantum Information, School of Physics, Beihang Univ, China. In ghost imaging with narrow-band pseudo-thermal signal embedded in thermal light background, signal-arm narrow band optical filters bring higher signal-to-noise ratio and improve the quality of ghost image.

JTh2A.117  Femtosecond optical tweezers as sensitive nano-thermometers, Dipankar Mondal1, Debabrata Goswami1, 92 Indian Inst. of Technology, Kharagpur, India. Nanovolume temperature around optical trap is measured by exploiting nonadiabatic relaxation in solvents. Copropagating 1560nm femtosecond laser pulses change solvent temperature and viscosity while trap-stiffness is unaffected during 780nm trapping.

JTh2A.118  Presentation of OSA student chapter Cameroon, Munirelle Vanessa Tchakui1, Université de Yaounde I, Cameroon. In this poster we present the OSA student chapter Cameroon. We focus on its mission and its organigram. Some outreach and recruitment activities done recently are also developed.

JTh2A.119  Optics Research Activity in LAMSEBP, Munirelle Vanessa Tchakui1, Université de Yaounde I, Cameroon. In this poster we present by starting the LAMSEBP group at the Unv. of Yaounde1 Cameroon and the staff members. After that many topics investigated there in the area of optics and photonics are given.

JTh2A.120  Withdrawn.

JTh2A.121  Withdrawn.

JTh2A.122  Localization analysis and dimensional scaling in a disordered optical waveguide, Behnam Abaie1, Arash Mafi1, 92 Univ. of New Mexico, USA. Anderson localization properties of a disordered optical waveguide are studied using the mode-width probability density function (PDF). The scaling and convergence of the PDF with the transverse size of the waveguide is explored.

JTh2A.123  Optical Study of Dual-width Plasmonic Nanogap Gratings for Bio sensor Applications, Stephen Bauman1, Ahmad A. Darweesh2, David A. French3, Joseph B. Herzog4, 92 Microelectronics & Photonics, Univ. of Arkansas, USA; 3Physics, Univ. of Arkansas, USA; 4Plasmonic grating (1D) and grid (2D) structures with two unique widths and sub-10 nm gaps have been fabricated, and electromagnetical simulations and Raman spectroscopy results have been performed to optimize the geometry for optical enhancement.

JTh2A.124  In Vivo Assessment of Molecular Aging by Quasi-Elastic Light Scattering in the Human Lens, Olgia V. Minaeva1,2, Srikant Sarangi3,1, Juliet A. Moncaster3,1, Danielle M. Ledoux2,4, Caitlin A. Rook1, 92 Microelectronics & Photonics, Univ. of Arkansas, USA; 2Physics, Univ. of Arkansas, USA; 3Boston Children’s Hospital, USA; 4Boston Univ., USA. We focus on its mission and its organigram. Some outreach and recruitment activities done recently are also developed.

JTh2A.125  New Trend in Terahertz Medicine, Vychaslav I. Fedorov1, 92 Inst. of Laser Physics RAS, Russian Federation; 2ITMO Univ., Russian Federation. Fundamental study of biological effects of terahertz radiation may be the basis for therapeutic and diagnostic use of terahertz radiation in medicine. Examples of application for treatment and diagnostics will be presented.

JTh2A.126  The Nuclear Refractive Index from Quantitative Phase Imaging: Correcting Factors and Application to a/LCI, Zachary A. Steelman1, William J. Eldridge1, Han Sang Park1, Adam Wax1, 92 Duke Univ., USA. Recent Quantitative Phase Microscopy experiments have measured the refractive index of cell nuclei to be lower than the cytoplasm. We suggest a potential error capable of corrupting these measurements.

JTh2A.127  Detection of Organic Matter in Simulant Martian Soil using Plasmonic-Biosilica SERS Substrate, Kenneth Squire1, Xianning Kong1, Paul Ledulf2, Gregory Rorer2, Sining Tang2, Bin Chen3, Christopher McKay1, Rafael Navarro-Gonzalez4, Alan X. Wang1, 92 Oregon State Univ., USA; 2Crystal Research, USA; 3NASA, USA; 4UNAM, Mexico. We demonstrate efficient frequency-comb source using plasmonic-biosilica diatoms and gold nanoparticles to detect organic matter down to part-per-billion levels in soil samples that simulate conditions of soil on Mars.

JTh2A.128  Video-rate volume imaging confocal microscope based on wavelength / space conversion by use of multichannel spectral interferometer, Shiji Miyamoto1, Eiji Hase2,3, Takeo Minamikawa1,2, Takeshi Yasui1, Hirotugu Yamanota1, Tokushima Univ., Japan; 92 ERATO Intelligent Optical Synthesizer Project, JST, Japan; 3Usunomiya Univ., Japan. Video-rate volume imaging confocal microscopy employing line-focused confocal microscopy, wavelength/1D-space conversion and a PZT objective scanner was proposed. The system enables 1.4 volumes/s (13 slices) with the axial resolution of 8.4 μm.

JTh2A.129  Galvanometer Scanning for Optical Coherence Tomography, Virgil-Florin Duma1,2, Patrice Tanham1, Jinjun Huang1, Juncheng Won1, Jannick P. Rolland3, 92 Universitatea Aurel Vlaicu Arad, Romania; 3University College London, UK. We measure the speed of surface acoustic waves propagating in porcine skin for treatment and diagnostics will be presented.

JTh2A.130  FRET-Modulated Cell Lasers, Quishu Chen1, Michael Ritt1, Biming Wu1, Rhima Coleman1, Sivaraj Sivaramakrishnan1, Xudong Fan2, 92 Biomedical Engineering, Univ. of Michigan, USA; 3Genetics, Cell Biology, and Development, Univ. of Minnesota, USA. Lasing from living cells expressing fluorescent protein FRET pairs were studied. Experimental results and theoretical analysis showed that difference in FRET energy transfer efficiency resulted in distinct cell lasing behavior.

JTh2A.131  E-Poster

Optical Coherence Elastography of the Cornea by Tracking the Propagation of Surface Acoustic Waves, Jose F. Zvietcovich1, Jinxin Huang1, Jannick P. Rolland3, Kevin Parker, 92 Univ. of Rochester, USA. We measure the speed of surface acoustic waves propagating in a porcine cornea using optical coherence tomography since it provides of depth-resolved elastic modulus which is important for the study of ocular diseases and treatments. This presentation will be presented as an E-Poster on Screen 1 from 09:30–10:15.

JTh2A.132  Z-scan technique: A new concept for Diagnosis of Prostate Cancer in blood, Camila T. Nabeshima1, Flavia R. Silva1, Antonio M. Neto1, Sarah I. Alves1, Ricardo E. Samad1, Lilia C. Corrêa1, 92 Ciências Exatas e da Terra, Universidade Federal de São Paulo, Brazil; 2Departamento de Ciências Exatas e da Terra, Universidade Federal de São Paulo, Brazil; 3Centro de Ciência e Tecnologia de Materiais, Instituto de Pesquisas Energéticas e Nucleares, Brazil; 4Instituto de Física, Universidade de São Paulo, Brazil; 5Centro de Lentes e Aplicações, Instituto de Pesquisas Energéticas e Nucleares, Brazil. Porphyrin accumulate substantially more in tumors than in normal tissues. The optical nonlinearity of the blood porphyrin was analyzed using Z-scan technique. The results showed a decrease in nonlinear refractive index value for tumor blood.
JTh2A.133
High-Speed Stimulated Brillouin Scattering Profilometry, Itay Remer1, Lear Cohen1, Alberto Bilenca1,2; 1Biomedical Engineering Department, Ben-Gurion Univ. of the Negev, Israel; 2Ilse Katz Inst. for Nanoscale Science and Technology, Ben-Gurion Univ. of the Negev, Israel. We show high-speed stimulated Brillouin scattering (SBS) profilometry of layered liquids at 30 ms per pixel-frame-time < 100-fold faster than current backward SBS methods. This is a step forward to rapid SBS profilometry in biomedical mechanics.

JTh2A.134
An achromatic system for multi-wavelength fluorescence lifetime imaging of the lung in intensive care units, Fiona M. Kenny1, Laura Young1, Timothy Morra1, Chris Saunter1, John M. Girkin1,2; Durham Univ., UK. This work used an endoscopic fiber bundle for lifetime imaging of lung tissue which provided information on bacterial infections. The system was designed with reflective optics to maximise efficiency of emission detection and wavelength range.

JTh2A.135
Multi-Species Coherent Anti- Stokes Raman Spectroscopy in Gas-Filled Hollow-Core Photonic Crystal Fiber, Robert J. Hupfer1, Barbara M. Trabold1, Amir Abdolvand1, Philip S. Russell1, Max Planck Inst. for the Science of Light, Germany. Coherent anti-Stokes Raman spectroscopy is conducted on gas-mixtures in kagome-PCF. Pressure-tunable dispersion enables broadband phase-matching which, combined with broadband Stokes seeding, allows simultaneous detection of multiple trace gases.

JTh2A.136
Optimized Endoscopic Laser Surgery in Colon Tumors, Felix Fanjul-Velez1, Jose L. Arce-Diego1,2; TEISA, Univ. of Cantabria, Spain. Common colonoscopic techniques present disadvantages. Laser surgery, including ablation and thermal effects, is analyzed, considering several wavelengths, pulse durations and irradiances. A short pulse Nd:YAG laser is considered to be optimum.

JTh2A.137
Quantitative Phase Microscopy of Live Cells Flowing in a Micro-Channel Using Flipping Interferometry, Natán T. Shaked1, Bahram Javidi1,2, Nir Turko1, Darina Rothfuss1,2; Tel-Aviv Univ., Israel; 3Univ. of Connecticut, USA. We present wide-field off-axis interferometry for rapid quantitative phase microscopy of biological cells during flow in microfluidic channels, with potential of integration into cell sorting devices. Various experimental demonstrations are presented.

JTh2A.138
Nanometer-class Optical Coherence Tomography for In Vivo Tear Film Thickness Estimation, Jinxin Huang1, Holly B. Hindman1, Jannick P. Rolland1,2; Univ. of Rochester, USA. To advance the Dry Eye management, we demonstrated the capability to simultaneously estimate the thickness of both the lipid and aqueous layers of the tear film in vivo using optical coherence tomography and maximum-likelihood estimation.

JTh2A.139
Withdrawn.

JTh2A.140
Investigating Corneal Disease Using High Resolution Gabor-domain Optical Coherence Microscopy, Patrice Tanka1, Zhiqiu He1, Gillees Thuret1, Holly B. Hindman1, Thierry Lepine1, Cristina Canavesi1, Philippe Gain2, Jannick P. Rolland1,2; Univ. of Rochester, USA; Faculty of Medicine, Jean Monnet Univ., France; Ophthalmology, Univ. of Rochester Medical Center, USA; 3Institut d’Optique, France; 4LighTopTech, USA. We demonstrate the capability of Gabor-domain optical coherence microscopy in identifying key features of the structural modification of the cornea in three diseases including Fuchs’ endothelial corneal dystrophy, lattice dystrophy and keratoconus.

JTh2A.141
Optical Simulation of Nonlinear Twisted-Ring Defect States with Planar Waveguide Arrays, Alexander A. Dovgoy1, Andrey E. Miroshnichenko1, Alexander Moroz1, Alexander Szaflarski1, Demetrios Christodoulides1, Andrey A. Sukhorukov2; 1Nonlinear Physics Centre, RSPE, Australian Natl. Univ., Australia; 2Wave-scattering.com, Germany. We presented a model for 2D arrays of nonlinear twisted-ring defects in planar waveguide arrays. We demonstrated stable half wave voltage ($V_\pi$) and electrode length ($L$) product of 2.5 $V cm$ for the vertical slot waveguide scanner. A 2-D scanning motion presents an electrostatic actuated 2-D cantilever waveguide scanner. A 2-D scanning motion has been successfully demonstrated with two fundamental resonances found at 202($V$) and 536($V$) Hz with corresponding FOV of 0.062 and 0.009 rad. 2-D scanning motion has been successfully demonstrated with two fundamental resonances found at 202($V$) and 536($V$) Hz with corresponding FOV of 0.062 and 0.009 rad.

JTh2A.142
Withdrawn.

JTh2A.143
Vertical Split-Ring Resonator based Meta- Surface for Light Manipulation, Mu Ku Chen1,2, Min Gu 2; Univ. of Washington, USA; 3National Taiwan Univ., Taiwan; 4Department of Engineering, Univ. of Massachusetts Boston, USA; 5Research Center for Applied Sciences, Academia Sinica, Taiwan. We used e-beam process for the deposition of 3D nanostructures called vertical split-ring resonators to explore the functionality of beam steering with phase modulation by tuning only the vertical dimension.

JTh2A.144
Electro-Absorption Modulators Based on Carrier Depletion in Epilson-Near-Zero Films, Kai Feng Shi1, Feichuan Yin1, ZhaoLuo1,2; Rochester Inst. of Technology, USA. We report field effect electro-absorption modulators, made of a thin epsilon-near-zero (ENZ) film sandwiched in a silicon or plasmonic waveguide. The significant bias-induced reduction of absorption of the ENZ film may promise nanoscale modulators.

JTh2A.145
An efficiency breakthrough in perovskite solar cells realized by Al-coated Cu nanoparticle arrays, Xi Chen1, Min Gu1,2; Swinburne Univ. of Technology, Australia; 3RMIT Univ., Australia. Al-coated Cu nanoparticles with strong light-trapping effects were synthesized. An efficiency boost of 21% in perovskite solar cells has been demonstrated, which is significantly higher than those from other plasmonic nanostructures.

JTh2A.146
Interactions of two counter-propagating waveguides in the dry photopolymer material using fibre optics, Re’d A. Malallah1, Ibararasa Muniraj1, Haoyu Li1, Derek Cassidy1, John T. Sheridan1; 1Univ. College Dublin, Ireland. We demonstrated Schwarzschild interferometers based on experimentally accessible planar waveguide arrays, where the light evolution exactly replicates nonlinear defect state dynamics governed by topologically nontrivial Hamiltonians.

JTh2A.147
High Stability and Higher Poling Efficiency for Electro-Optic Polymer/TiO2 Vertical Slot Waveguide Modulators, Yusufumi Enami1,2, Jia-Wern Chen1,2, Haoyu Li1,2, Min Gu1,2; 1School of System Engineering, Kochi Univ. of Technology, Japan; 2Department of Materials Science and Engineering, Univ. of Washington, USA. We demonstrate stable half wave voltage ($V_\pi L$) product of 2.5 $V cm$ for the modulators shows the same value for two years.

JTh2A.148
Focusing grating coupler for integration of a liquid-crystal spatial light modulator onto a Si photonic circuit, Takahiro Inaba1,2, Ryutaro Eguchi1, Hirokiyo Tsuda1,2; Keio Univ., Japan. Focusing gratings couplers for integrating a liquid-crystal spatial light modulator into a photonic circuit were designed, which had the total loss of 4.6 $dB$.

JTh2A.149
Nano-scatter enabled Optical Mapping of Orbital Angular Momentum of Broadband Light, Haoran Ren1, Min Gu2,1; Centre for Micro-Photonics, Faculty of Science, Engineering and Technology, Swinburne Univ. of Technology, Australia; 2Artificial Intelligence Photonics Laboratory, School of Science, RMIT Univ., Australia. We demonstrate a nano-scatter enabled single-path wavefront sensing approach capable of distinguishing of arbitrary integer or fractional topological charges of orbital angular momentum of broadband light.

JTh2A.150
Numerical modeling of the generation of a Kerr comb in a coupled cavity system using coupled mode equations, Yusuke Okabe1,2, Akimasa Takanashi1,2, Kenta Katoh1,2, Shun Fujii1,2, Riyo Suzuki1,2, Takatani Tanabe1,2; Keio Univ., Japan. We show the modeling of Kerr comb generation in a coupled cavity system and perform a numerical simulation in a normal dispersion regime. We show that the repetition rate is selectable and soliton generation is possible.

JTh2A.151
An Electrostatic Actuated 2-D MEMS Scanner for Potential Image Display Application, Wei-chih Wang1,2, Kebin Gu1; 1Univ. of Washington, USA; 2National Tsinghua Univ., Taiwan. Paper presents an electrostatic actuated 2-D cantilever waveguide scanner. A 2-D scanning motion has been successfully demonstrated with two fundamental resonances found at 202($V$) and 536($V$) Hz with corresponding FOV of 0.062 and 0.009 rad.
JTh2A.153
Giant circular dichroism enhancement and strong supercircular field in hybrid molecule-plasmonic nanostuctures, Y. N. Liu, Xia men Univ., China. We have demonstrated a direct correlation between the strong chirality of the local field and the giant CD response at the plasmon resonance bands induced by chiral molecules in the hot spots.

JTh2A.154
Design of Compact Plasmonic Polarim. Based on Polarization-Sensitive Nano-Grooves, Kyoko C. Le e, Joonsoo kim, Sang-Eun Mun, Gun-Yeon Lee, Byoung ho. Lee; 1Seoul National Univ., USA. A compact plasmonic polarimeter is proposed. The polarization state of the incident light is measured using interference between surface plasmon polaritons, excited by nano-grooves. The design method and simulation results will be shown.

JTh2A.155
Eu-doped ZnO-HfO2 hybrid nanocrystals embedded glass-ceramic waveguides as blue-light emitting source, Subhabrata Ghosh, Shivkaran Bhakta B. N.; 1Indian Inst. of Technology Kharagpur, India. Eu-doped SiO2-HfO2 hybrid glass-ceramic waveguides have been fabricated for on-chip blue-light emitting source application. The reduction of Eu2+-Eu3+ in the presence of ZnO nanocrystals leads to enhanced blue-emission in the low-wavelength waveguides.

JTh2A.156
High-Q and Small Mode-Volume Oxide-Cladding Aluminum Nitride Photonic Crystal Nanocavity, Emerson G. Melo, Marcelo N. Carrelo, Marco I. Alayo, 1Univ. of Sao Paulo, Brazil. A high bandgap material is very attractive in some photonic applications. Therefore, we propose a high-quality-factor and small mode-volume oxide-cladding AlIn photonic crystal nanocavity and assess the effects of fabrication induced disorder.

JTh2A.157
Adjusting Spectrum of MIM Optical Filters by Stub Inclination, Shuhao Wu1, Dingxin Wu1; 1Columbia Univ., USA. We analyze the stub inclination on stub-based MIM optical filters. Analytical analysis and simulation results show that inclination of stub generally causes a blue shift to the transmission spectrum, while emphasizing certain resonances.

JTh2A.158
Si-ITO solar cells with CdTe quantum dots, Mananna Kovalova1, Serhy Kondratenko1, Vasyl Lendel1; 1Taras Shevchenko National Univ. of Kyiv, Ukraine. We've investigated p-Si/STO with CdTe quantum dots. The J-V characteristics was found to be nonlinear. The photocurrent spectra in spectral range above band gap of Si is caused by presence of CdTe quantum dots.

JTh2A.159
Radiative lifetime changes in the vicinity of a nanofiber: dielectric, and alignment effects, Pablo Solano, Jeffrey Grover, Burkley Patterson1, Steve L. Rolston1, Luis A. Orozo1, Yunku Xu1, Jeremy N. Munday1; 1Univ. of Maryland at College Park, USA. We measure the radiative lifetime of the D1 line of atomic rubidium in the evanescent mode of a nanofiber and find enhancements and suppressions depending on the nanofiber size and the atomic-dipole orientation.

JTh2A.160
Optical Bistability in a VCSEL Connect ed Across Serially-Coupled PIN Photo- diodes, Sanaz Faryadzadeh1, Azad Nakhmak1; 1Department of Physics and Optical Engineering, Rose-Hulman Inst. of Technology, USA. Two serially-coupled PIN-PDs connected to a VCSEL is theoretically modeled and experimentally demonstrated to exhibit optical bistability. The bistable device operates in MHz range mainly due to parasitic inductance and capacitance of the circuit.

JTh2A.161
Bent Metal-Clad Waveguides for Fiber-to- Waveguide and 3D Chip-to-Chip Light Coupling Applications, Zhaolin Li1, Peichuan Yin1, Kaifeng Shi1; 1Rochester Inst. of Technology, USA. We report efficient fiber-to-waveguide and 3D chip-to-chip light coupling devices based on bent metal-clad waveguides. According to our FDTD simulation, the coupling efficiency is over 90% within a broad range of working wavelengths.

JTh2A.162
Dual-Layer Plasmonic Metasurfaces for Phase-Hologram Generation, Yohan Lee1, Joonsoo kim1, Byoungho Lee1; 2Seoul National Univ., USA. A dual-layer plasmonic metasurface which offers effective control of the phase of the transmitted wave by simple translational motion is proposed. It can operate on phase-mode and is controlled by adjusting the lateral shift of lower surface.

JTh2A.163
Supercontinuum generation beyond 2µm in Ge955S waveguides, Ji Won Choi1, Zhao Hong Han1, Byoung-Uk Sohn1, George F. Chen1, Lionel C. Kimerling2, Kathleen A. Richardson1, Anuradha M. Agarwal3, Dawn T. H. Tan1; 1Engineering Product Development, Singapore Univ. of Technology and Design, Singapore; 2Department of Materials Science and Engineering, Massachusetts Inst. of Technology, USA; 3College of Optics and Photonics, Univ. of Central Florida, USA; 4Materials Processing Center, Massachusetts Inst. of Technology, USA. SPM-induced nonlinear phase shift in Ge555S chalcogenide waveguides allows us to extract a nonlinear parameter of ~7 W/mm and a self-assembly integration technique which can be used in data centers and access networks for short wavelength applications.

JTh2A.164
Thermo-optic oscillatory behavior in on-chip lithium-niobate microdisk resonators, Jang W1, Bowen Zhu1, Zhanhong Hao1, Fang Bo1, Xiaolei Wang1, Guoquan Zhang1, Jinning Xu1; 1MOE Key Laboratory of Weak Light Nonlinear Photonics, TEDA Applied Phys. Inst. and School of Physics, Nankai Univ., China; 2Key Laboratory of Optical Information Science and Technology, Ministry of Education, Inst. of Modern Optics, Nankai Univ., China. We report the first experimental observation of an oscillatory behavior of transmission on on-chip lithium-niobate microdisk resonators, which was attributed to the competition between a fast thermo-optic effect and a slow heat dissipation process.

JTh2A.165
Withdrawn.

JTh2A.166
A Compact and Highly Sensitive Bio-sensor using Directional Coupling between Metal Clad Ridge Waveguides, Ramezet Dwivedi1, Anun Kumar1; 1Indian Inst. of Technology, Delhi, India. We propose a compact and highly sensitive bio-sensor based on directional coupling between two metal-under-cladded ridge waveguides. The sensitivity of the proposed sensor is found to be 6500 nm/RIU for the ambient RI = 1.33.

JTh2A.167
Mid-Infrared TE-pass and TM-pass polariz er based on Silicon on Sapphire (SOS) waveguide, Raghil El Shamy1; 1National University of Singapore, USA. An easy to fabricate, wideband and compact silicon-based TE-pass and TM-pass integrated MIR polarizers are proposed. The polarizers cover the whole mid-infrared transparency range of the SOS waveguide.

JTh2A.170
Design and Fabrication of Heterogeneously Integrated Planar Triplexer for Optical Net. works, Pallav Karukuntla1, Ayodej. Kuti1, Geddis Demetrios1, 2Norfolk State Univ., USA. We report the design and fabrication of heterogeneously integrated silicon based planar triplexer, using a self-assembly integration technique which can be used in data centers and access networks for short wavelength applications.

JTh2A.171
A Linearization Technique in Silicon Modula tors for Analog Signal Processing, Lingyun Jiang1, Pengfei Wu2, Young H. Kim1, Stephen Anderson1, Weimin Zhu1, Zhaoran R. Huang1; 1Rensselaer Polytechnic Inst., USA; 2Sensors &Electronics Devices Directorat e, US Army Research Laboratory, USA. We investigate a linearization technique in silicon electro-optic (EO) modulator for spur-free dynamic range (SFD) improvement. Using 3rd order derivative of the transfer function, an optimal DC bias is applied to get a maximum SFDR.

JTh2A.172
Coherent perfect absorption in chiral ma terials, Yuqian Ye1; 1Darrick Hay, Zhimin Shi1; 2Department of Physics, Univ. of South Florida, USA; 3Department of Physics, Hangzhou Normal Univ., China. We derive analytically the coherent perfect absorption condition of a transversely isotropic chiral structure. We use a THz chiral metamaterial structure to numerically demonstrate coherent absorption and polarization control.

JTh2A.173
Nanocoatings of Cerium Oxide and Platinum on Black Silicon Substrate for Enhanced Pho tocurrent Generation, Gabriela Dahal1, Dionisio Pereira1, Elango Evanuguru1, Janie P. Viegas1; 1Masdar Inst. of Science and Tech, United Arab Emirates. We demonstrate a 32-times photocurrent improvement on nanolayers of platinum and cerium oxide on black silicon due to the combined plasmonic effect with the multiple pathway photon scattering events leading to significant absorption improvement.

Empire Hall

JTh2A • Joint Poster Session II—Continued

Thursday, 20 October

FiO/LS 2016 • 16–21 October 2016
JTh2A.174
Optically reconfigurable chip in micro/nano-fiber Bragg gratings, Wei Luo1, Fei Xu1, Yan-qing Lu1, *Nanjing Univ., China. We theoretically demonstrate the optimomechanical effect of optically reconfigurable chip in silica micro/nano-fiber Bragg gratings. The fiber grating devices utilizing the optically reconfigurable chip may offer a means for all-optical.

JTh2A.175
Withdrawn.

JTh2A.176
Self-Assembled Plasmonic Core-Shell Clusters for Infrared Resonators, Kan Yao1, Yong-ming Liu1, *Northeastern Univ., USA. Infrared resonators are key building blocks of optical devices for widespread applications. We show that self-assembled core-shells exhibit unique spectral features determined by the number, configuration, and dielectric properties of the particles.

JTh2A.177
Right-Angle Bends and Splitters for Inter-lateral Optical Links of Transverse Electric Waves, Peichuan Yin1, KaiFeng Shi1, Zhaolin Lu1, *Rochester Inst. of Technology, USA. We theoretically demonstrate the implementation of Metal-Dielectric-Metal structures to design wavelength size H-plane waveguide bends and power splitters for TE modes. These designs can be implemented as layer-to-layer links or sharp bends in the same layer.

JTh2A.178
Estimation and Compensation of Coupling Loss between Bend and Straight Silicon Waveguides, Vikash Kumar1, *Nishit Malviya1, Vrushna Priye1, *Indian School of Mines, Dhanbad, India. To optimize space utilization in interconnects of Photonic Integrated Circuits, estimation and compensation of coupling loss between junction of straight and bend waveguide using Multiple Scaling Method having great effect on the data transceiver.

JTh2A.179
Nonlinear Waveguides Based on III-V Semiconductors, Shayan Saedt1, Kashif M. Awan2, Lilian Sirbu1, Ksenia Dolgaleva1, *Univ. of Tawawa, Canada. We propose nonlinear integrated waveguide designs based on semiconductors not widely used for nonlinear photonics previously. The materials belong to the group III-V and are expected to demonstrate interesting nonlinear optical properties.

JTh2A.180
Elastic Scattering from a Sapphire Microsphere in the THz Region, Syed Sultan Shah Bukhari1, Muhammad Rehan Chaudhry1, Mustafa Mert Bayer1, Ali Serpengüzel1, *KOC Univ., Turkey. We analyze numerically TE and TM polarization 0° transmission and 90° elastic scattering from a sapphire microsphere with a radius of 2000 µm in terahertz region from 790 µm to 850 µm by utilizing generalized Lorenz-Mie theory.

JTh2A.181
In Vitro Neuronal Depolarization and Increased Synaptic Activity Induced by Infrared Neural Stimulation, Blake Entwistle1, Simon McMullan1, Philip Bokinec1, Simon Gross1, Roger Chung1, Michael Withford1, *Macquarie Univ., Australia. Neural responses to infrared laser stimulation are explored in single cells. We examined synaptic events of Sprague-Dawley rat neurons, stimulated using an 810 nm laser. We show that infrared radiation increased spontaneous synaptic event frequency.

JTh2A.182
Simulation of Vision Corrected by the Light Sword Lens, Karol Kakarenko1, Krzysztof Petelczyc1, Andrezej Kolodziejczyk1, Zbigniew Jaroszewicz2, Alejandro Mira-Aguado1, *John Fredy Barrera1, Rodrigo Henao4, *Universidad de Los Andes, Colombia. The morphological vision corrected by LS provide a homogenous performance in a wide range of defocus. We show the simulated visual performance by means of objective and subjective assessment of images created in optical system emulating the human eye.

JTh2A.183
In-Vivo Three-Photon Excited Fluorescence Imaging in the Spinal Cord of Awake, Locomoting Mouse, Yu-Ting Cheng1, SallyAnne L. Ness1, Sofia H. Hu1, Jared Raikin2, Lilian D. Pani3, Tianyu Wang4, Dimitre G. Ouzounov1, Jean C. Cruz-Hernandez1, Isle M. Bastille1, Nozomi Nishimura1, Joseph R. Fetcho1, Chris Xu1, *Xiu B. Schaffer1, *Neurobiology and Behavior, Cornell Univ., USA, *Veterinary Medicine, Cornell Univ., USA, *Mengen School of Biomedical Engineering, Cornell, USA, *School of Applied and Engineering Physics, Cornell Univ., USA. We constructed a system for in-vivo three-photon deep imaging in the spinal cord of awake, locomoting mouse that facilitates detailed studies of neural firing patterns correlated with rhythmic locomotion.

JTh2A.184
Challenges in appearance characterization of coatings with effect pigments, Alejandro Ferrero1, Joaquin Campos1, *CSIC, Spain. New methods to characterize coatings with effect pigments are necessary to quantify their complex appearance. A description of the challenges faced by their characterization is given in this contribution.

JTh2A.185
Optical Fiber based Methods for Deep Brain Calcium Signal Measurements in Behaving Mice, Ling Fu1, Wuhan National Lab for Optoelectronics, China. The traditional optical systems are not suitable for recording of neuronal activity here. A multichannel fiber photometry system and a GRIN lens based confocal microscope are developed to acquire calcium signals in deep brain of behaving mice.

JTh2A.186
Age- and Glaucoma-Related Changes in Corneal Deformation Dynamics Utilizing Scheimpflug Imaging, Marta E. Musa1, *Department of Biomedical Engineering, Warsaw Univ. of Science and Technology, Poland. Our experimental and statistical research have shown that high speed Scheimpflug imaging is a potential tool to determine and regress changes in corneal biomechanics associated with age and glaucoma occurrence.

JTh2A.187
Simultaneous CW three laser wavelengths generation using precise gain control by VBGs, Ching-Nien Chen1, Yu-Hua Hsieh1, Te-Yuan Chung1, *National Central Univ., Taiwan. Three wavelength operation of a diode pumped Nd:glass fiber laser was constructed using three volume Bragg gratings (VBGs) as the output couplers. By precisely controlling the temperatures of the VBGs, the laser output wavelengths and power are stable.

JTh2A.188
Superfluid in helical container as a sensor of metric disturbances, Alex Okulov1, *Russian Academy of Sciences, Russia. The quantum fluid in double-helix pipe is analyzed in accelerated reference frame. The slow rotations and small modulations of free-fall acceleration are taken into account.

JTh2A.189
Characterization of C-band SOA-based bidirectional tunable fiber laser with two nested fiber ring cavities, Simeon Bokinova1, Muhammad A. Ummy1, Nicholas Madamopoulos1, Roger Dorisvillie1, *Electrical Engineering, CUNY City College, USA, *Electrical & Telecommunications Engineering Technology, New York City College of Technology, USA. We report a simple, stable, inexpensive SOA-based bidirectional tunable fiber laser, which consists of three SOAs and two nested fiber ring cavities. A beam combining gain of more than + 4.77 dB is demonstrated.

JTh2A.190
Spatial-temporal dynamics of broad-area semiconductor lasers, Stefan Bittrner1, Brandon Redding1, Hui Cao1, Daehwan Jung1, Minjoo Larry Lee1, *Yale Univ., USA. We study experimentally the spatial-temporal dynamics of broad-area semiconductor lasers. Fast random and periodic oscillations of the laser emission are observed. Their dependence on the pump strength and cavity size are investigated.

JTh2A.191
Theoretical Analysis of Temperature Characteristics of Coupled Quantum Dot Lasers, Zhiyan Lin1, Guohua Yuan1, Zhuruan Wang1, *UESTC, China. Spectra of coupled quantum dot lasers at different temperatures are calculated using a probabilistically coupled model. Calculated results show that the spectra at low temperatures are much flatter than the ones at high temperatures.

JTh2A.192
Nonaxially passively mode-locked laser with a hundred megahertz spectral bandwidth, Michael Kues1, Christian Reimer1, Benjamin Wetzel1, Piotr Rzotocki1, Brent Little1, Tai C. Chu3, David J. Moss1, Roberto Morandotti1,2, INRS-EMT, Canada, *School of Mathematical and Physical Sciences, Univ. of Sussex, UK, *X’an Inst. of Optics and Precision Mechanics, Chinese Academy of Science, China, *Department of Physics and Materials Science, City Univ. of Hong Kong, Hong Kong, *Center for Micro-Photonics, Swinburne Univ. of Technology, Australia, *Inst. of Fundamental and Frontier Sciences, Univ. of Electronic Science and Technology of China, China. We demonstrate a passively mode-locked laser emitting 4.3 nanosecond quasi-Fourier-limited pulses at (104.9 MHz) spectral bandwidth, based on simultaneous filtering and cavity-enhanced nonlinear interactions in an on-chip photonic crystal.

JTh2A.193
Multiplexing and Amplification of 2 µm Vortexteams, Yuan Li1, Wensheng Li3, Keith Miller3, Eric O. Johnson1, *Clemson Univ., USA. The multiplexing and amplification of optical vortices with orbital angular momentum (OAM) is demonstrated in a Ho:YAG rod amplifier. The phase of the amplified vortex is also studied and proven to be well maintained.

JTh2A.194
Theoretical analysis on fast saturable-absorber effects in a mode-locked laser with an intra-cavity nonlinear medium, Toru Sato1, Sakae Kawato2, Fukui Univ., Japan. We analyzed fast saturable-absorber effects in a mode-locked laser with an intra-cavity highly nonlinear medium. The nonlinear effects were required to obtain shorter output pulse widths below the Fourier-transform-limit of the gain spectra.
JTh2A.195
Theoretical Investigation of Laser-diode-pumped High Efficiency CW Ti:sapphire Laser, Motoki Morioka, Fukui Univ., Japan. The efficiency of laser-diode-pumped cw Ti:sapphire laser was investigated theoretically. The optical to optical conversion efficiency was obtained to be higher than 19%.

JTh2A.196
Spectral selectivity in capillary dye lasers, Esmaeil Mobini, Behnam Abaie, Arash Mali, Univ. of New Mexico, USA. The free spectral range (FSR) of the spectral features in a fluidic capillary dye laser appears considerably larger than what is expected from a Fabry-Perot cavity analysis. We theoretically explain the reason behind this phenomenon.

JTh2A.197
Withdrawn.

JTh2A.198
Surface Profilometry Using Vortex Beams, Alejandro Serrano, Jan L. Chaloupka, Matthew Anderson, Universidad Autonoma de Baja California, Mexico; Physics, Univ. of Northern Colorado, USA; Physics, San Diego State Univ., USA. We explore the use of scanning vortex beams to reveal the surface profile of sub-micron scale topological features. It is shown that a 200 nm step is easily discernible using this technique. This presentation will be presented as an E-Poster on Screen 2 from 09:30-10:15.

11:00–12:30 JTh3A • Light the Future Speaker Series featuring Michio Kaku, Lilac Ballroom

12:30–14:00 Free Lunch (provided by OSA), Exhibit Hall, Empire Hall

12:30–14:00 VIP Industry Leaders Networking Event: Connecting Corporate Executives, Young Professionals & Students, Hyatt Regency Rochester, Grand Ballroom B-C

Thank you for attending FiO/LS. Look for your post-conference survey via email and let us know your thoughts on the program.
**FiO**

**Grand Ballroom A (Radisson)**
14:00–16:00  
FTh4A • Symposium on Mid-Infrared Fiber Sources I  
Presider: Morten Ibsen; Univ. of Southampton, UK

**Grand Ballroom B (Radisson)**
14:00–16:00  
FTh4B • Optical Vortices  
Presider: Carlos Lopez Mariscal, Underwater Photonics, Mexico

**Grand Ballroom C (Radisson)**
14:00–16:00  
FTh4C • Computational Imaging I  
Presider: Marc Christensen, SMU, USA

**Grand Ballroom D (Radisson)**
14:00–16:00  
FTh4D • Optics Meets Neuroscience I  
Presider: Elizabeth Hillman, Columbia Univ., USA

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**FTh4A.1 • 14:00**  
Highly Nonlinear Fibre for Applications in the Mid-IR, Brandon Shaw; US Naval Research Laboratory, USA. Highly nonlinear fibre for applications in the Mid-IR are explored.

**FTh4A.2 • 14:30**  
Generation and Applications of High Average Power Mid-IR Supercontinuum in Chalcogenide Fibres, Christian Rosenberg Petersen; Denmark. Mid-infrared supercontinuum with up to 54.8 mW average power, and maximum bandwidth of 1.77-8.66 μm is demonstrated as a result of pumping tapered chalcogenide photonic crystal fibres with a MHz parametric source at 4 μm.

**FTh4B.1 • 14:00**  
Tutorial  
Spinning Light on the Nanoscale, Natalia M. Litchinitser, Jingbo Sun, Mikhail Shalaev; State Univ. of New York at Buffalo, USA. We discuss fundamental optical phenomena at the interface of singular and nonlinear optics in engineered optical media and show that the unique optical properties of metamaterials and metasurfaces open unlimited prospects to “engineer” light itself.

**Biography:** Natalia Litchinitser is a Professor of Electrical Engineering at University at Buffalo, The State University of New York. Her research focuses on fundamental properties and applications structured light in engineered nanostructures, biomedical imaging, optical communications and nonlinear optics. She previously held a position of a Member of Technical Staff at Bell Laboratories, Lucent Technologies, USA, and a Senior Member of Technical Staff at Tyco Submarine Systems. She authored 7 invited book chapters and over 150 research papers. She is a Fellow of the Optical Society of America, Fellow of the American Physical Society, and a Senior Member of the IEEE.

**FTh4B.1 • 14:00**  
Tutorial  
Spinning Light on the Nanoscale, Natalia M. Litchinitser, Jingbo Sun, Mikhail Shalaev; State Univ. of New York at Buffalo, USA. We discuss fundamental optical phenomena at the interface of singular and nonlinear optics in engineered optical media and show that the unique optical properties of metamaterials and metasurfaces open unlimited prospects to “engineer” light itself.

**FTh4C.1 • 14:00**  
Invited  
Nanoparticle and Virus Sensing Enabled by Computational Lensfree Imaging, Euan McLeod; Optical Sciences, Univ. of Arizona, USA. More than 10⁵ individual viruses and nanoparticles <40 nm are detected using on-chip digital lensfree holography. The weak scattered waves from these objects are enhanced by self-assembled liquid polymer nanolenses that boost signal-to-noise ratio.

**FTh4C.2 • 14:30**  
Improvement of experimental methods for studying dust plasma and colloidal systems, Nikita P. Kryuchkov, Anatoly Kislev, Evgeniy Yakovlev, Kirlil Zaytsev, Stanislav Yurchenko; European Lab for Non-Linear Spectroscopy, Italy. Here we use a multi-level approach to investigate complementary aspects of brain plasticity after stroke.

**FTh4D.1 • 14:00**  
Invited  
Multi Scale Morpho-functional Characterization of Damage and Rehabilitation after Stroke, Francesco S. Pavone; European Lab for Non-Linear Spectroscopy, Italy. Here we use a multi-level approach to investigate complementary aspects of brain plasticity after stroke.

**FTh4D.2 • 14:30**  
Invited  
Chemical Sectioning: High Throughput Imaging Brain Networks ex vivo at Synaptic Resolution, Shaoqun Zeng; Huazhong Univ of Science & Technology, China; Biomedical Photonics, Wuhan National Lab for Optoelectronics, China. We present Chemical Sectioning (CS) method to systematically reconstruct the integral morphology of a neuron. This method will pave the way towards single cell projectome, and other studies involving neuronal organization.

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In the context of multi-carrier transmission, optimizing the performance versus complexity in digital nonlinear mitigation in these systems, new challenges and opportunities towards multi-carrier transmission emerge. We review how optical communications are currently evolving, focusing on key advancements.

**FTh4E • 14:00**
**Presider: Fernando Guimarães, Politecnico di Torino, Italy**

**Advanced Techniques for Digital Nonlinear Compensation in Multi-carrier Optical Transmission Systems**, Fernando Guimarães, Politecnico di Torino, Italy. High-capacity optical communications are currently evolving towards multi-carrier transmission. We review the new challenges and opportunities for digital nonlinear mitigation in these systems, highlighting the performance versus complexity trade-off.

**FTh4F • 14:30**

**Fibre Network, Wolfgang Tittel**

**Quantum Teleportation across the Calgary Fibre Network**, Wolfgang Tittel1, Raju Valivarthi1, Marcello Gaudio Puigibert1, Qiang Zhou2, Gabriel Aguilar3, Daniel Opacki2, Varun Verma2, Francesco Marsili4, Matthew Shaw1, Sae Woo Nam2,1Univ. of Calgary, Canada; 1NIST, USA; 2JPL, USA. We report quantum teleportation between telecom and 795 nm photons. This improves the distance over which teleportation takes place from 818 m to 6.2 km and constitutes a milestone towards a global quantum internet.

**FTh4G • 14:30**

**Nonlinear Optic Induced Transparency and Suboptimal Algorithms**, David R. Williams1, Mark A. Foster1,1Johns Hopkins Univ., USA. Physical keys store secret information in their structure. Here we demonstrate an unclonable key based on a nonlinear reverberant silicon photonic microcavity. Beyond cloning this key also cannot be emulated due to its ultrafast response.

**FTh4H • 14:30**

**Brillouin Microscopy for Ocular Biomechanics**, Seok-Hyun A. Yun1,2New York Univ., USA. The limits of human visual sensitivity can be factored into retinal function at a cellular spatial scale. We studied the response of porcine eyes to air pulse at well-controlled levels of intracocular pressure (IOP) using air-puff OCT instrument. We observed significant changes of hysteresis after cross-linking for higher levels of IOP.

**FTh4I • 14:30**

**Visual Sensitivity and Object Recognition**, Dennis G. Pelli1,2New York Univ., USA. The limits to human visual sensitivity can be factored into equivalent input noise, mostly due to unreliable communication, and efficiency, mostly due to suboptimal algorithms.

**FTh4J • 14:00**

**FTh4J • 14:30**

**Invited**

**Integrating Novel Applications of Wavefront Correction**, David R. Williams1, Mark A. Foster1,1Johns Hopkins Univ., USA. The correction of the eyes wave aberration is enabling advances ranging from laser refractive surgery without removing tissue to retinal imaging tools capable of capturing retinal function at a cellular spatial scale.
FTh4A.3 • 15:00 Tutorial
Mid-infrared Wavelength Conversion in Chalcogenide Optical Microfibers, Thibaut Sylvestre1, Thomas Goëri1, John M. Dudley1, Raja Ahmad2, Martin Rochette2; 1Optics, CNRS FEMTO-ST Inst., France; 2Department of Electrical and Computer Engineering, McGill Univ, Canada. Chalcogenide fibers have been identified as very attractive nonlinear waveguides for mid-infrared applications. We review our recent achievements on mid-IR frequency conversion and supercontinuum generation in chalcogenide tapered optical fibers.

FTh4B.2 • 14:45 Fractional Vortex Hilbert’s Hotel, Gregory J. Gbur1; 1Physics and Optical Science, Univ of North Carolina at Charlotte, USA. We demonstrate theoretically how the unusual mathematics of infinite sets appears in the propagation of light through fractional vortex spiral waveplates. It is shown how Hilbert’s famous hotel is manifested in a singularity of vortices.

FTh4B.3 • 15:00 Spatio-Temporal Optical Vortices, Nihal Jhajj1, Ila Larkin1, Eric Rosenthal1, Sina Zahedpour1, Jared Wahlstrand1, Howard Milchberg1; 1Univ. of Maryland at College Park, USA. We present the first measurements of spatio-temporal optical vortices (STOVs). STOV generation/propagation is a universal feature of nonlinear pulse collapse and collapse arrest.

FTh4B.4 • 15:15 Partially Coherent Vortex Beams of Arbitrary Order, Charlotte Stahl1, Gregory J. Gbur1; 1Univ of North Carolina at Charlotte, USA. We derive analytic solutions for an infinite set of partially coherent vortex beams of any azimuthal order. Such beams may be useful for free space optical communication and understanding them is a necessary first step.

Biography: Thibaut Sylvestre is leading the nonlinear photonics group at the Femto-ST institute in France and he is supervising studies of nonlinear optical phenomena in specialty fibers with the aim of investigating potential applications to telecommunications, lasers and sensors.

FTh4C.3 • 14:45 Motion Artefact Detection in Structured Illumination Microscopy, Ronny Förster1, Kai Wicker1, Walter Müller2, Aurélie Jost3, Rainer Heintzmann1; 1Microscopy, Leibniz Inst. of Photonic Technology, Germany; 2Friedrich Schiller Univ Jena, Germany; 3Corporate Research and Technology, Carl Zeiss AG, Germany. The necessary image processing in structured illumination microscopy generates high resolution artefacts if the sample has moved during the acquisition. Our algorithm locates motion and distinguishes artefacts from real high resolution cell features.

FTh4C.4 • 15:00 Integrating sphere based speckle generation for wavelength determination and laser stabilization, Nikolaus K. Metzger1, Roman Spasyutsev1, Bill Miller2, Gareth Maker2, Graeme Malcolm1, Michael Mazilu1, Kishan Dholaria1; 1Univ. of St Andrews, UK; 2M-Squared Lasers, UK. An integrating sphere generates wavelength dependent speckle patterns that realizes an ultra-sensitive wavemeter with sub-femtometre resolution. Utilizing this wavemeter, we stabilize a laser for atom cooling of Rubidium to better than 1 MHz.

FTh4C.5 • 15:15 Withdrawn.

FTh4D.3 • 15:00 Imaging Activity in the Spinal Cord, Daniel C. Cote1; 1Université Laval, Canada. We will show various strategies (both for surgery and imaging techniques) to image activity in the spinal cord using genetically encoded calcium indicators for neuronal activity and monitoring dendrites for microglial activity.
We examine the modal properties of perturbed few-mode optical fibers with respect to two common fiber perturbations, birefringence and core non-circularity, and investigate the relationship of the fiber’s true and LP modes in a quantitative way.

Photonics-chip-based widely tunable microwave source using a Brillouin opto-electronic oscillator, Moritz Merklein1, Birgit Stiller1, Irina Kabakova2, Udana Mutugala1, Khu Vu1, Stephen Madden1, Benjamín J. Eggleton1, Radan Slavík2, Center for Ultrahigh bandwidth Devices for Optical Systems (CUDOS), The Univ. of Sydney, Australia; 2Blackett Laboratory, Imperial College London, UK. We experimentally demonstrate the pump-phase-noise-tolerant wavelength multicasting for 20 GBAud’s QPSK signals using Kerr frequency combs. The EVM of multicasted copy almost stays unchanged when the pump linewidth is broadened to 2 MHz.

We report on the direct modulation of blue laser diodes for underwater optical communication utilizing wavelength, polarization and space division multiplexing. Using this scalable architecture, we demonstrate an effective data rate of 10 Gbit/s.

The intrinsic multimode character of optical frequency combs is demonstrated to be an ideal candidate for quantum information processing. Generation of on demand quantum networks and versatile mode-dependent non-gaussian operations are demonstrated.

Asymmetric Light-Light Interaction by Non-Hermitian Photonics, Han Zhao, William Pegg-adali, Jaka Yu, Zhiqiang Zhang, Li Ge, Axel Scherer1, Liang Feng1, SUNY Buffalo, USA; Department of Physics and Kavli Nanoscience Inst., California Inst. of Technology, USA; Department of Engineering Science and Physics, CUNY, USA. Effective light-light interaction enables energy-efficient optical networks. By non-Hermitian on-chip engineering, we demonstrate asymmetric light control where intense laser field is manipulated by weak control with an extinction ratio up to 60 dB.

Wideband spectral broadening in ultra-short ultra-silicon rich nitride waveguides, Ji Won Choi1, George F. R. Chen1, D. K. T. Ng1, Kelvin J. A. Ooi1, Dawn T. H. Tan1, Engineering Product Development, Singapore Univ. of Technology and Design, Singapore; 2Data Storage Inst., Agency for Science, Technology and Research (A*STAR), Singapore. Ultra-silicon rich nitride (USRN) waveguide with 1-mm-length possessing high Kerr nonlinearity and low two photon absorption achieved femtosecond spectral bandwidth of 225 nm at near-infrared wavelength range, which is a 4 fold spectral broadening.

Multichannel optical phase noise compensation using Kerr frequency combs, Peicheng Liao1, Lin Zhang1, 3, Amirhossein Mohajerin-Ariaei1, Morteza Ziyadi2, 1Univ. of Southern California, USA; 2Ecole Polytechnique Federale Lausanne, Switzerland; 3Fujian Univ., China. We experimentally demonstrate the pump-phase-noise-tolerant wavelength multicasting for 20 GBAud’s QPSK signals using Kerr frequency combs. The EVM of multicasted copy almost stays unchanged when the pump linewidth is broadened to 2 MHz.

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**Thursday, 20 October**

16:00–16:30 Coffee Break, West Corridor and Skyway Lobby (Radisson)

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**FTh4A • Symposium on Mid-Infrared Fiber Sources I—Continued**

FTh4A.4 • 15:30 Invited
**Mid-Infrared Photonics in Healthcare, Angela Seddon,** *Univ. of Nottingham, UK.* We set a record in demonstrating extreme broad-band supercontinuum generated light 1.4 to 13.3 microns in a specially engineered MIR fibre, a key first step towards bright, portable, broadband MIR sources for applications in healthcare.

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**FTh4B • Optical Vortices—Continued**

FTh4B.5 • 15:30 Invited
**Quantum and Classical Properties of Vector Modes, Andrew Forbes***, *Univ. of Witwatersrand, South Africa*, and *CSIR National Laser Centre, South Africa.* Vector beams are non-separable light fields. By borrowing tools from quantum mechanics, we show how to create, define and measure them, and demonstrate how they may be used to simulate quantum processes.

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**FTh4C • Computational Imaging I—Continued**

FTh4C.6 • 15:30 Invited
**Imaging Quality of Intensity-Interferometric Spectral-Domain Optical Coherence Tomography with Dispersion Insensitivity, Tomohiro Shirai,** *Natl Inst of Adv Industrial Sci & Tech, Japan.* We demonstrate that unwanted artifacts observed in dispersion-insensitive optical coherence tomography based on spectral intensity interferometry can be reduced by means of a relative displacement between the detector and the spectrum to be captured.

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**FTh4D • Optics Meets Neuroscience I—Continued**

FTh4D.4 • 15:30
**A Miniaturized Optical System for Monitoring Cerebrovascular Perfusion during Deep Brain Stimulation, Linhui Yu***, *Electrical and Computer Engineering, Schulich School of Engineering, Univ. of Calgary, Canada*, and *Hotchkiss Brain Inst., Department of Clinical Neurosciences, Cumming School of Medicine, Univ. of Calgary, Canada.* We present the design of a miniaturized optical system to measure changes in cortical perfusion in response to deep brain stimulation. The system design and preliminary results are presented.

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FTh4D.5 • 15:45
**A diamond-based, hybrid optrode for multisite optogenetics, Antoine Boudet***, *Univ. of Strathclyde, UK*, and *Hotchkiss Brain Inst., Department of Clinical Neurosciences, Cumming School of Medicine, Univ. of Calgary, Canada.* We present a diamond optrode integrating transfer-printed GaN µLEDs, allowing extended/high-power emission and versatility.

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FTh4C.7 • 15:45
**Digital refocusing of fluorescent light intensity with spatial frequency modulated imaging, Jeffrey J. Field***, *Colorado State Univ., USA.* We present an imaging method that transfers the spatial phase difference between two coherent illumination beams into temporal modulations of fluorescent light emission collected on a single-pixel detector, enabling refocusing of fluorescent light.
Generating and analysis of correlated pairs of photons on a satellite, Alexander Ling, Zhongkun Tan, Rajitha Chandrasekara, Yue Chuan Tan, Cliff Cheng, Daniel Oi, Centre for Quantum Technologies, Singapore; SUPA, Dept. of Physics, Univ. of Strathclyde, UK. We report the operation of a photon pair source on board a nanosatellite: an important milestone towards compact entangled photon sources for future space-based quantum communication.

On-chip Turing pattern formation for coherent high-power THz radiation, Shu-Wei Huang, Pinghui Yang, Virginia Romeike, Alexandre Guillot, and Mathias Gwinner, and the group of Jürgen Korsch, Physikalisches Institut, Universität Erlangen-Nürnberg, Germany. We report on-chip Turing pattern formation, uniquely enabled by mode-hybridization induced phase matching. The robustness, tunability, coherence, and efficiency lend itself to an excellent pump for high-power narrow-line-width THz radiation.
Gran Ballroom A (Radisson)

16:30–18:30
FTh5A • Symposium on Mid-Infrared Fiber Sources II
Presider: Morten Ibsen; Univ. of Southampton, UK

FTh5A.1 • 16:30 Invited
All-fiber Sources Operating in the Mid-infrared, Martin Bernier1; 1Université Laval, Canada. The architecture of an all-fiber laser operating at 2.94 microns at a continuous output power of 30W will be detailed. Different recent technical achievements based on the same mastered technology will also be discussed.

FTh5A.2 • 17:00 Invited
Power Scaling Concepts for Mid-infrared Fibre Lasers Using Fluoride Glass, Stuart D. Jackson1; 1Engineering, Macquarie Univ., Australia. I will briefly overview the field of mid-infrared fibre lasers with a focus on recent developments aimed at increasing the output power. I will mainly focus on fibre gain elements involving fluoride glass as the host material.

Grand Ballroom B (Radisson)

16:30–18:30
FTh5B • Optical Vortices, Polarization and Mode Shaping
Presider: Greg Gbur, Univ. of North Carolina at Charlotte, USA

FTh5B.1 • 16:30 Invited
Towards Chiral Materials Science Based on Optical Vortices Illumination, Takahige Omatsu1; 1Chiba Univ., Japan. Illumination of optical vortices enables us to twist melted materials to establish chiral structures on a nanoscale. Such structured materials will open the door to develop chirality sensors, chiral chemical reactors, and metamaterials.

FTh5B.2 • 17:00 Invited
Generation of tunable orbital angular momentum in polarization maintaining fiber, Robert Niedermayer1, Mark Siemens1, Juliet T. Gopinath1,2; 1Department of Physics, Univ. of Colorado at Boulder, USA; 2Department of Electrical, Computer, and Energy Engineering, Univ. of Colorado Boulder, USA. We demonstrate tunable orbital angular momentum (OAM) in two-mode polarization-maintaining optical fiber. The OAM and spatial beam profile can be varied as the relative phase and coherence between fiber modes is adjusted.

Grand Ballroom C (Radisson)

16:30–18:30
FTh5C • Computational Imaging II
Presider: David Hasenauer, Synopsys, USA

FTh5C.1 • 16:30 Invited
Imaging Beyond the Limits: Active Imaging for Enhancing Resolution, 3D Information, and Indirect Imaging, Marc P. Christensen1, Prasanna Rangarajan1; 1Southern Methodist Univ., USA. We present a technique of utilizing active illumination to surpass the limitations of passive imaging systems alone. An approach to combine super resolution and profilometry is presented. Recent applications to indirect imaging will be discussed.

FTh5C.2 • 17:00 Invited
Experimental x-ray ghost imaging, Daniele Pelliccia1,2, David M. Paganin1; 1Science, RMIT Univ., Australia; 2Physics and Astronomy, Monash Univ., Australia. We report the experimental demonstration of x-ray ghost imaging using synchrotron emission. Our experiment opens a clear path towards low dose x-ray medical diagnostics, and also towards single-molecule diffraction imaging at Free Electron Lasers.

Grand Ballroom D (Radisson)

16:30–18:30
FTh5D • Optics Meets Neuroscience II
Presider: Ann E. Elsner, Indiana Univ., USA

FTh5D.1 • 16:30 Invited
Cone Signals, Adaptive Optics, and the Brain, Lawrence Sincich1; 1Optometry and Vision Science, Univ. of Alabama at Birmingham, USA. Cone-targeted microstimulation using adaptive optics provides access to the processing of single cone signals in the visual system. Recent progress revealing cone signal variability and summation in the human and macaque brain will be presented.

FTh5D.2 • 17:00 Invited
Parallel Processing in the Visual System, Bart Borghuis1; 1Univ. of Louisville, USA. Optical imaging is transforming the study of neural circuit function in the brain, including the retina. Here, I will show how 2-photon fluorescence imaging revealed key properties of information processing in retinal bipolar cell pathways.
Increase the telecommunication capacity of an orbital angular momentum (OAM) does not stand alone. We demonstrate that using Choi, Kishan Dholakia, and Free Space Systems, Practical Continuous Variable QKD in Fiber and Free Space Systems, Christoph Marquardt; 1, Department of Physics, Univ. of Erlangen-Nuremberg, Germany; 2, Max Planck Inst. for the Science of Light, Germany. I will review recent activities in continuous variable QKD that aims for the deployment of QKD equipment compatible with current telecom standards and research in satellite QKD that will make it possible to bridge long distances.

Experimental Demonstration of Inserting Phase-Locked Lines into Kerr Combs using Electro-Optical Modulation, Chang Biao Pei, Chenguang Liao, Yinwen Cao, Guodong Xie, Arne Korda, Lin Zhang, Maxim Karpov, Martin Hubert, Peter Pleifler, Cong Liu, Moreza Ziyadi, Yan Yan, Ahmed Almasain, Amirhossein Mohajeran-Ar, Fatemeh Alishahi, Tobias J. Kippenberg, Alan Willner; 1, Univ. of Southern California, USA; 2, École Polytechnique Fédérale de Lausanne (EPFL) Lausanne, Switzerland; 3, School of Precision Instrument and Optoelectronics Engineering, Tianjin Univ., China. We experimentally demonstrate the flexibility of inserting one or two lines into Kerr combs. The effect of the spacing between two sidebands (260 KHz and 770 KHz) from EO modulation on the communication system is studied.

Can information Capacity be Increased with Orbital Angular Momentum?, Mingzhou Zhou; 1, Google, USA. In this talk I will present a new method to increase the communication system bandwidth. Can information Capacity be Increased with Orbital Angular Momentum?, Kishan Dholakia, 1; 1, University of St Andrews, UK. We demonstrate that using Choi, Kishan Dholakia, and Free Space Systems, Practical Continuous Variable QKD in Fiber and Free Space Systems, Christoph Marquardt; 1, Department of Physics, Univ. of Erlangen-Nuremberg, Germany; 2, Max Planck Inst. for the Science of Light, Germany. I will review recent activities in continuous variable QKD that aims for the deployment of QKD equipment compatible with current telecom standards and research in satellite QKD that will make it possible to bridge long distances.

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<tr>
<td><strong>FTh5A</strong> • Symposium on Mid-Infrared Fiber Sources II—Continued</td>
<td><strong>FTh5B</strong> • Optical Vortices, Polarization and Mode Shaping—Continued</td>
<td><strong>FTh5C</strong> • Computational Imaging II—Continued</td>
<td><strong>FTh5D</strong> • Optics Meets Neuroscience II—Continued</td>
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<td><strong>FTh5A.3</strong> • 17:30 Invited</td>
<td>Mid-Infrared Sources for Ultra-Broadband Cavity Enhanced Spectroscopy, Caroline G. Amiot1,2, Piotr Ryczkowski1, Antti Aalto1, Juha Toivonen1, Goëry Genty1; 1Tampere Univ. of Technology, Finland; 2Institut FEMTO-ST, France. We developed an all-fiber based supercontinuum source spanning from 900 to 3700 nm. We performed incoherent broadband cavity enhanced absorption spectroscopy using that source and were able to detect multicomponent simultaneously.</td>
<td><strong>FTh5B.3</strong> • 17:15</td>
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<td><strong>FTh5B.4</strong> • 17:30 Nonlinear Generation of High Power and Higher order Hollow Gaussian Beam, Apurvu Chaitanya Nellikka1, Jabir M. V.1, Jay Banerji1, Goutam K. Samanta1; 1Physical Research Laboratory, India. We demonstrate novel experimental scheme generating high-power, higher-order hollow-Gaussian-Beam (HGB) through annihilation of OAM of interacting photons in nonlinear process. Also, report a new and only method for characterizing the order of HGBs.</td>
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<td><strong>FTh5B.5</strong> • 17:45 Computational imaging with adaptive spatially-variable resolution, David B. Phillips1, Ming-Jie Sun1, Matthew Edgar1, Jonathan Taylor1, Graham Gibson1, Stephen Barnett1, Miles Padgett1; 1Univ. of Glasgow, UK. We describe a single-pixel imaging system with an enhanced frame-rate, achieved by reconstructing images with a variable resolution across the field-of-view. Resolution can be adaptively changed from frame to frame to track moving objects.</td>
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<td><strong>FTh5C.3</strong> • 17:15 Shape Reconstruction and Orientation Estimation of Transparent Microscopic Object using Light Field Microscopy, Xiaopeng Peng1, Grover A. Swartzlander1; 1Rochester Inst. of Technology, USA. This paper reports a framework for high speed volumetric imaging and orientation estimation of transparent microscopic objects using light field microscopy. The framework provides a potentiality for kinetic characterization of microscopic objects.</td>
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<td><strong>FTh5C.4</strong> • 17:30 Multi-spectral visible-to-shortwave infrared smart camera built on a compressive sensing platform, Lenore McMackin1, Matthew A. Herman1, Tyler Weston1; 1InView Technology Corporation, USA. We describe development of a multi-spectral camera built on a compressive sensing platform. Its novel yet simple design takes advantage of the diffractive properties of a micromirror array used in the well-known single-pixel camera architecture.</td>
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<td><strong>FTh5C.5</strong> • 17:45</td>
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<td><strong>FTh5D.3</strong> • 17:30 Imaging Microglia in the Physiological Brain, Anna Majewska1,2; 1Univ. of Rochester, USA. Microglia are traditionally thought to be the immune cells of the brain. Here we present evidence from in vivo imaging experiments, that microglia have critical roles in normal brain function.</td>
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In this tutorial, we will review recent advances on optical fibers including ultra-low-loss ultra-large area fibers for systems, multicore fibers and few-mode fibers for space-division-multiplexing transmissions. Their optical fiber properties and performance are provided.
FTh5A • Symposium on Mid-Infrared Fiber Sources II—Continued

FTh5A.4 • 18:00 Invited
Mid-IR Ultrafast Fibre Laser Sources, Khanh Kieu1; 1Univ. of Arizona, USA. I will review mid-IR fiber laser sources and present different schemes to generate ultrafast pulses in this spectral range. Some interesting applications of ultrafast mid-IR sources will be also discussed.

FTh5B • Optical Vortices, Polarization and Mode Shaping—Continued

FTh5B.6 • 18:00 Generation of wavelength-independent and sub-wave-length Bessel beams by meta-axicons, Wei-Ting Chen1, Mohammadreza Khorasaninejad1, Alexander Y. Zhu1, Jaewon Oh1,2, Rober Devlin1, Aun Zaidi1, Federico Capasso1; 1Harvard Univ., USA, 2Univ. of Waterloo, Canada. We report meta-axicons with high numerical aperture for generating Bessel beams with $\lambda/3$ spot size. The spot size of the generated Bessel beams is independent of wavelength of incident light because of tailored phase profile.

FTh5C • Computational Imaging II—Continued

FTh5C.6 • 18:00 Single Shot Time Domain Ghost Imaging using Wavelength Multiplexing, Piotr Ryczkowski1, Margaux Barbier1, Ari Tapio Friberg1, John M. Dudley1, Goëry Genty1; 1Optics Laboratory, Tampere Univ. of Technology, Finland; 2Inst. of Photonics, Univ. of Eastern Finland, Finland; 3Institut FEMTO-ST, CNRS–Université de Franche-Comté, France. We report on the first demonstration of computational ghost imaging in the time domain using wavelength multiplexing. The wavelength-multiplexed Hadamard patterns used to probe a time-varying waveform enables image reconstruction in real time.

FTh5D • Optics Meets Neuroscience II—Continued

FTh5D.4 • 18:00 Mapping the birefringence of amyloid deposits found in retinas in association with Alzheimer’s disease, Tao Jin1, Laura Emptage1, David DeVries1, Melanie C. Campbell1,2; 1Department of Physics and Astronomy, Univ. of Waterloo, Canada, 2School of Optometry and Visual Science, Univ. of Waterloo, Canada. A new method is established for mapping birefringence of the amyloid plaques found in the retinas of subjects in association with Alzheimer’s disease using fluorescence confocal microscopy and Mueller matrix polarimetry.

FTh5B.7 • 18:15 Custom-Tailored Sorting of Structured Light by Controlled Scattering, Robert Fickler1, Robert W. Boyd1,2; 1Univ. of Ottawa, Canada, 2Instut of Optics, Univ. of Rochester, USA. Light with a complex structure is interesting for foundations and applications in classical and quantum optics. We investigate controlled scattering processes to realize novel transformations such as custom-tailored sorting of structured photons.

FTh5C.7 • 18:15 Image Quality of Compressive Imaging with Quantum Light, Kam Wai C. Chan1, Vamsi Manthapuram1, Lu Zhang1; 1Univ. of Oklahoma - Tulsa, USA. Several common reconstruction algorithms were used to perform compressive quantum imaging with Fock states, coherent states, and squeezed light. It was found that the different light sources gave the same scaling law for the root-mean-squared error.

FTh5D.5 • 18:15 Hyperspectral Imaging in Live Mouse Cortex Using a 48-Channel Multiphoton Microscope, Amanda Barnes1, Mitchell A. Pender1, Menansili A. Mejooli1, Steven Tilley1, Kuang E. Chen1, Jingyuan Dong1, Peter C. Doerschuk1, Chris B. Schaffer1; 1Cornell Univ., USA. We constructed a hyperspectral multiphoton microscope collecting 48 channels of excitation/emission spectral data, while retaining the imaging depth of nonlinear microscopy. We demonstrate imaging of multiple overlapping fluorophores in vivo.

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**FTh5F • Quantum Communication and Networking II—Continued**

**FTh5F.4 • 18:00** Chip-scale MOT for Microsystems Technology, Argyrios Dello1, Matthew T. Hummon1, Songbai Kang1, Elizabeth A. Donley1, John Kitching1. 1NIST, USA. We are developing a micro-fabricated platform to support the creation of laser cooled samples. We are able to cool and trap ~5x10^5 atoms. We are in the process of replacing the actively pumped cell with a passively pumped cell.

**FTh5G • Integrated Nonlinear Optics II—Continued**

**FTh5G.6 • 18:00** Ultraviolet Second Harmonic Generation in Aluminum Nitride Microring Resonators, Michael J. Fanto1,2, Jeffrey A. Steidle1, Dirk Englund3, Christopher P. Tison3, A. Matthew Smith2, Gregory A. Howland2, Kathy-Anne Soderberg2, Paul Alsing2. 1Rochester Inst. of Technology, USA; 2Information Directorate, Air Force Research Laboratory, USA; 3Massachusetts Inst. of Technology, USA. Aluminum nitride, with a bandgap of 6.2 eV, and a $\chi(2)$ of ~10's of pm/V can generate ultraviolet photons. This article describes using aluminum nitride microring resonators to produce second harmonic photons below 400nm.

**FTh5G.7 • 18:15** Second-Harmonic Generation in Periodically-Poled Thin Film Lithium Niobate on Silicon, Ashutosh Rao1, Marcin Malinowski1, Amirmahdi Honardoost1, Javed Roul Talukder1, Payam Rabiei2, Peter Delfyett2, Sasan Fathpour3, CREOL, Univ Central Florida, USA; 2Partow Technologies LLC, USA. Thin films of lithium niobate are wafer-bonded onto oxidized silicon substrates and periodically poled for quasi-phase matching to demonstrate second-harmonic generation in submicron waveguides with a record-high conversion efficiency of 730%W^2cm^-1.

Biography: Benyuan Zhu joined Bell Laboratories, Lucent Technologies in Holmdel, NJ USA as a Member of Technical Staff (MTS) in 1999, then became a MTS at OFS Labs in 2002, and he was promoted to a Distinguished Member of Technical Staff in 2011. His research interests include DWDM transmission, advanced modulation, novel fibers and optical amplifier technologies. He has authored/coauthored 180 journal/conference papers, one book chapter, and he has 18 US patents. He has served as TPC members or chair for the conferences of OFC, IPC, WOCC, ACP. He is an Associate Editor of the Electronics Letters. Benyuan Zhu received Ph.D. degree in Physics from Bath University, UK.

**LTh5H • Topological Photonics I—Continued**

**LTh5H.4 • 18:00** Invited Topological Theory of Disallowed Couplings, Bo Zhen1,2, Hengyun Zhou1, Chia Wei Hsu1, Ling Lu1, A. Stone1, Mordechai Segev1, John Joannopoulos1, Marin Soljacic1. 1MIT, USA; 2Technion, Israel; 3Yale Univ., USA. We reveal the topological nature of disallowed couplings. We first show “bound states in the continuum” are fundamentally vortices in the polarization directions carrying topological charges. We then reveal their connections to Chern numbers.

**LTh5I • High Harmonic Generation I—Continued**

**LTh5I.4 • 18:00** Invited Upper Limits to Near-field Radiative Heat Transfer: Generalizing the Blackbody Concept, Owen Miller1. 1Yale Univ., USA. I describe energy-conservation principles that answer a basic question: what is the maximum radiative heat transfer rate between closely separated bodies? The new bounds offer the possibility for significant future enhancements, for thermophotovoltaics and beyond.
FF1A.1 • 08:00 Invited
Chemophototherapy with Porphyrin-Phospholipid Lipo-
somes: A Treatment Possibility for Solid Tumors, Jonathan
Lovell1; SUNY Buffalo, USA. Liposomes containing small
amounts of porphyrin-phospholipid are developed that
otherwise have similar composition and pharmacokinetics
to FDA-approved liposomal doxorubicin. Laser irrad-
iation potently induces tumor ablation via chemophototherapy.

FF1B.1 • 08:00 Tutorial
New Opportunities with, and Future Challenges of, Optical
Fiber Sensor Technology, Jose Luis Santos1; Universidade
do Porto, Portugal. Optical sensing has been associated with
high performance and recent developments indicate this
trend will continue. The talk elaborates on challenges and
opportunities facing this field, in particular when the sensor
platform is the optical fiber.

Biography: José Luís Santos received his graduation in
Physics from University of Porto, Portugal, and Ph.D. degree
from the same University, benefiting from collaboration with
the University of Kent at Canterbury, UK. He is currently
a Professor of Physics at the Physics and Astronomy
Department of Faculty of Sciences of University of Porto,
Portugal. Optical fiber sensing is the main area of his research,
with focus on interferometric and wavelength encoded
devices. He is author or co-author of more than 230 scientific
articles and co-author of 5 patents. With Professor Faramarz
Farahi of University of North Carolina was Editor of

FF1A.2 • 08:30 Invited
Kagome Fiber Based Ultrafast Laser Microsurgery
Probes, Adela Ben-Yakar1; Univ. of Texas at Austin, USA. I
will present our efforts towards achieving a fully hand-held, 5
mm, ultrafast laser scalpel for microsurgery with a capability to
deliver energies in excess of 5 μJ per pulse using large-area,
hollow-core kagome fibers.

FF1B.2 • 08:30 Invited
Boson Sampling with Continuous Variable Measure-
ments, Timothy C. Ralph1; Univ. of Queensland, Austra-
lia. We show that it is classically hard to sample the output
distribution of certain continuous variable measurements
from a BosonSampling device. Our argument is presented
for exact BosonSampling. We discuss extending this result
to approximate sampling.

FF1C.1 • 08:00 Invited
Implementation and Certification of Boson Sampling with
Integrated photonics, Fabio Sciarrino1; Univ degli Studi di
Roma La Sapienza, Italy. Boson sampling is a computational
task hard for classical computers, but efficiently solvable via
bosonic interference in a specialized quantum computer. We
report several experiments of boson sampling implemented
with integrated quantum photonics.

FF1C.2 • 08:30 Invited
First-Photon 3D Imaging with a Single-Pixel Camera, Mat-
thew Edgar1; Univ. of Ottowa, Canada. Quantum Imaging strives to form
improved images based on quantum phenomena. We give
eamples of how these quantum images can be superior to
conventional images in terms of sharpness, signal-to-noise
ratio, and low-light-level image formation.
or to Diversify?,

FF1E.2 • 08:30

Michael for Photonic Integrated Circuits, AIM Photonics – Manufacturing Challenges for Photonic Integrated Circuits, Michael Lienh, 1 AIM Photonics, USA, 2 SUNY Polytechnic Inst., USA. The recently established American Inst. for Manufacturing Photonics is a manufacturing consortium headquartered in NY, to advance the state of the art in the design, manufacture, testing, assembly, and packaging of integrated photonic devices.

Silicon Photonics Platforms: to Standardize or to Diversify?, Roel G. F. Baets 1,2; 1 Photonics Research Group, Ghent Univ., Belgium; 2 IMEC, Belgium. Silicon photonics has emerged as a major PIC-technology because it builds on the maturity and infrastructure of the CMOS world. But where is the middle ground between yield-driven diversification and cost-driven standardization and application-driven diversification?

High-Q Photonic Crystal Resonators for Nonlinear Optics, Aude Martin 1; Gregory Mollai 1, Sylvain Cambri 1, Gaelle Lehoucq 1, Thierry Debuisschert 1, Allard, P. Mosk 1, Alfredo De Rossi 2, 1 Thales Research & Technology, France, 2 Laboratoire de Photonique et de Nanostructures, CNRS UPR 20, France. ‘Physics of Light in Complex Systems (LINX), Debye Inst. for Nanomaterials Science, Utrecht Univ., Netherlands. Small volume cavities and cavity arrays made of III-V semiconductor with large electronic gap allow very large optical fields to be established. The spectral alignment of a triplet of resonances results into ultra-efficient four-wave-mixing.

Exceptional contours and band structure design in parity-time symmetric photonic crystals, Alexander Cerjan 1, Aaswath Raman 1, Shanhui Fan 1, Stanford Univ., USA. We investigate the properties of 2D parity-time symmetric periodic systems whose periodicity is an integer multiple of the underlying Hermitian system’s periodicity. Such systems possess novel band structure engineering, and yield supercollimation.

Multi-plane Phase Retrieval in Generalized Two-Path Interferometry, Wesley Farriss 1, James R. Fienup 1, Tanya Malhotra 1, A. Nick Varnavikas 1, Univ. of Rochester, USA. Generalized interferometry is a novel technique that decomposes fields into transverse basis set components and weighting coefficient magnitudes. Nonlinear optimization phase retrieval algorithms using multiple intensity planes are developed.

Optical Characteristics of Bio-Inspired Lasers Based on Fluorescent Biomaterials and Bioconjugates, Jose A. Rivera 1, James G. Eden 1, IIUC, USA. Changes in the chemical environment of a biolaser were detected by analyzing spectral, temporal, and polarization properties. Such detailed characterizations are fundamental for biolasers to realize their potential as diagnostics tools.

Enhanced Lasing Through Tailoring of Photonic Density of States, Martin Soljacic 1, Massachusetts Inst. of Technology, USA. Nanophotonics offers unprecedented opportunities for tailoring photonic density of states. Weyl and Dirac dispersions could thus enable single-mode lasing for substantially larger lasers. Novel gain media can be enabled as well.

Controlling the Direction of Optical Power Flow in an Active Photonic Cavity, Ali Kazemi Jahromi 1, Ayman Abouraddy 1, Univ. of Central Florida, CREOL, USA. We demonstrate experimentally that the direction of Poynting’s vector and thus power flow in an optical cavity provided with net gain can be controllably reversed by modulating a passive intra-cavity loss element.

Recent Progress in Photonic Crystals, Susumu Noda1; Kyoto Univ., Japan. I will report on recent progresses in manipulation of photons by photonic crystals. They include (1) ultrahigh-Q nanocavities and their applications, (2) thermal emission control with a very fast modulation speed, and (3) broad-area coherent photonic-crystal lasers with a high output-power.
FF1A • Imaging and Therapy Inside the Human Body—Continued

FF1B • Optical Fiber Sensors I—Continued

FF1B.2 • 08:45
Fast-light Enhanced Brillouin Laser Based Active Fiber Optics Sensor for Simultaneous Measurement of Rotation and Acceleration, Minchuan Zhou, Zhan Zhou, Mohammad Fadzi, Jacob Scheuer, Selim Shahnia, Northwestern Univ., USA; Tel Aviv Univ., Israel. We show an enhancement of ~358 for two counter-propagating Brillouin lasers in the sensitivity of an Active Fast Light Fiber Optic Sensor, which performs as a gyroscope and a sensor for acceleration, strain and temperature.

FF1B.3 • 09:00
A Kind of Mechanical Robust Photonic Crystal Fiber with Dual Luna Buffer Structure for Fiber Optic Gyroscope, Song Jingming, Weile Li, Cai Wei, Wenyong Luo, Wei Li, Beihang Univ., China; FiberHome Telecommunications Technologies COM, Ltd, China. A kind of mechanical robust photonic crystal fiber with dual luna buffer structure for fiber optic gyroscope (FOG) is proposed, which offers a new possibility to further optimize the condition characteristics of FOG.

FF1B.4 • 09:15
3D Shape Sensing using Optical Fiber, Brian Soller, Luna Innovations, Inc., USA. 3D shape sensing using optical fibers is discussed.

Biography: Dr. Soller joined the executive team as Vice President in April 2014. Prior to joining Luna he served as Vice President of Marketing for Micron Optics & VP of global sales and business development for Lightpath Technologies. Previously he spent ten years in fiber optics with Luna, beginning as a scientist and ultimately moving up through the organization to General Manager of the Products Division. Dr. Soller co-developed the instrumentation for fiber optic devices manufactured by Luna today. He has over 15 issued patents in optics with an expertise in the interferometric measurement field. He received a bachelor's and master's degree in mathematics and physics from the University of Wisconsin–La Crosse, and a doctoral degree from the Institute of Optics, University of Rochester.

FF1C • Quantum Information Processing in Integrated Systems—Continued

FF1C.3 • 09:00
A Quantum Fredkin Gate, Raj Patel, Joseph Ho, Franck Ferreyrol, Timothy C. Ralph, Geoff J. Pryde, Griffith Univ., Australia; Laboratoire Photonique, Institut d’Optique, France; School of Mathematics and Physics, Univ. of Queensland, Australia. We report the first demonstration of a quantum Fredkin gate using linear optics. In addition to excellent performance in the logical basis, the gate can generate high-fidelity GHZ states and is used in small-scale algorithms.

FF1C.4 • 09:15
Detection loophole-free heralded quantum steering over a high-loss quantum channel, Sergei Slussarenko, Morgan M. Weston, Helen M. Chrzanowski, Sabine Wollmann, Geoff J. Pryde, Griffith Univ., Australia; Clarendon Laboratory, Univ. of Oxford, UK. We demonstrate a single step quantum relay, allowing quantum steering for verifying entanglement between distant parties with detection loophole closed even in the presence of very high channel loss.

FF1D • Quantum Optical Technologies—Continued

FF1D.3 • 09:00
A Variable Partially-Polarizing Beamsplitter, Jefferson Flores, Codey Nacke, Nathan John Carlson, Caterina Bacci, Jeff S. Lundeen, Univ. of Ottawa, Canada. We present a variable partially-polarizing beamsplitter that allows for the complete and independent control of the horizontal and vertical polarization splitting ratios. It is based on a Sagnac interferometer and two liquid crystal cells.

FF1D.4 • 09:15
Spectral Compresssion of Single Photon Wavepackets by an Electro-optic Time Lens, Michal Jachura, Michal Karpiński, Brian J. Smith, Department of Physics, Univ. of Warsaw, Poland; Clarendon Laboratory, Univ. of Oxford, UK. We demonstrate sixfold spectral bandwidth compression of a single photon by employing electro-optic time lens. The device increases photon flux through a narrowband spectral feature, making a key step in development of hybrid quantum networks.

Join the conversation. Follow @Opticalsociety on Twitter. Use hashtags #FIo16 and #OSA100
Providing Silicon-Photonic Transceivers with an Efficient Laser Source: Where does "III-V/Silicon Heterogeneous Integration" Stand?, Sylvie Menzel; CEA-LETI, France. Packaging of finished III-V-chips (SOAs and DFB Lasers) is the strategy adopted for providing Si-Photonic transceivers with a laser source. We develop a general temporal coupled-mode theory formalism to derive bounds on the asymmetric radiation from a photonic crystal slab for arbitrary geometries and wavevectors, and present designs with asymmetry ratios exceeding 10^4.

Highly Directional Radiation from Photonic Crystal Slabs, Hengyun Zhou, Bo Zhen, Chia Wei Hsu, Owen Miller, Steven G. Johnson, John Joannopoulos, Marin Soljacic; MIT, USA. We will review advances in nanotechnology that have enabled fabrication of nanoscale optical devices in diamond, as well as discuss the applications of diamond photonic platform in nonlinear and quantum nanophotonics, optomechanics, and high-power optics.

Transmission of Individual Optical Signals through a Multimode Fiber Using Digital Optical Phase Conjugation, Lars Buettner, Daniel Haufe, Nektarios Koukourakis, Jürgen Czarske; Technische Universität Dresden, Germany. Transmission through a multimode fiber is demonstrated using phase conjugation. Using multiple windows of a spatial light modulator allows asynchronous imaging through the fiber. Potential for optogenetics and communications engineering is outlined.

Wide-Field Imaging Interferometer Testbed, Alexander S. Iacchetta, Owen Miller, David T. Leisawitz, Matthew R. Bolcar; Univ. of Rochester, USA; NASA Goddard Space Flight Center, USA. We discuss the results of an experiment to recover system aberrations from Wide-field Imaging Interferometer Testbed images. We model the system with a unifying wavefront for all wavelengths, allowing slowly varying axial chromatic aberrations.

Towards Wavefront Sensing with Metamaterials, Brian Vohnsen, Denise Valente, Rucha A Deshpande, Anders Fors, Sergey Bazhevolny; Univ. College Dublin, Ireland; Department of Technology and Innovation, Univ. of Southern Denmark, Denmark. Rapid phase variations caused by higher-order aberrations contain information that may not be captured using standard wavefront sensing techniques. We examine the possibilities for ultradense wavefront sensing using nanostructured metamaterials.

Flat, High Power VUV ($h\nu = 7.2$ eV) Lamp Tiles Comprising Large Arrays of Microwatt-Plasmas, Sung-Jin Park, Cyrus Herring, James G. Eden; Univ of Illinois at Urbana-Champaign, USA; Eden Park Illumination, Inc., USA. Flat lamps generating more than 20 W of average power in the vacuum ultraviolet with an efficiency above 10% have been realized. These narrowband lamps produce > 500 W of peak power in ~100 ns FWHM pulses at a repetition frequency up to 135 kHz.
FF1A • Imaging and Therapy Inside the Human Body—Continued

Multispectral Endoscopic Imaging Enabled by Mapping Spectral Bands into the Time Domain, Sarah A. Locknar, John B. Barton, Gary E. Carver; Omega Optical, Inc., USA. Rapid multispectral confocal imaging is performed with a single-shot-limited detector. This approach uses fiber delay lines to map spectral bands into the time domain, and has been integrated with fiber bundles for endoscopic applications.

Single-Shot Polarimetry Imaging of Multicore Fibers, Miguel A. Alonso, Siddharth Sivankutty, Esben R. Andersen, Gérard Bouwmans, Thomas G. Brown, Hervé Rigneault; Univ. of Rochester, USA; Institut Fresnel, France; Université Lille 1, France. We report an experimental test of single-shot polarimetry to monitor in real time the output polarization of multicore fibers. With this technique we characterize the Jones matrices of up to 180 fiber cores simultaneously.

FF1B • Optical Fiber Sensors I—Continued

FF1C • Quantum Information Processing in Integrated Systems—Continued

Photon-pair generation and sum-frequency conversion in nonlinear dielectric nanoresonators, Alexander S. Solntsev, Luca Carletti, Lei Xu, Alexander Poddubny, Costantino De Angelis, Giuseppe Leo, Yuri S. Kivshar, Andrey A. Sukhorukov; Nonlinear Physics Centre, Australian National Univ., Australia; Department of Information Engineering, Univ. of Brescia, Italy; ITMO Univ., Russian Federation; Ioffe Physical-Technical Inst. of the Russian Academy of Science, Russian Federation; Univ. Diderot-CNRS, France. We predict photon-pair generation with non-classical angular correlations through spontaneous parametric down-conversion in quadratic nonlinear AlGaAs nanoresonators, and establish a quantum-classical correspondence with sum-frequency conversion.

Measurement of Incompatible Observables via the Cloning of Quantum States, Rebecca Saaltink, Lambert Giner, Jeff S. Lundeen; Univ. of Ottawa, Canada; Max Planck Centre for Extreme and Quantum Photonics, Canada. We experimentally measure a complementary pair of observables, one on each of two optimally cloned photons. Just as in a classical version of this procedure, the results give the original state of the photon.

FF1D • Quantum Optical Technologies—Continued

Demonstration of a Bit-Flip Correction for Enhanced Sensitivity Measurements, Lior Cohen, Yehuda Pilnyak; Hebrew Univ. of Jerusalem, Israel. Error correction can be used to recover the sensitivity in a noisy environment. We implement such correction after a bit-flip error. Our results show 87% recovery of the sensitivity, independent of the noise rate.

Weak Values and Balanced Homodyne Detection Working Together, Julian Martinez, Weitao Liu, Gerardo Viza, John Howell; Univ. of Rochester, USA; National Univ. of Defense Technology, China. We present a metrological technique which, without discarding of data, resembles a larger anomalous amplification than weak-value-amplification (WVA). The protocol surpasses WVA techniques by amplifying an almost-balanced homodyne signal.
FF1E • Symposium on Integrated Photonic Manufacturing I—Continued

FF1E.4 • 09:30 Invited
Manufacturing Silicon Photonics for High-performance Datacom Systems, Keren Bergman1; Columbia Univ., USA. Manufacturing silicon photonics for high-performance datacom systems is discussed.

FF1F • Strongly Confined Nanoscale Waveguides, Photonic Crystals and Resonator Devices—Continued

FF1F.5 • 09:30 Invited
Silicon Optomechanical Structures and Coherent Microwave-to-optical Converters, Amir Safavi-Naeini1; Stanford Univ., USA. In this talk I will outline on-going experiments at the intersection of optomechanics, nonlinear optics, and quantum electromechanics.

FF1G • Wavefront Sensing and Phase Retrieval—Continued

FF1G.6 • 09:30
Segmented Spherical Space Telescope, Samuel T. Thurman1; Richard Kendrick2; Lockheed Martin Coherent Technologies, USA; 2Lockheed Martin Advanced Technology Center, USA. We present a space telescope concept based on a spherical primary mirror that is composed of segments mounted on small satellites that dock together. The telescope design and an on-orbit alignment approach will be discussed.

FF1G.7 • 09:45
A Water Phase Mask for Optical Encryption Applications, David R. Schipf1; Wei-Chih Wang1,2; Univ. of Washington, USA; 2National Tsinghua Univ., Taiwan. A new analog optical encryption scheme is presented that uses a parametrically driven shallow fluid as an oscillating phase mask in the Fourier domain. A simulation of the proposed encryption scheme is presented.

FF1H • General Optical Sciences I—Continued

FF1H.7 • 09:30
Nonisochronism of Material Vibrations in Stimulated Raman Scattering, Valeri I. Kovalyev1,2; P.N. Lebedev Physical Inst., Russian Federation; 2National Research Nuclear Univ. (MEPhI), Russian Federation. Evidence is found for decrease of the Raman shift in stimulated Raman scattering with increase of the pump intensity. It is shown that in fused silica the nonisochronism corresponds to saturation-type nonlinearity of material vibrations.

FF1H.8 • 09:45
Realization of Gain with Electromagnetically Induced Transparency using Zeeman Sublevels in 87Rb for Gravitational Wave Detection, Minchuan Zhou1, Zifan Zhou1, Selim Shahriar1; Northwestern Univ., USA. We show how to realize a negative dispersion medium using Zeeman sublevels in 87Rb, which produces a broad gain with an electromagnetically induced transparency dip, for enhancing the sensitivity-bandwidth product of a gravitational wave detector.

10:00–10:30 Coffee Break, West Corridor and Skyway Lobby (Radisson)

LF1 • Nanophotonics II—Continued

LF1I.4 • 09:30 Invited
Title to be Announced, Takashi Yabe1; Tokyo Inst. of Technology, Japan. Abstract not available.
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<td>10:30–12:30</td>
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Please check the Program Update Sheet for the Postdeadline abstracts.
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Highland Room A

10:30–12:30
LF2D • General Laser Science I
President: Joanna M. Atkin; Univ. of North Carolina-Chapel Hill, USA

Ultrafast XANES of Excited State Dynamics in Vitamin B_{12}, Nicholas A. Miller; Roseanne J. Sension; "Univ. of Michigan, USA. Ultrafast x-ray and UV-visible transient absorption spectroscopies were used to characterize the excited state dynamics of vitamin B_{12} covalent compounds. Polarized XANES was used to separate in-plane and out-of-plane contributions.

10:30–12:30
LF2E • General Laser Science II
President: Owen Miller; Yale Univ., USA

Two-Photon Absorption Spectrum of Fluorenone composites were measured using a sparsity-based signal analysis method. Quantitative analysis of the coupling strength mechanism leads to a unidirectional perfect optical isolator.

Highland Room B

10:30–12:30
LF2F • Quantum Light Sources II
President: Tsusumu Noda; Kyoto Univ., Japan

We present an experimental approach to quickly opened the path to extending attosecond science from atomic gases to solids. In this talk, the basic mechanisms driving strong field processes in solids, such as ionization and HHG, will be discussed.

Highland Room C

10:30–12:30
LF2G • General Laser Science III
President: Andy Aquila; Stanford Univ., USA

Optical rogue waves are highly unpredictable and non-reciprocal. They are studied by using symbolic time-series analysis. Pulse patterns that are likely to occur before the rogue wave are identified.

Highland Room D

10:45–12:30
LF2H • High Harmonic Generation II
President: Eleftherios Goulielmakis; Max-Planck-Inst. fur Quantenoptik, Germany

Predictability of Optical Rogue Waves in Optically Injected Semiconductor Lasers, Nuria Martinez Alvarez; Jose Reinoso; Cristina Masoller; Univ. Politecnica de Catalunya, Spain. The predictability of ultra-high pulses emitted by optically injected semiconductor lasers is studied by using symbolic time-series analysis. Pulse patterns that are likely to occur before the rogue wave are identified.

Highland Room E

10:30–12:30
LF2H • High Harmonic Generation II
President: Eleftherios Goulielmakis; Max-Planck-Inst. fur Quantenoptik, Germany

Invited

Invited

Invited

Invited

Invited
Highland Room A

LF2D • General Laser Science I—Continued

LF2D.4 • 11:15
Wide-band-gap semiconductor oxide optical microcavities, Hongxing Dong1, Yong Liu1, Long Zhang1, Zhihong Chen1, Long Zhang1,1 Shanghai Inst. of Optics and Fine Me, China; 2Fudan Univ., China. High quality ZnO microstructure optical cavities with different morphologies were fabricated by various physical/chemical vapor deposition methods. Optical resonant modes were directly observed experimentally.

LF2E • General Laser Science II—Continued

LF2E.4 • 11:15
Theory of Loss in a Distributed Feedback Cavity-Enhanced Single-Photon SPDC Source, Michael G. Raymer1, Dileeep V. Reddy1,1 Univ. of Oregon, USA. A nonlinear-optical waveguide with distributed optical feedback serves as a compact, high-brightness, narrowband SPDC source if the losses are low enough. A new theoretical formalism shows how to include distributed loss in such systems.

LF2F • Quantum Light Sources II—Continued

LF2F.3 • 11:30
Invited
Quantum Light on Silicon Photonic Chips, Qiang Lin1,1 Univ. of Rochester, USA. In this talk, we will discuss our recent progress in developing silicon photonic devices for producing non-classical light for quantum photonic applications.

LF2F.4 • 11:45
Nonlinear Interferometric Plasmonic Sensors, Emily M. Layden1,2, Tabitha Coulter1, Joseph M. Lukens1, Nicholas Peters1, Benjamin Lawre1, Raphael Pooser1, Quantum Information Science Group, Oak Ridge National Laboratory, USA. We demonstrate improved sensitivity for constant probe power with nonlinear interferometric plasmonic sensors.

LF2E • General Laser Science II—Continued

LF2E.5 • 11:30
Phase Mask-Based Superresolution Nonlinear Microscopy, Ryan Beams1, Stephen J. Strainick1, National Inst. of Standards & Technology, USA. We experimentally and theoretically explore various phase masks for superresolution nonlinear microscopy. By engineering the excitation and collection volumes, we can achieve resolutions of ≈λ/7 for a wide range of nonlinear processes.

LF2F.5 • 11:45
Plasmonic Bowtie Nanowires with Nano-crystal Quantum Dots for Single-Photon Source Applications, Svetlana G. Lukishova2, Dilyana Mihaylova1, Huiqing Zhu1, Andreas Liapis1,2, Robert W. Boyd1,1 Univ. of Rochester, USA; 2Brookhaven National Laboratory, USA. Absorption antireemission was observed from CdSeTe nanocrystal quantum dots within gold bowtie plasmonic nanowires. We also showed polarization selectivity in photoluminescence of gold bowtie nanowires.

LF4G • General Laser Science III—Continued

LF4G.4 • 11:15
Temporal Superoscillatory Pulse Generation, Hao Chenglong1,2, Hao Li1, Xia Yu1, Ying Zhang1, Changyu Yang1, Chengwei Dui1, National Univ. of Singapore, Singapore; 2Singapore Inst. of Manufacturing Technology, Singapore. The Hong Kong Polytechnic Univ., Hong Kong. We report the design of temporal superoscillatory pulse (TSP) generation. Theoretical model is analyzed. Simulation shows that a TSP with full width at half maximum (FWHM) is 65% of Fourier transform limited pulse is generated.

LF4H • High Harmonic Generation II—Continued

LF4H.3 • 11:30
Invited
Intense Laser-cluster Interactions in Mid-infrared Wavelengths, Louis F. DiMauro1,1 Ohio State Univ., USA. High-order harmonic generation and electron energy distribution are investigated in rare gases from atom to nano-scale clusters using intense mid-infrared fields. We discuss the shape dependence of the harmonics and photoelectrons at various wavelengths.
**LF2D • General Laser Science I—Continued**

**LF2D.7 • 12:00**
The Influence of an Electric Field on Reversible Photodegradation of a Dye-Doped Polymer, Benjamin R. Anderson\(^1\), Mark G. Kuzyk\(^1\); \(^1\)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 experimental observations.

**LF2E • General Laser Science II—Continued**

**LF2E.7 • 12:00**
Giant Enhancement in Nonlinear Optical-Atomic Magnetometry, Lu Deng\(^1\), F Zhou\(^1\), E.W. Hagley\(^2\); \(^1\)National Inst of Standards & Technology, USA; \(^2\)Wuhan Inst. of Physics & Mathematics, Chinese Academy of Sciences, China. We demonstrate a cross-polarization wave-mixing nonlinear atomic magnetometer that results in >500X optical signal-to-noise ratio enhancement with perfect field sensitivity preservation and significant reduction of laser power.

**LF2F • Quantum Light Sources II—Continued**

**LF2F.4 • 12:00**
Invited
Single Photons from Weakly Nonlinear Photonic Structures, Vincenzo Savona\(^1\), Hugo Play\(\acute{a}\)o\(^2\); \(^1\)Ecole Polytechnique Federale de Lausanne, Switzerland. It was predicted that a quantum optical system with arbitrarily weak nonlinearities can generate strongly subpoissonian light. I will review this phenomenon, present recent results, and discuss possible implementations in photonic platforms.

**LF2G • General Laser Science III—Continued**

**LF2G.7 • 12:00**
Toward BCF on small molecules, Scott E. Gali\(\acute{c}\)\(^1\), Leland Aldridge\(^1\), Donal Sheets\(^1\), Edward E. Eyler\(^1\); \(^1\)Univ. of Connecticut, USA. Theoretical work suggests that the optical bichromatic force (BCF) should be an effective method for slowing molecular species. We describe this together with progress on experimental application of the BCF to the diatomic molecule CaF.

**LF2H • Invited**
Title to be Announced, David A. Reis\(^1\); \(^1\)Stanford Univ., USA. Abstract not available.

**LF2D.8 • 12:15**
Ionization Dynamics in Intense Two-Color Circularly Polarized Laser Fields, Jan L. Chaloupka\(^1\), Daniel D. Hickstein\(^2\), Christopher A. Marcuza\(^2\), Kevin M. Dorney\(^2\), Henry C. Kapteyn\(^2\), Margaret M. Murmane\(^3\); \(^1\)Department of Physics and Astronomy, Univ. of Northern Colorado, USA; \(^2\)JILA - Department of Physics, Univ. of Colorado and NIST, USA. Ionization in intense two-color circularly polarized laser pulses is explored numerically and experimentally. Double ionization is enhanced with counterrotating fields, and diverse dynamics are uncovered that are impossible with linear polarization.

**LF2E.8 • 12:15**
White-light laser based on an organo-inorganic photonic structure, Yu-Cheng Hsiao\(^1\), Jui-Chieh Huang\(^1\), Yu-Ting Lin\(^1\), Wei Lee\(^1\); \(^1\)National Chiao Tung Univ., Taiwan. This study demonstrates the lasing modes in organo-inorganic photonic (OIP) structure. The OIP is composed of dye-doped cholesteric liquid crystal and photonic crystals. Through this device, a white-light laser source can be produced.

**LF2F.8 • 12:15**
Radiance Enhancement of Diode Laser Arrays Using Advanced Micro-optics and Passive Phase-locking Techniques, Sheldon S. Wu\(^1\), Frank Ravizza\(^1\), Raymond J. Beach\(^2\), Kurt Cüter\(^2\), Michael A. Johnson\(^1\), William Molander\(^2\), Mark Rotter\(^1\); \(^1\)Lawrence Livermore National Laboratory, USA. Significant advancements were made in the last decade in area of optical radiance conditioning for laser diode arrays. We present experimental results on single-bar arrays leveraging recent advances in several external-cavity phase-locking schemes.
**Grand Ballroom A (Radisson)**

**FF3A** • Advanced Microscopy Methods and Applications  
**Presider:** Daniel C. Cote, Universite Laval, Canada

**FF3A.1** • 13:30  
Invited  
High Dynamic Range Imaging in Brain Tissue, Jerome C. Mertz\(^1\), Rouhui Yang\(^1\), Timothy Weber\(^1\), Ian Davison\(^1\); \(^1\)Boston Univ., USA. An electronic add-on is described that vastly improves the dynamic range of a multiphoton microscope while reducing potential photodamage. The add-on provides real-time feedback to regulate the laser power delivered to the sample.

**FF3A.2** • 14:00  
Higher-Order Multiphoton Microscopy of the Beating Mouse Heart Using Resonant Scanning, Jason S. Jones\(^1\), David M. Small\(^1\), Nozomi Nishimura\(^1\); \(^1\)Cornell Univ., USA. Contractile motion and tissue light-scattering properties make in vivo microscopy studies of the heart difficult. We have developed a microscopy platform that uses 3PE excitation and fast acquisition techniques to make this possible.

**Grand Ballroom B (Radisson)**

**FF3B** • Optical Fiber Sensors II  
**Presider:** Jose Luis Santos, Universidade do Porto, Portugal

**FF3B.1** • 13:30  
Invited  
Lab-on-Fiber Technology for Biological Sensing Applications, Armando Ricciardi\(^1\), Andrea Cusano\(^1\); \(^1\)Univ. of Sannio, Italy. Lab-on-Fiber technology is an emerging research field envisaging the integration of functionalized materials and devices with optical fibers, aimed at developing a new generation of advanced all-in-fiber probes exploitable for biosensing applications.

**FF3B.2** • 14:00  
Integrated FBG Sensor Interrogator in SOI Platform using Passive Phase Demodulation, Ysbel Marin\(^1\), Tiziano Nannipieri\(^1\), Fabrizio Di Pasquale\(^1\), Claudio Otoni\(^1\); \(^1\)Scuola Superiore Sant’Anna, Italy. We present a Fiber Bragg Grating sensor interrogator in silicon-on-insulator (SOI) platform based on interferometric wavelength-shift detection. A commercial FBG readout unit is used as a reference for validation of dynamic strain measurement.

**Grand Ballroom C (Radisson)**

**FF3C** • Quantum Electronics I  
**Presider:** Christoph Marquardt; Max-Planck-Instit Physik des Lichts, Germany

**FF3C.1** • 13:30  
Invited  
Towards attosecond pulse generation in the X-ray regime, Hanieh Fattahi\(^1\), Ferenc Krausz\(^1\); \(^1\)Max-Planck-Institut fur Quantenoptik, Germany. A laser architecture based on the frequency synthesis of optical parametric chirped-pulse amplifiers is demonstrated. The apparatus keeps promise to generate multi-TW, high-power, light-transients, presenting a new route toward keV attosecond pulses.

**FF3C.2** • 14:00  
Holographic Reconstruction of Single Photon Spatial Wavefunction, Michal Jachura\(^1\), Radoslaw Chrapkiewicz\(^1\), Konrad Banaszek\(^1\), Wojciech Wasilewski\(^1\); \(^1\)Department of Physics, Univ. of Warsaw, Poland. We experimentally show that the complex transversal wavefunction of the unknown photon can be fully recovered from the spatially-resolved coincidence pattern resulting from its two-photon interference with the reference photon.

**Grand Ballroom D (Radisson)**

**FF3D** • Quantum Optical Measurement and Quantum Technologies I  
**Presider:** Nicolas Treps; Laboratoire Kastler Brossel, France

**FF3D.1** • 13:30  
Invited  
New Frontiers in Quantum Optomechanics: From Levitation to Gravitation, Markus Aspelmeyer\(^1\); \(^1\)Universitat Wien, Austria. The quantum optical control of levitated massive systems may enable a completely new class of experiments at the interface between quantum physics and gravity.

**FF3D.2** • 14:00  
Invited  
Putting the Photon into Photonics, Andrew G. White\(^1\); \(^1\)Univ. of Queensland, Australia. Realising the disruptive applications offered by quantum photonics requires efficient production, processing, and detection of single photons. Here we review significant recent progress in efficient photon generation and processing—using quantum-dot systems—and discuss attractive near-term applications.
Dobbelaere
Presider: Stefan Preble; Rochester
Photonic Manufacturing II
FF3E • Symposium on Integrated Photonic Manufacturing II
Presider: Stefan Preble; Rochester Inst. of Technology, USA

FF3E.1 • 13:30
Invited
Silicon Photonics: Applications and High Volume Manufacturing Platform, Peter de Dobbeleere1; 1LuXera, USA. We start with an introduction on applications of silicon photonics in high-speed data connectivity and highlight the advantages compared with other technologies. After that we will present our silicon photonics technology platform and how it enables high volume, high performance manufacturing of silicon photonics products. Amongst others we will address wafer manufacturing, device libraries, light source integration, packaging and assembly. We will illustrate the technology with some examples.

FF3E.2 • 14:00
Invited
Development of Integrated Photonic Packaging Standards and Foundry Capabilities, Peter A. O’Brien1; 1Photronics, Tyndall National Inst., Ireland. An overview of PIC packaging standards and foundry capabilities led by researchers at the Tyndall Inst. in collaboration with European partners will be presented. Details of optical and electrical packaging technologies will be reviewed.

Biography: Leonid V. Zhigilei studied materials science at the Leningrad Polytechnic Institute, Russia, and did is Ph.D. dissertation work on the structure of metallic glasses at Tomsk State University and St. Petersburg State University, Russia (Ph.D. degree 1991). After several years of industrial work in Russia and Lithuania, and postdoctoral work at the Department of Chemistry at the Pennsylvania State University, in 2000 he joined the Department of Materials Science and Engineering at the University of Virginia. His research interests are in the general area of computational materials science. Zhigilei has given more than 80 invited talks and authored more than 100 journal papers that have been cited more than 7000 times (his current h-index is 44).

FF3G.1 • 13:30
Invited
Propagation-invariant Beams: A Ray-optical Perspective, Miguel A. Alonso1, 1Univ. of Rochester, USA. A ray-based description of beams whose transverse shape is preserved under propagation (e.g. HG, LG, ICG, Airy, Mathieu and Bessel beams) is given, which clarifies their sometimes strange behavior and shows their surprising hidden geometry.

Biography: Miguel Alonso loves the mystery and surprises that physics and mathematics offer. He is a professor of physics and mathematics at the University of Rochester, NY, where he manages research on the propagation of light and sound waves in both free space and in many different material media. In addition to helping graduate students and postdocs pursue independent research, he is interested in the careful mentoring of teaching assistants, a role he has held for over a decade. Miguel Alonso is the author of dozens of research papers in published in refereed journals and proceedings, has written two books and teaches a course on geometric optics. He received his PhD in physics in 1999 from the University of Colorado at Boulder.

FF3G.2 • 14:00
Hilbert-Space Analyzers: Basis-Neutral Modal Analysis via Generalized Optical Interferometry, Lane Martin1, Walker D. Larson1, Hasan E. Kondakci1, Davood Marandi2, Soroush Shabahang1, Ali Jahromi1, Tanya Malhotra3, Nick Vamvakas4, George Atia5, Ayman Abouarady5; 1CREOL, Univ. of Central Florida, USA; 2Dept. Electrical Engineering and Computer Science, Univ. of Central Florida, USA; 3Department of Physics and Astronomy, Univ. of Rochester, USA; 4Institute of Optics, Univ. of Rochester, USA; 5Univ. of Colorado at Boulder. We demonstrate a ‘Hilbert-space analyzer’ capable of projecting optical beams onto any modal basis by exploiting an inherently stable interferometer in which the traditional delay is replaced by optical implementations of fractional transforms.

Biography: Lane Martin is an assistant professor of physics at the University of Rochester, where he joined the faculty in 2006. He received his Ph.D. in physics from the University of Colorado in 2005 under the supervision of Prof. Manos Mavrikakis. After two years as a postdoc at the Institute of Science, University of Southern Denmark, he moved to Rochester. His research interests are in the general area of computational materials science. He is the author of dozens of research papers in refereed journals and proceedings, has written two books and teaches a course on geometric optics. He received his Ph.D in physics in 1999 from the University of Colorado at Boulder.

FF3N.1 • 13:30
Removing Pulse Jitter with Temporal Waveguides, Brent Plansinis1, Govind P. Agrawal1, William R. Donaldson1; 1Inst. of Optics, Univ. of Rochester, USA; 2Laboratory for Laser Energetics, Univ. of Rochester, USA. A pair of temporal boundaries separated in time acts as the temporal analog of planar waveguides. We show numerically how such a waveguide can be used to remove pulse jitter and synchronize two pulses.

Biography: Brent Plansinis is a Ph.D. Student in the Optics Program of Rochester, USA. His research interests include optical pulse propagation, temporal waveguides, and ultrafast optical communications.

LF3I.2 • 14:00
Experimentation of Reflection and Refraction of Optical Pulses from Temporal Boundaries, Bethany J. Little1, Brent Plansinis1, Govind P. Agrawal1, John Howell1; 1Univ. of Rochester, USA. We experimentally implement the proposal of Plansinis et al. [PRL 115, (2015)] using slow light in Rb vapor. Time-dependent frequency shifts on probe pulses behave like angles in the analogous spatial reflection and refraction from classical optics.

Biography: Bethany Little finished her Ph.D. degree at the University of Rochester in the field of optical physics. Her work centers on the modulation and control of light as it propagates through optical waveguides. She has discovered unique light phenomena that can be used for encryption, quantum communication, and detection. Her research has been described in the New York Times and on CNN, and she was a TEDx speaker for Rochester. Her work has received industry awards from IBM, the Rochester Democrat & Chronicle, and Rochester Business Week. She was selected as a 2016 Outstanding Young Scientist by the National Academy of Inventors. She is the co-founder of a startup called Indigo Photonics, which uses her research to create novel optical devices for quantum computing.

LF3I.3 • 14:00
Attosecond Electron Dynamics in Transition Metals, Zhengsheng Tao1, Cong Chen1, Adra carr1, Piotr Matyba2, Tiber Savil2a, Sebastian Emmrich1, Martin Preuc2c, Mark Keller1, Dmitriy Zuzin1, Steffen Eich1, Markus Rollinger1, Wenjing You1, Stefan Mathias1, Uwe Thumm5, Manos Mavrikakis1, Martin Aeschlimann5, Peter M. Oppeneer1, Henry C. Kapa1, Margaret M. Murnane1; 1Univ. of Colorado at Boulder, USA; 2Dept. of Chemical and Biological Engineering, Univ. of Wisconsin-Madison, USA; 3Dept. of Physics and Research Center OP-TIMAS, Univ. of Kaiserslautern, Germany; 4Dept. of Physics, Kansas State Univ., USA; 5Dept. of Physics and Astronomy, Uppsala Univ., Sweden. We use attosecond pulse trains to directly measure photoelectron lifetimes in Ni(111) and Cu(111). We observe a strong influence of material band structure on the measured lifetimes, which reveal attosecond timescale electron screening and scattering.

Biography: Zhengsheng Tao is a professor in the Department of Physics at the University of Colorado Boulder. He studies ultrafast processes of single atoms and surfaces and uses ultrafast pump-probe techniques and combined pump-probe-diffraction experiments to understand fundamental physical properties of materials. Tao’s group is currently investigating ultrafast soft electron dynamics in transition metals for the development of attosecond x-ray and xUV techniques.

LF3L.1 • 14:00
Time-Resolved XUV and X-Ray Spectroscopy at the Free-Electron Laser Facility FLASH, Wilfried Wurth1, 2; 1Universität Hamburg, Germany; 2DESY Photon Science, Germany. Recent results from time-resolved spectroscopy studies in the XUV and soft-x-ray regime on ultrafast dynamics in solids and at surfaces obtained at FLASH at DESY in Hamburg will be presented.

Biography: Wilfried Wurth is an experimental physicist working at DESY in Hamburg. His group uses FEL based soft-x-ray and extreme-ultraviolet light to measure the time evolution of matter on the attosecond scale.

Biography: Bethany Little finished her Ph.D. degree at the University of Rochester in the field of optical physics. Her work centers on the modulation and control of light as it propagates through optical waveguides. She has discovered unique light phenomena that can be used for encryption, quantum communication, and detection. Her research has been described in the New York Times and on CNN, and she was a TEDx speaker for Rochester. Her work has received industry awards from IBM, the Rochester Democrat & Chronicle, and Rochester Business Week. She was selected as a 2016 Outstanding Young Scientist by the National Academy of Inventors. She is the co-founder of a startup called Indigo Photonics, which uses her research to create novel optical devices for quantum computing.

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Biography: Wilfried Wurth is an experimental physicist working at DESY in Hamburg. His group uses FEL based soft-x-ray and extreme-ultraviolet light to measure the time evolution of matter on the attosecond scale.
FF3A • Advanced Microscopy Methods and Applications—Continued

**FF3A.3 • 14:15**

Disease Modeling in Human Induced Pluripotent Stem Cell Derived Cardiomyocytes Using High-Throughput All-Optical Dynamic Cardiac Electrophysiology, Aleks Klimas1, Yi Yang Wu1, Christina Ambrosi1, Jinheu Yu1, John Williams2, Harold Brien3, Ghislain-Lyon4, Emilia Enecheva4; 1Biomedical Engineering, George Washington Univ., USA; 2Biomedical Engineering, Stony Brook Univ., USA; 3Cold Spring Harbor Laboratory, USA; 4Department of Molecular Genetics and Microbiology, Stony Brook Univ., USA. We present an all-optical high-throughput system for phenotyping and monitoring iPSC-CMs, with capabilities for performing personalized cardiotoxicity screening. We demonstrate the system’s utility for characterizing a new disease model in iPSC-CMs.

**FF3B • Optical Fiber Sensors II—Continued**

**FF3B.3 • 14:15**

A fiber-optic probe based on quantum dots integrated cavity for temperature sensing, Q. Zhang1, Hai Xiao1, Lei Yuan2; 1Clemson Univ. COMSET, USA. We report a trumpet-shape micro-cavity probe based on quantum dots for temperature sensing. By analyzing the fluorescence signals generated from the quantum dots, the temperature of the micro-cavity structure could be correlated.

**FF3C • Quantum Electronics I—Continued**

**FF3C.3 • 14:15**

Enhanced Second-Order Optical Nonlinearity in Doped Graphene on a Two-Dimensional Diffraction Grating, Tet-suyuki Ochiai1; 1National Inst. for Materials Science, Japan. Doped graphene placed on a diffraction grating can exhibit a strong modulation of graphene plasmon polarization in the THz range. We present a theoretical analysis of the enhanced second-harmonic generation in doped graphene for plane-wave irradiation.

**FF3D • Quantum Optical Measurement and Quantum Technologies I—Continued**

**FF3D.3 • 14:30**

Overcoming Vacuum Noise: The Unforeseen Benefits of Quantum Heterodyne Detection, Christian R. Mueller1,2, Christian Peuntinger1,2, Christoph Marquardt1,2, Gerd Leuchs1,2, Ulrich Vogl1,2, Christoph Marquardt1,2, Gerd Leuchs1,2, Luis L. Sánchez-Soto1,2, Yong Siah Teo3,4, Jaroslav Rehacek4; 1Max-Planck-Institut für Physik des Lichts, Germany; 2Inst. of Optics, Information and Photonics, Univ. of Erlangen-Nuremberg, Germany; 3Departamento de Optica, Facultad de Física, Universidad Complutense, Spain; 4Department of Optics, Palacky Univ., Czech Republic. We experimentally demonstrate that heterodyne detection outperforms homodyne tomography for almost all Gaussian states. Our results reveal the operational differences between the theoretically equivalent concepts of Wigner- and Husimi Q-functions.

**FF3A.4 • 14:30**

Cell Ablation in a Single Plane Illumination Microscope, John M. Girkin1, Charlotte Buckley2, Mariana Torres-Carvalho1, Laura Young1, Sebastien Rider1, Clare McFadden1, Caroline Carvalho2, Laura Young2, Charlotte Buckley2, Mariana Torres-Carvalho1; 1Physics, Univ. of Durham, UK; 2Queen’s Medical Research Inst., Edinburgh Univ., UK; 3Physics, Glasgow Univ., UK. We have developed a SPIM system with the ability to ablate single or groups of cells either through a photo-activated dye or direct cell ablation. Results will be presented demonstrating cellular ablation in the heart and kidney.

**FF3B.4 • 14:30**

Dual-LSPR based Optical-Fiber Sensor Platform for Multiplexed Biosensing Application, Nirmal S. Punjabi1, Soumyo Mukherji1; 1Indian Inst. of Technology, Bombay, India. Gold and silver nanoparticle decorated LSPR based fiber-optic probe has been designed for multiplexing. The dual nanoparticle coated probe is evaluated for RI sensitivity and multiplexed biosensing is demonstrated.

**FF3C.4 • 14:30**

Linear Amplifier Noise and Which-Path Information, James D. Franson1, Richard A. Brewster1; 1Univ. of Maryland Baltimore County, USA. Linear amplifiers are generally assumed to add noise that is independent of the signal. We show that which-path information left in the idler mode can produce decoherence effects that cannot be described by that model.

**FF3A.5 • 14:45**

Fast DMD based super-resolution structured illumination microscopy, Ming Lei1; 1Xian Inst of Optics and Precision Mech, China. We propose an alternative reconstruction algorithm based on image recombination transform (IRT), which provides an alternative solution to address this problem even in a weak modulation depth.

**FF3B.5 • 14:45**

Distributed Vibration Sensing: Principles, Techniques and Applications, Vincent Handerek1; 1Fotech Solutions Ltd., UK. This tutorial introduces the fundamental principles of distributed vibration sensing and technical elements that have enabled commercial development. Some limitations of the technology and possible ways to overcome them will also be discussed.
Quantum Optics I
14:30–15:30
Inst. of Technology, USA
Presider: Stefan Preble, Rochester

O'Brien
1;
Jeremy L.  
Title to be Announced,  
FF4A.1 • 14:30
Univ. of Bristol, UK.  
Abstract not
Invited

Sharum  
1  
propagation geometries is reported.  
Comparison  
THz pulse traveling in the opposite direction  
Enhanced Fluorescence from air plasma with  
We studied THz-Radiation-  
Rochester, USA.

Smith  
1;
The steering of THz pulses using thin emitters  
FF3F.4 • 14:45
The steering of THz pulses using thin emitters excited by tilted optical pulse-fronts, Bradley  
Smith1, John Whitaker1, Stephen Rand1; Univ. of  
Michigan, USA. A potentially scalable, efficient, and rapid method of steering THz pulses  
emitted from thin media using optical pulse-front tilt is developed theoretically and verified  
in a proof-of-concept experiment. This method can also measure pulse-front tilt.

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**FiO**

**Grand Ballroom A (Radisson)**

FF3A • Advanced Microscopy Methods and Applications—Continued

**Grand Ballroom B (Radisson)**

FF3B • Optical Fiber Sensors II—Continued

**Grand Ballroom C (Radisson)**

FF3C • Quantum Electronics I—Continued

**Grand Ballroom D (Radisson)**

FF3D • Quantum Optical Measurement and Quantum Technologies I—Continued

**Friday, 21 October**

**FF3A.6 • 15:00**

**Linking Cellular Disorder Strength and Shear Stiffness using Quantitative Phase Imaging**, William Eldridge⁴, Brianna Loomis⁴, Adam Wax⁴; ¹Duke Univ., USA.

Quantitative phase imaging (QPI) was implemented to image cells before and during subjugation of shear flow. Simultaneous evaluation of disorder strength and cellular stiffness showed a correlation between the two metrics.

**FF3C.6 • 15:00**

**Novel Single-photon Fringes from Momentum-Correlated Photon Pairs**, Mayukh Lahiri², Armin Hochrainer², Gabriela Lemos¹, Radek Lapkiewicz¹, Anton Zeilinger³; ¹Faculty of Physics, Univ. of Warsaw, Poland; ²Faculty of Physics, Univ. of Vienna, Austria; ³IQOIQ, Austrian Academy of Science, Austria.

We create a novel single-photon fringe pattern using non-degenerate photon pairs. Although one photon in each pair is not detected, its wavelength characterizes the fringe shift. The fringe visibility depends on the two-photon momentum correlation.

**FF3D.5 • 15:00**

**Non-linear Optomechanical Measurement in Sliced Photonic Crystal Nanobeams**, Rick Leijssen¹, Lars Fresen¹, Giada La Gala¹, Juha Muhonen¹, Ewald Verhagen¹; ¹FOM Inst. AMOLF, Netherlands.

We develop silicon sliced photonic crystal nanobeams with extreme coupling between light and motion. We demonstrate that measurements of the nanoscale thermal motion in these structures enter a new regime, where the readout is highly non-linear.

**Biography: Vincent Handerek** studied electrical engineering at Imperial College London, gaining a B.Sc.(Eng.) in 1975 and a PhD on polarised light in optical fibres. After researching fibre measurements in UK industry, he moved to the USA to work on polarisation maintaining components and fibre gyroscopes. In 1988, he joined King’s College London, concentrating on distributed optical fibre sensor research. In 1999, he returned to industry, developing optical amplification, communication, and sensing systems. Dr. Handerek joined Fotech Solutions Ltd. in 2008 to develop distributed acoustic vibration sensing systems. He has authored over 90 publications, three book chapters and a range of patents.

**FF3C.7 • 15:15**

**Directly Measuring the Density Matrix Using Weak Measurements**, Guillaume S. Thekkadath¹, Lambert Giner¹, Yann Chalish¹, Matthew Horton¹, Jash Barker¹, Jeff Lundeën¹; Univ. of Ottawa, Canada. We demonstrate a method to measure any chosen density matrix element of a quantum system. We determine a photon’s mixed or pure polarization state by sequentially weakly measuring three observables, each complimentary to the last.

**15:30–16:00 Coffee Break, West Corridor and Skyway Lobby (Radisson)**

**FF3D.6 • 15:15**

**Quantum correlations in measurement-based control of a mechanical oscillator**, Vivshek Sudhir¹, Dalziel Wilson¹, Sergey Fedorov¹, Ryan Schilling¹, Hendrik Schuetz¹, Amir Ghandi¹, Andreas Nunnenkamp², Tobias J. Kippenberg¹; ¹Ecole Polytechnique Federale de Lausanne, Switzerland; ²Cambridge Univ., UK. Quantum correlations are distilled by feedback on a mechanical oscillator. Feedback back-action is observed to destroy these correlations. A generalized uncertainty relation characterizes this transition between efficient and inefficient feedback.
FF3F • Ultrafast Dynamics and Laser Ion Acceleration—Continued

FF3F.5 • 15:00 Invited
Recent advances in laser-driven ion acceleration research, Marco Borghesi1; Queen’s Univ. of Belfast, UK. We will present recent experimental progress in ion acceleration driven by ultra-intense laser pulses, including optimization of the established Target Normal Sheath Acceleration process, as well as investigations of Radiation Pressure Acceleration.

FF3G • Polarization Control and Measurements—Continued

FF3G.6 • 15:00 Highly Asymmetric Polarization-Independent Near Infrared Light Transmission In An All-Dielectric Photonic Structure, Łukasz J. Zinkiewicz1, Michał Nawrot1, Jakub Haberkorn1, Piotr Wasylczyk2; 1Faculty of Physics, Univ. of Warsaw, Poland; 2Faculty of Physics and Applied Computer Science, AGH Univ. of Science and Technology, Poland. We designed and 3D-printed a dielectric structure, exhibiting significant difference in transmittance for the opposite incident wave vectors. Measured asymmetry is polarization-independent and spans over 70 nm in the near infrared (780 nm).

FF3G.7 • 15:15 The Phenomenon of Vector Polyphotochromism in Polarization-sensitive Materials, Barbara N. Kilosanidze1, Irakli Chaganava1, George Kakauridze1, Luis Oriol1, Milagros Piñol2, Alfonso Martinez-Felipe2; 1Laboratory of Holographic Recording and Processing of Information, Georgian Technical Univ., Inst. of Cybernetics, Georgia; 2Faculty of Science., Inst. of Materials Science of Aragon (ICMA), Univ. of Zaragoza-CSIC, Spain. Phenomenon of vector polyphotochromism was observed in some high-efficient polarization-sensitive materials dependent on the radiant exposure when material is illuminated with linearly polarized actinic light. The phenomenon has purely vector nature.

FF3H • General Optical Sciences II—Continued

FF3H.7 • 15:00 Ghost Imaging with Atoms, Roman I. Khakimov1; Research School of Physics and Engineering, Australian National Univ., Australia. Here we report the first realisation of ghost imaging of using atoms. The correlated pairs of ultracold metastable helium atoms are originating from two colliding (BECs) to generate the correlated atom pairs required for creation of a ghost image.

15:30–16:00 Coffee Break, West Corridor and Skyway Lobby (Radisson)
Unraveling Tissue Metabolism using Endogenous, Two-photon Imaging: Mechanisms and Diagnostic Biomarkers

Presider: Jonathan Lovell, SUNY Buffalo, USA

Integrated Dual-modal Microscope for Imaging of Key Metabolic and Vascular Endpoints in Preclinical Cancer Models

Presider: Martin Li, Megan C. Madonna, Marianne Lee, Helen Murphy, Nirmala Ramanujam; Biomedical Engineering, Duke Univ., USA. We have developed and utilized a widefield, high resolution microscope to capture multiple key metabolic and vascular endpoints to different indolent from metastatic disease.

Microkelvin Control of an Optically Levitated Nanoparticle

Presider: Viraj Jain; 1, Felix Tebbenjohanns; 1, Photonic Laboratory, ETH Zürich, Switzerland; 2, Physics, Univ. of Rochester, USA. Here, a high-power photodetector is used in conjunction with parametric feedback in an optical tweezer trap to cool the center-of-mass motion of a levitated nanoparticle from room temperature to 145 µK, or n = 21.

Quantifying Defect Densities in Monolayer Graphene Using Near-field Coherence Measurements

Presider: Rochi Dogariu; 1, James Grieve; 1, Brigitta Septriani; 1, Physics, Univ. Erlangen-Nürnberg, Germany. We report on the experimental implementation of a free-space setup for phase shifts controlled by a single ion. We determine the phase shift of a weak coherent beam to 2.2°.

Quantifying Defect Densities in Monolayer Graphene Using Near-field Coherence Measurements

Presider: Roxana Rezvani; 1, Georgia Inst. of Technology, France; 2, GT-CNRS, UMI 2958, Georgia Tech Lorraine, France. Recent plasmonics experiments focus light to 10 nm focal spots. We show that with such illumination, electrostatically gated graphene nanoribbon photoconductors produce photocurrents whose direction depends on illumination wavelength.

Thick-crystal regime in photon pair sources

Presider: Alexander Ling; 1, Georgia Inst. of Technology, USA; 2, NTU, Singapore. We present a thorough exploration of photon pair sources built around thick crystals, achieving concurrently high brightness and efficiency, despite pump beam walk-off. This surprising result is important when designing practical sources.

Quantum controlled phase shift with a single 4n mirror

Presider: Markus Weber; 1, Markus Sondermann; 1, Gerd Leuchs; 1, ETH Zurich, Switzerland. Abstract not available.

Quantum controlled phase shift with a single 4n mirror

Presider: Paolo Villoresi, Universita degli Studi di Padova, Italy

Title to be Announced

Presider: Andreas Wallraff; 1, ETH Zurich, Switzerland. Abstract not available.
Quantum simulation. Silicon PICs for quantum communications and measuring optical quantum states. We describe recent progress on programmable silicon PICs for quantum communications and quantum simulation.

Multiplexing of Integrated Single Photon Sources, Benjamin J. Eggleton; ‘Univ. of Sydney, Australia’. We present recent progress on increasing the probability of heralded single photon generation from integrated photonic devices through active spatial and temporal multiplexing.

Optical beam spatial modal analysis using a two-path generalized Michelson interferometer, Tanya Malhotra, Wesley Farris, James R. Fienup, Ayman Abouraddy, A. Nick Vami, James A. Davies, Tanya Malhotra, Wesley Farris, James R. Fienup, Ayman Abouraddy. We demonstrate stretchable, high-index-contrast photonic devices monolithically integrated on a PDMS elastomer substrates. The devices can sustain 42% strain and 3,000 stretching cycles without measurable optical performance degradation.

Generation of path-polarization hyperentanglement using quasi-phase-matching in quasi-periodic nonlinear photonic crystals, Chengrui Zhu, Xuechu Shen, 1; Ryan R. P. Burghartz, 2; Jonathan Simon, 1, 2; A. Nick Vami, 1; Tanya Malhotra, 1; James A. Davies, 1; Ayman Abouraddy, 1; 1Department of Physics, Optoelectronics and Quantum Electronics, Huazhong Univ. of Science and Technology, China. 2Wuhan National Laboratory for Optoelectronics, Huazhong Univ. of Science and Technology, China. A compact scheme for the generation of path-polarization entangled photon pairs is experimentally demonstrated. Giant Rabi splitting of ~270 meV for A exciton and ~780 meV for B exciton were obtained from the fitting of the cavity polariton dispersions.

A compact scheme for the generation of path-polarization hyperentanglement using quasi-phase-matching in quasi-periodic nonlinear photonic crystals, Chengrui Zhu, Xuechu Shen, 1; Ryan R. P. Burghartz, 2; Jonathan Simon, 1, 2; A. Nick Vami, 1; Tanya Malhotra, 1; James A. Davies, 1; Ayman Abouraddy, 1; 1Department of Physics, Optoelectronics and Quantum Electronics, Huazhong Univ. of Science and Technology, China. 2Wuhan National Laboratory for Optoelectronics, Huazhong Univ. of Science and Technology, China. A compact scheme for the generation of path-polarization entangled photon pairs is experimentally demonstrated. Giant Rabi splitting of ~270 meV for A exciton and ~780 meV for B exciton were obtained from the fitting of the cavity polariton dispersions.

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Methodologies are being developed for minimally invasive discrimination of early and late malignancies. Various novel nano-imaging applications, optical and ferroelectric properties of the nanoparticles tailored for electro-optical and nano-imaging applications, optical and ferroelectric properties of the produced colloids are discussed.

Raman spectroscopy can provide unlabelled information about tissue and can provide a non-invasive way to detect malignancies. This method can be particularly useful in early detection of malignancies, where traditional methods may not be as effective.

Quantum Coherence Emergent Self-Organized Criticality and Nonequilibrium Light Localization, Pankaj K. Jha 1,2, Kosmas Tsakmakidis 1, Yuan Wang 1, Xiang Zhang 1; 1Univ of California, Berkeley, USA. We introduce a quantum-coherence driven many-body photonic nanostructure, in which we observe self-organized phase-transitions to a new type of non-potential light localization, resilient to dissipation, fluctuations, and nonlinear interactions.

High-dimensional quantum cloning of orbital angular momentum qudits, Frederic Bouchard 1,2, Alexander V. Sergienko 1,2, Daan Jennewein 1,2, Robert Fickler 1, 1Univ. of Ottawa, Canada; 2Univ. of Rochester, USA. We present high-dimensional quantum cloning of orbital angular momentum quantum states of light. Moreover, we characterize the cloning machine for various dimensions and by performing full quantum state tomography on the cloned states.

Light-Matter Interactions using a Nanofiber-Segment Ring Resonator, Todd B. Pittman 1, Daniel E. Jones 1, Garrett Hickman 1, James D. Franson 1, 1Univ. of Maryland Baltimore County, USA. We describe work on a nanofiber-based ring resonator that enables strong interactions between the cavity-enhanced field and atoms near the nanofiber surface. This “all fiber” cavity has applications in nonlinear spectroscopy and quantum optics.
Quantum Photonics II—Continued

Konstantinos Lagoudakis

For new applications in communications, computing, and sensing.

Demonstration of Self-Aligned Flip-Chip Photonic Assembly with 1.1dB Loss and >120nm Bandwidth, Tymon Barwicz1, Yves Martin1, Jae-Woong Nah1, Swetha Kamnapurkar1, Robert L. Bruce1, Sebastian Engelmann1, Yuri A. Vlasov1, IBM TJ Watson Research Center, USA. We demonstrate direct flip-chip assembly of photonic dies with solder-induced self-alignment to sub-micron accuracy. We find a peak chip-to-chip transmission of -1.1 dB with 0.2 dB penalty over the 120 nm spectrum measured.

III-V-on-silicon Photonic Integrated Circuits for Optical Communication and Sensing, Gunther Roelkens1, Universiteit Gent, Belgium. The integration of III-V sources, high-speed germanium optical modulators and photodetectors on silicon waveguide circuits, and the co-integration with electronic integrated circuits will be discussed in this paper.

Evolution of coherence singularities of beams associated with structurally stable Gaussian modes, Tatiana Alieva1, Eugeny Abramochkin1, Jose A. Rodrigo2, Universidad Complutense de Madrid, Spain; Lebedev Physical Inst., Russian Federation. The propagation of partially coherent Schell model beams associated with structurally stable Gaussian modes is studied using ambiguity function. This allows deriving a simple expression for the cross-correlation function in near and far field.

Multiple Wavelength Concentric Vortex Optics: λ = 1064 nm and 2090 nm, Wenhui Li1, Yuan Li2, Keith Miller2, Eric G. Johnson1, Clemson Univ., USA. Using a single concentric vortex optic to generate vortices with multiplexed 1064 nm and 2090 nm laser sources is studied and experimentally confirmed. The rotation of the resulting diffracted patterns is also explored.

Vortex beam characterization in terms of Hypergeometric-Gaussian modes, Berenice C. Sephton1,2, Angela Dudley1, Andrew Forbes2, CSIR National Laser Centre, South Africa; Physics, Univ. of Witwatersrand, South Africa. Q-plates are commonly used for uncomplicated generation of polarization controlled vortex beams. Here we show experimentally that the output is not a pure vortex but rather a Hypergeometric-Gaussian mode. Results are in good agreement with theory.

A Simple Hubbard Model for the Excited States of N Conjugated-acene Molecules, Zheheng S. Sadegh1, John E. Sipe2, Physics, Univ. of Toronto, Canada. We investigate the excited states of tetracene, pentacene, and hexacene using a truncated Hubbard model; our technique yields reasonable energies and oscillator strengths. We show that the lowest doubly excited state acts like two triplets.

Dispersion Engineering in Whispering Gallery Mode Microbubble Resonators, Nicolas N. Resen1, Wenzhang Zhang2, Tanya I. Monro1, Inst. for Photonics and Advanced Sensing (IPAS), Univ. of Adelaide, Australia; Univ. of South Australia, Australia. The opportunities for engineering dispersion in whispering gallery microbubbles are explored. Using certain materials it is shown that dispersion equalization can be realized at interesting wavelengths such as deep within the visible or mid-infrared.
FF5A • In-vivo Spectroscopy, Metabolism and Raman—Continued

FF5A.4 • 17:30
Identification of Single Human Immune Cells with Wavelength Modulation Raman Spectroscopy, Mingzhou Chen1, Naom McReynolds1, E. C. Campbell1, Michael Maaliu1, Kishan Dhollakia1, Simon J. Powis1; 1Univ. of St Andrews, UK. We present a completely label-free optical method, wavelength modulation Raman spectroscopy (WMRS), for identifying closely related single human immune cells.

FF5A.5 • 17:45
Rapid detection of HIV1-p24 antigen in human blood plasma using Raman spectroscopy, Ben O. Otange2, Ronald Rop2, Julius O. Oyugi3, Zephania Birech1; 1Department of Physics, Univ. of Nairobi, Kenya; 2Department of Physics, Egerton Univ., Kenya; 3Department of medical microbiology, Univ. of Nairobi, Kenya. Raman spectroscopy together with principal component analysis (PCA) has been applied in detecting HIV1-p24 antigen in plasma. PCA distinguished Raman data of human blood Plasma contaminated with HIV1-p24 antigens from plasma without the antigen.

FF5B • Optical Manipulation, Processing and Applications—Continued

FF5B.7 • 17:30
Efficiency Enhancement in Organic Solar Cell using Dielectric Nanoparticles, Vidhi Mann1, Vipul Rastogi1; 1Physics, IIT Roorkee, India. We propose to incorporate the dielectric nanoparticles at anode to increase the efficiency of organic solar cells. 20% enhancement in efficiency could be achieved using the proposed organic solar cell structure.

FF5B.8 • 17:45
Raman spectroscopy of few-layer MoSe2 in wide range of temperature, Malgorzata M. Zinkiewicz1, Magdalena Grzeszyk1, Katarzyna Golasa1, Karol Nagajewski2, Adam Babinski1; 1Faculty of Physics, Univ. of Warsaw, Poland; 2LNCMI, CNRS-UJF-UPS-INSA, France. We focus on MoSe2 micro-Raman analysis in wide range of temperature (4-300 K) for sample thickness varying: 1 to 4 layers. Results are compared with previously studied excitation resonances at room temperature in this material.

FF5C • Quantum Electronics II—Continued

FF5C.7 • 17:30
Ancilla-aided recovery of quantum super-sensitivity diminished by decoherence, Walker D. Larson1, Bahaa E. Saleh1; 1UCF CREOL, USA. The quantum super-sensitivity of phase estimation in two-photon interferometry is diminished by decoherence. We show that this quantum advantage can be restored by employing an ancillary optical mode.

FF5C.8 • 17:45
Frequency Comb Generation at Near Visible Wavelengths in a Microbubble Resonator, Yong Yang1, Xuefeng Jiang2, Sho Kasumie1, Guangming Zhao2, Linhua Xu2, Jonathan Ward1, Lan Yang1, SilicNicChormaic1; 1Okinawa Inst of Science & Technology, Japan; 2Washington Univ., USA. We demonstrate frequency comb generation with 14 lines for visible wavelengths in a silica microbubble resonator, with a Q-factor of 10^7, via dispersion engineering. The visible wavelength comb has applications in metrology and bioimaging.

FF5D • Quantum Optical Measurement and Quantum Technologies II—Continued

FF5D.6 • 17:30
Ancilla-aided recovery of quantum super-sensitivity diminished by decoherence, Walker D. Larson1, Bahaa E. Saleh1; 1UCF CREOL, USA. The quantum super-sensitivity of phase estimation in two-photon interferometry is diminished by decoherence. We show that this quantum advantage can be restored by employing an ancillary optical mode.

FF5D.7 • 17:45
Theoretical Interpretation of Light Storage by Coherent Population Oscillation, Pascal Neveu1, Marie-Aude Maynard1, Chitram Banerjee1, Jasleen Lugani1, Etienne Brion1, Fabienne Goldfarb1, Fabien Bartenaker1; 1Laboratoire Aimé Cotton, France. We report a theoretical interpretation of an optical memory based on Coherent Population Oscillation (CPO). We introduce a new quantity superposition of light and matter that propagates with a controlled group velocity.
Quantum Photonics II—Continued

FF5E • Symposium on Integrated Quantum Photonics II—Continued

Highland Room A  Highland Room B  Highland Room C  Highland Room D  Highland Room E

FF5F • Hybrid Integration—Continued

FF5F.5 • 17:30
InAs quantum dot mode-locked lasers on a Si substrate by Pd-GaAs wafer bonding, Zhao Wang1, Stefan F. Frebel1, Michael Fant0, Jeffrey A. Steidle1, Chi Sen Lee1, Wei Guo1, Rochester Inst. of Technology, USA; Air Force Research Laboratory, USA; Univ. of Massachusetts-Lowell, USA. Room temperature operation of passively mode locked InAs quantum dot lasers integrated on a Si substrate are demonstrated by using low-temperature palladium-GaAs wafer bonding.

FF5F.6 • 17:45
Efficient extraction of zero-phonon-line photons from single nitrogen vacancy centers in an integrated GaP-on-diamond platform, Emma Schmidgall1, Michael Gould1, Shabnam Dadgostar2, Fariba Hatami2, Kai-Mei Fu1, Univ. of Washington, USA; Humboldt-Universität zu Berlin, Germany. We demonstrate coupling of single NV center zero phonon emission to integrated GaP-on-diamond waveguides, with estimated total quantum efficiency values above 10% due to Purcell enhancement and efficient coupling between the cavities and waveguides.

FF5F.7 • 18:00
Graphene-based electrostatic control of InAs quantum dots, Laura Kinnischtk1,2, Kenneth M. Goodfellow2,3, Chitraleema Chakraborty4, Ying M. Lai5, Antonio Badolato1, Stefan Fahl6, Werner Wegscheider1, A. Nick Vamivakas1,2, Department of Physics and Astronomy, Univ. of Rochester, USA; Center for Coherence and Quantum Optics, Univ. of Rochester, USA; Inst. of Optics, Univ. of Rochester, USA; Materials Science, Univ. of Rochester, USA; Solid State Physics Laboratory, ETH Zurich, Switzerland. We characterize voltage-dependent photoluminescence from single InAs quantum dots gated by graphene. Our device also exhibits a higher photon count rate than devices using thin-metallic films due to graphene’s low absorption.

FF5G • Beams and Optical Coherence—Continued

FF5G.5 • 17:30
Tunable Bessel Beam in 2D PPLT Crystal, Dongmei Liu1, Nanjing Univ., USA. We demonstrate the generation of a tunable diffraction-free Bessel beam from a 2D periodically-poled LiTaO3 crystal. Our observation not only enriches the diffraction-free optics, but also has potential applications for photolithography and imaging.

FF5G.6 • 17:45
Experimental Generation of Attenuation-resistant Frozen Waves Inside an Absorbing Medium, Ahmed Dorrah1, Michel Zamboni-Rached2, Mohammad Hafezi1, Venkata Vikram Orre1, Mohammad Mittal1, Jordan K. Ball1, QJRI/IREAP/Department of Electrical and Computer Engineering, Univ. of Maryland, College Park, USA. We study transport of entangled photons in a topological system of coupled-ring resonators and show that the edge states could enable robust on-chip quantum communication channels. We report on the experimental progress towards this demonstration.
FiO/LS Sessions, Symposia and Invited/Tutorial Speakers by Topic

FiO 1 Optical Design and Instrumentation

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FTu1F • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning, Tuesday, 08:00–10:00 .......................... page 37
FTu2F • Resolution and Measurement Limits, Tuesday, 10:30–12:00 .......................... page 43
FTu4A • Tutorial - Bill Casserly, Tuesday, 14:45–15:30 .......................... page 48
FTu5A • Optics in Consumer Electronics, Tuesday, 16:00–17:30 .......................... page 52
FW2C • Biomedical Optics, Wednesday, 10:30–12:00 .......................... page 58
FW2H • Adaptive Optics and Interferometry, Wednesday, 10:30–12:00 .......................... page 59
FW3H • Optical Design and GRIN Materials, Wednesday, 13:00–14:30 .......................... page 65
FW5G • Optical Fabrication and Metrology, Wednesday, 16:00–18:00 .......................... page 81
FW5H • Freeform Design and Metrology, Wednesday, 16:00–18:00 .......................... page 81
FTh4C • Computational Imaging I, Thursday, 14:00–16:00 .......................... page 98
FTh5C • Computational Imaging II, Thursday, 16:30–18:30 .......................... page 104
FF1G • Wavefront Sensing and Phase Retrieval, Friday, 08:30–10:00 .......................... page 111
FF3G • Polarization Control and Measurements, Friday, 13:30–15:30 .......................... page 121
FF5G • Beams and Optical Coherence, Friday, 16:00–18:00 .......................... page 127

Tutorial Speaker
FTu4A.1 • Illumination Design for Consumer Electronic Applications, William Casserly, Synopsys, Inc, USA, Tuesday, 14:45–15:30 .......................... page 48

Invited Speakers
FF3G.1 • Propagation-invariant Beams: A Ray-optical Perspective, Miguel Alonso, Univ. of Rochester, USA, Friday, 13:30–14:00 .......................... page 121
FW2H.4 • Advances in Adaptive Optics for Microscopy and Nanoscopy, Martin Booth, Univ. of Oxford, Univ. of Erlangen Nuremberg, UK, Wednesday, 11:15–11:45 .......................... page 61
FF5G.1 • Generation and propagation of a partially coherent beam, Yangjian Cai, Soochow Univ., China, Friday, 16:00–16:30 .......................... page 127
FW2C.1 • 3D High-definition Wide Field-of-view Optical Coherence Microscopy Advancing Real-time in-vivo Cellular Imaging, Cristina Canavesi, LightTopTech Corp., USA, Wednesday, 10:30–11:00 .......................... page 58
FTh5C.1 • Imaging Beyond the Limits: Active Imaging for Enhancing Resolution, 3D Information, and Indirect Imaging, Marc Christensen, Southern Methodist Univ., USA, Thursday, 16:30–17:00 .......................... page 104
FTu1F.3 • Inverse Methods and the Design of Subwavelength Scattering Elements for Superresolution, Michael Fiddy, Univ. of North Carolina at Charlotte, USA, Tuesday, 08:45–09:15 .......................... page 39

FW5G.4 • Optical Metrology Systems Spanning the Full Spatial Frequency Spectrum, Dae Wook Kim, Univ. of Arizona, USA, Wednesday, 17:00–17:30 .......................... page 81
FTu5A.1 • Human Centric Optical Design Enabling Next Generation Wearable Displays, Bernard Kress, Microsoft Corporation, USA, Tuesday, 16:00–16:30 .......................... page 52
FTh4C.1 • Nanoparticle and Virus Sensing Enabled by Computational Lensfree Imaging, Euan McLeod, Univ. of Arizona, USA, Thursday, 14:00–14:30 .......................... page 98
FW3H.1 • Tolerance Eigenmode Analysis of Optical Systems, John Rogers, Synopsys, Inc, USA, Wednesday, 13:00–13:30 .......................... page 65
FW5G.1 • Optical Fabrication Science & Technology for High Energy Laser Optics, Tayyab Suratwala, Lawrence Livermore National Laboratory, USA, Wednesday, 16:00–16:30 .......................... page 81
FTu1F.1 • Reconfigurable Photonics Metasurfaces, Nikolay Zheludev, Univ. of Southampton, Nanyang Technological Univ., UK, Tuesday, 08:00–08:30 .......................... page 37

FiO 2 Optical Sciences

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FTu2C • Laser-Matter Interactions, Tuesday, 10:30–12:00 .......................... page 42
FTu3C • Ultrafast Sources and Applications, Tuesday, 13:30–15:30 .......................... page 46
FTu3F • Optical Properties of Materials, Tuesday, 13:30–15:30 .......................... page 47
FTu5B • Laser Material Processing, Tuesday, 16:00–18:00 .......................... page 52
FTu5C • Frequency Combs and High Harmonic Generation, Tuesday, 16:00–18:00 .......................... page 52
FW2E • Exotic States and Applications I, Wednesday, 10:30–12:00 .......................... page 59
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FTh4B • Optical Vortices, Thursday, 14:00–16:00 .......................... page 98
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FF3F • Ultrafast Dynamics and Laser Ion Acceleration, Friday, 13:30–15:30 .......................... page 121
FF3H • General Optical Sciences II, Friday, 13:30–15:30 .......................... page 121
FF5B • Optical Manipulation, Processing and Applications, Friday, 16:00–18:00 .......................... page 126
FF5H • Exotic States and Applications II, Friday, 16:00–18:00 .......................... page 127
FThSD.3 • Imaging Microglia in the Physiological Brain, Anna Majewska, 
Univ. of Rochester, USA, Thursday, 17:30–18:00 ......................... page 106
FF3A.1 • High Dynamic Range Imaging in Brain Tissue, Jerome Mertz, Boston 
Univ., USA, Friday, 13:30–14:00 ............................................. page 120
FTh4D.1 • Multi Scale Morpho-functional Characterization of Damage and 
Rehabilitation After Stroke, Francesco Pavone, European Lab for Non-Linear 
Spectroscopy, Italy, Thursday, 14:00–14:30 ............................... page 98
FF5A.1 • Integrated Dual-modal Microscope for Imaging of Key Metabolic 
and Vascular Endpoints in Preclinical Cancer Models, Nirmala Ramanujam, 
Duke Univ., USA, Friday, 16:00–16:30 .................................... page 126
FTh1A.3 • Scanning Fiber Endoscopy with New Technologies and Forward- 
Viewing Applications, Eric Seibel, Univ. of Washington, USA, Friday, 
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FThSD.1 • Cone Signals, Adaptive Optics, and the Brain, Lawrence Sincich, 
Univ. of Alabama at Birmingham, USA, Thursday, 16:30–17:00 .......... page 104
FF5A.3 • Raman spectroscopic tools for medical applications., Nicholas Stone, 
Univ. of Exeter, Royal Devon and Exeter Hospital, UK, 17:00–17:30 .... page 128
FTh4D.2 • Chemical Sectioning: high throughputs in imaging brain networks 
ex vivo at synaptic resolution, Shaoqun Zeng, Huazhong Univ of Science 
& Technology, Wuhan National Lab for Optoelectronics, China, Thursday, 
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FiO 4 Fiber Optics and Optical Communications

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FTuI2 • Novel Fiber Devices, Tuesday, 10:30–12:00 .......................... page 43
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FW2F • Optical Fibers for Space Projects, Wednesday, 10:30–12:00 .... page 59
FW3B • Quantum Communications II, Wednesday, 13:00–14:15 .......... page 64
FW5B • High-Power Fiber Lasers and Beam Combining, Wednesday, 
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FTh4E • High-Capacity Optical Communications and Data Centers I, Thursday, 
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FF1B • Optical Fiber Sensors I, Friday, 08:00–10:00 .......................... page 110
FF3B • Optical Fiber Sensors II, Friday, 13:30–15:30 .......................... page 120

Tutorial Speakers

FTuI1.1 • UV Generation in Silica Fibres, Gilberto Brambilla, Univ. of 
Southampton, The Future Manufacturing Hub, UK, Tuesday, 08:00–08:45 .. page 37
FTuI5.1 • Polarization Effects in Optical Fibers For Distributed Sensing, 
Andrea Galtarossa, Universita degli Studi di Padova, Italy, Tuesday, 
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FW2F.1 • Recent Advances in Radiation Hardened Fiber-Based Technologies, 
Sylvain Girard, Universite Saint Etienne, USA, Wednesday, 10:30–11:15 ...... page 59
FF3B.5 • Distributed Vibration Sensing: Principles, Techniques and 
Applications, Vincent Handerek, Fotech Solutions Ltd., UK, Friday, 
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FW3B.1 • Quantum-crypto Systems in the Commercial Service Network, 
Jeongskil Cho, Univ. of Southampton, UK, Wednesday, 13:00–13:45 .... page 64
FF1B.1 • New Opportunities with, and Future Challenges of, Optical Fiber 
Sensor Technology, Jose Luis Santos, Universidade do Porto, Portugal, Friday, 
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FF1B.4 • 3D Shape Sensing using Optical Fiber, Brian Soller, Luna Innovations, 
Inc., USA, Friday, 09:15–10:00 .................................................. page 112
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Zhu, OFS Laboratories, USA, Thursday, 17:45–18:30 ........................ page 107

Invited Speakers

FW5B.1 • Coherent Beam Combining and Nonlinear Suppression of Multi-
Kilowatt All-Fiber Amplifiers, Angel Flores, US Air Force Research Laboratory, 
USA, Wednesday, 16:00–16:30 ......................................................... page 80
FTh4E.1 • Advanced Techniques for Digital Nonlinear Compensation in 
Multi-carrier Optical Transmission Systems, Fernando Guiochar, Politecnico 
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FW2F.3 • Miniaturized Interferometric Fiber Optical Gyroscopes for Space 
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FF3B.1 • Lab-on-Fiber Technology for Biological Sensing Applications, 
Armando Ricciardi, Univ. of Sannio, Italy, Friday, 13:30–14:00 ................ page 120
FW5B.7 • All-fiber Combining Concepts in the Wavelength Range Around 
2 µm, Hakan Sayinc, Laser Zentrum Hannover e.V., Germany, Wednesday, 
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FW2B.1 • The Interplay Between Cryptography and Quantum Technology - 
Challenges and Opportunities, Rainer Steinwandt, Florida Atlantic Univ., USA, 
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FTuI3.1 • The Inviscid Burgers’ Equation in Nonlinear Fiber Optics, Benjamin 
Wetzel, INRS - EMT, Univ. of Sussex, Canada, Tuesday, 13:30–14:00 .......... page 47
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<td>Silicon Photonics I</td>
<td>Tuesday, 08:00–10:00</td>
<td>Michal Lipson, Leuthold, Tuesday, 13:30–14:30</td>
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<td>Tu2D</td>
<td>Silicon Photonics II</td>
<td>Tuesday, 10:30–12:00</td>
<td>Amir Safavi-Naeini, Stanford Univ., USA, Thursday, 16:00–18:30</td>
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<td>Tu3D</td>
<td>Plasmonic and Photonic Crystal Devices</td>
<td>Tuesday, 13:30–15:45</td>
<td>Kerry Vahala, Univ. of California Berkeley, USA, Thursday, 16:00–18:00</td>
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<tr>
<td>Tu5D</td>
<td>Mid-Infrared Integrated Photonics</td>
<td>Tuesday, 16:00–17:45</td>
<td>Jonathan Klamkin, Marko Loncar, Wednesday, 14:00–15:30</td>
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<tr>
<td>FW3E</td>
<td>Plasmonics</td>
<td>Wednesday, 13:00–14:30</td>
<td>George Volker Sorger, Thales Research &amp; Technology, Tuesday, 14:00–15:30</td>
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<td>FW5D</td>
<td>Integrated Photonics</td>
<td>Wednesday, 16:00–18:00</td>
<td>Yeshaiahu Fainman, Univ. of California, San Diego, USA, Thursday, 16:00–18:00</td>
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#### Invited Speakers

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<tr>
<td>Tu5D.1</td>
<td>Mid IR Silicon Photonics</td>
<td>Tuesday, 16:00–16:30</td>
<td>Graham Reed, Univ. of Southampton, UK, Tuesday, 16:00–16:30</td>
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#### Technical Sessions

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<tr>
<td>Tu1G</td>
<td>Quantum Effects in Metamaterials</td>
<td>Tuesday, 08:00–10:00</td>
<td>Antonio Zentilli, D. Santamato, Thursday, 16:00–18:00</td>
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<td>Tu2G</td>
<td>Optics and Photonics of Disordered Systems</td>
<td>Tuesday, 10:30–12:00</td>
<td>Franz Bohn, Univ. of St. Petersburg, Thursday, 14:00–15:30</td>
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<td>Tu3G</td>
<td>Integrated Quantum Optics</td>
<td>Tuesday, 13:30–15:30</td>
<td>Rui Huang, Univ. of Science and Technology, Hong Kong, Thursday, 16:00–18:00</td>
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<td>Tu5G</td>
<td>Nonlinear Optics in Micro/Nano-Optical Structures</td>
<td>Tuesday, 16:00–18:00</td>
<td>Andrew Neureuther, Univ. of California Berkeley, USA, Thursday, 16:00–18:00</td>
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<td>Tu5D.1</td>
<td>Mid IR Silicon Photonics</td>
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<td>Graham Reed, Univ. of Southampton, UK, Tuesday, 16:00–16:30</td>
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<td>Tu5D.1</td>
<td>Quantum Entanglement</td>
<td>Tuesday, 16:00–16:30</td>
<td>Marko Loncar, Harvard Univ., Thursday, 14:00–15:30</td>
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- Large-data Center Interconnect: emerging technologies and scaling challenges, Xiang Zhou, Google, USA, Thursday, 16:30–17:00
- Quantum Effects in Metamaterials, Tuesday, 08:00–10:00
- Quantum Entanglement, Tuesday, 16:00–18:00
- Quantum Information Processing in Integrated Systems, Friday, 08:00–10:00
- Quantum Optical Technologies, Friday, 08:00–10:00
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- Quantum Optical Measurement and Quantum Technologies I, Friday, 13:30–15:30
- Quantum Optical Measurement and Quantum Technologies II, Friday, 16:00–18:00
- Quantum Optical Measurement and Quantum Technologies, Friday, 16:00–18:00
- Quantum Communication and Networking I, Thursday, 14:00–16:00
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- Quantum Information Processing in Integrated Systems, Friday, 08:00–10:00
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Yabashi, Makina - LTu5F.3
Yabe, Takashi - LF1I.4
Yabronovitch, Eli - FWSF.1, LF2E.2
Yakovlev, Alexey - JTh2A.87
Yablonovitch, Eli - FW5F.1, LF2E.2
Yablon, Joshua - JTh2A.102
Yabe, Takashi - LF1I.4
Yabashi, Makina - LTu5F.3
Yabe, Takashi - LF1I.4
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