

08:30–09:15

FM1A • Visionary: Jan-Erik Kallhammer

Presider: Sabbir Rangwala;
Patience Consulting LLC, USA

FM1A.1 • 08:30 VISIONARY

From Night Vision to LiDAR: An Automotive Perspective, Jan-Erik Kallhammer¹; ¹*Autoliv Sverige AB, Sweden*. Work is underway to complement cameras and radar with LiDAR in serial automotive use. There are many considerations besides technical challenges to be made before LiDAR can be launched as a serial product. The talk will draw on experiences of taking Night Vision to the automotive market.

09:15–10:00

FM2A • Visionary: Teri Odom
Presider: Ortwin Hess; Imperial College, London, UK**FM2A.1 • 09:15 VISIONARY**

Peering Through the Looking Glass: The Next Frontier in Nano-Optics, Teri W. Odom¹; ¹*Northwestern Univ., USA*. Over the past decade, significant progress in controlling light-matter interactions at the nanoscale has been achieved. Most of the advances, however, have relied on fixed systems limited to as-fabricated nanostructures and singly periodic arrays and simple unit cells. This visionary talk will discuss how the ability to engineer complex nanophotonics responses—on demand—may address key challenges and open unexpected possibilities in nanoscale optics. We will highlight new designs in topological photonics, stimuli-responsive nanostructured substrates for tunable nano-lasing and reconfigurable lensing, and prospects of multi-periodic structured materials.

08:00–10:00

LM1B • Quantum Science I

Presider: Evan Meyer-Scott; Universität Paderborn, Germany

LM1B.1 • 08:00

Hong-Ou-Mandel Effect Between Single-Photon Source and Thermal Light, Elisha Siddiqui¹, Tim Byrnes², Jonathan P. Dowling¹; ¹*Louisiana State Univ., USA*; ²*New York Univ., China*. We describe the theory of Hong-Ou-Mandel (HOM) interference, between a single photon source and thermal light and demonstrate the maximum visibility attainable for non-ideal single photon resources.

LM1B.2 • 08:15

Quantum-Limited Discrimination between Laser Light and Noise, Jonathan Habib¹, Saikat Guha²; ¹*Information Sciences Inst., Univ. of Southern California, USA*; ²*College of Optical Sciences, Univ. of Arizona, USA*. We evaluate quantum limits and structured receiver performance for discriminating between a mode excited in a thermal or a coherent state, and show an interesting inversion in receiver performance going from single-shot to collective measurements.

LM1B.3 • 08:30

Characterizing Photon Statistics in an Unbalanced Beam Splitter, Hamed Pourbeyram¹, Cody Bassett¹, Arash Mafi¹; ¹*Univ. of New Mexico, USA*. A theoretical framework has been developed and examined experimentally for photon statistics in an unbalanced beam splitter. We show that it is possible to determine the photon statistics of a lights source without coincidence counting.

LM1B.4 • 08:45

Quantum Enhanced Measurement Using SU(1,1) Interferometer with Dual-beam Sensing, Yuhong Liu¹, Jiamin Li¹, Liang Cui¹, Nan Huo¹, Xiaoying Li¹, Zheyu Ou^{1,2}; ¹*Tianjin Univ., China*; ²*Dept. of Physics, Indiana Univ.-Purdue Univ. Indianapolis, USA*. Using an SU(1,1) interferometer with dual-beam as the sensing field, we experimentally demonstrate the sensitivity of phase measurement is 2.4 dB higher than the standard quantum limit achieved by directly measuring a probe beam.

LM1B.5 • 09:00

Observation of One-way Einstein-Podolsky-Rosen Steering, Sabine Wollmann^{1,2}, Travis J. Baker², Nathan Walk^{2,3}, Adam Bennet², Nora Tischler², Howard M. Wiseman², Geoff J. Pryde², Jonathan C. Matthews¹; ¹*Univ. of Bristol, UK*; ²*Griffith Univ., Australia*; ³*Dept. of Computer Science, Univ. of Oxford, UK*. We prove and experimentally demonstrate that EPR-steering can be rigorously asymmetric, unlike Bell tests, by constructing quantum states which are steerable in one direction, whilst two-way steering is impossible with arbitrary quantum measurements.

LM1B.6 • 09:15

Generation of Photon-Subtracted Two-Mode Squeezed Vacuum States, Roberto d. Leon Montiel¹, Omar Magana Loaiza², Armando Perez Leija^{3,4}, Alfred U'Ren¹, Kurt Busch^{3,4}, Adriana E. Lita², Saw W. Nam², Thomas Gerrits², Richard Mirin²; ¹*Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de Mexico, Mexico*; ²*National Inst. of Standards and Technology, USA*; ³*Max-Born-Institut, Germany*; ⁴*Inst. für Physik, Humboldt-Universität zu Berlin, Germany*. We experimentally demonstrate that the simultaneous subtraction of photons from a two-mode squeezed vacuum state leads to the generation of entangled states with increasingly larger average photon number.

LM1B.7 • 09:30

Tailored photon-pair generation in optical fiber through dual-pump spontaneous four-wave mixing, Yujie Zhang¹, Ryan Spiniolas¹, Kai B. Shinbrough¹, Fang Bin¹, Offir Cohen¹, Virginia O. Lorenz¹; ¹*Dept. of physics, Univ. of Illinois at Urbana-Champaign, USA*. We experimentally tailor the joint spectra of photon pairs produced via dual-pump spontaneous four-wave mixing, achieving a joint spectral intensity without sidelobes, presenting a new route towards generating spectrally uncorrelated photon pairs.

LM1B.8 • 09:45

Generation of quantum correlated photons in different spatial modes using few-mode fibers, Cheng Guo¹, Jie Su¹, Zhenzhen Zhang¹, Liang Cui¹, Xiaoying Li¹; ¹*Tianjin Univ., China*. We generate photon pairs at 1550 nm telecom through the intermodal four-wave mixing between LP₀₁ and LP₁₁ mode in a few-mode fiber. The ratio of coincidence to accidental coincidence rates is measured to be 28.

08:00–10:00

LM1C • Carl E. Anderson Division of Laser Science Dissertation Award Presentations**LM1C.1 • 08:00**

Frequency Comb Generation from Laser Diodes, Mark Dong¹, Herbert G. Winful¹, Steven T. Cundiff¹; ¹*Univ. of Michigan, USA*. We model and experimentally characterize frequency combs generated from laser diodes. Their optical and RF spectra are measured and analyzed.

LM1C.2 • 08:30

An Optical Frequency Atomic Clock Based On Quantum Matter, Sara L. Campbell^{2,3}, Ross B. Hutson^{2,3}, G. E. Marti², Akihisa Goban², Nelson D. O'Connell², Rees L. McNally^{2,3}, Lindsay Sonderhouse^{2,3}, John M. Robinson^{2,3}, Wei Zhang², Benjamin J. Bloom^{2,3}, Jun Ye^{2,3}; ²*JILA, NIST and Univ. of Colorado, USA*; ³*Dept. of Physics, Univ. of Colorado, USA*. We present the first atomic clock based on quantum degenerate matter, which reaches a record spectroscopic quality factor of $Q = 5.2e15$ and can measure a frequency difference to 3e-19 in 2 hours.

LM1C.3 • 09:00

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

LM1C.4 • 09:30

Manipulation of Photonic Quantum States: From Generation, Engineering, and Characterization To Storage And Retrieval, Bin Fang¹; ¹*Dept. of Physics, Univ. of Illinois at Urbana-Champaign, USA*. We present our work on various critical aspects of manipulation of photonic quantum states, including the generation of entangled states, engineering of the spectral correlations of photon-pairs, characterization of quantum states and ultra-broadband storage.

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

10:30–11:15

LM3A • Visionary: Prem Kumar
Presider: Peter Delfyett;
University of Central Florida,
USA

LM3A.1 • 10:30 **VISIONARY**

Quantum Communication and Networking, Prem Kumar¹; ¹*Northwestern Univ., USA*. Machines that process quantum information are likely to be commercially available in the near future. Networking them via quantum communication to achieve a higher level of performance is a topic of current interest. In this talk I will review the current status and speculate on the future possibilities.

11:30–12:30

LM3B • Quantum Science II
Presider: Peter Rakich; Yale
University, USA

LM3B.1 • 11:30 **Invited**

Engineering Integrated Sources of Entangled Photon Pairs, Evan Meyer-Scott¹, Nidhin Prasannan¹, Nicola Montaut¹, Johannes Tiedau¹, Georg Harder¹, Linda Sansoni¹, Harald Herrmann¹, Christof Eigner¹, Raimund Ricken¹, Viktor Quiring¹, Tim J. Bartley¹, Sonja Barkhofen¹, Christine Silberhorn¹; ¹*Univ. of Paderborn, Germany*. We present progress on our optimization of photon pair sources using waveguides. The sources show high heralding efficiency, indistinguishability, brightness, and entanglement visibility, and require low pump power.

10:30–12:30

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

FM3C.1 • 10:30 **Invited**

Structured Light-Matter Interactions in Nano-Engineered Nonlinear Photonic Media, Natalia M. Litchinitser¹, Jingbo Sun¹, Wiktor Walasik¹, Salih Silahlı², Yun Xu², Mikhail Shalaev¹, Jesse Frantz³, Jason Myers³, Robel Bekele⁴, Jasbinder Sanghera³, Alexander Tsukernik⁵; ¹*Duke Univ., USA*; ²*Univ. at Buffalo, The State Univ. of New York, USA*; ³*US Naval Research Lab, USA*; ⁴*Univ. Research Foundation, USA*; ⁵*Univ. of Toronto, Canada*. We discuss theoretical and experimental studies of the nonlinear beam shaping in engineered nano-colloidal suspensions with negative polarizability and saturable nonlinearity and in all-optically reconfigurable chalcogenide glass based metasurfaces.

FM3C.2 • 11:00

Self-imaging of Azimuthal Intensity Petal Based on Orbital Angular Momentum Beams, Jianqi Hu¹, Camille-Sophie Bres¹, Chen-Bin Huang²; ¹*École polytechnique fédérale de Lausanne, Switzerland*; ²*National Tsing-Hua Univ., Taiwan*. We demonstrate for the first time azimuthal Talbot effect based on orbital angular momentum beams. The intensity petal is self-imaged in the azimuthal angle. We also draw the analogy between azimuthal and temporal Talbot effect.

FM3C.3 • 11:15

The zoo of topological singularities in 2D random waves: from phase and polarization singularities to polarization vortices, Lorenzo De Angelis¹, Filippo Alpeggiani¹, L. Kuipers¹; ¹*Kavli Inst. of Nanoscience, Delft Univ. of Technology, Netherlands*. With experiments and theory, we demonstrate that the correlation of C points in random light undergoes dramatic changes when confining waves propagation to 2D, concluding a comprehensive overview on topological singularities in random light.

FM3C.4 • 11:30

Measuring Geometric Phase Without Interferometry, Rodrigo Gutiérrez-Cuevas¹, Tanya Malhotra¹, Jeremy Hassett¹, Mark R. Dennis^{2,3}, Anthony N. Vamivakas¹, Miguel A. Alonso^{1,4}; ¹*Univ. of Rochester, USA*; ²*Univ. of Bristol, UK*; ³*Univ. of Birmingham, UK*; ⁴*Aix Marseille Université, Centrale Marseille, Institut Fresnel, France*. A simple, non-interferometric method for measuring geometric phases of structured-Gaussian beams is presented. By studying the intensity distribution of an occluded beam, the Gouy and Pancharatnam-Berry phases can be determined.

10:30–12:30

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

FM3D.1 • 10:30

Performance of an Adaptive Optics System in the Presence of Diffractive Grooves, Emily Finan¹, Tom D. Milster¹, Youngsik Kim¹; ¹*Univ. of Arizona, USA*. Diffractive phase introduced by light reflected from grooves on optical storage media might be problematic for AO correction in high-performance systems. Simulations and experiments are presented to examine the performance of AO with media samples.

FM3D.2 • 10:45

Three-dimensional Direct Laser Writing of Ultra-low Density Neuron-inspired Steiner Tree Structures, Haoyi Yu¹, Qiming Zhang¹, Min Gu¹; ¹*RMIT Univ., Australia*. We fabricate neuron-inspired Steiner tree structures using the three-dimensional direct laser fabrication method. An ultra-low density three-dimensional Steiner tree structure with the feature size of 1 μm is achieved.

FM3D.3 • 11:00

Full-Field Optical Coherence Tomography Using Acousto-Optically Tuned External-Cavity Laser Diode and Wavelet Transform, Takamasa Suzuki¹, Gen Suda¹, Samuel Choi¹, Osami Sasaki¹; ¹*Niigata Univ., Japan*. An acousto-optically tuned external-cavity laser diode using Littrow configuration is proposed. The thickness distribution of a cover glass was obtained using this light source with maximum scanning range of 45 nm and continuous wavelet transform.

FM3D.4 • 11:15

Development of Flexible Pad Polishing for Freeform Surface, Vinod Mishra^{1,2}, Daliramu Burada², Vinod Karar¹, Alakesh Manna³, Gufran Khan²; ¹*Optical Devices and System, CSIR-CSIO, India*; ²*IDDC, IIT Delhi, India*; ³*Mechanical Engineering, PEC Chandigarh, India*. A method for polishing of freeform mould is demonstrated by using flexible pad polishing on a diamond turning machine. The results show that the presented polishing setup is capable to polish low slope freeform optics.

FM3D.5 • 11:30

Describing Mid-Spatial Frequencies consistently for Optical Design, Manufacturing and Metrology, Sven Wickenhagen¹, Anna Möhl¹, Ulrike Fuchs¹; ¹*Asphericon GmbH, Germany*. This paper is dealing with different specifications and tolerancing of Mid-spatial frequency (MSF) for aspheric and freeform surfaces. Various models are discussed with respect to suitability for optical design, manufacturing, and metrology.

10:30–12:35

FM3E • LIDAR Approaches and the Demands on Optical Components*Presider: Sabbir Rangwala; Patience Consulting LLC, USA*FM3E.1 • 10:30 **Invited**

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

FM3E.2 • 10:54 **Invited**

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

FM3E.3 • 11:18 **Invited**

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

10:30–12:30

FM3F • Biomedical Optics*Presider: David Busch; UT Southwestern Medical Center at Dallas, USA*FM3F.1 • 10:30 **Invited**

From Man To Mouse: Translational Studies in Stroke Recovery, Adam T. Eggebrecht¹, Adam Q. Bauer¹; ¹Radiology, Washington Univ. in Saint Louis, USA. This joint talk will cover 1) Bedside neuromonitoring with high density DOT during the acute phase of stroke recovery and 2) Understanding and optimizing endogenous mechanisms of stroke recovery in mouse models of stroke.

FM3F.2 • 11:00

Evaluation of Oximetry Measurement Accuracy of Multispectral Photoacoustic Imaging Systems Using a Dynamically Tunable Blood Flow Phantom, Xuewen Zhou¹, William C. Vogt¹, Rudy Andriani¹, Keith Wear¹, Brian Garra¹, Joshua Pfefer¹; ¹US Food and Drug Administration, USA. A blood flow phantom with tunable oxygen saturation (SO₂) was developed as an oximetry performance test method for emerging photoacoustic imaging systems. Results highlight the importance of fluence corrections in improving SO₂ measurement accuracy.

FM3F.3 • 11:15

Porcine Tissues Characterization by Diffuse Reflectance Spectroscopy, Felix Fanjul-Velez¹, Jose Luis Arce-Diego¹; ¹Univ. of Cantabria, Spain. Biological tissues characterization can be made by diffuse reflectance spectroscopy (DRS). Tissue discrimination is critical in surgery. In this work data from porcine tissues are statistically analyzed for estimating discrimination potential.

FM3F.4 • 11:30

Pulsed-Laser-Induced Modification of Gold Nanorods: Damage Thresholds and Impact on Photoacoustic Imaging in Turbid Media, Andrew M. Fales¹, William Vogt¹, Keith Wear¹, Ilko Ilev¹, Joshua Pfefer¹; ¹U.S. Food and Drug Administration, USA. Nanorod reshaping during photoacoustic imaging (PAI) may severely impact performance. Nanorod damage thresholds were studied with electron microscopy and spectrophotometry, and the effect of laser exposure on PAI was studied in a turbid phantom.

10:30–12:30

FM3G • Frontiers of Nanoplasmonics: New Materials – Active – Slow Light*Presider: Ortwin Hess; Imperial University, UK*FM3G.1 • 10:30 **Invited**

Solids in Ultrafast Strong Laser Fields: Optical Control of Electronic State, Mark Stockman¹; ¹Georgia State Univ., USA. When a strong optical field with amplitude comparable to the internal fields acts on a solid, it creates, for a femtosecond duration of the pulse, a new state of solid where fundamental properties are modified.

FM3G.2 • 11:00 **Invited**

Nanophotonics with metal nitrides and carbides: from bulk to 2D, Alexandra Boltasseva¹; ¹Purdue Univ., USA. We explore emerging materials for nanophotonics, plasmonics and optical metasurfaces namely transition metal nitrides and carbides in their bulk, ultra-thin and 2D form known as MXenes for applications in on-chip circuitry, sensing, energy.

FM3G.3 • 11:30 **Invited**

Bose-Einstein Condensation and Ultrafast Lasing in a Plasmonic Lattice, Paivi Torma¹, Tommi Hakala¹, Antti Moilanen¹, Aaro Väkeväinen¹, Rui Guo¹, Jani-Petri Martikainen¹, Konstantinos Daskalakis¹, Heikki Rekola¹, Aleksi Julku¹; ¹Aalto Univ., Finland. We demonstrate a Bose-Einstein condensate (BEC) of surface plasmon polaritons in lattice modes of a metal nanoparticle array interacting with molecules. A crossover from BEC to ultrafast lasing is realized by tailoring the band structure.

LM3B • Quantum Science II—
Continued

LM3B.2 • 12:00 **Invited**
Optical-Fiber Source of Energy-Entangled Three-Photon W-State, Virginia O. Lorenz¹; ¹*U. Illinois at Urbana-Champaign, USA*. We experimentally demonstrate an energy-entangled three-photon W-state source based on spontaneous four-wave mixing in polarization-maintaining optical fiber. We characterize the source using reduced density-matrix tomography, without the need for frequency conversion.

FM3C • Advanced Beam
Shaping and Trapping—
Continued—Continued

FM3C.5 • 11:45
Generation of Quantum Airy Photons, Santosh Kumar¹, Stephanie Maruca¹, Yong Meng Sua¹, Yu-Ping Huang¹; ¹*Dept. of Physics, Stevens Inst. of Technology, USA*. Airy beams have been studied for many exciting applications. Here we extend those studies to the quantum domain by creating quantum-correlated photons in Airy spatial modes and explore their potential applications.

FM3C.6 • 12:00
Huygens Dipole for Nanolocalization, Ankan Bag^{1,2}, Martin Neugebauer^{1,2}, Pawel Wozniak^{1,2}, Gerd Leuchs^{1,2}, Peter Banzer^{1,2}; ¹*Max Planck Inst. for the Science of Light, Germany*; ²*Inst. of Optics, Information and Photonics, Dept. of Physics, Friedrich-Alexander-Univ. Erlangen-Nuremberg, Germany*. We discuss a nanolocalization technique with sub-nanometer localization resolution based on position dependent transverse Kerker scattering, obtained via interference of tailored electric and magnetic dipole moments.

FM3C.7 • 12:15
Arrays of dark optical traps on a toroidal surface, Jakub Belin¹, Vassilis Lembessis², Andreas Lyras², Omar Aldossary^{2,3}, Johannes K. Courtial¹; ¹*Univ. of Glasgow, UK*; ²*Dept. of Physics and Astronomy, College of Science, King Saud Univ., Saudi Arabia*; ³*The National Center for Applied Physics, KACST, Saudi Arabia*. We have theoretically constructed light fields containing arrays of dark optical traps distributed on the surface of a torus. The array dimensions are not diffraction-limited and their period can be, in principle, deeply sub-wavelength.

FM3D • Novel Devices,
Manufacturing and Testing—
Continued

FM3D.6 • 11:45
Vibration Testing and Thermal Vacuum Flight Qualification of NASA's Global Ecosystem Dynamics Investigation (GEDI) Laser Transmitters, Furqan Chiragh³, Donald B. Coyle¹, Erich Frese², Paul R. Stysley¹; ¹*NASA Goddard Space Flight Center, USA*; ²*ASRC Federal Space and Defense, USA*; ³*Velos LLC, USA*. The GEDI Mission will employ three lasers systems developed, built, and tested by NASA Goddard Space Flight Center. We discuss the flight level Thermal Vacuum (TVAC) and vibrational qualification testing each unit must pass.

FM3D.7 • 12:00 **Invited**
Electrically Tunable Liquid Crystal Lenses for Augmented Reality, Yi-Hsin Lin¹; ¹*National Chiao Tung Univ., Taiwan*. We demonstrate an optical-see-through system via liquid crystal lenses for augmented reality (AR) in order to solve the challenges of vision correction and image registration. The optical zoom function is also added in the AR system.

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

12:30–14:00 Lunch break on your own

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

FM3E.4 • 11:42 **Invited**
Integrated Optical Phased Arrays for Solid-State LiDAR, Matthew Byrd; *Analog Photonics, USA*. LiDAR with integrated optical phased arrays provides an attractive solution to the automotive industry by enabling solid-state, small form factor systems. Here, we review this technology and present beam steering and real-time coherent LiDAR results.

FM3E.5 • 12:06 **Invited**
A vehicle platform perspective on 3D sensing, Matthew Weed, *Luminar Technologies, USA*. Photons are the currency of LiDAR design, but time is the currency of self-driven vehicles. High-resolution, long-range 3D data with low latency gives these vehicles enough time to make safe, informed decisions about their environment.

FM3F • Biomedical Optics—Continued

FM3F.5 • 11:45
Supercontinuum Laser for Spectroscopic Photoacoustic Imaging of Lipids in the Extended Near-Infrared Region, Manoj Kumar Dasa¹, Christos Markos¹, Michael Maria¹, Ivan Gonzalo¹, Christian Petersen¹, Peter Morten Moselund², Ole Bang^{1,2}; ¹*Technical Univ. of Denmark, Denmark*; ²*NKT Photonics, Denmark*. We demonstrate a cost-efficient high-power supercontinuum laser source based on a telecom range diode laser system and few meters of a standard optical fiber for spectroscopic photoacoustic imaging of lipids in the extended near-infrared region.

FM3F.6 • 12:00 **Invited**
Lowering the Cost and Improving the Usability of Retinal Imaging and Visual Function Assessment, Ann E. Elsner^{1,2}, Matthew S. Muller², Joel Papay¹, Bryan P. Haggerty¹, Thomas J. Gast^{1,2}, Stephen A. Burns¹; ¹*Indiana Univ., USA*; ²*Aeon Imaging, LLC, USA*. Cost, size, and complexity are all barriers to the use of improved optical technology to provide eye care. Resolution, wavelength, and computer-assisted detection of imagers can be targeted to the optical signature of biomarkers.

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

FM3G.4 • 12:00 **Invited**
Non-Equilibrium Photonics with Self-Adaptive Order, Xiang Zhang¹, Chad Ropp¹, Nicolas Bachelard¹, David Barth¹, Yuan Wang¹; ¹*UC Berkeley, USA*. Structures driven far from thermodynamic equilibrium can self-organize and behave as artificial living matter. We show how such dynamic order emerges in an array of initially disorganized photonic resonators, coupled through thermo-optic feedback.

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

12:30–14:00 **Lunch break on your own**

14:00–16:00

LM4A • Quantum Science III

Presider: Peter Rakich; Yale University, USA

LM4A.1 • 14:00 **Invited**

Photons Probe Processes in the Brain, Robert R. Alfano¹; ¹CUNY City College, USA. The salient properties of photons as they enter and excite quantum processes in brain tissue: spin and orbital angular momentum, complex wave front, polarization, classical and quantum entanglement will be presented.

LM4A.2 • 14:30

Correlation Properties of Photon Pairs Generated near the Pump in the Normal Group-Velocity-Dispersion Regime, Kyungdeuk Park¹, Dongjin Lee¹, Yong Sup Ihn¹, Yoon-Ho Kim¹, Heedeuk Shin¹; ¹POSTECH, South Korea. We present photon pairs generated near the pump wavelength in the normal GVD regime by spontaneous four-wave mixing. The generated photons have temporal and spectral correlations and can be exploited as telecom-band quantum light sources.

LM4A.3 • 14:45 **Invited**

Quantum Acoustics: Controlling Phonons Using Light and Superconducting Circuits, Peter Rakich¹; ¹Yale Univ., USA. We demonstrate powerful new strategies to control high frequency (10-40GHz) bulk acoustic phonons using optomechanical interactions and superconducting circuits. We identify a path towards robust ground-state control in cavity optomechanics and realize complex quantum states using circuit QED techniques.

14:00–16:00

FM4B • Light – Matter Interaction

Presider: To be Determined

FM4B.1 • 14:00 **Invited**

Motion Rectification and Transport Control in 2D Optical Brownian Ratchets, Karen. Volke-Sepulveda¹, Alejandro Vasquez Arzola¹, Mario Villasante-Barahona¹, Petr Jaki², Pavel Zemanek²; ¹Univ Nacional Autonoma de Mexico, Mexico; ²Inst. of Scientific Instruments of CAS, Czechia. We create a reconfigurable 2D ratchet formed with a static asymmetric potential, based on holographic optical micromanipulation techniques, and an unbiased driving generating a rocking mechanism. Motion rectification is obtained along different directions.

FM4B.2 • 14:30

Multi-photon Fabrication of Compact Low-loss Optical Waveguides in Polydimethylsiloxane, Giulia Panusa¹, Ye Pu¹, Jieping Wang¹, Christophe Moser¹, Demetri Psaltis¹; ¹EPFL, Switzerland. We report the fabrication of compact flexible optical waveguides in polydimethylsiloxane through multiphoton direct laser writing, for the first time without a photoinitiator. A transmission loss of 0.03 dB/cm was measured in the 650-700 nm band.

FM4B.3 • 14:45

Probing lipid membranes with vibrational sum-frequency scattering, Jan Dedic^{2,1}, Halil Okur², Sylvie Roke²; ¹EPFL Photonics Chapter, Switzerland; ²Lab for Fundamental Biophotonics, EPFL, Switzerland. To understand how biological membranes work we must study the behavior of their constituent molecules in-situ. With vibrational sum-frequency scattering, we now have a non-invasive way of accessing this information.

FM4B.4 • 15:00

Advanced Multiphoton Polymerization Using Tunable Shaped Laser Wavepackets, MARIA MANOUSIDAKI^{1,2}, Vladimir Y. Fedorov^{3,4}, Dimitrios G. Papazoglou^{1,2}, Maria Farsari¹, Stelios Tzortzakos^{3,1}; ¹IESL-FORTH, Greece; ²Materials Science and Technology Dept., Univ. of Crete, Greece; ³Texas A&M Univ. at Qatar, Qatar; ⁴Lebedev Physical Inst. of the Russian Academy of Sciences, Russia. Tunable abruptly autofocusing ring Airy beams enable advanced multiscale photo-polymerization. Scaling down to the paraxial regime, these beams can approach the wavelength limit while presenting a strong enhancement of their focal intensity.

FM4B.5 • 15:15

Evidence of Magnetic Torque Dynamics in Optically-induced Magnetization, Krishnandu Makhil¹, Minh T. Trinh¹, Stephen C. Rand^{1,2}; ¹Electrical Engineering and Computer Science, Univ. of Michigan, USA; ²Dept. of Physics, Univ. of Michigan, USA. Rotational assignments and polarization states of inelastic components in the cross-polarized spectrum of light scattered by liquid samples of tetrahedral molecules provide direct evidence of a theorized enhancement mechanism for induced magnetism.

14:00–16:00

FM4C • Imaging and Sensing Technologies

Presider: Byoungcho Lee; Seoul National University, South Korea

FM4C.1 • 14:00 **Invited**

Fundamental Limits in Imaging: A Computational Imaging Approach, Amit Ashok¹; ¹Univ. of Arizona, USA. While the computational imaging approach has been explored and applied to various imaging problems, such as compressive imaging, it has been only shown recently that it can achieve fundamental limits using rigorous information-theoretic analysis.

FM4C.2 • 14:30 **Invited**

Progress on Optical Trap Volumetric Displays, Daniel Smalley¹, Erich Nygaard¹, Wesley Rogers¹, Kamran Qaderi¹; ¹Brigham Young Univ., USA. We review the fundamentals photophoretic trap displays and discuss the possibility of creating occlusion capable image points. Anisotropic scattering is observed independently in single and double point traps.

FM4C.3 • 15:00

Digital Aberration Correction with Single-Pixel Spatial Frequency Projection Imaging, Jeffrey J. Field¹, Jeff Squier², Randy Bartels¹; ¹Colorado State Univ., USA; ²Colorado School of Mines, USA. We show that single-pixel with CHIRPT microscopy encodes optical aberrations in temporal modulations of fluorescent light emitted from a specimen. We recover aberrations from several test objects and remove them digitally after image collection.

FM4C.4 • 15:15

Towards Scalable Fabrication of Plasmonic Colour via Nanoimprint Lithography, Muhammad F. Shahidan¹, Jingchao Song¹, Evgeniy Panchenko¹, Paul Mulvaney², Timothy James^{1,3}, Ann Roberts¹; ¹School of Physics, The Univ. of Melbourne, Australia; ²ARC Centre of Excellence in Exciton Science, Bio 21 and School of Chemistry, The Univ. of Melbourne, Australia; ³Reserve Bank of Australia, Australia. We demonstrate the versatility of nanoimprint lithography to fabricate scalable 'plasmonic pixels' which producing non-diffractive color. Several designs are present and the colors produced shows their dependence upon the direction of polarization.

14:00–16:00

FM4D • A Realistic Assessment of Optics for Self-driving VehiclesModerator: *Sabbir Rangwala, Patience Consulting LLC, USA*

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

Panelists:

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

14:00–16:00

FM4E • Advanced MicroscopyPresider: *Felix Fanjul Velez; University of Cantabria, Spain*

FM4E.1 • 14:00

Invited

Optical Imaging for Cardiac Ablation, Christine P. Hendon¹; ¹*Columbia Univ., USA*. I will discuss developments within optical coherence tomography and near infrared spectroscopy to enable monitoring of cardiac radiofrequency ablation, including extraction information on energy delivery, tissue composition, and fiber orientations.

FM4E.2 • 14:30

Fiber-Laser-Based Ultrasound Sensors for Fast-Scanning *in vivo* Photoacoustic Microscopy, Long Jin¹, Yizhi Liang¹, Lidai Wang², Jinwei Liu¹; ¹*Inst Photonics Tech, Jinan Univ, China*; ²*Dept. of Mechanical and Biomedical Engineering, City Univ. of Hong Kong, Hong Kong*. We present a new fiber-laser-based ultrasound sensor with high sensitivity and large field-of-view, based on which a fast-scanning optical-resolution photoacoustic microscope was built for *in vivo* microvascular imaging with a frame rate of 2 Hz.

FM4E.3 • 14:45

Quantification of *Staphylococcus aureus* on Contact Lenses using Mobile Holographic Imaging of Curved Surfaces and Machine Learning, Muhammed Veli¹, Aydogan Ozcan¹; ¹*Electrical and Computer Engineering, Univ. of California, Los Angeles, USA*. We present a cost-effective mobile sensor based on 3D imaging of contact lenses and machine learning for quantification of *Staphylococcus aureus*. Compatible with human tear, this wearable-sensor can detect various pathogens and analytes in tear.

FM4E.4 • 15:00

Chip-based Total Internal Reflection Fluorescence Microscopy, Vishesh Kumar Dubey^{1,3}, Rajwinder Singh², Azeem Ahmad^{1,3}, Dalip S. Mehta¹, Balpreet S. Ahluwalia³; ¹*Indian Inst. of Technology Delhi, India*; ²*Cell Biology and Biophysics Unit, EMBL, Germany*; ³*Dept. of Physics and Technology, UiT The Arctic Univ. of Norway, Norway*. In present study we have performed total internal reflection fluorescence microscopy on optical waveguide chip. This enables large field of view of imaging with high axial resolution and signal to noise ratio with low phototoxicity.

FM4E.5 • 15:15

Holographic Region-of-Interest with Oblique Illumination, Alexander Jügler¹, Jan Becker¹, Patrick Then¹, Rainer Heintzmann^{1,2}; ¹*Leibniz Inst. of Photonic Technology, Germany*; ²*Inst. of Physical Chemistry and Abbe Center of Photonics, Friedrich-Schiller-Univ. Jena, Germany*. Our programmable holographic microscopy approach allows an adaptive oblique regions-of-interest illumination. This reduces phototoxicity and out-of-focus blur and improves potentially Single-Molecule-Localization-Microscopy while easy to integrate.

14:00–16:00

FM4F • Complex NanophotonicsPresider: *Ortwin Hess; Imperial University, UK*

FM4F.1 • 14:00

Invited

Structuring Light with Metastructures, Nader Engheta¹; ¹*Dept. of Electrical and Systems Engineering, Univ. of Pennsylvania, USA*. Sculpting waves with metamaterials may lead to useful functionalities. In this talk, I will present several scenarios in which metastructures and metasurfaces can be used as platforms for structured light with desired features.

FM4F.2 • 14:30

Invited

Topological Photonics in Gyroids: 3D Nano-Printing of Weyl Points, Min Gu¹, Benjamin P. Cumming¹; ¹*Royal Melbourne Inst. of Technology, Australia*. The gyroid is a useful platform for the study of topological photonics. In this talk we demonstrate the creation and characterization of gyroid Weyl points at optical frequencies using 3D Nano-Printing and high refractive-index coating.

FM4F.3 • 15:00

Invited

Next Generation Photonics Based on 2D Materials, Michal Lipson¹; ¹*Columbia Univ., USA*. Two dimensional materials such as monolayer transition metal dichalcogenides (TMD) are expected to have large changes in their optical sheet conductivity by controlling their carrier densities. We demonstrate a platform for waveguide-integrated phase modulators in the nearinfrared regime based on Tungsten disulphide (WS₂) gating.

LM4A • Quantum Science III—Continued

FM4B • Light – Matter Interaction—Continued

FM4B.6 • 15:30

Remote Detection Sodium Cell Magnetometry using Amplitude Modulated Light, Renu Tripathi¹, Christiane Ebongue¹, Lorna Caesar¹, Gour S. Pati¹, Anthony Yu², Michael Krainak²; ¹Delaware State Univ., USA; ²NASA GSFC, USA. We investigated performance of a remote-detection sodium cell magnetometer using synchronous optical pumping. This magnetometer is used to measure ambient geomagnetic field with high-sensitivity using backscattered resonance fluorescence.

FM4B.7 • 15:45

High Sensitivity CPT and Pulsed CPT based Axial Magnetic Field Measurements, Gour S. Pati¹, Bruce Barrios¹, Robin Depto¹, Renu Tripathi¹, Anthony Yu², Michael Krainak²; ¹Delaware State Univ., USA; ²NASA GSFC, USA. We have demonstrated high-sensitivity axial B-field measurements based on coherent population trapping (CPT) and pulsed CPT phenomena.

FM4C • Imaging and Sensing Technologies—Continued

FM4C.5 • 15:30

Incorporating Polarization into Phase Retrieval Methods, Scott Paine¹, James R. Fienup¹; ¹Univ. of Rochester, USA. Traditional wavefront-sensing phase retrieval problems often neglect the effects of polarization. In order to improve simulated point-spread functions, we present a method to parameterize and include polarization in phase retrieval models.

FM4C.6 • 15:45

Sensing polarization rotation through scattering media, Abhijit Roy¹, Rakesh K. Singh², Maruthi Manoj Brundavanam¹; ¹Dept. of Physics, Indian Inst. of Technology Kharagpur, India; ²Dept. of Physics, Indian Inst. of Space Science and Technology, India. We present a technique based on an interferometric approach to sense the polarization rotation through scattering media with the help of a known reference speckles, by studying the degree of coherence of the mixed speckles.

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

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

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

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

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

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

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

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

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

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

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

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

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

FM4D • A Realistic Assessment of Optics for Self-driving Vehicles—Continued**FM4E • Advanced Microscopy—Continued****FM4F • Complex Nanophotonics—Continued****FM4E.6 • 15:30**

A Portable Optical Diagnostic System for Malaria Screening, Dongyu Chen², Samantha E. McBirney¹, Kristina Kaypaghian¹, Alexis Scholtz², Hossein Ameri⁴, Andrea M. Armani⁵; ¹Dept. of Biomedical Engineering, Univ. of Southern California, USA; ²Ming Hsieh Dept. of Electrical Engineering-Electrophysics, Univ. of Southern California, USA; ³Dept. of Biomedical Engineering, Johns Hopkins Univ., USA; ⁴USC Roski Eye Inst., Dept. of Ophthalmology, Keck School of Medicine of the Univ. of Southern California, USA; ⁵Mork Family Dept. of Chemical Engineering and Materials Science, Univ. of Southern California, USA. We developed a portable optical diagnostic system for rapid malaria screening in low-resource areas. Detection limits well below the clinical relevance are demonstrated using β -hematin in unprocessed, whole rabbit blood.

FM4E.7 • 15:45

cellSTORM – Super-Resolution on a Cellphone, Benedict Diederich¹, Patrick Then¹, Alexander Jügler¹, Ronny Förster¹, Rainer Heintzmann^{1,2}; ¹Leibniz Inst. of Photonic Technology, Germany; ²Inst. of Physical Chemistry and Abbe Center of Photonics, Friedrich-Schiller-Univ. Jena, Germany. We present a way to use smartphones for Single-Molecule-Localization-Microscopy. Using consumer-grade smartphone cameras and neural networks instead of scientific-grade cameras we achieved optical resolution below 80 nm.

FM4F.4 • 15:30 **Invited**

Linear Frequency Conversion in a Rapidly Time-variant Metasurface, Bumki Min¹; ¹Korea Advanced Inst of Science & Tech, Korea (the Democratic People's Republic of). The frequencies of electromagnetic waves are converted as the waves propagate through a temporally varying medium. Interestingly, this frequency conversion is not based on well-known nonlinear processes. Here, we explain basic principles of linear frequency conversion and show various interesting properties of rapidly time-variant metadevices.

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

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

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

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

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

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

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

08:00–09:30

JTU1A • Plenary Session

JTU1A.1  Plenary

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

JTU1A.2  Plenary

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

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

10:00–11:00

Rapid Fire Oral Presentation I, Science & Industry Theater

Presider: David Busch; *Univ. Texas Southwestern Medical Center at Dallas, USA*

Participating posters are noted in the list of poster for session JTU2A with the icon **RAPID**. Each presenter will have 3 minutes and the order will be determined by poster number.

JOINT FIO + LS

10:00–12:00

JTU2A • Poster Session I and Dynamic E Posters

JTU2A.1  E-Poster

Organic Molecular Beam Deposition and In-Situ Poling of Dense Supramolecular Assemblies for Second Order Nonlinear Optics, Michael Erickson¹, Lauren Dallachiesa¹, Ivan Biaggio¹; ¹*Lehigh Univ., USA*. We demonstrate that in-situ poling during organic molecular beam deposition of single-component dense supramolecular assemblies can be used to obtain a preferential molecular order and a bulk linear electro-optic effect in the resulting organic films.

JTU2A.2  E-Poster

Self-assembling of functionalized micro-optical element driven by pyro-electrohydrodynamic forces, Sara Coppola¹, Giuseppe Nasti¹, Veronica Vespini¹, Pietro Ferraro¹; ¹*Inst. of Applied Sciences and Intell., Italy*. We present a repeatable and accurate method to pattern fluorescent particles into polymer microlens array and flexible elastomeric membranes. This method uses intense electric field generated by a Periodically Poled Lithium Niobate (PPLN) in order to direct the self-assembly electrophoretic and dielectrophoretic forces.

JTU2A.3  E-Poster

3D Fractal Analysis of Optical Images of Retinal Amyloid for Staging in Alzheimer's Disease, Peter A. Neathway¹, Tao Jin¹, Melanie C. Campbell^{1,2}; ¹*Physics and Astronomy, Univ. of Waterloo, Canada*; ²*School of Optometry and Vision Science, Univ. of Waterloo, Canada*. Fractal dimensions of retinal amyloid deposits were calculated using a 3D box counting method. The maximum and average fractal dimensions were significantly correlated to the number of deposits ($p < 0.03$ and $p < 0.05$, respectively).

JTU2A.4  E-Poster

Universal All-Optical Computing Based on Interconnected Lasers, Tuomo von Lerber^{2,1}, Matti Lassas¹, Quang Trung Le², Franko Küppers²; ¹*Dept. of Mathematics and Statistics, Univ. of Helsinki, Finland*; ²*Photonics Lab, Technische Universität Darmstadt, Germany*. We present an all-optical computing scheme based on normalization operations of injection-locked lasers. We show cascaded operations in cellular automaton by an all-optical Conway's Game of Life and simulate 100 generations of gaming.

JTU2A.5  E-Poster

Diffraction of Laguerre-Gauss Vortex Beams from Sierpinski Triangles, Sean Nomoto¹, Reeta Vyas¹, Surendra Singh¹; ¹*Univ. of Arkansas, USA*. Fraunhofer diffraction of Laguerre-Gauss beams from Sierpinski triangle apertures of different iteration orders is studied and its dependence on iteration order, topological charge, and aperture location relative to the beam-waist is investigated.

JTU2A.6  E-Poster

Towards the Use of Machine Learning in Setups for OAM Mode Excitation in Optical Fibers, Antonio Astorino¹, Jesper Glückstad¹, Karsten K. Rottwitz¹; ¹*DTU, Denmark*. Machine Learning algorithms driving spatial light modulators may help achieve higher purity in excited orbital angular momentum modes in fibers. Some preparatory steps are investigated to potentially enable effective Machine Learning in such a configuration.

JTU2A.7  E-Poster

Coherent Blue Light Driven by a Diode Laser and a High Repetition Rate Pulse Train, Marco P. Moreno¹, Alexandre A. Almeida², Sandra S. Vianna²; ¹*Departamento de Física, Universidade Federal de Rondônia, Brazil*; ²*Departamento de Física, Universidade Federal de Pernambuco, Brazil*. Using a diode laser and a 1 GHz femtosecond pulse train, we investigate the Autler-Townes splitting and the influence of an electromagnetic induced transparency window in the coherent blue light generated in rubidium vapor.

JTU2A.8  RAPID

Generating Broadened UV Pulses for Ultrafast Nonlinear Experiments, James D. Gaynor¹, Joel Leger¹, Munira Khalil¹; ¹*Univ. of Washington, USA*. Broadened UV pulses are generated and used in Fourier transform two-dimensional electronic-vibrational spectroscopy to study vibronic couplings in a solar cell sensitizing dye.

JTU2A.9

Dye-Doped Random Microlasers Fabricated via Two-Photon Polymerization, Nathalia B. Tomazio¹, Lucas F. Sciuti¹, Gustavo F. Almeida¹, Leonardo De Boni¹, Cleber R. Mendonça¹; ¹*USP Inst de Física de Sao Carlos, Brazil*. We demonstrate coherent random lasing in dye-doped microstructures fabricated by two-photon polymerization. Randomly distributed irregularities on the microstructure sidewall surfaces act as back-scattering elements, providing feedback for lasing.

JTU2A.10

Dynamic Ferroelectricity of Trojan Electrons on Multiple Parallel Regular 2-dimensional Lattices, Matt Kalinski¹; ¹*Utah State Univ., USA*. Dynamic ferroelectric orders are discovered in a volume filled with a parallel layers of various regular 2-dimensional lattices consisting of hydrogen atoms self-consistently supporting Trojan Wave Packet states via the rotating dipole interactions.

JTU2A.11

Study of the generation dynamics in a strict polarization-controlled passively mode-locked Er-fiber laser, Luis Alberto Rodriguez Morales², Hector Santiago-Hernandez², Baldemar Ibarra-Escamilla², Georgina Beltrán Pérez¹, Ivan Armas Rivera², Manuel Durán Sánchez², Yazmin Bracamontes³, Olivier Pottiez³, Marco V. Hernández-Arriaga², Evgeny A. Kuzin²; ¹*BUAP, Mexico*; ²*Optics, INAOE, Mexico*; ³*Centro de investigaciones en Óptica, Mexico*. We report the relation between the polarization state of the pulses propagating in the cavity and the generation regimes. Rotating the polarization azimuth gets transition from the generation of noise-like pulses to soliton molecules

JTU2A.12

Magnetically Controllable Random Lasers, Yun-Tzu Hsu¹, Yu-Ming Liao¹, Cheng-Yen Tsai¹, Wei-Cheng Liao¹, Wei-Ju Lin¹, Shih-Yao Lin¹, Cheng-Han Chang¹, Golam Haider¹, Tzu-Min Sun¹, Yang-Fang Chen¹; ¹*National Taiwan Univ., Taiwan*. Controllability is crucial for random lasers. Here, magnetically controllable random lasers (MCRs) are designed, fabricated. The applied magnetic field can be used to manipulate the distribution of scatterers, which finally determines laser action.

JTU2A.13

Comparison Between InGaAs SPD and Superconducting Nanowire Detector Using a Silicon Photon-pair Source, Woncheol Shin¹, Heedeuk Shin¹, Kyungdeuk Park¹, Young-Wook Choi², Yong-Su Kim²; ¹*Pohang Univ. of Science and Technol, South Korea*; ²*Center for Quantum Information, Korea Inst. of Science and Technology, South Korea*. Photon-pair generation rate through a silicon photon-pair source is measured by InGaAs SPD and superconducting nanowire detector, showing 240 times higher coincidence count than InGaAs SPD. A high coincidence-to-accidental ratio of 524 is achieved.

JTU2A • Poster Session I and Dynamic E Posters—Continued

JTU2A.14
Withdrawn

JTU2A.15

Independent phase modulation of two polarization states with reflection-type metasurface, Jangwoon Sung¹, Gun-Yeal Lee¹, Chulsoo Choi¹, Byoung-ho Lee¹; ¹Seoul National Univ., South Korea. Taking the advantage of propagation phase with geometric phase, we designed a novel reflection-type metasurface enabling independent phase control of two polarization states. This method achieves phase control with the high efficiency up to 95%.

JTU2A.16

High Peak Intensity and Tunable Range Bessel Beams Generation and Characterization, A. Srinivasa Rao¹, Goutam K. Samanta²; ¹AMOPH, Physical Research Lab, India. We report on a novel method to generate high peak intensity, segmented, smooth, zero-order Bessel beams with tunable range peak position using axicon with hollow Gaussian beam (HGB) as pump mode.

JTU2A.17

Optical Simulations of Wavefront Aberrations of Interpenetrating Polymer Network Hydrogel's Artificial Cornea, Chung-Tsung Hsieh¹, Jia-Han Li¹; ¹National Taiwan Univ., Taiwan. The various structure parameters and materials are chosen for artificial cornea. Our simulation results show that increasing the complexity of structures and choosing high refractive index material are important to properties of artificial cornea.

JTU2A.18

Multimode supercontinuum generation in As₂S₃ chalcogenide photonic crystal fiber, Amani Ben Khalifa¹, Rim Cherif¹, Amine Ben Salem¹; ¹Univ. of carthage, Tunisia. The mid-infrared supercontinuum generation spanning 2 to 4 μm at -40 dB for mode HE₁₁ is obtained in multimode As₂S₃ photonic crystal fiber. Energy transfer occurs only with long pulses between modes with comparable geometries.

JTU2A.19

Reflective Liquid Crystal Lenses with Electrically Anisotropic Wavefront Modulation, Yu-Jen Wang¹, Jun-Lin Chen¹, Yi-Hsin Lin¹; ¹Dept. of Photonics, National Chiao Tung Univ., Taiwan. Reflective lenses are important in optical design and applications. We investigate reflective liquid crystal lenses with anisotropic wavefront modulation. The impact of this study is to design electrically tunable devices for adaptive optics.

JTU2A.20

Revealing of Axial Separation between Diffusers through Lateral Speckle Correlation, Gokul G. Nair¹, Dinesh N. Naik¹, Michael L. Jakobsen², Steen G. Hanson², Rakesh K. Singh¹; ¹IIST Trivandrum, India; ²Dept. of Photonics Engineering, Technical Univ. of Denmark, Denmark. We experimentally demonstrate that the intensity correlation of speckled speckles before and after the lateral displacement of the concealed scatterer discloses the axial separation through speckle size, decorrelation length and speckle gearing.

JTU2A.21

Single shot vectorial shearing interferometry technique for wavefront reconstruction and aberration calculation, Pramod Panchal¹, Surya Gautam¹, Dinesh N Naik¹, C. S. Narayanamurthy¹; ¹Physics, IIST, India. We propose a vectorial sheared interferometry technique based on two sagnac interferometer to calculate gradient information along two orthogonal directions. We present an approach to reconstruct the wavefront and calculation of wavefront aberration.

JTU2A.22

Optimized Growth of Titanium Nitride Films using Plasma Enhanced Atomic Layer Deposition, Dhruv Fomra¹, Ray R. Secondo¹, Vitaliy Avrutin¹, Natalia Izyumskaya¹, Ümit Özgür¹, Nathaniel Kinsey¹; ¹Virginia Commonwealth Univ., USA. We investigate and find that the quality of titanium nitride grown at 350°C and 375°C using atomic layer deposition on silicon and sapphire substrates respectively are approaching the metallicity of sputtered films.

JTU2A.23

Automatic Surface Defect Detection using Autoregressive Modeling based Fringe Analysis, Dr. Rishikesh Kulkarni², Earu Banoth¹, Dr. Parama Pal¹; ¹TCS Research and Innovation, Tata Consultancy Services, India; ²Dept. of Electronics and Electrical Engineering, Indian Inst. of Technology Guwahati, India. We propose a novel fringe analysis technique based on an autoregressive (AR) modeling of fringe signals for detecting surface defects. Defects are localized by studying variations in fringe frequencies computed using estimated AR coefficients.

JTU2A.24

KW-level Triple-Cladding Laser Fiber, Shuang Liu^{1,2}, Huan Zhan¹, Kun Peng¹, Xiaolong Wang¹, Li Ni¹, Juan Yu¹, Jianjun Wang¹, Feng Jing¹, Rihong Zhu², Aoxiang Lin¹; ¹Laser Fusion Research Center, China; ²Nanjing Univ. of Science and Technology, China. We fabricated a kW-level triple-cladding Yb-doped aluminophosphosilicate fiber with an added low-refractive-index fluorine-doped silica cladding. 1.36kW laser output was obtained at 1079.6nm with 82.3% slope efficiency and without nonlinear effects.

JTU2A.25

Development of Multi-modal Bacterial Rapid Detection Instrument, Iyell-joon Doh¹, Huisung Kim¹, Jennifer Sturgis², Valery Patsekina², J. Paul Robinson^{2,3}, Euiwon Bae¹; ¹Mechanical Engineering, Purdue Univ., USA; ²Basic Medical Sciences, College of Veterinary Medicine, Purdue Univ., USA; ³Weldon School of Biomedical Engineering, Purdue Univ., USA. An instrument providing simultaneous optical measurement modalities is presented. Integrating custom confocal module, three laser diodes, and sensors into an upright microscope allows measuring multiple optical characteristics of a bacterial colony.

JTU2A.26

Resolution Enhancement for AR/VR Displays Based on LC Sub-pixel Frame Shift, Kyookeun Lee¹, Nikolay Muravyev², Dmitry Piskunov², Jaeyeol Ryu², Kyusub Kwak¹, Myongjo Choi¹, James D. Kim¹; ¹Samsung Research, South Korea; ²Samsung R&D Inst. Russia, Russia. We propose a resolution enhancement method for AR/VR displays based on sub-pixel frame shift using a LC deflector. Experimental results using Samsung Gear VR and Galaxy S8 show that the resolution is doubled and the screen door effect is reduced.

JTU2A.27

Effect of Temperature on the Efficiency of Thin-Film Amorphous Silicon Tandem Heterojunction Solar Cells with AFORS-HET, Muhammad Riaz¹, Ahmad S. Azzahrani^{1,2}, Ahmed C. Kadhim¹; ¹Florida Inst. of Technology, USA; ²Northern Borders Univ., Saudi Arabia. Simulation and design of a-SiC/a-Si(i)/a-Si:H and a-SiC/a-Si(i)/a-SiGe:H solar cells are investigated and optimized. The maximum efficiency is achieved by changing temperature up to 400K.

JTU2A.28

Localized Electromagnetic Field Enhancement with Patterned Hyperbolic Metamaterials, Jongwoo Hong¹, Chulsoo Choi¹, Byoung-ho Lee¹; ¹Seoul National Univ., South Korea. The electromagnetic field enhancement is a key factor in efficient light-matter interaction due to small mode volume and loss. We propose hyperbolic metamaterial cavity for field enhancement by patterning funneled aperture on metal-dielectric layers.

JTU2A.29

Extended Propagation Distances For Diffraction-Free Space-Time Light-Sheets, Basanta Bhaduri¹, Murat Yessenov¹, Ayman Abouraddy¹; ¹Univ. of Central Florida, CREOL, USA. We synthesize propagation-invariant space-time wave packets in the form of a pulsed light-sheet of transverse spatial width ~200 nm and spectral bandwidth of ~2 nm, and observe its diffraction-free propagation for a record ~6 meters.

JTU2A.30

Dynamic Footprint Differentiation from Machine Acceleration Effect, Guoyu Yu¹, Christina Reynolds¹, Oliver Faehnle², David Walker¹; ¹OptIC Centre, Univ. of Huddersfield, UK; ²QA/QES & Continuous Improvement, FISBA AG, Switzerland. This paper investigates the differentiation between machine's static and dynamic footprint (FP). Results have shown progressing footprint variation related to tool's tilt angle. Tilt angle compensation has been applied to offset this effect.

JTU2A.31

Linear and nonlinear hyperspectral imaging of nano- and bio- materials in photo-induced force microscopy, Eun S. Lee¹; ¹Korea Research Inst of Standards & Sci, South Korea. Linear and nonlinear optical responses of nano materials are measured through force detection in photo-induced optical microscopy. The measurement results of Raman vibrational signal and excited state absorption of molecular clusters are presented.

JTU2A.32

An opposite approach to steam generation using solar power: cooler for more, Lyu Zhou¹, Haomin Song¹, Youhai Liu¹, Matthew Singer¹, Dengxin Ji¹, Nan Zhang¹, Xie Zeng¹, Zongmin Bei¹, Zongfu Yu², Qiaoqiang Gan¹; ¹State Univ. of New York at Buffalo, USA; ²Electrical and Computer Engineering, Univ. of Wisconsin Madison, USA. We proposed a cold vapor generation beyond the input solar energy limit. The vapor was produced at a temperature below that of ambient, resulting in ~2.2 kg m⁻² h⁻¹ generation rate under one sun.

JTU2A.33

Actively mode-locked Yb-doped fiber laser via pump modulation, Zihao Zhao¹, Sze Set¹, Shinji Yamashita¹; ¹Univ. of Tokyo, Japan. An active mode-locked Yb-doped fiber laser via pump modulation is demonstrated. The mode-locked all-normal-dispersion fiber laser operates in dissipative soliton regime without any spectral filter.

JTU2A.34

Pulse Shaping and its Influence on Contrast Enhancement in Nonlinear Optical Imaging, George O. Dwapan-yin¹, Gurthwin Bosman¹, Pieter Neethling¹, Erich Rohrer¹; ¹Laser Research Inst., Dept. of Physics, Stellenbosch Univ., South Africa. The influence of temporal phase control of ultra-broadband femtosecond laser pulses on contrast enhancement in nonlinear imaging and its application in a custom built multimodal microscope, is presented in this study.

JTu2A • Poster Session I and Dynamic E Posters—Continued

JTu2A.35

Extreme nonlinear optics under vortex lasers, Chengpu Liu¹; ¹Shanghai Inst. of Optics and Fine Mechanics, CAS, China. As for the interaction of few-cycle vortex laser with matter, many novel phenomena beyond those occurred in traditional nonlinear optics are disclosed, such as nonlinear vortex precursors, THz necklace beam, and so on.

JTu2A.36

Modulation of Third Harmonic Generation Achieved through Ground State Depletion, Szu-Yu Chen¹, Hao-Hao Wu¹, Jui-Ting Hung¹, Jian-Ling Chen¹; ¹National Central Univ., Taiwan. Third harmonic generation (THG) is known being able to be enhanced through real-state absorption. Suppressing absorption through ground-state depletion, the THG intensity can be modulated for the purpose of resolution improvement of THG microscopy.

JTu2A.37

Beam Riders and Sailcraft Based on Diffractive Light Sails, Grover A. Swartzlander¹, Ying-Ju Lucy Chu¹, Prateek R. Srivastava¹; ¹Rochester Inst. of Technology, USA. Both solar and laser driven sailcraft are described whereby diffraction, rather than reflection, is used to impart momentum to a sailcraft for in-space propulsion.

JTu2A.38

Laguerre-Gauss Beams with Polarization-OAM Entanglement in a Graded-Index Medium, Nikolai I. Petrov¹; ¹Scientific and Technological Center of Unique Instrumentation of the Russian Academy of Sciences, Russia. Propagation of linearly and circularly polarized vortex light beams in cylindrical graded-index waveguide taking into account spin-orbit and nonparaxial effects is investigated. Effects of collapse and long-term revival of wave packets are examined.

JTu2A.39

Collective Three-Photon Blockade In A Cavity QED System, Chengjie Zhu¹, Yaping Yang¹, Girish Agarwal²; ¹Tongji Univ., China; ²Texas A&M Univ., USA. We present a theoretical proposal to realize three-photon blockade in a coherently-driven, two-qubits cavity QED system. We show that the three-photon blockade with two-photon bunching can be achieved when two qubits couple the cavity asymmetrically.

JTu2A.40

Optically tunable conductivity of carbon nanotubes in terahertz frequency range, Daniel Gomon¹, Sviatoslav Gusev¹, Petr Demchenko¹, Ilya Anoshkin², Dmitry Lyubchenko², Mikhail Khodzitsky¹; ¹ITMO Univ., Russia; ²KTH Royal Inst. of Technology, Sweden. Impact of infrared radiation illumination (980 nm) on the properties of carbon nanotubes (CNT), such as complex conductivity and permittivity, with different geometric parameters in the frequency range of 0.2-1.0 THz was studied.

JTu2A.41

Theoretical Approach to Resolution Limit Calculations in Optical Microscopy with the use of Feynman Diagrams, Naoki Fukutake¹; ¹Nikon Corporation, Japan. By means of double-sided Feynman diagrams describing optical processes, we formulate the calculation rules of the resolution limits for all types of optical microscopy that employ linear, nonlinear, coherent, and incoherent optical processes.

JTu2A.42

Stimulated Supercontinuum Generation in CW-pumped Regime, Chao Huang¹, H. Y. Fu², Qian Li¹; ¹Peking Univ., China; ²Tsinghua Univ., China. We numerically demonstrate the significant improvement in spectral bandwidth and coherence of CW pumped supercontinuum generation stimulated by a weak CW seed.

JTu2A.43

Energetic ultrafast self-similar fiber laser tunable in 1030-1100 nm wavelength range, Chunyang Ma¹, Ankita Khanolkar², Andy Chong²; ¹JILIN UNIV., China; ²Univ. of Dayton, USA. We report a tunable Yb-doped self-similar fiber laser for 1030-1100 nm by tuning center wavelength of a narrow spectral filter. The result shows the self-similar operation is suitable for tunable lasers with short pulse durations.

JTu2A.44

Generalized Laguerre-Gauss vortex beams, Alfonso I. Jaimes-Nájera¹, Jesús Gómez-Correa^{2,3}, Sabino Chávez-Cerda¹; ¹INAOE, Mexico; ²Facultad de Ingeniería Mecánica y Eléctrica, UANL, Mexico; ³Unidad Monterrey, CICESE, Mexico. We present new families of vortex beams with orbital angular momentum establishing a generalization of the Laguerre-Gauss beams in its standard and elegant formulation. Their closed analytical free-space propagation formula is obtained.

JTu2A.45

Nonuniform Dynamic Bragg Gratings for Laser Pulses Manipulation, Andrey ILJIN¹, Svitlana Bugaychuk¹, Vyacheslav Pinchuk¹; ¹Inst. of Physics, NAS of Ukraine, Ukraine. Nonlinear Schrödinger equation describes effects of wave self-diffraction in an extended dynamic nonlocal medium. The resulting dynamic grating has a soliton-like envelope of modulation depth and provides energy exchange and laser pulse amplification.

JTu2A.46

The Micromaser in a Cross Cavity: A Fidelity Perspective, Julio C. Garcia-Melgarejo¹, Nestor Lozano-Crisóstomo¹, Ariel Dominguez-Pachecano¹, J. Sanchez-Mondragon²; ¹Universidad Autonoma de Coahuila, Mexico; ²INAOE, Mexico. We discuss the generation of a Fock state photon distribution in a perfect cross-cavity. We verify such generation through the numerical computation of the fidelity in two important cases.

JTu2A.47

Analysis of the Twin-soliton Bound States in Passive Microresonator, Maitrayee Saha¹, Samudra Roy¹, Shailendra Varshney¹; ¹IIT-KGP, India. We numerically study spectral characteristics of frequency comb in presence of two solitons separated by a delay much greater than their characteristic width. Nature of interaction potential and energy signify the stability of bound state.

JTu2A.48 **RAPID**

Superdiffusive charge screening for phase singularities in isotropic random waves, Lorenzo De Angelis¹, L. Kuipers¹; ¹Kavli Inst. of Nanoscience, Delft Univ. of Technology, Netherlands. We present a quantitative study on the screening among phase singularities in random waves. We prove that the fluctuation of the total topological charge Q contained in an area R^2 satisfies $\langle \Delta Q^2 \rangle \sim R \log R$ rather than the ordinary diffusive $\langle \Delta Q^2 \rangle \sim R$.

JTu2A.49 **RAPID**

Femtosecond Pulse-Splitting Effect in Second Harmonic Generation in the Laue Diffraction Scheme From 1D Photonic Crystals, Vladimir B. Novikov¹, Boris I. Mantsyzov¹, Tatiana V. Murzina¹; ¹M. V. Lomonosov Moscow State Univ., Russia. Phase-matched second harmonic generation at temporal laser pulse-splitting effect in one-dimensional photonic crystals under the Bragg diffraction in the Laue geometry is studied experimentally and theoretically involving supercomputer resources.

JTu2A.50 **RAPID**

Plasma Formed by Dual-Filament Interaction, Danielle Reyes¹, Jessica Pena¹, Matthieu Baudelet¹, Shermineh R. Fairchild¹, Martin C. Richardson¹; ¹Univ. of Central Florida, USA. The filament plasma resulting from the interaction between two co-propagating beams, separated by 180 and 280 μm , was characterized for different energy distributions – two subcritical beams, one subcritical beam with one filament, and two filaments.

JTu2A.51

Surface Enhanced Raman Scattering Efficiency of Metal Coatings on Photochemically Roughened Silicon Surfaces, Tuba Önder¹; ¹Middle East Technical Univ., Turkey. The aim is obtaining optimal surface to enhance Raman scattering by applying different parameters (power, duration). Laser assisted wet etching technique was used to roughened surface of Si surfaces and they were analyzed to measure enhancement factors.

JTu2A.52

High harmonic generation in diamond driven by intense femtosecond near infrared laser pulse, Boyan Obreshkov¹; ¹INRNE-BAS, Bulgaria. We present theoretical results on photoionization high-harmonic generation in bulk diamond induced by intense laser pulse of photon energy 1.55 eV, having a time duration of 15 fs.

JTu2A.53 **RAPID**

Two-qubit deterministic optical quantum logic in a single photon, Poolad Imany¹, Jose A. Jaramillo-Villegas¹, Joseph M. Lukens², Ogaga D. Odele¹, Daniel E. Leaird¹, Minghao Qi¹, Andrew M. Weiner¹; ¹Purdue Univ., USA; ²Oak Ridge National Lab, USA. We demonstrate deterministic two-qubit gates using the time and frequency degrees of freedom of a single photon, showing the potential of our scheme for deterministic quantum computing in high-dimensional Hilbert spaces.

JTu2A.54 **RAPID**

Quantum-Limited Electro-Optic Modulator Based on Thermal Rydberg Atoms, Kevin C. Cox¹, David H. Meyer^{2,1}, Zachary A. Castillo^{2,1}, Paul D. Kunz¹; ¹US Army Research Lab, USA; ²Physics, Univ. of Maryland, College Park, USA. We discuss the standard quantum limit for electro-optic conversion using a quantum sensor and experimentally demonstrate quantum-limited operation using electromagnetically-induced-transparency with thermal Rydberg atoms.

JTu2A.55 **RAPID**

The Quest for Nonclassicality using Number-Resolving Single-Photon Detectors, Raphael A. Abrahao^{1,2}, Farid Shahandeh², Geoff Gillett^{1,2}, Martin Ringbauer^{1,2}, Till Weinhold^{1,2}, Marcelo P. Almeida^{1,2}, Timothy C. Ralph², Andrew G. White^{1,2}; ¹Centre for Engineered Quantum Systems, School of Mathematics and Physics, Univ. of Queensland, Australia; ²Centre for Quantum Computation and Communication Technology, School of Mathematics and Physics, Univ. of Queensland, Australia. The quest for nonclassicality is the search for the border between classical and quantum physics. Our work aims to show that nonclassical correlations can be observed even in the absence of entanglement and quantum discord.

JTu2A.56 **RAPID**

Enhancing the number of bi-photon orbital angular momentum modes using asymmetric vortex beam, Jabir M. V.¹, Goutam K. Samanta¹, Ali Anwar¹; ¹Physical Research Lab, India. We report on controlling the bi-photon OAM eigenmodes in down-conversion process by simply adjusting the asymmetry of the pump vortex beam. Calculation of the Schmidt number shows the increase in the number of OAM eigenmodes.

JTU2A • Poster Session I and Dynamic E Posters—Continued

JTU2A.57

First-Principles Study of the Optical Properties of AA-Stacked Bilayer Graphene, Jun-Fu Zhang¹, Min-Hsueh Chiu¹, Chang-Tsung Hsieh¹, Tony Wen-Hann Sheu¹, Jia-Han Li¹; ¹National Taiwan Univ., Taiwan. The density functional theory is used to study optical properties in AA-stacked bilayer graphene. The band gap increases as the interlayer distance gets smaller. The anisotropic permittivity of AA-stacked bilayer graphene is demonstrated.

JTU2A.58

Conductive Gap-Plasmon Nanocavity, Seied Ali Saifiabadi Tali¹, Wei Zhou¹; ¹Virginia Tech, USA. We can design and create conductive gap-plasmon nanocavity structures using vertically stacked nanodisks made of metals or conductive oxides, which can simultaneously serve as nanoelectrodes and nanoantennas for hybrid electrical-optical interface.

JTU2A.59

A Comparative Analysis of TM Guided Modes in Silicon on Insulator (SOI) based Rectangular Optical Waveguide, Dhananjoy De¹, Ritu Raj Singh¹, Vishnu Priye¹; ¹Indian Institute of Technology, Dhanbad, India. In this paper, TM guided modes of SOI based rectangular optical waveguide of different widths have been investigated. Conditions for first and higher order modes are analyzed mathematically and justified with the FEM simulation.

JTU2A.60

Example of Guessing Probability on Secret Key by Known-Plaintext Attack on Y00 Quantum Stream Cipher, Takehisa Iwakoshi¹; ¹Tamagawa Univ., Japan. While Quantum-Key-Distribution is regarded as promising secure communication, security of Y00 protocol H. P. Yuen proposed for the affinity to conventional optical communication is not well-understood yet. This study gives some insights.

JTU2A.61

Influence of multiple scattering on self-focusing in nematic liquid crystals, Alessandro Alberucci¹, Chandroth P. Jisha², Serena Bolis^{3,4}, Jeroen Beeckman⁴, Stefan Nolte^{1,5}; ¹Friedrich-Schiller-Universität Jena, Germany; ²Universidade do Porto, Portugal; ³Université libre de Bruxelles, Belgium; ⁴Ghent Univ., Belgium; ⁵Fraunhofer Inst. of Applied Optics and Precision Engineering, Germany. We study the interplay between multiple scattering and self-focusing in Nematic Liquid Crystals (NLCs). At low powers self-focusing increases the coherence, but for large powers a continuous temporal oscillation is observed.

JTU2A.62

Thermal Decoherence of the Carrier-Envelope-Offset Frequency in a Kerr-Microresonator Comb, Tara E. Drake¹, Jordan Stone^{1,2}, Travis C. Briles^{1,2}, Daryl Spencer¹, Scott B. Papp^{1,2}; ¹Time and Frequency Division, NIST, USA; ²Physics, Univ. of Colorado, Boulder, USA. We present measurements of the carrier-envelope-offset frequency noise spectrum of a silicon nitride Kerr-microresonator comb. Our preliminary observations suggest that thermal decoherence is an important contribution.

JTU2A.63

Withdrawn

JTU2A.64

Pump-probe Quantum State Tomography and Photon Statistics in Semiconductor Quantum Dots, Fabian Boehm¹, Nicolai B. Grosse¹, Mirco Kolarczik¹, Bastian Herzog¹, Nina Owschimikow¹, Ulrike K. Woggon¹; ¹Technische Universität Berlin, Germany. Quantum state tomography is applied to InGaAs quantum dot-semiconductor optical amplifiers to reconstruct the Wigner function and photon statistics for a coherent state interacting with QDs with high time-resolution and in the few-emitter limit.

JTU2A.65

Quantum holography with twin photons of large spatial dimensionality, Fabrice Devaux¹, Alexis Mosset², Florent Bassignot³, Eric Lantz¹; ¹Université de Franche-Comte, France; ²FEMTO-ST, France; ³FEMTO Engineering, France. We report results of quantum holography where spatial information stored in phase hologram is restored by measuring spatial coincidences between two images formed by spatially entangled twin photons of high-dimensionality transmitted by the hologram.

JTU2A.66

Experimental Implementation of Directionally-Unbiased Linear-Optical Multipoint, Shuto Osawa¹, David S. Simon^{1,2}, Alexander V. Sergienko¹; ¹Boston Univ., USA; ²Stonehill College, USA. A directionally-unbiased optical multipoint allows a photon to reverse direction inside and exit at any port, including the input port. This multipoint could be used as a quantum gate and for efficiently implementing quantum walks.

JTU2A.67

Multiphoton discrete fractional Fourier operations in waveguide beam splitters, Armando P. Leija^{1,2}, Konrad Tschernig², Roberto D. Leon Montiel³, Omar Magana Loaiza⁴, Alexander Szameit⁵, Kurt Busch^{1,2}; ¹Max Born Inst., Germany; ²Inst. of Physics, Humboldt Univ., Germany; ³ICN, UNAM, Mexico; ⁴NIST, USA; ⁵Inst. of Physics, Univ. of Rostock, Germany. We show that exciting a waveguide beam-splitter with N indistinguishable photons, give rise to lattice-like structures in the photon number space that are formally equivalent to coupled systems that perform discrete fractional Fourier transforms.

JTU2A.68

Experimental Implementation of One-Qubit Logic Gates and Verification Via Quantum State Tomography, Christian D. Torres Quelal¹, Carlos A. Melo¹, John H. Reina¹; ¹Physics, Universidad del Valle, Colombia. We implemented one-qubit quantum gates testing through the production of the polarization set of states, with |Hi as input. Complementary, we reconstructed the state for each output via the quantum-tomography protocol with fidelities over 95%.

JTU2A.69

Link between Debye Temperature, Bang Gap Energy, and Fine Structure Constant, Haowen Xi², Bruno Ullrich¹, Mithun Bhowmick³; ¹Ullrich Photonics LLC, USA; ²Dept. of Physics and Astronomy, Bowling Green State Univ., USA; ³School of Chemical Sciences, Univ. of Illinois at Urbana-Champaign, USA. The link between the fine structure constant, energy band gap, and Debye temperature of semiconductors is reported. The revealed relation has the potential to be highly influential for the design of optoelectronic and photonic devices.

JTU2A.70

Phase Noise Based Quantum Random Number Generator Suppressing Classical Noise, Ziyang Chen¹, Zhengyu Li¹, Yichen Zhang², Hong Guo¹; ¹State Key Lab of Advanced Optical Communication Systems and Networks, School of Electronics Engineering and Computer Science, Center for Quantum Information Technology, Peking Univ., China; ²State Key Lab of Information Photonics and Optical Communications, Beijing Univ. of Posts and Telecommunications, China. We present a phase-noise-based random number generation scheme with a rate of 600Mbps without using optical delay line, which can remove the classical noise induced by fiber jitter.

JTU2A.71

Stochastic Runge-Kutta Algorithm and Parameter Optimization in Optical Simulations Using MATLAB, John R. Thompson¹, Hongbo Zhang¹; ¹Virginia Military Inst., USA. An algorithm and MATLAB code for solving nonlinear stochastic rate equations are presented and applied to the problem of parameter optimization using high performance computing.

JTU2A.72

Spatial solitons as fixed points of Fox-Lee integral equation, Alex Okulov¹; ¹Russian Academy of Sciences, Russia. The exactly solvable model of nonlinear eigenmodes of laser cavities in Fox-Lee integral equations form includes correctly boundary conditions. Bright soliton solutions and their instability increments are obtained explicitly.

JTU2A.73

Quantum Fractional Fourier Transform, Yesid A. Madrid Carrillo^{2,1}, Martha Molina², Rafael Torres³; ¹Grupo de Ciencias Computacionales, Universidad de Pamplona, Colombia; ²Grupo de Óptica Moderna, Física, Universidad de Pamplona, Colombia; ³Grupo de Óptica y Tratamiento de Señales, Escuela de Física, Universidad Industrial de Santander, Colombia. Our propose consist in show a new quantum gate that can perform the Fractional Fourier Transform defined by Namias as a tool to solve the differential equation of the quantum mechanical oscillator, which it can satisfy the condition of to be unitary.

JTU2A.74 **RAPID**

Characterization of Fiber Bragg Gratings in Multicore Fibers Using Quantitative Phase Imaging, Yijun Bao¹, Thomas K. Gaylord¹; ¹Georgia Inst. of Technology, USA. A quantitative phase imaging method is applied to characterize fiber Bragg gratings in multicore fibers. Digital image processing techniques are developed to overcome the difficulties arising from the short period of the fiber Bragg gratings.

JTU2A.75

Mode-Transition Bragg Gratings with Increased Group Index for On-Chip Optical Delay Lines, Lingjun Jiang¹, Zhaoran R. Huang¹; ¹Electrical, computer and systems engineering, Rensselaer Polytechnic Inst., USA. We proposed and demonstrated mode-transition Bragg gratings for optical delay line applications. It shows a stronger slow light effect than conventional apodized Bragg gratings, and a maximum group index of 15.8 has been achieved.

JTU2A.76

Scintillation Index Analysis for a Downlink Satellite Communication Based on the Three-layer Altitude Model for Moderate-to-strong Turbulence, Xin Shan^{1,2}, Yong Ai¹, Curtis Menyuk²; ¹Electronic Information School, Wuhan Univ., China; ²Computer Science and Electrical Engineering Dept., Univ. of Maryland Baltimore County, USA. Scintillation is analyzed by adopting different wave-structure functions in the three-layer model. Results show that weak-fluctuation theory is limited to smaller zenith angles, and the scintillation index has a larger peak in the focusing regime.

JTU2A • Poster Session I and Dynamic E Posters—Continued

JTU2A.77

Mode-locking Pulse Generation Based on In-fiber Acousto-optic Tunable Bandpass Modulator, Andrés Camarillo-Avilés^{1,2}, Erika N. Hernandez^{1,2}, Miguel Bello-Jiménez^{1,2}, Manuel Durán-Sánchez³, Baldemar Ibarra-Escamilla³, Olivier Pottiez⁴, Evgeny A. Kuzin³; ¹Universidad Autónoma de San Luis Potosí, Mexico; ²Instituto de Investigación en Comunicación Óptica, Mexico; ³Óptica, Instituto Nacional de Astrofísica, Óptica y Electrónica, Mexico; ⁴Centro de Investigaciones en Óptica, Mexico. An all-fiber acousto-optic tunable bandpass modulator and its application to perform mode-locking operation is reported. Experimental results demonstrate efficient spectral filtering to support high intense and ultrashort pulse generation.

JTU2A.78

Fast Quasiadiabatic 2x2 Broadband 3-dB Couplers on SOI Strip Waveguides, Zhong-Ying Li¹, Tung-Ke Huang¹, Hung-Ching Chung¹, Shuo-Yen Tseng¹; ¹National Cheng Kung Univ., Taiwan. We propose a short and broadband 2x2 silicon 3-dB coupler optimized by the fast quasiadiabatic approach. The designed device is 67.6 μm long and has a bandwidth of 280 nm for 3±1 dB splitting ratio.

JTU2A.79

Experimental Supercontinuum Generation with Combination of Different Types of Optical Fibers, Daniel Torres González¹, Juan Manuel Sierra Hernández¹, Daniel Jáuregui Vázquez¹, Julian Moises Estudillo Ayala¹, Juan Carlos Hernández García¹, Roberto Rojas-Laguna¹; ¹Universidad de Guanajuato, Mexico. Supercontinuum generation was achieved with numerous setups of optical fibers which include SMF-28, high-Numerical Aperture and dispersion-shifted fiber. Supercontinuum flatness was studied by modifying the configurations and inducing fiber losses.

JTU2A.80

Micro-Ring Resonator based Digital Photonic Half Adder Demonstration, F. K. Law¹, Mohammad Rakib Uddin¹, Nur Musyirah Masir¹; ¹Universiti Teknologi Brunei, Brunei Darussalam. This paper presents the design and simulation of a digital photonic half adder with two silicon micro-ring resonators as its base element. Simulation result with timing diagrams have been shown to justify the adder function.

JTU2A.81

Design of Interaction Gate for high performance computing structures, Santosh Kumar², Amna Bedi¹, Nan-Kuang Chen²; ¹DIT Univ., India, India; ²School of Physics Sciences and Information Technology, Liaocheng Univ., China. The present work provides a reversible optical computation universal signal interaction gate using lithium-niobate based Mach-Zehnder interferometer for high performance computing structures. The results are verified using beam propagation method.

JTU2A.82

Accurate Optical Vortex Identification in the Presence of Distortions Using a Shack-Hartmann Sensor, Jaime A. Anguita¹, Jaime E. Cisternas¹, Gustavo L. Funes¹; ¹Universidad de los Andes - Chile, Chile. We present and evaluate a robust method to identify orbital angular momentum states with a SH sensor for possible use in free-space optical communication links. Experimental verification using a 200m-range test bed is presented.

JTU2A.83

Analysis and Optimization of Edge-Filter Interrogation Scheme for FBG Sensors, SAI R. EAGALA¹, Abhinav Gautam¹, Ritu Raj Singh¹, Amitesh Kumar¹, Vishnu Priye¹; ¹Indian Inst. of Technology (ISM), India. A technique to interrogate an FBG based on edge-filter detection is proposed and demonstrated. The interrogation is performed along the slope of a filter. The filters used are Trapezoidal, Gaussian, Bessel and Butterworth filter.

JTU2A.84

Simulation of the Brillouin Effect in an Optical Feedback, Leidy J. Quintero Rodríguez¹, Min Won Lee², Ana G. Correa Mena¹, Ignacio E. Zaldivar Huerta¹; ¹INAOE, Mexico; ²Laboratoire de Physique des Lasers, Université Paris 13, France. Simulations of the dynamical behavior of a semiconductor laser subjected to stimulated Brillouin scattering and conventional optical feedback are presented. It is corroborated that the laser parameters are changed and the BFS is at 11.12GHz.

JTU2A.85

Temperature Sensor Based on Fiber-Optic Fabry-Perot Interferometer, Sigifredo Marrujo¹, Sofia Flores¹, Miguel Torres-Cisneros¹, Daniel López², David Monzón³, Daniel May², Iván Hernández¹; ¹Guanajuato Univ., Mexico; ²Centro de Investigaciones en Óptica, Mexico; ³Centro de Investigaciones en Óptica, Mexico. A fiber optic Fabry-Perot interferometer was fabricated. It was constructed by splicing a single mode fiber and a hollow core fiber, cleaving the last one to a length of 16 μm and filling it with polydimethylsiloxane. The sensitivity was 0.61 nm/°C.

JTU2A.86

Correlating Macroscopic and Microscopic Vibrations in Silicon Carbide (SiC) Micromechanical Resonators, Yanan Wang¹, Jaesung Lee¹, Vivian Zhou¹, Caleb Main¹, Christian Zorman¹, Qiang Lin², Philip Feng¹; ¹Electrical Engineering, Case Western Reserve Univ., USA; ²Electrical Engineering, Univ. of Rochester, USA. Device and lattice vibrations in SiC resonators have been comprehensively studied by laser interferometry and Raman spectroscopy. Bridging macroscopic and microscopic objects via strain mediation or phonon coupling will open up opportunities toward quantum applications.

JTU2A.87

Efficient second-harmonic generation in sub-micron PPLN waveguides, Jiayang Chen¹, Yong Meng Sua¹, Zhaohui Ma¹, Chao Tang¹, Zhan Li¹, Yu-Ping Huang¹; ¹Stevens Inst. of Technology, USA. Efficient second-harmonic generation (SHG) is demonstrated in sub-micron periodically poled lithium niobate waveguides with normalized conversion efficiencies over 440% W⁻¹cm⁻².

JTU2A.88

Excitation of hybrid epsilon-near-zero/plasmonic modes in ALD-AZO coated nanoantennae, Subhajit Bej¹, Sudip Gurung¹, Aleksei Anopchenko¹, Brian Ko¹, Howard Lee¹; ¹Baylor Univ., USA. We study optical properties of nanoantennae conformally coated with epsilon-near-zero (ENZ) Al-doped zinc oxide thin films. Results show splitting of nanoantenna resonance due to coupling between plasmonic and ENZ modes.

JTU2A.89

Entanglement Enhancement in Multimode Integrated Circuits, Zacharie M. Léger¹, Aharon Brodutch^{2,3}, Amr Helmy^{1,3}; ¹The Edward S. Rogers Sr. Dept. of Electrical & Computer Engineering, Univ. of Toronto, Canada; ²Dept. of Physics, Univ. of Toronto, Canada; ³Center for Quantum Information and Quantum Control, Univ. of Toronto, Canada. Entanglement enhancement through photon subtraction is studied in the multimode scenario. Optimal gain regions were identified for bipartite and multipartite measures; positive gains in entanglement were found after losses of 80% for specific bipartite splittings.

JTU2A.90

RAPID

Broadband and Gate-Tunable Conducting Oxide Epsilon-Near-Zero Perfect Absorber, Long Tao³, Aleksei Anopchenko³, Sudip Gurung³, Catherine Arndt³, Jason Myers², Howard Lee^{3,1}; ¹The Inst. for Quantum Science and Engineering, Texas A&M Univ., USA; ²US Naval Research Lab, USA; ³Dept. of Physics, Baylor Univ., USA. We demonstrate broadband and gate-tunable conducting oxide epsilon-near-zero perfect absorbers grown by atomic layer deposition. Absorption bandwidth (> 90%) of 214 nm for Berreman mode in NIR region is realized.

JTU2A.91

RAPID

Random Lasers Based on Polymer Membranes with Silver Nanoflowers, Junhua Tong¹, Tianrui Zhai¹; ¹College of Applied Sciences, Beijing Univ. of Technology, China. Low-threshold random lasing was achieved in a polymer membrane with silver nanoflowers. The random laser was fabricated by attaching the polymer membrane on the silver nanoflowers.

JTU2A.92

Demonstration of a High Q-factor Microring Resonator Fully Suspended by a Subwavelength Sidewall Grating, Soha E. Yousuf¹, Anatol Khilo², Marcus S. Dahlem¹; ¹Khalifa Univ. of Science and Technology, United Arab Emirates; ²Boston Univ., USA. A microring resonator fully suspended by a subwavelength sidewall grating is demonstrated, with measured quality factor of 125k around 1550 nm. The structure is promising for sensing applications, with predicted sensitivities up to 1250 nm/RIU.

JTU2A.93

Mid-Infrared Supercontinuum Generation with a Weak CW Trigger, Rongle Huang¹, Renlai Zhou², Qian Li¹; ¹Peking Univ., China; ²Naval Univ. of Engineering, China. We numerically demonstrate picosecond pulse pumped mid-infrared supercontinuum generation in chalcogenide photonic crystal fibers with a weak CW trigger. An ultra-stable and bright supercontinuum with greatly enhanced coherence is achieved.

JTU2A.94

Small-Period Titanium-Diffused Periodically Poled Lithium Niobate Waveguides for Strongly Nondegenerate Quantum Frequency Conversion, John W. Snyder¹, Alexander V. Sergienko^{1,2}; ¹Electrical and Computer Engineering, Boston Univ., USA; ²Physics, Boston University, USA. A Ti-diffused periodically poled Lithium Niobate device with ultra-short poling periods has been developed for strongly nondegenerate quantum nonlinear optics. Quantum frequency conversion from 369.5nm to 1550nm with a 485nm pump laser is targeted.

JTU2A.95

A Novel Photonic Stampfli Quasicrystal Fiber Based D-Glucose Microbiosensor, Aruna Gandhi M S¹, Xuanyi Liu¹, Qian Li¹; ¹Shenzhen Graduate School, Peking University, China. The proposed photonic Stampfli quasicrystal fiber-based D-glucose Microbiosensor achieves a maximum sensitivity of 20000 nm/RIU and a resolution of 5 × 10⁻⁸ RIU in the different concentrations from 50% to 60% of the D-glucose solution.

JTU2A.96

Tunable Electromagnetically Induced Transparency in Ge₂Sb₂Te₅-Based Infrared Metasurfaces, Riad Yahiaoui¹, Joshua Burrow², Jay Mathews², Andrew Sarangan², Imad Agha², Thomas A. Searles¹; ¹Howard Univ., USA; ²Dayton Univ., USA. We report the investigation of an all-dielectric metasurface (ADM) based on an array of Ge₂Sb₂Te₅ (GST) meta-molecules exhibiting a tunable electromagnetically induced transparency (EIT) effect in the infrared frequency regime.

JTU2A • Poster Session I and Dynamic E Posters—Continued

JTU2A.97

Novel refractive index sensor based on hybrid long range plasmon in H-shaped optical fiber, Nelson Gomez-Cardona^{2,1}, Erick Reyes^{2,1}, Rodrigo Acuña², Pedro Torres²; ¹Departamento de Electrónica y Telecomunicaciones, Instituto Tecnológico Metropolitano, Colombia; ²Escuela de Física, Universidad Nacional de Colombia, Sede Medellín, Colombia. We propose a novel design for a refractive index (RI) sensor based on hybrid long-range plasmon in H-shaped microstructured optical fiber. Good sensitivity, as high as 6.1×10^3 nm/RIU, can be achieved in the proposed structure.

JTU2A.98

Highly confined light guiding in a dielectric-nanowire-loaded hybrid Bloch-surface-polariton waveguide, Weijing Kong¹, Yu Sun², Haiyang Zhang¹, Yu Sun¹, Shuang Wang¹, Wenhui Zhao¹; ¹School of Electronic Engineering, Tianjin Univ. of Technology and Education, China; ²School of Information Science and Technology, Beijing Forestry Univ., China. A hybrid dielectric-nanowire loaded Bloch-surface-polariton waveguide is presented and investigated. The results reveal the hybrid configuration enables significantly improved mode confinement combined with low propagation loss.

JTU2A.99

Topologically-protected Edge Modes in Thue-Morse Photonic Crystals, Mukesh K. Shukla¹, Ritwick Das¹; ¹National Institute of Science Education & Research, India. We report topologically-protected optical edge modes in Thue-Morse (TM) sequence based distributed-reflector (DR) with exceptionally high quality-factor. Topological features are explored through the phase and surface-polaritons in TM-DR lattice.

JTU2A.100

Carbon-dots Embedded Glass Based Inverse Micropillar Structures by Two-photon Polymerization Process, Pratyusha Das¹, Meher Wan¹, Subhrajit Mukherjee¹, Samit K. Ray^{1,2}, Shivakiran Bhaktha B N¹; ¹Indian Inst. of Technology Kharagpur, India; ²S N Bose National Centre for Basic Sciences, India. A simple fabrication of 2D photonic crystal with hexagonal lattice system of air-column in a high-dielectric medium based on 3D photolithography technique and interaction of quantum emitters embedded in a microcavity is presented.

JTU2A.101

Inverse Design of Long-range Intensity Correlations in Scattering Media, Milan Koirala¹, Raktim Sarma², Hui Cao², Alexey G. Yamilov¹; ¹Missouri Univ of Science & Technology, USA; ²Applied Physics, Yale University, USA. We obtain analytical expression for the long-range spatial intensity correlation in a disordered waveguide of an arbitrary shape. Inverting this relationship allows a possibility to manipulate wave transport complimentary to the wavefront shaping.

JTU2A.102

Mid Infra-red Directional Coupler Optical Switch Based on Phase Change Material Embedded in Partially Etched SOI Waveguide, Nadir Ali¹, Rajesh Kumar¹; ¹Indian Inst. of Technology Roorkee, India. An ultra-compact 1x2 optical coupler switch at wavelength 2.1 μ m is designed and simulated using Ge₂Sb₂Te₅ embedded in silicon waveguide. The phase alteration of Ge₂Sb₂Te₅ results in coupling ratio change from >90% to <2%.

JTU2A.103

Sub-wavelength focusing in air using semiconductor based Hyperbolic Metamaterial for infrared imaging, Norhan Salama¹, Mai Desouky¹, Mohamed M. Swillam¹; ¹Physics, American Univ. in Cairo, Egypt. We theoretically demonstrate sub-wavelength focusing in air using doped InAs/intrinsic InAs hyperbolic metamaterial (HMM). Sub-wavelength focusing in air is achieved in the near field at wavelength of 9.31 μ m with focusing distance of 1 μ m with resolution down to 0.13 λ .

JTU2A.104

Honeycomb photonic crystal as a zero index metamaterial, Nishant Shankhwar¹, Yogita Kalra¹, Ravindra K. Sinha¹; ¹Delhi Technological Univ., India. In this article zero index behaviour of honeycomb photonic crystal has been demonstrated. The zero index behaviour arises due to the dirac-like dispersion induced by degeneracy of modes at the dirac point.

JTU2A.105

Design and Analysis of Broadband Square Spiral Shaped Nanoantenna, Ritika Ranga¹, Nishant Shankhwar¹, Yogita Kalra¹; ¹Delhi Technological Univ., India. In this paper, a broad band square spiral shaped nanoantenna is proposed and analysed by finite element method via COMSOL Multiphysics software. Electric field is enhanced in the gap of nanoantenna.

JTU2A.106

Disordered coupled photonic crystal slab cavities: effects on the coupling strength, Juan P. Vasco¹, Vincenzo Savona¹; ¹Physics, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland. We study the effects of disorder on the coupling strength of coupled photonic crystal slab cavities and establish upper bounds for the quantity of disorder in order to the system work into the coupling regime.

JTU2A.107

Leaky-mode Band Dynamics of Photonic Crystal Slabs, Sun-Goo Lee¹, Robert Magnusson¹; ¹Univ. of Texas at Arlington, USA. We present analytical and numerical results on the formation of the second (leaky) stop band of photonic crystal slabs. We show that Bragg processes generated by spatial Fourier harmonics control the band transition dynamics.

JTU2A.108

Super-Absorbing Metamaterials Using Epsilon-Near-Zero Plasma Resonance, Jinnan Chen¹, Justin W. Cleary², Joshua R. Hendrickson², Evan M. Smith^{2,3}, Junpeng Guo¹; ¹Univ. of Alabama in Huntsville, USA; ²Air Force Research Lab, USA; ³KBRwyle, USA. Metamaterials of epsilon-near-zero (ENZ) and dielectric layer structures are investigated for wideband light absorption in the wavelength range from 1 to 2 micron. Increasing the number of ENZ-dielectric layers results in wider absorption band.

JTU2A.109

Design of microring resonator sensor for liquid chemical sensing applications, Amna Bedi¹, Sonika Singh¹, Santosh Kumar², Nan-Kuang Chen²; ¹Dept. of Electrical and Electronics & Communication Engineering, DIT Univ., India, India; ²School of Physics Sciences and Information Technology, Liaocheng Univ., China. A microring resonator sensor for liquid chemical sensing applications is proposed, which is based on the change in optical signal intensity with refractive index of analytes. The input and output intensity inside sensor is measured.

JTU2A.110

Design and Characterization of Nanocavity Photonic Crystal Lasers, Binte M. Muminur¹, Muhammad M. Rahman¹; ¹Physics, Jahangirnagar Univ., Bangladesh. Photonic laser sources have great potential in communication applications. We explore the design, fabrication and characterization of lasers based on photonic crystal nanocavities. We demonstrate CW and ultrashort pulse response of photonic lasers.

JTU2A.111

Standoff microparticles characterization with digital holographic Raman spectroscopy, Nava R. Subedi¹, Gombojav O. Ariunbold¹, Prakash Adhikari¹, Matthew J. Berg²; ¹Mississippi State University, USA; ²Physics, Kansas State Univ., USA. A detail standoff interrogation of microparticles irradiated with a coherent light source will be discussed. The results suggest that the methodology could be applied to characterize airborne respirable-sized particles in free-flowing aerosol form.

JTU2A.112

Optically induced pure frequency modulation based on a mid-infrared quantum cascade laser, Hai J. Zhou¹, Chen Peng², Tao Chen², Biao Wei¹; ¹Chongqing Univ., China; ²China Academy of Engineer Physics, China. Purified frequency modulation is demonstrated in a middle-infrared quantum cascade laser by illuminating its front facet with two optimized near infrared lasers. It is beneficial in improving signal fidelity for free space optical communication.

JTU2A.113

Near Field Enhancement in a Hollow Flower Shaped Nanoantenna, Parul Goyal¹, Nishant Shankhwar¹, Yogita Kalra¹; ¹Delhi Technological Univ., India. In this paper, a metallic hollow flower shaped nanoantenna has been designed to obtain a near field enhancement in the feed gap of nanoantenna in the visible vision. The modeling of the nanoantenna has been done using COMSOL Multiphysics software.

JTU2A.114

Optical Biosensor Based on Guided Mode Grating Coupler, Rukmani Singh¹, Ritu Raj Singh¹, Vishnu Priye¹; ¹Indian Institute of Technology, Dhanbad, India. Demonstration of highly sensitive optical biosensor based on interaction of analyte with guided mode light in silicon-on-insulator waveguide through grating coupler is proposed. The presented device is compact and high sensitive (422nm/RIU).

JTU2A.115

Dual-Functional Integrated Modulator-Detector for Optical Communication On-Chip, Shuai Sun¹, Ruoyu Zhang¹, Jiaxin Peng¹, Hamed Dalir², Tarek El-Ghazawi¹, Volker J. Sorger¹; ¹George Washington Univ., USA; ²Omega Optics, Inc., USA. Here we show a novel integrated broadband hybrid photonic-plasmonic device termed MODetector featuring dual light modulation and detection, with 10 dB extinction ratio, 0.8 dB insertion loss, and 0.7 A/W responsivity.

JTU2A.116

Ultrafast sources for optical virtual skin biopsy: a fiber-based solution to pulses at 1250 nm, Hsiang-Yu Chung^{1,2}, Wei Liu^{1,2}, Rüdiger Greinert³, Franz Kärtner^{1,2}, Guoqing Chang^{1,4}; ¹DESy, Germany; ²Physics, Universität Hamburg, Germany; ³Skin Cancer Center Buxtehude, Germany; ⁴The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Germany. We demonstrate a fiber-based ultrafast source generating 450-mW, sub-100-fs pulses centered at 1250 nm by implementing self-phase modulation enabled spectral selection. This source is ideal for harmonic generation microscopy in human skin.

JTU2A • Poster Session I and Dynamic E Posters—Continued

JTU2A.117

Fast Hyperspectral Detection of the Frequency Response of Highly Scattering Tissue using a Femtosecond Pulse with Light Labeling, Patrick A. Stockton¹, Randy Bartels¹, Mohammad Torabzadeh², Bruce J. Tromberg³, ¹Colorado State University, USA; ²Biomedical Engineering, Univ. of California, USA. We introduce a new diffuse optical spectroscopy measuring technique for fast acquisition of optical properties. We utilize a broad bandwidth femtosecond illumination to simultaneously probe the spectral and frequency response of a scattering tissue.

JTU2A.118

Silicon photonics with hybrid integrated 2D MoO₃: plasmonic pH driven sensing and reconfigurability, Guanghui Ren¹, Baoyue Zhang¹, Markus Knoerzer¹, Arnan Mitchell¹, Jianzhen Ou¹, ¹Royal Melbourne Inst. of Technology, Australia. A new plasmonic label-free optical pH sensing platform is realized by integrating two-dimensional H⁺ doped molybdenum oxide on a silicon micro-ring resonator.

JTU2A.119

Quantitative Second-harmonic Generation Imaging of Tissue Damage from Environmental-scanning Electron Microscopy, Wooon Lee¹, Kimani C. Toussaint, Jr.¹, ¹Univ. of Illinois, USA. We quantitatively evaluate changes of collagenous tissue due to beam exposure in an environmental-scanning electron microscope. Quantitative second-harmonic generation microscopy is used to image and assess selected regions before and after exposure.

JTU2A.120

Development of Medical Diagnostic System using a Non-labeled Extraordinary Optical Transmission Biosensor, Yeji Lee¹, Hyerin Song¹, Heesang Ahn¹, Kyujung Kim¹, ¹Pusan National Univ., South Korea. Extraordinary optical transmission sensor with sensitivity of 458.33 nm/RIU was designed and distinguished the hypoalbuminemia group with a probability of over 98 %.

JTU2A.121

1.7- μ m gain-switched thulium-doped fiber laser with electrically tuning and its application to spectroscopic photoacoustic imaging, Can Li¹, Jiawei Shi¹, Cihang Kong¹, Xiaojing Gong², Liang Song², Kenneth K. Wong¹, ¹Univ. of Hong Kong, Hong Kong; ²Inst. of Biomedical and Health Engineering, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China. We demonstrate a gain-switched thulium-doped fiber laser with electrically wavelength tuning in the 1.7- μ m band. The achieved stable laser pulses with an energy of 1.6 μ J are exploited to implement spectroscopic photoacoustic microscopy of lipid.

JTU2A.122

Single-shot multiple-color holography of single neuron using spatial frequency multiplexing, Behnam Tayebi¹, Yeonwoo Jeong¹, Jae-Ho Han¹, ¹Korea Univ., South Korea. Here, we present a single-shot triple-wavelength holographic microscopy technique for high-resolution color imaging of the neuronal cells using a monochromatic camera. The feasibility of the technique is demonstrated by imaging of neuronal cells.

JTU2A.123

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

JTU2A.124

Optimal Plasmonic Nanopillars Array for Light Confinement of Fluorescence Imaging, Soojung Kim¹, Hyerin Song¹, Tae Young Kang¹, Heesang Ahn¹, Kyujung Kim¹, ¹Pusan National Univ., South Korea. Vertical SiO₂ nanopillars array terminated with Au nanofilms for light localization. Reducing light scattering to enable light localization in the vicinity of metals. As a result, we could confirm reducing light scattering.

JTU2A.125

Development of Four Channel Based Linear Stokes-Mueller Polarization Microscope For Tissue Characterization, Spandana K. U¹, Krishna K. Mahato¹, Nirmal Mazumder¹, ¹Manipal Academy of Higher Education, India. We have developed Stokes-Mueller based polarization imaging technique to extract the quantitative microstructural information of biological sample.

JTU2A.126

High Speed, High-Resolution First Surface Defect Detection for Virtual and Augmented Reality Optics, Timothy A. Potts¹, ¹Dark Field Technologies, USA. First surface inspection of uncoated and coated optics is critical for high volume production of Virtual and Augmented Reality headsets and eyewear. Solid State Laser Reflection (SSLR) technology delivers high-speed first surface inspection.

JTU2A.127

Vibrational Spectroscopic Preliminary Study of Blood and Its Components in Mice, Ariunbold Gombojav¹, Supriya Nagpal¹, Prakash Adhikari¹, Enkhsaikhan Purejav², Lu Lu³, ¹Mississippi State Univ., USA; ²Pediatrics, Univ. of Tennessee Health Science Center, USA; ³Genetics, Genomics and Informatics, Univ. of Tennessee Health Science Center, USA. Spectroscopic study of blood and serum of the mice strains produced from progenitors C57BL/6J and DBA/2J for identifying biomarkers is underway. A preliminary study shows that multivariate spectral analyses discriminate the mice with their ages.

JTU2A.128 **RAPID**

Imaging Brain Pathology in Alzheimer's Disease by Contrast-Enhanced Optical Coherence Tomography, Bernhard Baumann¹, Antonia Lichtenegger¹, Pablo Eugui¹, Martina Muck¹, Marco Augustin¹, Thomas Roetzer¹, Danielle J. Harper¹, Adelheid Woehrer¹, Christoph Hitzenberger¹, ¹Medizinische Universität Wien, Austria. We present three approaches for using optical coherence tomography (OCT) to visualize neuritic plaques in Alzheimer's disease based on intrinsic optical properties, namely their birefringence, spectroscopic characteristics and scattering profile.

JTU2A.129 **RAPID**

Spatial resolution of compressive-sensing-based ghost imaging can approach theoretical upper bound, Xieyu Du¹, Junhui Li¹, Guohua Wu¹, Bin Luo¹, Dongyue Yang¹, Longfei Yin¹, Hong Guo², ¹Beijing University of Posts & Telecom, China; ²Peking Univ., China. We present a method for the spatial resolution of ghost imaging to approach its theoretical upper limit based on parameter optimization of compressive sensing. This method shows robustness against additive noise in bucket detector.

JTU2A.130 **RAPID**

Pixel-based Engineering for Suppression of Higher Orders of Diffraction, Joanna Starobrat¹, Jan Bolek¹, Michal Makowski¹, ¹Faculty of Physics, Warsaw Univ. of Technology, Poland. For the reduction of higher diffraction orders in computer hologram reconstructions, pixel engineering methods are proposed: pixel apodization (phase and amplitude) and their randomization. The results of simulations and experiments are discussed.

JTU2A.131 **RAPID**

Numerical Modeling of Unit Cell and Field Stop Effects in Apodized Pupil Lyot Coronagraphs, Scott Will¹, James R. Fienup¹, ¹Univ. of Rochester, USA. We show that the field diffracted from the apodizing mask of an apodized pupil Lyot coronagraph can be computed exactly, and analyze the effect on instrument performance as a function of field stop diameter

JTU2A.132

Sparsity-based One-dimensional Phase Retrieval of Continuous Non-negative Pulse Trains, Qianqian Su¹, Jianfei Hua¹, ¹Tsinghua Univ., China. Represented by discrete-time signals, continuous non-negative pulse trains have been successfully reconstructed from under-sampled measurements of their Fourier amplitude based on assumptions of sparsity and finite support.

JTU2A.133

Contour-based depth-of-field extension in multi-focus integral imaging system, Miao Zhang¹, Yongri Piao¹, Chuanzhen Wei¹, Rui Xu¹, ¹Dalian Univ. of Technology, China. To solve the limited DoF of integral imaging, the contour-based object extraction and minimum bounding box based size correction are developed. Finally, all-in-focus IIs are obtained by the block-based image fusion method.

JTU2A.134

Programmable Multiwavelength Achromatic Focusing Through Scattering Media, Jiannan Wang¹, Wei Li¹, Jietao Liu¹, Xueying Sun¹, Guo Chengfei¹, Xiaopeng Shao¹, ¹XiDian Univ. of China, China. We demonstrate with numerical simulations that multiple scattering can be controlled via serial optical transmission matrix and parallel optical transmission matrix to obtain achromatic 3D focusing at arbitrary position by wavefront shaping.

JTU2A.135

Surface Normals Correction by Removing Specular Reflection for 3D Polarization Imaging, Shengzhi Huang¹, Fei Liu¹, Pingli Han¹, Xuan Li¹, Xiaopeng Shao¹, ¹XiDian Univ., China. 3D polarization imaging is challenged by surface distortion caused by the specular reflection. We used the dichromatic reflection model to remove the specular reflection and correct surface normals to obtain accurate 3D image.

JTU2A.136

Bit-length vs. dimension: Image formation of ghost imaging, Meijing Ke¹, Junhui Li¹, Guohua Wu¹, Bin Luo¹, Dongyue Yang¹, Longfei Yin¹, Hong Guo², ¹Beijing Univ of Posts & Telecom, China; ²Peking Univ., China. Length-variant pooling according to conducted sample number excludes endeavor to expand image dimension from image formation process of ghost imaging, leaving bit-length growth alone.

JTU2A.137

Structural contrast function improves image alignment precision of ghost imaging, Dongchu Han¹, Junhui Li¹, Guohua Wu¹, Bin Luo¹, Dongyue Yang¹, Longfei Yin¹, Hong Guo², ¹Beijing University of Posts & Telecom, China; ²Peking Univ., China. Structural contrast function prevails cross-correlation and mutual information on image alignment of ghost imaging, both accuracy (pixel shift) and robustness (error curve kurtosis), especially in under-sampling condition.

JTu2A • Poster Session I and Dynamic E Posters—Continued

JTu2A.138

Open Source Computational Photonics Toolbox, Alec Hammond¹, Ryan M. Camacho¹; ¹*Electrical & Computer Engineering, Brigham Young Univ., USA*. We present an open source and collaborative integrated photonics simulation environment capable of accurately modeling individual components using traditional vectorial methods and large circuits using linear system theory and deep learning.

JTu2A.139

3D Multiple Sclerosis Image Analysis Based on Probabilistic Methods for a 4F Array, Eduardo Perez¹; ¹*DICIS, Mexico*. This work presents a detection of multiple sclerosis (MS) knowing is a challenging process, which usually requires several analysis of the imaging over time. All of this to be implemented in a 4F array.

JTu2A.140

Raman Spectroscopy as a Tool for Characterisation of Liquid Phase Devices, Benjamin T. Hogan¹; ¹*Univ. of Exeter, UK*. In this paper, we demonstrate how Raman spectroscopy can be an effective tool for the elucidation of the properties of liquid phase devices, looking at signal enhancement through to beam profiling.

JTu2A.141

Stationary Fourier Transform Spectrometer, Erez N. Ribak¹; ¹*Technion Israel Inst. of Technology, Israel*. We developed a non-scanning and extremely stable Fourier Transform Infra-red Spectrometer, for detection of narrow atmospheric lines. We intend to use it to identify and measure molecules in our own atmosphere or in remote planets.

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

Science & Industry Showcase

13:00–14:00

Rapid Fire Oral Presentation II, Science & Industry Theater

Presider: David Busch; Univ. Texas Southwestern Medical Center at Dallas, USA

Participating posters are noted in the list of poster for session JTU3A with the icon **RAPID**. Each presenter will have 3 minutes and the order will be determined by poster number.

JOINT FIO + LS

13:00–15:00

JTu3A • Poster Session II and Dynamic E Posters

JTu3A.1 **E-Poster**

Polarization-Filtering Negative Curvature Fibers, Chengli Wei¹, Curtis Menyuk², Jonathan Hu¹; ¹Baylor Univ., USA; ²Univ. of Maryland Baltimore County, USA. We design a polarization-filtering negative curvature fiber. The loss ratio between the two polarizations is more than 100. This simple design will be useful in hollow-core fiber devices that are sensitive to polarization effects.

JTu3A.2 **E-Poster**

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

JTu3A.3 **E-Poster**

Biomolecule Detection Based on a Liquid Crystal Film Coated on a Single Substrate, Wei Liang Hsu¹, Chao-Ping Pai¹, Po-Chang Wu¹, Mon-Juan Lee², Wei Lee¹; ¹Inst. of Imaging and Biomedical Photonics, National Chiao Tung Univ., Taiwan; ²Dept. of Bioscience Technology, Chang Jung Christian Univ., Taiwan. In comparison with the conventional approach entailing sandwiched cells for LC-based biosensing, here we demonstrate a simpler label-free platform—a unique single-substrate technique capable of rapid screening and bioassay of DNA hybridization.

JTu3A.4 **E-Poster**

Non-linear vertical coupling for III-V/SOI interconnects, Ruth Rubio Noriega¹; ¹National Inst. for Research and Training in Telecommunications, Peru. Hybrid III-V/Si devices have been recently exploited for optical interconnects applications. In this work, a 0.2dB loss for the S, C and L bands, process tolerant, vertical evanescent coupling structure is presented.

JTu3A.5 **E-Poster**

Mode-Selective Image Upconversion, Santosh Kumar¹, He Zhang¹, Stephanie Maruca¹, Yu-Ping Huang¹; ¹Dept. of Physics, Stevens Inst. of Technology, USA. We experimentally demonstrate selective frequency up-conversion of complex spatial modes through a nonlinear crystal, with potential applications in areas of quantum communications and pattern recognition.

JTu3A.6 **E-Poster**

Rotation of dielectric microspheres trapped near an ultrathin optical fiber, Cindy Liza C. Esporas¹, Georgiy Tkachenko¹, Aili Maimaiti¹, Viet Giang Truong¹, Sile Nic Chormaic¹; ¹Okinawa Inst. of Science & Technology, Japan. We experimentally investigate the rotational motion arising from laser light scattering of dielectric particles trapped near the evanescent field of a water-clad ultrathin optical fiber with a guided quasi-circularly polarized fundamental mode.

JTu3A.7 **E-Poster**

Ultra-Fast Relaxation and Singlet-Triplet Conversion Quantum Yield of Ir Complexes, Salimeh Tofiqhi¹; ¹Univ. of Central Florida, CREOL, USA. The nonlinear-optical properties of Iridium complexes including triplet yield and excited-state cross-sections was studied by steady-state time-resolved measurements using picosecond and femtosecond excitation at multiple wavelengths.

JTu3A.8 **RAPID**

Noise tolerant LIDAR via mode selective up-conversion detection, Yong Meng Sua¹, Amin Shahverdi¹, Ivan Dickson¹, Malvika Garikapati¹, Yu-Ping Huang¹; ¹Stevens Inst. of Technology, USA. We study mode selective up-conversion detection to improve SNR for LIDAR applications. We demonstrate a 41-dB increase in the SNR for single-photon counting compared to that of direct detection using a InGaAs single-photon detector.

JTu3A.9 **RAPID**

Enhanced Light Absorption in Silicon Nanococones for Solar Applications, Sara Al Menabawy¹, Joumana El-Rifai¹, Mohamed M. Swillam¹; ¹American Univ. in Cairo, Egypt. In this work, we report a one-step fabrication of silicon nanococones from amorphous silicon substrates using excimer laser by melting and re-solidifying the deposited material. They show broadband absorption enhancement at multiple angles.

JTu3A.10 **RAPID**

Coherence Resonances and Bandgaps in Plasmonic Hole Arrays, Matt Smith¹, Gregory J. Gbur¹; ¹Univ. of North Carolina at Charlotte, USA. We theoretically demonstrate the existence of optical coherence bandgaps by simulating plasmonic interaction with a partially coherent field on a subwavelength-thickness gold plate perforated by a linear array of circular holes.

JTu3A.11

Development of an In-situ Metrology Technique for Freeform Optics, Daliramu Burada¹, Kamal Pant^{1,2}, Vinod Mishra^{1,3}, Bichra Mohamed⁴, Gufran Khan¹, Stefan Sinzinger⁴, Chandra Shakher¹; ¹Indian Inst. of Technology Delhi, India; ²DRDO, IRDE, India; ³CSIR, CSIO, India; ⁴Fachgebiet Technische Optik, Technische Universität Ilmenau, Germany. The paper presents the development of Shack-Hartmann sensor as *in-situ* metrology technique that can be integrated to the machining platforms and helps in the development process of aspheric and freeform optics within the required tolerances.

JTu3A.12

High-Efficiency Beam Deflection of Visible Light Based on Dielectric Metasurfaces, Rifat Ahmmed Aoni¹, Mohsen Rahmani¹, Lei Xu², Khosro Kamali¹, Andrei Komar¹, Jingshi Yan¹, Dragomir Neshev¹, Andrey Miroshnichenko²; ¹Nonlinear Physics Centre, Research School of Physics and Engineering, The Australian National Univ., Australia; ²School of Engineering and Information Technology, Univ. of New South Wales, Australia. We experimentally demonstrate a dielectric metasurface for beam-deflection with off-resonance near-unity transmittance in the visible wavelength. By reducing the supercell length, the beam deflection can switch efficiently and achieved 16.50°.

JTu3A.13

Superbunching Effect of Light with Digitally Designed Wavefront, Lu Zhang¹, Yiping Lu¹, Liming Li¹, Guoquan Zhang¹; ¹Nankai Univ., China. Superposition of multiple two-photon paths is introduced with digital wavefront encoding technique, resulting in superbunching effect. Experimentally, we measured a bunching peak of 4.18 ± 0.05 with the digitally designed wavefront of classical light.

JTu3A.14

A Metasurface-inspired Focusing Collector for Concentrated Solar Power Applications, Qing Ding¹, Shama Barna¹, Kyle Jacobs¹, Aakash Choubal¹, Glennys Mensing¹, Zhong Zhang², Kaito Yamada², Robert Tirawat³, Nicholas Kincaid³, Guangdong Zhu³, Tim Wendelin⁴, L. Jay Guo², Placid Ferreira¹, Kimani C. Toussaint, Jr.¹; ¹Univ. of Illinois at Urbana-Champaign, USA; ²Univ. of Michigan, Ann Arbor, USA; ³National Renewable Energy Lab, USA; ⁴Solar Dynamics, USA. We present a metasurface-inspired planar focusing collector for concentrated solar power. Fabrication is achieved using two-photon lithography and subsequent nanoimprint lithography test for scalability. Optical characterization results are reported.

JTu3A.15

Thin Film High Efficiency Epitaxial Lift-Off Solar Cells, Drew Cardwell¹, Alex Kirk¹, Martin Drees¹, Christopher Stender¹, Ray Chan¹, Andree Wibowo¹, Chris Youtsey¹, Glen Hillier¹, Mark Osowski¹, Noren Pan¹; ¹MicroLink Devices Inc., USA. MicroLink Devices has developed flexible, lightweight, high efficiency III-V inverted metamorphic multi-junction epitaxial lift-off solar cells that are attractive for mobile, terrestrial, airborne, and space applications.

JTu3A.16

Femtosecond Written Silica Waveguides for High Extinction Polarization Filtering, Timothy Lee¹, Qi Sun¹, Rand Ismaeel¹, Marta Castro-Lopez², Bocheng Cao³, Martynas Beresna¹, Gilberto Brambilla¹; ¹Optoelectronics Research Centre, Univ. of Southampton, UK; ²Huawei Technologies Duesseldorf GmbH, Germany; ³Huawei Technologies Japan KK, Japan. Silica waveguides with polarization-selective transmission were written by femtosecond laser inscription using linear and circular polarization. By tailoring writing parameters, polarization-dependent losses from 0.5 to 24dB at 1310nm were achieved.

JTu3A.17

Polarization-Holographic-Element-Based-Method for Determining the Complex Birefringence Distribution, Barbara N. Kilosanidze¹, George Kakauridze¹, Irina Kobulashvili¹, Yuri Mshvenieradze¹; ¹Lab of Holographic Recording and Processing of Information, Georgian Technical Univ., Georgia. A new method is presented for determining the distribution of complex birefringence in different materials based on the polarization-holographic element when circularly polarized light beam transmitted through the sample diffracts on the element

JTu3A.18

Image rotation with three skew lenses, Jakub Belin¹, Gergely Ferenczi²; ¹Univ. of Glasgow, UK; ²Univ. of Strathclyde, UK. We present an image-rotating arrangement of skew lenses. We demonstrate the image-rotating property using ray-tracing simulations.

JTu3A.19

Design and Fabrication of Microring Resonator Array for mid-IR Filter Applications, Rajat K. Sinha¹, Meher Wan¹, Saawan Kumar Bag¹, Shailendra Varshney¹; ¹Indian Inst. of Technology Khharagpur, India. Mid-IR bandpass filter based on microring resonators 2D array is designed and fabricated. The structure is analyzed using transfer matrix-method and simulated using FDTD. The design is fabricated with IP-Dip using two-photon polymerization process.

JTU3A • Poster Session II and Dynamic E Posters—Continued

JTU3A.20

Classification of Propagation-Invariant Space-Time Wave Packets in Free-Space, Basanta Bhaduri¹, Murat Yessenov¹, Hasan E. Kondakci¹, Ayman Abouraddy¹; ¹Univ. of Central Florida, CREOL, USA. We classify all propagation-invariant pulsed beams with respect to their group velocity, direction of propagation, and spatial-frequency content. We identify 10 unique classes that we synthesize experimentally using a single optical arrangement.

JTU3A.21

Comparative Characteristics of the Properties of Photoanisotropic Materials Composed with Covalent Bond and Electrostatic Interactions, Irakli Chaganava^{1,2}, Sakinah M. Alauddin⁴, Nurul F. Aripin⁴, Alfonso M. Felipe³, Irine Kobulashvili¹; ¹Lab of Holographic Recording and Processing of Information, Inst. of Cybernetics of Georgian Technical Univ., Georgia; ²Georgian State Teaching Univ. of Physical Education and Sport, Georgia; ³Chemical and Materials Engineering Research Group, Univ. of Aberdeen, King's College, UK; ⁴Faculty of Chemical Engineering, Univ. of Technology MARA, Malaysia. The paper presents the study of the polarization-sensitive materials developed by us. It is demonstrated the advantages of these light-recording organic media composed both via covalent bindings and through electrostatic interactions.

JTU3A.22

Reflection By and Transmission Through an ENZ Interface, Zhangjin Xu¹, Henk F. Arnoldus¹; ¹Dept. of Physics and Astronomy, Mississippi State Univ., USA. Reflection and transmission of radiation by an ENZ interface is studied. For s polarization, the transmitted magnetic field is circularly polarized. For p polarization, the electric field is circularly polarized and the magnetic field vanishes.

JTU3A.23

High-Resolution, In-Situ Defect Detection, Timothy A. Potts¹; ¹Dark Field Technologies, USA. Defect detection of optical glass, during vacuum deposition, has been a long-standing industry need. A special Solid State Laser Reflection (SSLR) technology has been developed which is easily installed and delivers 100% inspection during deposition.

JTU3A.24

Ion Assisted E-beam Deposition of Silicon dioxide Thin films with Graded Refractive Index, Vemuri Srs Praveen Kumar^{1,2}, Mukesh Kumar¹, Neelam Kumari^{1,2}, Vinod Karar¹, Amit L. Sharma^{1,2}; ¹Central Scientific Instruments Organisation, India; ²Optical Devices and Systems, Academy of Scientific and Innovative Research, India. We report the design and fabrication of SiO₂ films using the GLAD technique with different incidence angles from 10° to 80° by Ion-Assisted E-beam deposition resulting in the decrease of effective film refractive index from 1.46 to 1.38.

JTU3A.25

Phasing a Segmented Space Telescope, Erez N. Ribak¹, Martin Levine¹; ¹Technion – Israel Inst. of Technology, Israel. We wish to phase a segmented and sparse telescope in space, employing only wide-band light from an extended object. A stochastic search for the sharpest image lasts up to one day, for a four-segment telescope.

JTU3A.26

Measurement of remote sound based on laser feedback interferometry, Zongren Dai¹, Kaiyi Zhu¹, Yidong Tan¹; ¹Tsinghua Univ., China. An optical sound measurement technology is developed based on microchip Nd:YVO₄ laser feedback interferometry. The system can recover the sound signal by measuring the vibration of non-cooperative target, which is located in the sound field.

JTU3A.27

Variation of Refractive indices from twisted dielectric media, Dipan Sinha¹, Dipti Banerjee²; ¹Dept. of Physics, Univ. Of Calcutta, India; ²Dept. of Physics, Vidyasagar College for Women, India. The properties of twisted dielectric matrix has been studied for symmetric and anti-symmetric part. Variation of refractive index with the internal and external birefringence is also been studied.

JTU3A.28

Polarization and Coherence in the Hanbury Brown-Twiss Effect, Taco D. Visser¹, Ari Friberg², David Kuebel³; ¹Vrije Universiteit Amsterdam, Netherlands; ²Univ. of Eastern Finland, Finland; ³Univ. of Rochester, USA. We study the correlation of intensity fluctuations in random electromagnetic beams, the Hanbury Brown-Twiss effect. Not just the state of coherence of the source, but also its state of polarization has a strong influence.

JTU3A.29

Turbulence Mitigation using Chaos-modulated Image Propagation along a Slanted Path under Gamma-Gamma Atmospheric Turbulence, Monish R. Chatterjee¹, Ali A. P. Mohamed¹; ¹Univ. of Dayton, USA. Mitigation of distortion under gamma-gamma turbulence is examined for propagation along a low-altitude slanted path using acousto-optic chaos and the Huffnagel-Valley model. System performance is measured using bit error rates and compared with non-chaotic propagation.

JTU3A.30

RAPID

Quantum Random Number Generator with Programmable Probability Distributions, Lac Nguyen¹, Yu-Ping Huang², Yong Meng Sua², Patrick Rehn²; ¹Physics, Stevens Inst. of Technology, USA; ²Physics, Stevens Inst. of Technology, USA. We present a method of generating quantum random numbers with arbitrarily defined probability distributions featuring high dimensionality and post-processing free, for significantly improved Monte-Carlo simulations and data analyses.

JTU3A.31

Withdrawn

JTU3A.32

Demonstration of Ultra-High Time-Bandwidth Product in a Non-Reciprocal Fiber-Optic System, Davide Grassani¹, Ivan Cardea¹, Simon Fabbri¹, Jeremy Upham², Robert Boyd², Hatice Altug¹, Sebastian Schulz³, Kosmas Tsakmakidis¹, Camille-Sophie Bres¹; ¹Ecole Polytechnique Federale de Lausanne, Switzerland; ²Dept. of Physics, Univ. of Ottawa, Canada; ³School of Physics and Astronomy, Univ. of St Andrews, UK. We demonstrate that a non-reciprocal, time-variant fiber cavity can operate above the “fundamental” time-bandwidth limit (TBL) of reciprocal structures by more than two orders of magnitude.

JTU3A.33

Mid-Wave Infrared Nonlinear Optics in Polycrystalline Zinc Selenide and Zinc Sulfide, Kevin Werner², Noah Talisa², Brian Wilmer³, Laura Vanderhoef¹, Aaron Schweinsberg¹, Christopher Wolfe⁴, Anthony Valenzuela⁴, Chowdhury Enam²; ¹ORISE, USA; ²The Ohio State Univ., USA; ³SURVICE Engineering, USA; ⁴U.S. Army Research Lab, USA. We investigate the nonlinear optical properties of ZnSe and ZnS using ultrashort mid-wave infrared laser pulses. Multiple harmonic generation in both materials was observed, as well as significant spectral modification of the fundamental pulse.

JTU3A.34

High-repetition-rate Femtosecond-laser Inscription of Low-loss Thermally Stable Waveguides in Lithium Niobate, Teerawat Piromjitpong^{2,1}, Mykhaylo Dubov³, Sonia Boscolo^{2,1}; ¹School of Engineering and Applied Science, Aston Univ., UK; ²Aston Inst. of Photonic Technologies, UK; ³Optoscribe Ltd., UK. Optical-lattice-like WGs were fabricated in z-cut LiNbO₃ by HRR pulse laser. Low propagation loss was observed in both orthogonal polarizations in the visible and near-IR spectrum. Single-mode guiding was maintained after high-temperature annealing.

JTU3A.35

Large Scale Optical Comb Frequencies Stabilization by Using An Intro-cavity Electro-optic Polarization Modulator, Yanyan Zhang^{1,2}, Pan Zhang¹, Lulu Yan^{1,2}, Bingjie Rao¹, Xiaofei Zhang^{1,2}, Wenge Guo¹, Shougang Zhang^{1,2}, Haifeng Jiang^{1,2}; ¹National Time Service Center (China), China; ²School of Astronomy and Space Science, Univ. of Chinese Academy of Sciences, China. We demonstrate a frequency control approach of a nonlinear-polarization-rotation mode-locked Er:fiber laser by rotating polarization state with an intro-cavity electro-optic modulator, enabling a large scale high bandwidth frequency control.

JTU3A.36

Partially Coherent Vortex Beams in the Atmosphere, Gregory J. Gbur¹, Charlotte Stahl¹; ¹Univ of North Carolina at Charlotte, USA. We investigate, through simulations, the robustness of vortices in partially coherent beams propagating through atmospheric turbulence. Several classes of partially coherent vortex beams are considered.

JTU3A.37

Withdrawn

JTU3A.38

Measurements of the Nonlinear Refractive Index (n₂) for Indium Fluoride (InF₃) Bulk Glass and Fiber, Anthony M. Johnson¹, Isaac Basaldua¹, Robinson Kuis¹, Paul Burkins¹, Zack Jiang²; ¹Univ. of Maryland Baltimore County, USA; ²Thorlabs, USA. We measured the n₂ of InF₃ bulk glass and fiber using the Z-scan and the induced grating autocorrelation (IGA), respectively. The n₂ value measured for the InF₃ fiber is 1.5X that for ZBLAN fiber.

JTU3A.39

Photonically Tunable MIR Epsilon-Near Zero Modes in CdO Thin Films, Elizabeth Radue¹, Evan Runnerstrom², Kyle Kelley³, J. P. Maria², Patrick Hopkins⁴; ¹Mechanical and Aerospace Engineering, Univ. of Virginia, USA; ²Materials Science, Penn State Univ., USA; ³Materials Science, North Carolina State Univ., USA; ⁴Materials Science and Engineering, Univ. of Virginia, USA. We propose a novel way of tuning plasmonic absorption of light. By photoexciting electrons from platinum to a CdO film, we are able to control of the ENZ resonance frequency of the film.

JTU3A.40

Experimental Research on the KrF Laser Driven quasi-isentropic compression, Zhao Wang¹, Pinliang Zhang², Bao-xian Tian¹, Zhi-xing Gao¹, Jing Li¹, Feng-Ming Hu¹; ¹China Inst. of Atomic Energy, China; ²Beijing Inst. of Spacecraft Environment Engineering, China. The HEAVEN I laser is used to direct drive quasi-isentropic compression up to 18 GPa in samples of aluminum without temporal pulse shaped. The monotonically increasing loading with rise time is over 16 ns.

JTU3A.41

Withdrawn

JTU3A • Poster Session II and Dynamic E Posters—Continued

JTU3A.42

Quadratic Bright Soliton and Cnoidal Wave Frequency Combs in Microresonators by Second Harmonic Generation, Zhen Qi¹; ¹Univ. of Maryland Baltimore County, USA. We study bright solitons and cnoidal waves in microresonators with quadratic nonlinearity. In the case of both fundamental frequency and second harmonic in the same dispersion regime, we obtain stable bright solitons and cnoidal waves.

JTU3A.43

Implementation of an Alternative Method for the Detection and Temporal Correlation of Spontaneous Parametric Down Converted Photons with Single Photon Counters, Francisco Sierra¹; ¹Universidad del Valle, Colombia. We propose an alternative method for the detection of SPDC photons and their temporal correlations. All this doing mainly by photon counters, a BBO crystal type II, a PBS and taking counts on fundamental points (Control points).

JTU3A.44

Progress On Supercontinuum Generation of Highly Nonlinear Fibers at NTSC, Songtao Fan^{1,2}, Pan Zhang¹, Yanyan Zhang^{1,2}, Lulu Yan^{1,2}, Wenge Guo¹, Xiaofei Zhang^{1,2}, Shougang Zhang^{1,2}, Haifeng Jiang^{1,2}; ¹National time service center, China; ²Univ. of Chinese Academy of Sciences, China. We report on supercontinuum generation in four types of highly-nonlinear-fibers (HNLFs) pumped by 1.56- μm laser solitons. Experimental results provide guidelines for choosing and using HNLFs for erbium-fiber-based optical frequency combs.

JTU3A.45

Spectron and Dispersive Fourier Transformation: Phase Aspect, Narek Karapetyan^{1,2}, Minas Sukiasyan^{1,2}, Hrach Toneyan^{1,2}, Aghavni Kutuzyan¹, Levon Mouradian^{1,2}; ¹Dept. of Optics, Yerevan State Univ., Armenia; ²CANDLE Synchrotron Research Inst., Armenia. The phase behavior of spectron pulses, shaped in the far zone of dispersion, is discussed in view of dispersive Fourier transformation, on the basis of our analytical, numerical and experimental studies.

JTU3A.46 **RAPID**

Synthesis and Analysis of Ultrafast Waveform Generation using Coherent Raman Sidebands, Aysan Bahari¹, Alexandra A. Zhdanova¹, Mariia Shutova¹, Alexei Sokolov¹; ¹Texas A&M Univ., USA. We combine four coherent Raman sidebands generated inside diamond with an OPA-generated beam to create an ultrashort pulse. By using frequency-resolved optical gating (FROG) and interferometric techniques, we characterize the resultant pulse.

JTU3A.47

Mode-Locked Fiber Laser Pulse Repetition Rate Adjustment with Piezoelectric Transducer and Thermoelectric Cooler, Alexander I. Donodin¹, Vasili S. Voropaev¹, Vladimir A. Lazarev¹, Mikhail Tarabrin^{1,2}, Valeriy Karasik¹; ¹Bauman Moscow State Technical Univ., Russia; ²P. N. Lebedev Physical Inst. of the Russian Academy of Sciences, Russia. We demonstrate an adjustment of the all-fiber ring femtosecond erbium laser pulse repetition rate using piezoelectric transducer and thermoelectric cooler. The experimental values are verified with theoretical results.

JTU3A.48

Withdrawn

JTU3A.49

Endurance of photon indistinguishability in noisy quantum networks, Armando P. Leija¹, Diego Guzman-Silva², Roberto Leon-Montiel³, Markus Graefe⁴, Matthias Heinrich⁵, Hector-Cessa⁶, Alexander Szameit², Kurt Busch¹; ¹Max Born Inst., Germany; ²Physics, Univ. of Rostock, Germany; ³ICN, UNAM, Mexico; ⁴Physics, Univ. of Jena, Germany; ⁵Physics, Rostock Univ., Germany; ⁶Optics, INAOE, Mexico. We show that when indistinguishable photons copropagate through quantum networks affected by nondissipative noise, the system always evolves into a steady state in which coherences accounting for particle indistinguishability perpetually prevail.

JTU3A.50

Four-wave mixing of 10 μm radiation in quadratic nonlinear crystals, Jeremy Pigeon², Sergei Tochitsky¹, Eric Welch¹, Ilan Ben-Zvi², Chan Joshi¹; ¹Univ. of California - Los Angeles, USA; ²Physics and Astronomy, Stony Brook Univ., USA. We report measurements of the effective nonlinear refractive index of quadratic nonlinear crystals using four-wave mixing of a dual-frequency CO₂ laser pulse. The contribution of second-order processes to the four-wave mixing efficiency is discussed.

JTU3A.51

Application of Machine Learning Techniques to Quantum Optical Problems, Anesan A. Reddy¹, Ilya Sinayskiy¹, Francesco Petruccione^{1,2}; ¹Chemistry and Physics, Centre for Quantum Technology UKZN, South Africa; ²National Inst. of Theoretical Physics, South Africa. Researchers have begun applying Machine Learning Techniques (MLT) to difficult problems in physics. E.g., Convolutional Neural Networks can detect phase transitions in Ising and Bose-Hubbard models. I will report on MLT applied in Quantum Optics.

JTU3A.52

Computational Modeling of InGaAs/InP Single Photon Detector for High Sensitive Applications, Ahmed C. Kadhim¹, Ahmad Alalayani¹, Ahmad S. Azzahrani¹, Saud Alanzi¹; ¹Florida Inst. of Technology, USA. An approach to define output current of single photon avalanche photodiode (SPAD) is introduced using a mathematical formula. The mathematical steps and derivations are shown that the dependency of SPAD on gating signals.

JTU3A.53

Multi-resonant Optical Nanocavities by Out-of-plane Magnetic Plasmon Hybridization, Seied Ali Safiabadi Tali¹, Wei Zhou¹; ¹Virginia Tech, USA. In vertically-stacked double-cavity metal-insulator-metal nanostructures, the strong optical interaction between magnetic plasmon modes in each of the nanocavities leads to new hybridized modes with individually tunable energy levels.

JTU3A.54

SHG from Nanoparticles of Noncentrosymmetric Geometry, Raksha Singla¹, Wolf L. Mochan¹; ¹Instituto de Ciencias Físicas, UNAM, Mexico. The effect in the SHG from an almost-centrosymmetric nanoparticle is studied analytically. We obtain its bulk and surface contributions, discuss their multipolar character and their spectral resonances, and compare them to numerical calculations.

JTU3A.55 **RAPID**

Experimental Demonstration of CNOT Gate for Frequency-Encoded Qubits, Hsuan-Hao Lu¹, Joseph M. Lukens², Poolad Imany¹, Nicholas A. Peters², Brian P. Williams², Andrew M. Weiner¹, Pavel Lougovski²; ¹School of Electrical and Computer Engineering, Purdue Univ., USA; ²Quantum Information Science Group, Oak Ridge National Lab, USA. We demonstrate the first two-photon gate for frequency-bin qubits, using optical pulse shaping and electro-optic phase modulation. Our coincidence-basis CNOT has a fidelity of 0.9947 ± 0.0008 and shows controlled qubit flips in the computational basis.

JTU3A.56 **RAPID**

A Single-Pass Quantum Source of Multimode Squeezed States of Light, Luca La Volpe¹, Syamsundar De¹, Tiphaine Kouadou¹, Valentina Parigi¹, Claude Fabre¹, Nicolas Treps¹; ¹Laboratoire Kastler Brossel, France. We present a parametric down-conversion based source generating broadband squeezed light in multiple spectral modes. The source will be used to create large-scale cluster states, and to perform space-time positioning measurements beyond classical limit.

JTU3A.57

Withdrawn

JTU3A.58

8x8 Programmable Quantum Photonic Processor Based on Silicon Nitride Waveguides, Caterina Tabbalione¹, Tom A. Wolterink², Jasleen Lugani², Andreas Eckstein², Bryn A. Bell², Robert Grootjans², Ilka Visscher², Jelmer J. Renema³, Dimitri Geskus³, Chris G. Roeloffzen³, Ian A. Walmsley², Pepijn W. Pinkse⁴, Klaus-J. Boller¹; ¹Laser Physics and Nonlinear Optics, Univ. of Twente, Netherlands; ²Ultrafast Quantum Optics and Optical Metrology, Univ. of Oxford, UK; ³LioniX International, Netherlands; ⁴Complex Photonic Systems, Univ. of Twente, Netherlands. Integrated universal linear optical networks are essential for the development of quantum information processing (QIP). We demonstrate a universal, reconfigurable, 8x8 photonic processor based on Si₃N₄ waveguides showing a variety of QIP primitives.

JTU3A.59

Highly Efficient Nonlinear Integrated Photonics in Ultracompact Periodically-Poled Lithium Niobate on Silicon, Ashutosh Rao¹, Kamal Abdelsalam¹, Tracy Sjaardema¹, Guillermo Camacho-González¹, Amirmahdi Honardoost¹, Sasan Fathpour¹; ¹Univ. of Central Florida, CREOL, USA. We present second-harmonic generation, pumped in the telecom wavelengths, with strong nonlinear conversion efficiencies up to $1230 \text{ \%W}^{-1}\text{cm}^2$ using ultracompact periodically-poled thin-film lithium niobate waveguides on a silicon chip.

JTU3A.60

Experimental Statistical Signature of Many-body Quantum Interference, Taira Giordani¹, Fulvio Flamini¹, Matteo Pompili¹, Niko Viggianiello¹, Nicolò Spagnolo¹, Andrea Crespi^{2,3}, Roberto Osellame^{2,3}, Nathan Wiebe⁴, Mattia Walschaers^{5,6}, Andreas Buchleitner⁶, Fabio Sciarino¹; ¹Fisica, Sapienza Università di Roma, Italy; ²Istituto di Fotonica e Nanotecnologie, Consiglio Nazionale delle Ricerche, Italy; ³Fisica, Politecnico di Milano, Italy; ⁴Station Q Quantum Architectures and Computation Group, Microsoft Research, USA; ⁵Laboratoire Kastler Brossel, UPMC-Sorbonne Universités, CNRS, ENS-PSL Research Univ., Collège de France, CNRS, France; ⁶Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Germany. Quantum interference is a fundamental ingredient for technologies that can provide a quantum advantage. In this work we investigate a clear signature of its presence in a BosonSampling experiment.

JTU3A • Poster Session II and Dynamic E Posters—Continued

JTU3A.61

Local filtering of polarization entangled photon pairs by the components of a telecom network, Brian T. Kirby¹, Dan Jones¹, Michael Brodsky¹; ¹The US Army Research Lab, USA. By treating the polarization dependent loss of fiber-optic quantum channels as a local filtering operation, we show both theoretically and experimentally how entanglement can be distilled by properly orienting local filters.

JTU3A.62

Towards Extending Super-conducting Nanowire Single-photon Detectors into the Infrared Wavelength Range, Paulina S. Kuo¹, Brian G. Alberding¹; ¹NIST, USA. We characterize the long-wavelength transmission of coiled and uncoiled SMF-28 and SM2000 fibers, which is important for extending the range of super-conducting nanowire single-photon detectors (SNSPDs) to infrared wavelengths beyond 1550 nm.

JTU3A.63

Self-referenced continuous-variable quantum key for distribution over longer optical fiber links, Ming Li¹, Milorad Cvijetic¹; ¹Univ. of Arizona, USA. We have evaluated the impact of phase noise in self-referenced continuous-variable quantum key distribution protocol and confirmed its application over longer optical fiber links.

JTU3A.64

Quantum Phase Transitions in Finite Atomic Ensemble under the EIT Configuration, Raúl A. Robles¹; ¹PT Tsing Hua, Taiwan. We study the ground states of finite ensembles of Λ -type three-level atoms interacting with two electromagnetic fields in the EIT approximation. Critical couplings are revealed for the existence of QPT.

JTU3A.65

Squeezed photons from a single quantum-dot with tuneable central frequency, Parvendra Kumar¹, Agnikumar G. Vedeshwar²; ¹Dept. of Physics and Astrophysics, Univ. of Delhi, India. We theoretically demonstrate the generation of quadrature squeezed photons from a single quantum-dot with tuneable central frequency. The effects of exciton-phonon coupling on quadrature squeezing are also investigated.

JTU3A.66

Design of Switch gate using Mach-Zehnder interferometer for quantum communications, Santosh Kumar², Amna Bedi¹, Nan-Kuang Chen²; ¹Dept. of EECE, DIT Univ., India; ²School of Physics Sciences and Information Technology, Liaocheng Univ., China. In this paper, a design of reversible switch gate using lithium-niobate based Mach-Zehnder interferometer for quantum communication is proposed. The results are verified using beam propagation method.

JTU3A.67

A dynamical approach to low-cost shortcut to adiabaticity, Hamidreza Ramezani¹, Fatemeh Mostafavi¹; ¹Univ. of Texas, Rio Grande Valley, USA. By introducing a class of non-Hermitian Hamiltonians we propose an approach to low-cost shortcut to adiabaticity. Our approach focuses on dynamical properties of the system and has application in STIRAP, tunable mode filtering.

JTU3A.68

Design and Analysis of a Cross V-shaped Nanoantenna for Visible Region, Shanu Kumar¹, Pooja Chauhan¹, Ajeet Kumar¹; ¹Delhi Technological Univ., India. A cross V-shaped nanoantenna is designed using gold with gap of 10 nm. The scattering cross-section and the Electric field at the centre is obtained with optical resonant wavelength of 530 nm in visible range.

JTU3A.69 **RAPID**

Polarization diversity phase modulator for measuring frequency-bin entanglement of biphoton frequency combs in a depolarized channel, Oscar Sandoval¹, Navin B. Lingaraju¹, Poolad Imany¹, Daniel E. Leaird¹, Michael Brodsky², Andrew M. Weiner¹; ¹Purdue Univ., USA; ²U.S. Army Research Lab, USA. We report frequency-bin entanglement measurements of arbitrarily polarized photon pairs using a polarization diversity phase modulator, thereby extending this technique to depolarized channels such as in a practical quantum networking environment.

JTU3A.70 **RAPID**

Direct extrusion of suspended-core polymer optical fibers from 3D printers, Wanvisa Talataisong¹, Rand Ismaeel¹, Martynas Beresna¹, Gilberto Brambilla¹; ¹Optoelectronics Research Centre, UK. We demonstrate the single-step manufacturing of a microstructured polymer optical fiber (MPOF) by extruding and directly drawing the polymer from a structured 3D printer nozzle.

JTU3A.71 **RAPID**

Open Cavity Raman-Erbium Hybrid Random Fiber Laser with Single Arm Pumping Scheme, Nadiah Zainol Abidin², Muhammad Hafiz Abu Bakar², Nizam Tamchek¹, Mohd Adzir Mahdi²; ¹Dept. of Physics, Faculty of Science, Universiti Putra Malaysia, Malaysia; ²Wireless and Photonics Networks Research Centre, Faculty of Engineering, Universiti Putra Malaysia, Malaysia. This paper analyzes forward and backward spectral outputs of 80 km Raman-erbium hybrid random fiber laser employing single arm pumping. Stable laser generation at the output is achieved without resonance within the entire cavity.

JTU3A.72

Propagation of a supercontinuum light source in a novel tellurite hollow core optical fiber, Hoang Tuan Tong¹, Nobuhiko Nishiharaguchi¹, Takenobu Suzuki¹, Yasutake Ohishi¹; ¹Toyota Technological Inst., Japan. We experimentally demonstrated the fabrication of a novel tellurite hollow core optical fiber and managed to propagate a supercontinuum light from 500 to more than 1550 nm in the fiber core by the fundamental mode.

JTU3A.73

ITO-based Mach Zehnder Modulator, Rubab Amin¹, Rishi Maiti¹, Caitlin Carfano¹, Volker J. Sorger¹; ¹The George Washington Univ., USA. We report the first experimental Mach Zehnder modulator on SOI-platform with ITO as the active phase-shifting material. Our results show a low V_{π} of 0.52 V-mm with 6 dB insertion loss.

JTU3A.74

Ultra-flat Optical Frequency Comb Generation Based on an Electroabsorption Modulated Laser and Adaptive Pulse Shaping, Linnan Li¹, Juanjuan Yan¹, Jing Chen¹; ¹BeiHang Univ., China. A scheme for the generation of ultra-flat optical frequency comb (OFC) is proposed by using an Electroabsorption Modulated Laser and adaptive pulse shaping. An OFC with a 0.5-dB bandwidth of 4nm containing 50 spectral lines is achieved.

JTU3A.75

Analysis and Elimination of Shrinkage Phenomenon of Photonic Crystal Fiber during Fusion Splicing, Chunxiao Wu¹, Ningfang Song¹, Jingming Song¹, Jiaqi Liu¹, Haowei Li¹; ¹BeiHang Univ., China. The impact of shrinkage phenomenon of photonic crystal fiber during fusion splicing is analyzed. A method based on temperature distribution analysis is proposed to eliminate the detrimental phenomenon. The splice loss and strength are improved.

JTU3A.76

Multi-wavelength Fiber Laser Temperature Sensor Based on Modal Fiber Interferometer, Yanelis Lopez Dieguez¹, Julian Moises Estudillo Ayala¹, Daniel Jauregui¹, Luis A. Herrera Piad¹, Juan M. Sierra Hernandez¹, Diego Garcia-Mina², Juan C. Hernandez-Garcia¹, Abraham Gatelum Barrios³, Roberto Rojas-Laguna¹; ¹Universidad de Guanajuato, Mexico; ²Universidad del Centro Occidente, Colombia; ³Universidad Autónoma de Queretaro, Mexico. A fiber optic laser arrangement for temperature sensing applications is presented. The multi-wavelength spectrum has a SMSR of 40dB and moreover, the temperature generated tunable multi-wavelength effect, here, a sensitivity of 20pm/°C is achieved.

JTU3A.77

Vehicular FSO Communication Systems Applying Real-time Recognition and Tracking, JIANAN ZHANG¹, Wentao Xia¹, Tim Kane¹; ¹PENN STATE UNIV., USA. As the field-of-view of an optical receiver decreases, the receiver gain increases. By applying real-time recognition and tracking, the demonstration of a vehicular free-space optical communication system which has a small field-of-view is presented.

JTU3A.78

Numerical Study of Spatio-Temporal Evolution of Chaotic Effects in the Generation of Broad Spectra, Jose Ramon Martinez Angulo¹, Juan C. Hernandez-Garcia^{1,2}, Jesus P. Lauterio-Cruz¹, Julian M. Estudillo-Ayala¹, Olivier Pottiez², Jose D. Filoteo-Razo¹, Carlos M. Carrillo-Delgado¹, Daniel Jauregui-Vazquez¹, Juan M. Sierra-Hernandez¹, Roberto Rojas-Laguna¹; ¹Universidad de Guanajuato, Mexico; ²Catedrático CONACYT, Consejo Nacional de Ciencia y Tecnología, Mexico; ³Centro de Investigaciones en Óptica (CIO), Mexico. We report the implementation of the RK4IP method for studying the propagation of a hyperbolic secant pulse into 10 km of standard fiber. The results describe the appearance of chaotic phenomena in the spectral broadening.

JTU3A.79

Extreme power fluctuations in optical communications, Stanislav Derevyanko¹, Alexey Redyuk^{2,3}, Sergey Vergesles^{4,5}, Sergei Turitsyn^{6,2}; ¹Ben Gurion Univ. of the Negev, Israel; ²Novosibirsk State Univ., Russia; ³Inst. of Computational Technologies, Russia; ⁴Landau Inst. for Theoretical Physics, Russia; ⁵Moscow Inst. of Physics and Technology, Russia; ⁶Aston Inst. of Photonic Technologies, Aston Univ., UK. We present an analysis of dangerous symbol sequences in CO-OFDM optical transmission systems leading to appearance of extreme power fluctuations and study their influence on system performance in dispersion uncompensated long haul fiber links.

JTU3A.80

One-step waveguide endface dicing approach for Silica-on-Silicon PIC chip, Xu Liu¹, Zhekai Zhang¹, Xiaohan Sun¹; ¹Southeast Univ. (China), China. The IL of 0.055dB/facet at 1550nm wavelength is achieved for Silica-on-Silicon waveguide using Disco ZH05-SD3500-N1-70FF/01 blade with spindle revolution speed, workpiece feed speed and cooling water flow velocity of 30000r/min, 1mm/s and 1.2L/min.

JTU3A.81 **RAPID**

Optomechanics Outside the Lab: Prototyping and Field-testing a Whispering Gallery Mode Accelerometer, Ying Lia Li¹, Peter F. Barker¹; ¹UCL, UK. The dispersive and dissipative optomechanical coupling between a whispering gallery mode (WGM) resonance and the motion of the WGM cavity is used to measure acceleration. We describe the prototype assembly and the results from outdoor field-trials.

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JTu3A.82 **RAPID**

Superhydrophobic SERS Substrates based on Plasmonic Hierarchical Micro-nanostructures, Junyeob Song¹, Weifeng Cheng², Jiangtao Cheng², Wei Zhou¹; ¹Electrical Engineering, Virginia Tech, USA; ²Mechanical Engineering, Virginia Tech, USA. Integration of multilayered plasmonic nanostructures with hierarchical micro-nanopillar arrays can result in a superhydrophobic surface with high-performance Surface Enhanced Raman Spectroscopy (SERS) functionality.

JTu3A.83 **RAPID**

Gallium Indium Phosphide Nanostructures with Suppressed Photoluminescence for Applications in Nonlinear Optics, Eleonora De Luca¹, Dennis Visser¹, Srinivasan Anand¹, Marcin Swillo¹; ¹KTH Royal Inst. of Technology, Sweden. Nanostructured GaInP shows remarkable nonlinear properties. By measuring the SHG before and after stimulating photobleaching, we observed suppressed photoluminescence and unchanged nonlinear properties, making it suitable for low-noise applications.

JTu3A.84 **RAPID**

Multifocal Optical Meta-Lenses, Nantakan Wongkasem¹, Patricia Briaea²; ¹Univ. of Texas Rio Grande Valley, USA; ²MetaSolver, USA. Multifocal optical and flat meta-lenses are investigated towards designing an improved multifocal meta-lens with ultra-thin multilayers and flat shape overcoming the background noise occurring from the physical restriction of multiple focus regions.

JTu3A.85

Double-sided guided-mode resonance metamaterials, Hafez Hemmati¹, Robert Magnusson¹; ¹Univ. of Texas at Arlington, USA. We fabricate resonant metamaterial membranes with subwavelength gratings on both sides employing nanoimprint lithography methods. Measured spectral response of the resonance membranes is in good agreement with numerical results.

JTu3A.86

GaN Distributed Bragg Reflector Cavity for Sensing Applications, Simeng Jia¹, Emmanuel L. Boulbar², Krishna C. Balram¹, Jon Pugh¹, Tao Wang², Duncan Allsopp³, Philip Shields³, Martin Cryan¹; ¹Univ. of Bristol, UK; ²Univ. of Sheffield, UK; ³Univ. of Bath, UK. GaN grating couplers and a distributed Bragg reflector cavity are fabricated using displacement Talbot lithography on GaN-on-sapphire. Cavity resonances are simulated and measured for two devices with Q factors of ~200.

JTu3A.87

A Narrowband Photothermoelectric Detector Using Guided-Mode Resonance Filter, Hosein Monshat¹, Longju Liu¹, Meng Lu¹; ¹Iowa State Univ., USA. A narrowband photothermoelectric detector, integrating a guided-mode resonance (GMR) structure and a metal thermocouple, is demonstrated. The detector utilizes the GMR effect to selectively absorb light and generate thermoelectric voltage outputs.

JTu3A.88

Implementation and Optimization of a Cost-Effective 2D Haar Transform Network for Image Compression, Catia Pinho^{1,2}, Tiago Morgado¹, Berta Neto^{1,2}, Mario Lima^{1,2}, António Teixeira^{1,2}; ¹Instituto de Telecomunicações (IT), UA, Portugal; ²Dept. of Electronics, Telecommunications and Informatics (DETI), Univ. of Aveiro, Portugal. A new cost-effective 2D Haar transform network for data compression composed by three 2×2 MMI magic-T disposed in a two level signal decomposition architecture is implemented and tested. A model for design optimization is proposed.

JTu3A.89

Novel Mid-Infrared Metamaterial Thermal Emitters for Optical Gas Sensing, Yongkang Gong², Sang Soon Oh², Diana L. Huffaker², Nigel Copner¹; ¹Univ. of South Wales, UK; ²School of Physics and Astronomy, Cardiff Univ., UK. We demonstrated that metamaterial technology enables us to tailor infrared thermal emission and provides a promising strategy towards novel, cost-effective and highly efficient mid-infrared source for optical gas sensing.

JTu3A.90

Withdrawn

JTu3A.91

Metamaterial Tunable Notch Filters Operating in Long-wave Infrared, Neelam Gupta¹, Mark S. Mirotznik²; ¹US Army Research Lab, USA; ²Dept. of Electrical and Computer Engineering, Univ. of Delaware, USA. We describe the design of metamaterial tunable notch filter operating from 8 to 12 μm based on the guided-mode resonance phenomenon using dielectric materials germanium and zinc selenide and their characterization using quantum cascade lasers.

JTu3A.92

Size dependent optical performance of light trapping metallic electrodes, Mengdi Sun¹, Pieter G. Kik^{1,2}; ¹CREOL, Univ. of Central Florida, USA; ²Physics Dept., Univ. of Central Florida, USA. The optical performance of light-trapping embedded metal electrodes with widths varying from 100-1000nm was investigated. Up to 90% of visible light incident on the metal wire can be trapped, limited by diffraction and plasmon-mediated absorption.

JTu3A.93

Optimized Ultrabroadband Absorbing Multilayer Thin Film Structure, Corey T. Matyas¹, Chenglong You¹, Yin Huang², Jonathan P. Dowling¹, Georgios Veronis¹; ¹Louisiana State Univ., USA; ²Central South Univ., China. We design an optimized aperiodic multilayer thin film structure with ultrabroadband absorption over a broad angular range. Using a hybrid optimization algorithm, we achieve an average 97.9% absorption from 400 nm to 2500 nm.

JTu3A.94

Design and Fabrication of Embedded Nanofences in Racetrack Microring Resonator for Single Gold Nanoparticle Detection, Saawan Kumar Bag¹, Rajat K. Sinha¹, Meher Wan¹, Shailendra Varshney¹; ¹Indian Inst. of Technology Kharagpur, India. Photonic nanofence assisted racetrack microring resonator is proposed, numerically analyzed and fabricated. Numerical results shows the device ability to detect single gold nanoparticle which can be a potential platform for biosensing applications.

JTu3A.95

Fano Resonances Based on Aperture-coupled Square Plasmonic System and its Application in Nanosensor, Yilin Wang¹, Li Yu¹; ¹Beijing Univ. of Posts and Telecommunications, China. A novel refractive index plasmonic nanosensor was proposed with high properties based on groove and aperture-coupled square resonator. This nanosensor with sharp Fano profiles yield an ultra-high sensitivity of ~1300nm/RIU and a FOM of ~9400.

JTu3A.96

Absolute Optimization Method of a Vertical Grating Coupler, Anat Demeter¹; ¹Tel-Aviv Univ., Israel. Based on S-matrix formalism a method for analyzing and designing vertical grating couplers is presented. Optimal efficiency values and corresponding design parameters are provided, including a theoretical return loss limit better than 56dB.

JTu3A.97

Mid IR absorption using Hyperbolic Silicon tubes, Mai desouky¹, Ahmed Mahmoud^{1,2}, Mohamed M. Swillam¹; ¹Physics, American Univ. in Cairo, Egypt; ²Electrical, American Univ. in Cairo, Egypt. Doped semiconductors have been extensively investigated for mid IR metamaterials. We theoretically demonstrate mid IR absorber using Doped Si/Si hyperbolic tubes with broad band absorption reaching 0.95 across the mid-IR range.

JTu3A.98

On Red, Stop. Simple Speed and Stop Control for Traffic Automation, Forrest F. Jesse¹; ¹Beijing Xixuan Lab, China. A simple design for local signaling in an intelligent transportation network which endows vehicles with awareness of sub-meter local transportation conditions, and which allows speed control and stop control of vehicles is discussed.

JTu3A.99

Single Spot Focusing with Dielectric based Plasmonic Phase Manipulation, Mayur S. Darak², Rakesh G. Mote¹, Shobha Shukla³; ¹Dept. of Mechanical Engineering, Indian Inst. of Technology, Bombay, India; ²Centre for Research in Nanotechnology and Science (CRNTS), Indian Inst. of Technology, Bombay, India; ³Dept. of Metallurgical Engineering and Materials Science (MEMS), Indian Inst. of Technology, Bombay, India. A slit type dielectric based phase manipulative plasmonic lens for in-plane focusing of linearly polarized light to a single spot is proposed. Focal spot with full-width at half-maximum of 0.28λ₀ is obtained to beat the diffraction limit.

JTu3A.100

Naturally phase matched waveguides and microrings on lithium niobate-on-insulator (LNOI), Jiayang Chen¹, Yong Meng Sua¹, Heng Fan¹, Yu-Ping Huang¹; ¹Stevens Inst. of Technology, USA. We demonstrate naturally phase matched waveguides and microrings on chip for second-harmonic generation (SHG) with submicron transverse mode confinement.

JTu3A.101 **RAPID**

Generation of shaped THz beams by nonlinear metasurfaces, Shay Keren-Zur^{1,3}, Daniel Mittleman², Tal Ellenbogen^{1,3}; ¹School of Electrical Engineering, Tel Aviv Univ., Israel; ²School of Engineering, Brown Univ., USA; ³Center for Light-Matter Interaction, Tel Aviv Univ., Israel. We present functional nonlinear plasmonic metasurfaces for generation of shaped broadband THz beams. The spatial phase of the emitted THz wavefront is tailored by the distribution of the meta-atoms orientation to control the generation process.

JTu3A.102

Multilayer plasmonic structures for ultrasensitive protein probing, Ildar Salakhtudinov¹, Bo Shrewsbury¹, Nolan Johnston¹, Ertan Salik¹; ¹Physics and Astronomy, California State Polytechnic Univ., USA. Multilayer plasmonic structures consisting of alternating layers of metal and dielectric create a new type of guiding modes with very high effective refractive index. We chose a biomedical sensing including protein detection as the main application.

JTu3A.103

Modulation of Electromagnetically Induced Transparency in Toroidal Resonance Terahertz Metasurface, Sirak M. Mekonen¹, Riad Yahiaoui¹, Joshua Burrow², Andrew Sarangan², Imad Agha³, Jay Mathews², Thomas A. Searles¹; ¹Howard Univ., USA; ²Electro-Optics and Photonics, Univ. of Dayton, USA; ³Physics, Univ. of Dayton, USA. We report modulation of electromagnetically induced transparency in toroidal planar terahertz metamaterials. By breaking symmetry, we demonstrate tunability of EIT while exciting multiple Fano-like resonances with high Q-factor.

JTU3A • Poster Session II and Dynamic E Posters—Continued

JTU3A.104

High Sensitivity Vibrational Mode Detection with Doppler Raman Spectroscopy, David Smith³, Jeffrey J. Field³, David Winters¹, Scott Domingue¹, Jesse Wilson³, Daniel Kane², Randy Bartels³; ¹KM Labs, USA; ²Mesa Photonics, USA; ³Colorado State Univ., USA. We present Doppler Raman, a novel detection technique for coherent Raman scattering that offers improved sensitivity and readily detects low frequency modes from 10cm⁻¹ to 1500cm⁻¹ for use in studying biological systems.

JTU3A.105

Spectroscopic Imaging of DDS Nano-particle by Polarization Interferometric Nonlinear Confocal Microscopy, Chikara Egami¹, Shota Kawasaki¹; ¹Shizuoka Univ., Japan. In this study, we propose a polarization-interferometric nonlinear confocal microscope targeted on Drug Delivery System (DDS) spectroscopic imaging. The microscope successfully measured microscopic optical anisotropy in a single DDS nano-particle.

JTU3A.106

Optical coherence propagation in biological tissues with significant scattering by Green's functions, Jose Luis Ganoza-Quintana¹, Felix Fanjul-Velez¹, Jose L. Arce-Diego¹; ¹Universidad de Cantabria, Spain. Diagnostic optical techniques employ usually intensity measurements, disregarding coherence. Scattering greatly influences propagation. Analyzing coherence propagation in scattering media by Green's functions could provide additional contrast.

JTU3A.107

Extracting Fluorescence Efficiency and Emission Spectra of Cervical Tissue, Shih Cheng Tu¹, Tsan-Hsueh Huang¹, Ting-Wen Yu¹, Ming-Hwa Hong¹, Ling-Hong Wei², Chi-Hau Chen², KUNG-BIN SUNG³; ¹National Taiwan Univ., Taiwan; ²National Taiwan Univ. Hospital, Taiwan. This study aims to extract layer-resolved fluorescence efficiency and emission spectral shape of in-vivo cervical mucosa tissue by a two-layered fluorescence Monte Carlo model.

JTU3A.108

Single Element Detection Phase Contrast Spatial Frequency Modulation Imaging, Nathan G. Worts¹, Jeff Field², Randy Bartels², Jason Jones³, Jeff Broderick⁴, Jeff Squier¹; ¹Colorado School of Mines, USA; ²Electrical and Computer Engineering, Colorado State Univ., USA; ³Moog Inc., USA; ⁴Epilog Laser, USA. For the first time, dynamic phase contrast imaging is demonstrated using single element detection, spatial frequency modulated imaging (SPIFI). Sub-micron axial resolution is shown.

JTU3A.109

The Influence of Melanopsin Activation on the Cone-mediated Photopic White Noise Electroretinogram (wnERG) in Humans, Prakash Adhikari¹, Andrew J. Zele¹, Dingcai Cao³, Jan Kremers⁴, Beatrix Feigl^{2,5}; ¹School of Optometry and Vision Science & Inst. of Health and Biomedical Innovation, Queensland Univ. of Technology (QUT), Australia; ²School of Biomedical Sciences & Inst. of Health and Biomedical Innovation, Queensland Univ. of Technology (QUT), Australia; ³Dept. of Ophthalmology and Visual Sciences, Univ. of Illinois at Chicago, USA; ⁴Dept. of Ophthalmology, Univ. Hospital Erlangen, Germany; ⁵Queensland Eye Inst., Australia. The white noise ERG (wnERG) measurements using silent-substitution methods show melanopsin activation suppresses the human cone wnERG, potentially mediated via retrograde signalling from melanopsin cells to cones through dopaminergic amacrine cells.

JTU3A.110

Modeling of SPAD Response of Absorbed Near-Infrared Light in a Biological Tissue to Improve Diffuse Optical Tomography Resolution, Ahmed C. Kadhim¹, Ahmad Alalayani¹, Ahmad S. Azzahrani¹, Muhammad Riaz²; ¹Florida Inst. of Technology, USA. This paper introduces a new mathematical model to determine the single photon avalanche photodiodes response and the dark count rate that occupied with the detector output when the photon is absorbed by the biological tissue.

JTU3A.111

Application of heat-sensitive fluorescent dyes to determine the spatial and temporal temperature distribution in liquid media, Mykyta O. Redkin¹, Yakunov V. Andrii², Gaiduk Natalia¹; ¹Minor Academy of Science, Ukraine; ²Optics, KNU, Ukraine. For many technological processes, a non-contact measurement of the local temperature is necessary. A pyrometric method doesn't provide the necessary spatial resolution and accuracy. There we used the phenomenon of fluorescence dependence on temperature.

JTU3A.112

Sensitivity Improvement for a Smartphone-Based Lateral Flow Immunoassay Reader, Lalita Saisina¹, Ratthasart Amari², Armote Somboonkaew², Oraprapai Gajanandana³, Orawan Himananto³, Boonsong Sutapun¹; ¹Suranaree Univ. of Technology, Thailand; ²National Electronics and Computer Technology Center, Thailand; ³National Center for Genetic Engineering and Biotechnology, Thailand. We show that manually adjusting the camera's exposure time of a smartphone lateral flow reader to the highest slope of the nonlinear transfer function can significantly improve the sensitivity of the reader.

JTU3A.113

An Accessible Implementation for Synthetic Optical Holography (SOH), Arturo Canales^{1,2}, Martin Schnell³, Raul I. Hernandez-Aranda², P. Scott Carney¹; ¹The Inst. of Optics, Univ. of Rochester, USA; ²Photonics and Mathematical Optics Group, Tecnológico de Monterrey, Mexico; ³CIC nanoGUNE, Spain. We propose an accessible implementation for synthetic optical holography (SOH) in confocal microscopes by using an interferometry objective, and a nano-positioning z-stage, thus providing quantitative phase imaging capabilities.

JTU3A.114

Optical Parametric Amplification of Gated Confocal Reflectance Microscopy Signals in Scattering Media, Yi Sun¹, Haohua Tu¹, Sixian You¹, Stephen Boppart¹; ¹Univ. of Illinois, USA. We apply optical parametric amplification to amplify weak ballistic photons and suppress the multiple-scattering background. The reflectance imaging signal are amplified with over 50 dB gain. Improvements in imaging depth are demonstrated.

JTU3A.115

Feasibility Study of Spectral Fusing GD-OCM using FPGA Acquisition Device, Panomsak Meemon¹, Yutana Lenaphet¹, Joewono Widjaja¹; ¹Suranaree Univ. of Technology, Thailand. Gabor-domain optical coherence microscopy (GD-OCM) overcomes depth-of-focus limitation by combining multiple images acquired at different focus positions. Here, an implementation of FPGA-based Gabor fusion to improve processing speed was studied.

JTU3A.116

Laguerre-Gaussian Vortex Beam Transmission through Mouse Brain Tissue, Sandra Mamani¹; ¹USL at City College, USA. Abstract: Light transmission of Laguerre-Gaussian (LG) vortex beams in different local regions in mouse brain tissue is investigated. Transmittance is measured in ballistic region with various polarizations states and orbital angular momentums (OAM).

JTU3A.117

Blue and Red Light Emitting Diode (LED) Variation on Soybean (Glycine Max) Growth, Selvy U. Hepriyadi¹, Wilda Prihasty¹, Intan D. Kurniawati¹, Achmad S. Hidayat¹, Iman R. Rosohadi¹, Detak Y. Pratama¹; ¹Institut Teknologi Sepuluh Nopember, Indonesia. Soybeans were grown in uniform boxes and obtained that most optimum soybean plant is using the lighting ratio of the red LEDs 75% and blue 25% as the reference of modern artificial light for soybean.

JTU3A.118 **RAPID**

Assessment of basal cell carcinoma from normal human skin tissues using Resonance Raman spectroscopy, Lin Zhang Chen¹, Cheng-hui Liu¹, Binlin Wu²; ¹The City College of New York, USA; ²Southern Connecticut State Univ., USA. VRR spectroscopy was used for BCC and normal skin tissues with 532nm excitation. The spectra showed significant changes in collagen, carotenoids and lipids. These enhanced fingerprints demonstrate a potential use as label-free pathology method.

JTU3A.119 **RAPID**

Photonic Resonator Outcoupler Microscopy (PROM) for Quantitative Monitoring of Stem Cell Focal Adhesion Area, Yue Zhuo¹, Ji Sun Choi¹, Thibault Marin², Hojeong Yu¹, Brendan A. Harley¹, Brian Cunningham¹; ¹Univ. of Illinois at Urbana-Champaign, USA; ²Univ. of Illinois Research Park, USA. We developed a novel label-free imaging approach, named Photonic Resonator Outcoupler Microscopy (PROM) utilizing the reduction of the peak-resonance intensity reflected from a photonic crystal surface. PROM can monitor the variation of focal adhesion areas in live cells dynamically and quantitatively for extended time.

JTU3A.120

Polarization Splitter with TE Homogeneous Media and TM Inhomogeneous Media, Poliane A. Teixeira¹, Daniely G. Silva¹, Lucas H. Gabrielli², Danilo Spadoti¹, Mateus Junqueira¹; ¹Federal Univ. of Itajubá, Brazil; ²School of Electrical and Computer Engineering, Univ. of Campinas, Brazil. QCTO is employed to develop reflectionless non-magnetic polarization splitter with uniaxial properties, where the transformation is applied only in the TM mode. A low insertion loss and high extinction rate within a broadband are achieved.

JTU3A.121

Passive Underwater Polarization Imaging in Neritic Area, Yi Wei¹, Pingli Han¹, Fei Liu¹, Kui Yang¹, Xinhua Wang², Xiaopeng Shao¹; ¹XiDian Univ., China; ²Changchun Inst. of Optics, China. A passive underwater polarization imaging method is proposed to address color cast and degradation of image contrast in neritic area imaging. Results demonstrate its contribution to object information restoration in underwater target detection.

JTU3A.122

Effective pipeline to suppress coherent noise in digital holograms recorded under visible and infrared laser light, Vittorio Bianco¹, Pasquale Memmolo¹, Melania Paturzo¹, Pietro Ferraro¹; ¹Consiglio Nazionale delle Ricerche-ISASI, Italy. We introduce an effective pipeline to reconstruct denoised digital holograms from multiple or single shot recordings. This is based on the simulation of noise diversity and a sparsity promoting filtering scheme.

JTU3A • Poster Session II and Dynamic E Posters—Continued

JTU3A.123

Parallel GPU Computing in Light Scattering Metrology of Ultrafast Surface Dynamics, Larry Theran¹, Armando Rúa¹, Felix Fernández¹, Sergiy Lysenko¹; ¹Univ. of Puerto Rico, USA. Phase-retrieval algorithms are developed for parallel computing of surface autocorrelation function (ACF) and for solving the inverse problem of light scattering. A real-time visualization of ACF was achieved for transient spectroscopy of materials.

JTU3A.124

Snow Cover Monitoring Algorithm in Northeast China Using FY-2G Satellite Data, Tong Wu¹, Lingjia Gu¹, Ruizhi Ren¹, Haoyang Fu¹; ¹College of Electronic Science and Engineering, Jilin Univ., China. The multi-temporal geostationary satellite FY-2G was used to reduce the cloud interference. The BRDF models were used in angular correction. An improved snow monitoring algorithm combined with geostationary satellite and BRDF model was proposed.

JTU3A.125

General Theoretical Analysis of Noise in Single-pixel Imaging, Robby Stokoe¹, Patrick Stockton¹, Ali Pezeshki¹, Randy Bartels¹; ¹Colorado State Univ., USA. In single-pixel imaging, every reconstructed pixel includes noise from the entire object. We derive a general expression for the noise associated with any single-pixel imaging technique, enabling development of techniques that account for noise.

JTU3A.126

Withdrawn

JTU3A.127

Classification of Saline-alkaline Soil Using Multispectral Remote Sensing Data, Haoyang Fu¹, Chenglin Sun¹, Lingjia Gu¹; ¹Jilin Univ., China. This paper analyzes the relationship between soil salinity and spectral characteristics. And LANDSAT 5 TM multispectral data is used to classify saline-alkaline soil into three degrees according to salinization ratings.

JTU3A.128

Speckle Reduction in Computer-Generated Holography with Multi-level Amplitude Encoding, Hang Feng¹, Weiping Wan¹, Qihuang Gong^{1,2}, Yan Li^{1,2}; ¹Peking Univ., China; ²Shanxi Univ., China. Speckles often occur in the reconstructed image of a phase-only computer-generated hologram. Here we present the speckle reduction by encoding hologram with both the phase and multi-level amplitude, which can be realized by a dielectric metasurface.

JTU3A.129

Image Focus Analysis using Gaussian Windows applied to Fourier Transform Frequency, Eduardo Perez¹; ¹DICIS, Mexico. Different analysis techniques have been developed to help understand and characterize image analysis with focal errors, in this paper we present an implementation using Gaussian windows applied to Fourier analysis.

JTU3A.130

Multi-resolution Based Cone-beam Computed Tomography High Precision Point Cloud Acquisition, Jia Zheng¹, Dinghua Zhang¹, Kuidong Huang¹, Yuanxi Sun¹; ¹Northwestern Polytechnical Univ., China. We improve disconnections in sub-pixels of cone-beam computed tomography (CBCT) slice images. The proposed method, which is based on the multi-resolution, can acquire more connective sub-pixels and point cloud with higher precision.

JTU3A.131

Graphene and the Control of Liquid Crystal Alignment, Benjamin T. Hogan¹; ¹Univ. of Exeter, UK. Here, we present results on using graphene as electrodes for controlling the orientation of liquid crystal molecules. We examine how graphene can pre-align the molecules as well as be used to apply electric field.

JTU3A.132 **RAPID**

Reconstruction of conditions of rays in space using a light-field display combined with Retro-Reflector, Toru Iwane¹, Hirotsugu Yamamoto²; ¹Nikon Corporation, Japan; ²Dept. of Optical Engineering, Utsunomiya Univ., Japan. With reversing a light-field camera system combined with retro-reflector which can be regarded as a time reversing device for light, 3D scene can be reconstructed from light-field data acquired by light-field camera.

JTU3A.133

Novel 1066nm Nd:GdYTaO₄ laser under indirect and direct pumping, Xudong Li¹, Guichuan Xu¹; ¹National Key Lab of Tunable Laser Technology, Harbin Inst. of Technology, China. CW and acousto-optically Q-switched operations with a novel Nd:Gd_{0.69}Y_{0.3}TaO₄ mixed crystal were demonstrated for the first time under indirect and direct pumping.

JTU3A.134

Surface Plasmon Polariton Generation in a Single-Walled Carbon Nanotube, Sergey G. Moiseev^{1,2}, Igor Zolotovskii^{1,3}, Yuliya Dadoenkova¹, Aleksei Kadochkin¹; ¹Ulyanovsk State Univ., Russia; ²Kotelnikov Inst. of Radio Engineering and Electronics of the Russian Academy of Sciences, Russia; ³Institute of Nanotechnologies of Microelectronics of the Russian Academy of Sciences, Russia. Show that high quality of carbon nanotube in surface plasmon polariton generator as a resonator is achieved due to modulation of the phase velocity of the surface plasmon polariton wave along the nanotube.

JTU3A.135 **RAPID**

Time Resolved Study of Optical Properties and Microscopic Dynamics During the Drying of TiO₂ Films by Spectral Diffusing Wave Spectroscopy, Luis F. Rojas-Ochoa¹, Damián Jacinto-Méndez¹, Angel A. Duran-Ledeza¹; ¹Cinvestav-IPN, Mexico. We present a combined experimental, theoretical and numerical study of photon transport and microscopic dynamics in rigid and drying turbid thin TiO₂ films during the full drying process.

JTU3A.136

Study of dual-wavelength quasi-mode-locked regimes in a strict polarization-controlled Er-fiber ring laser, Luis Alberto Rodríguez Morales¹, Hector Santiago-Hernández¹, Baldemar Ibarra-Escamilla¹, Manuel Durán Sánchez¹, Marco V. Hernández-Arriaga¹, Evgeny A. Kuzin¹; ¹Optics, INAOE, Mexico. We report a dual-wavelength quasi mode-locked (DWQML) operation of a strict polarization-controlled passively mode-locked Er-Fiber laser. The DWQML properties are studied by a birefringent fiber optical loop mirror (FOLM).

JTU3A.137

Acousto-Optic Filter with Ultra-Narrow Bandwidth, Nikolai I. Petrov¹, Vladislav I. Pustovoi¹; ¹Scientific and Technological Center of Unique Instrumentation of Russian Academy of Sciences, Russia. Significant increase in spectral resolution of acoustooptic filter due to spatial variation of refractive index of medium is shown. Influence of light absorption and random variation of dielectric constant on the filter spectrum is investigated.

JTU3A.138

Multiphoton processing technologies applied in laser-based 3D printing, Bogdan S. Calin¹, Marian Zamfirescu¹, Irina Paun¹, Catalin Luculescu¹, Florin Jipa¹, Stefana Iosub¹, Emanuel Axente¹, Felix Sima¹; ¹INFLPR, Romania. Micrometer scale 3D printing using various materials, either through additive or subtractive manufacturing, offers a clean, precise and reproducible method of fabricating various passive devices for biomedical applications.

JTU3A.139

Organic Microlasers with Tunable Output, Yongli Yan¹; ¹Chinese Academy of Sciences, China. A supermolecular inclusion strategy to construct wavelength-tunable microlasers was developed. Both β -cyclodextrin and metal-organic framework materials have been successfully adopted as matrix to encapsulate various dyes for lasing.

JTU3A.140

Relativistic Laser-Plasma Diagnostics with the Third Harmonic, Matthew Edwards¹, Alec R. Griffith¹, Tim Bennett¹, Julia Mikhailova¹; ¹Princeton Univ., USA. We experimentally demonstrate the efficient generation of second and third harmonic light from a solid-density plasma for relativistic laser intensities and compare the emission characteristics to simulation and theory.

JTU3A.141

Cr:ZnSe laser generation in two longitudinal modes regime with intracavity monoblock Fabry-Perot interferometer for methane saturation spectroscopy, Mikhail Tarabrin^{1,2}, Sergey Tomilov^{1,2}, Vladimir Lazarev¹, Valeriy Karasik¹, Alexey Kireev², Alexander Shelkovnikov², Dmitry Tyurikov², Mikhail Gubin^{2,3}; ¹Bauman Moscow State Technical Univ., Russia; ²P. N. Lebedev Physical Inst. of the Russian Academy of Sciences, Russia; ³National Research Nuclear Univ. MEPhI, Russia. We reported on the Cr:ZnSe single crystal laser with intracavity monoblock Fabry-Perot interferometer and two Lyot filters for methane saturation spectroscopy at 2.36 μ m.

15:00–16:30

FTu4A • Applied Nanoplasmonics: Solar – Sensing – Communication

Presider: Ortwin Hess; Imperial University, UK

FTu4A.1 • 15:00 **Invited**

Title to be Determined, Harry Atwater¹; ¹California Institute of Technology, USA. No abstract available.

FTu4A.2 • 15:00 **Invited**

Solving the Resistive Loss Problem in Optical Antennas, Eli Yablonovitch¹, Sean Hooten¹; ¹University of California, USA. One of the greatest problems in metal optics (of which plasmonics is a subset), is loss and dissipation in the metal. The basis of all radio is that antennas can concentrate electromagnetic energy within an extremely small volume, <10-15(l)3. Resistive loss limits every application of metals in optics, particularly in the new concept of "optical antennas". Such antennas produce sub-wavelength concentration of optical energy, enabling the antenna-LED (Light Emitting Diode), which can be faster than lasers. The tiny optical antenna vertices experience locally concentrated optical currents which severely increase Ohmic losses. When the concentrated optical region is smaller than the electron mean-free-path in the metal, surface collisions lead to even further dissipation. On the other hand, dielectric antennas have little dissipation, but they do not concentrate electromagnetic energy nearly as well as metallic antennas. If the metallic optical antenna is supplemented by 10nm dielectric tips at the vertices, they suffer only 2x larger concentration volume, but the Ohmic loss problem becomes solved.

15:00–16:30

FTu4B • Short Pulse Lasers

Presider: Junho Cho; Nokia Bell Labs, USA

FTu4B.1 • 15:00 **Invited**

Spatiotemporal Mode-Locking in Multimode Fiber Lasers, Frank W. Wise¹; ¹Cornell Univ., USA. Existing mode-locked lasers operate in a single transverse mode. Locking of multiple transverse and longitudinal modes in a laser was recently demonstrated. Implications for laser science and high-power sources will be discussed.

FTu4B.2 • 15:30

Patterned Graphene on SiN Waveguides with NPR for Fiber Laser Mode-Locking, Goran Kovacevic¹, Takuma Shirahata¹, Bingchang Wu¹, Ting-Hui Xiao², Lei Jin¹, Taiki Inoue³, Shigeo Maruyama³, Zhenzhou Cheng², Sze Set¹, Shinji Yamashita¹; ¹RCAST, Univ. of Tokyo, Japan; ²Dept. of Chemistry, Univ. of Tokyo, Japan; ³Dept. of Mechanical Engineering, Univ. of Tokyo, Japan. We passively mode locked a fiber laser using SiN waveguides covered with graphene of different lengths, and observed two types of solitons, with single and multiple pulses. Grating couplers induce NPR, but graphene triggers mode-locking.

FTu4B.3 • 15:45

Hybrid mode-locked erbium fiber laser with a 40 GHz phase modulator and graphene saturable absorber, Eduardo J. Aiub¹, Eunezio Thoroh de Souza¹, Lucia Saito¹; ¹Universidade Presbiteriana Mackenzie, Brazil. We report a hybrid mode-locked erbium fiber laser operating at 40 GHz using CVD monolayer graphene on a D-shaped fiber as saturable absorber. As result, we obtain ultrashort pulses with temporal width of 1 ps.

FTu4B.4 • 16:00

Pre-chirp Managed Amplification Using Chirped Mirrors for Pulse Compression, Huang Hangdong^{1,2}, Yang Xie¹, Hao Teng², Shaobo Fang², Hainian Han², Guoqing Chang², Zhiyi Wei²; ¹Xi Dian Univ., China; ²Chinese Academy of Sciences, China. We employ high-dispersion chirped mirrors as the pulse compressor and demonstrate an Yb-fiber pre-chirp managed amplification laser system, which produces 55 fs pulses with 43 W average power.

FTu4B.5 • 16:15

Passive Q-switching Tm-Doped Fiber Laser by Using an Alcohol-Based Saturable Absorber, Manuel Duran-Sanchez¹, Berenice Posada-Ramirez¹, Ricardo Iván Alvarez-Tamayo², Baldemar Ibarra-Escamilla¹, Jared Alaniz-Baylón¹, Miguel Bello-Jiménez³, Patricia Prieto-Cortés², Evgeny A. Kuzin¹; ¹INAOE, Mexico; ²Universidad Autónoma de Nuevo Leon, Mexico; ³IICO, UASLP, Mexico. With the maximum pump power of 1.42 W are obtained Q-switched pulses with minimum pulse duration of ~1.46 μs and maximum repetition rate of 66.71 kHz, peak power of 634 mW and pulse energy of 0.93 μJ.

15:00–16:30

FTu4C • Terahertz Science

Jelena Vuckovic; Stanford University, USA

FTu4C.1 • 15:00 **Invited**

Topological Insulator Lasers, Miguel A. Bandres¹, Steffen Wittek², Gal Harari¹, Midya Parto², Jinhan Ren², Demetrios N. Christodoulides², Mordechai Segev¹, Mercedeh Khajavikhan²; ¹Technion, Israel; ²CREOL, USA. We demonstrate a topological insulator laser exhibiting topologically-protected transport. The topological properties give rise to single mode lasing, robustness against defects, and higher slope efficiencies compared to its trivial counterpart.

FTu4C.2 • 15:30

Withdrawn

FTu4C.3 • 15:45

Effect of Pulse Duration on the Performance of Sub-Terawatt Laser Wakefield Acceleration, Chia-Ying Hsieh¹, Shih-Hung Chen¹, Ming-Wei Lin²; ¹Dept. of Physics, National Central Univ., Taiwan; ²Inst. of Nuclear Engineering and Science, National Tsing Hua Univ., Taiwan. A 3-D particle-in-cell (PIC) model is developed to investigate the effect of pulse duration when 1030-nm lasers are applied to drive the sub-terawatt laser wakefield acceleration.

FTu4C.4 • 16:00

Multiple Acceleration of High-velocity Flyer Driven By Long-pulse KrF Laser, Bao-xian Tian¹, Zhao Wang¹, Pinliang Zhang², Zhixing Gao¹, Jing Li¹, Fengming Hu¹; ¹Dept. of Nuclear Physics, China Inst. of Atomic Energy, China; ²Beijing Inst. of Spacecraft Environment Engineering, China. Planar aluminum flyers are accelerated to more than 10 km/s driven by long-pulse laser. Multiple acceleration processes were observed by VISAR. However, the flyer is easily broken up for four or more acceleration because of 2-D effects.

FTu4C.5 • 16:15

EuPRAXIA - a Compact, Cost-Efficient XFEL Source, Maria Katharina Weikum¹, Paul A. Walker¹, Ralph Assmann¹; ¹Deutsches Elektronensynchrotron DESY, Germany. The EuPRAXIA design study aims to develop a first large-scale accelerator and Free-Electron-Laser facility based on plasma acceleration technology. We present an overview over the status of the project as well as possible user applications.

15:00–16:30

FTu4D • Optical Technologies for Autonomy in Realistic Weather

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

Panelists:

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

15:00–16:30

FTu4E • Integrated Nanophotonic Devices

President: Mohammad Hafezi, University of Maryland Joint Quantum Institute, USA

FTu4E.1 • 15:00

Free-space Communication Links with Transmitting and Receiving Integrated Optical Phased Arrays, Matthew Byrd¹, Christopher V. Poulton¹, Murshed Khandaker¹, Erman Timurdogan¹, Diedrik Vermeulen¹, Michael R. Watts¹; ¹*Analog Photonics, USA*. A lens-free chip-to-chip free space optical communication link showing data transmission from a single transmitter to multiple receivers is demonstrated using steerable integrated silicon photonic optical phased arrays at a data rate of 1Gbps.

FTu4E.2 • 15:15

Highly-efficient second-harmonic generation in semi-nonlinear nanophotonic waveguides, Rui Luo¹, Yang He¹, Hanxiao Liang¹, Mingxiao Li¹, Qiang Lin¹; ¹*Univ. of Rochester, USA*. We report second-harmonic generation in semi-nonlinear nanophotonic waveguides composed of titanium oxide and lithium niobate, with a theoretical normalized conversion efficiency of 2900 W⁻¹cm², and an experimental efficiency of 650 W⁻¹cm².

FTu4E.3 • 15:30

Probing finite-size effects and disorder in extended slow light photonic crystal coupled-cavity waveguides, Mohamed S. Mohamed¹, Yiming Lai², Momchil Minkov³, Vincenzo Savona¹, Antonio Badolato⁴, Romuald Houdré¹; ¹*Inst. of Physics, École Polytechnique Fédérale de Lausanne, Switzerland*; ²*The Inst. of Optics, Univ. of Rochester, USA*; ³*Ginzton Lab, Stanford Univ., USA*; ⁴*Dept. of Physics, Univ. of Ottawa, Canada*. Slow light properties of Si photonic crystal coupled-cavity waveguides comprising up to 800 cavities are experimentally investigated using Fourier-space imaging. The influence of cavity chain length and disorder on slow light transport is elucidated.

FTu4E.4 • 15:45

High-quality two-dimensional lithium niobate photonic crystal slab nanoresonators, Mingxiao Li¹, Hanxiao Liang¹, Rui Luo¹, Yang He¹, Qiang Lin¹; ¹*Univ. of Rochester, USA*. We report a 2D LN PhC slab nanoresonators with high optical Q over 3 hundred thousand. Such a high quality enables us to probe the intriguing anisotropy of nonlinear optical phenomena of LN never reported previously.

FTu4E.5 • 16:00 **Invited**

Superconducting Nanowire Single-photon Detector Integrated with a Nanophotonic Cavity, Julian Münzberg², Andreas Vetter², Wladislaw Hartmann¹, Fabian Beutel¹, Carsten Rockstuhl², Wolfram Pernice¹; ¹*University of Munster, Germany*; ²*Karlsruhe Institute of Technology, Germany*. We present the design and the characterization of a new generation of on-chip single-photon detectors, integrated with a double heterostructure photonic crystal cavity to combine high detection efficiency in the near-infrared and sub-ns recovery time.

15:00–16:30

LTu4F • Extreme Laser Science I

President: David Reis; Stanford University, USA

LTu4F.1 • 15:00 **Invited**

Boiling the Quantum Vacuum with Extremely Intense Laser Light, Sebastian Meuren¹; ¹*Princeton Univ., USA*. According to our current understanding of quantum electrodynamics (QED) the properties of matter change qualitatively in the presence of ultra-strong electromagnetic fields. The scale at which novel quantum effects are predicted to occur is called the QED critical or Schwinger field. By colliding highly energetic gamma photons with ultra-intense optical laser pulses the strong-field quantum regime of light-matter interaction is exploratory with existing technology. In particular, nontrivial properties of the quantum vacuum (vacuum birefringence and dichroism, anomalous dispersion), the production of matter from pure light, and laser-induced electron-positron recollision processes are now within experimental reach. After a general introduction into strong-field QED recent results related to those phenomena are discussed and conceptual similarities to analogous phenomena in atomic physics are pointed out.

LTu4F.2 • 15:30 **Invited**

Extreme Conditions from Ultra-Intense Femtosecond Laser Pulses Interacting with Aligned Nanostructures, Jorge J. Rocca¹, Reed J. Hollinger¹, V. N. Shlyaptsev¹, Maria Capeluto¹, Alden H. Curtis¹, Chase Calvi¹, Stephen Kasdorf¹, Vural Kaymak², Alexander Pukhov², Yong Wang¹, Shoujun Wang¹, Alex Rockwood¹; ¹*Colorado State Univ., USA*; ²*Heinrich-Heine-Universität, Germany*. Irradiation of ordered nanowire arrays with highly relativistic pulses is demonstrated to volumetrically heat solid density matter to extreme temperatures, resulting in record conversion into keV photons, high energy ions, & ultrafast neutron bursts.

LTu4F.3 • 16:00

A high-energy mid-infrared to THz laser, Yuxi Fu¹, Katsumi Midorikawa¹, Eiji J. Takahashi¹; ¹*RIKEN, Japan*. Employing a dual-chirped difference frequency generation (DC-DFG) method, we generate a source tunable from mid-infrared (3 μm) to THz (15 THz). DC-DFG, which is an energy scalable approach, enables us to generate few-mJ THz pulses.

LTu4F.4 • 16:15

Jitter-Induced Max-of-N Fluence Distribution at National Ignition Facility, Zhi M. Liao¹, C.W. Carr¹, Paul Wegner¹; ¹*Lawrence Livermore National Lab, USA*. Measured pointing jitter from NIF is used to simulate the effect of Max-of-N accumulated fluence distribution. The simulate result was able to reproduce the measured Max-of-N effect for different energy and wavelength operations.

16:45–18:15

FTu5A • Quantum and Near-Field Nanoplasmonics

President: Ortwin Hess; Imperial University, UK

FTu5A.1 • 16:45 **Invited**

Strong Coupling of a Single Quantum Dot to a Plasmonic Nanoresonator at Ambient Conditions, Bert Hecht¹; ¹*Inst. of Physics, Univ. Of Würzburg, Germany*. We exploit the ultrasmall modal volume of plasmonic slit resonators to achieve broadband strong coupling to quantum dots at ambient conditions. The slit resonator is positioned by means of scanning probe technology with respect to the quantum dot.

FTu5A.2 • 17:15 **Invited**

Giant Nonlinear Response at a Plasmonic Nanofocus Drives Efficient Four-wave Mixing Over Micron Length Scales, Rupert Oulton¹, Michael P. Nielsen¹, Xingyuan Shi¹, Paul Dichtl¹, Stefan A. Maier¹; ¹*Imperial College London, UK*. We report efficient four-wave mixing (FWM) over micron-scale interaction lengths at telecommunications wavelengths on silicon. This was achieved by creating a giant nonlinear response within an integrated plasmonic gap waveguide incorporating a nonlinear polymer. The technique introduces the possibility of compact, broadband, and efficient frequency mixing integrated with silicon photonics.

FTu5A.3 • 17:45 **Invited**

Plasmonics with Quantum States of Light Towards Quantum Applications, Sahin Ozdemir¹; ¹*Department of Engineering Science and Mechanics, Pennsylvania State University, USA*. Plasmonics promise novel properties to integrated quantum photonics, such as nanoscale footprint and strong light-matter interactions. In this talk, I will discuss our studies on probing plasmonic structures using single and entangled photons and realizing quantum applications such as random number generation and entanglement distillation in plasmonic structures.

16:45–18:15

FTu5B • Semiconductor Lasers and SDM

President: Bob Jopson; Nokia Bell Labs, USA

FTu5B.1 • 16:45 **Invited**

Quantum-Inspired Redesign of the Semiconductor Laser for High Coherence, Amnon Yariv¹; ¹*Caltech, USA*. The semiconductor laser (sl) basic architecture reflects the historical need for high gain needed to achieve CW operation. This design is antithetical to high coherence i.e. to small Schawlow-Townes (ST) linewidth. Our new design starts with a drastic lowering of the optical modal losses which is a prerequisite to the reduction of the noisy coherence -lowering spontaneous emission into the laser mode. New lasers fabricated in our group will be described and relevant data shown which include ST linewidths in the single Hz regime Semiconductor lasers with sub hertz ST linewidths are extrapolated.

FTu5B.2 • 17:15

Influence of the upper nonlasing state on the route to chaos of InAs/GaAs quantum dot lasers, Heming Huang³, Dejan Arsenijević¹, Dieter Bimberg^{1,2}, Frederic Grillot^{3,4}; ¹*Institut für Festkörperphysik, Technische Universität Berlin, Germany*; ²*Bimberg Chinese-German Center of Green Photonics” of Chinese Academy of Science at CIOMP, China*; ³*COMTEC, LTCI, Télécom ParisTech, Université Paris-Saclay, 46 rue Barrault, France*; ⁴*Center for High Technology Materials, Univ. of New-Mexico, 1313 Goddard SE, USA*. This paper investigates the route to chaos of a quantum dot laser emitting exclusively on a single lasing state. Results reveal that amplified spontaneous emission from the upper non-lasing state drastically accelerates the destabilization process.

FTu5B.3 • 17:30 **Invited**

Laguerre-Gaussian Spatial Mode Sorter, Joel A. Carpen-ter¹; ¹*Queensland Univ., Australia*. Abstract not available.

FTu5B.4 • 18:00

Mode-Group Selective Air-Clad Photonic Lantern, Neethu Mariam Mathew¹, Lars Grüner-Nielsen², Mario A. Castaneda¹, Michael Gallili¹, Karsten K. Rottwitt¹; ¹*DTU, Denmark*; ²*Danish Optical Fiber Innovation, Denmark*. A new method for fabrication of mode group selective photonic lanterns is experimentally demonstrated. The design is very simple, using only a tapered fiber bundle and an air-cladding. Good mode group selectivity is demonstrated.

16:45–18:00

FTu5C • Novel Lasers and Applications

President: Kaoru Minoshima; University of Electro-Communications, Japan

FTu5C.1 • 16:45 **Invited**

Random Lasers for Sensing, Judith M. Dawes¹, Wan Zakiah Wan Ismail^{1,2}, Charlotte Hurot^{1,3}, Corentin Huard^{1,3}, Nonthanan Sitpathom^{1,4}; ¹*MQ Photonics, Dept of Physics and Astronomy, Macquarie Univ., Australia*; ²*Universiti Sains Islam Malaysia, Malaysia*; ³*Ecole Centrale de Lyon, France*; ⁴*Mahidol Univ., Thailand*. We sensitively detect biomolecules by their effect on gold nanoparticle aggregates in a random laser. The aggregation affects the scattering properties of the laser, enabling us to quantitatively measure dopamine to nanomolar concentrations.

FTu5C.2 • 17:15

Enhanced THz Emission from Two-Color Femtosecond Laser Filamentation at Low Pressures, Dogeun Jang¹, Yungjun Yoo^{1,2}, Ki-Yong Kim¹; ¹*Univ. of Maryland at College Park, USA*; ²*Thorlabs Imaging Systems, USA*. We report enhanced terahertz (THz) emission from elongated, two-color-laser filamentation at low gas pressures. This counterintuitive pressure dependence is investigated with experimental and numerical studies.

FTu5C.3 • 17:30

Coherent Extreme-Ultraviolet Source Applied to Atom Probe Tomography, Luis Miaja Avila¹, Ann N. Chiaromonte¹, Paul T. Blanchard¹, Norman A. Sanford¹, Henry C. Kapteyn², Margaret M. Murnane², David R. Diercks³, Brian P. Gorman³; ¹*NIST, USA*; ²*JILA, Univ. of Colorado, USA*; ³*Colorado School of Mines, USA*. We have adapted an atom probe tomograph (APT) with an extreme ultraviolet (EUV) source. The observations suggest that the photoionization pathway provided by the EUV light is superior to the thermal mechanism in conventional APT.

FTu5C.4 • 17:45

Measurement of the nonlinear refractive index of air constituents from $\lambda=2.5 \mu\text{m}$ to $\lambda=10.6 \mu\text{m}$, Sina Zahedpour Anaraki¹, Scott W. Hancock¹, Fatholah Salehi¹, Jared K. Wahlstrand², Howard Milchberg¹; ¹*Univ. of Maryland at College Park, USA*; ²*National Inst. of Standards and Technology, USA*. We measure the nonlinear refractive indices of major air constituents in the wavelength range of $\lambda=2.5\mu\text{m}$ - $10.6\mu\text{m}$ extending the range of prior measurements [1]. These results are important for the study of intense laser propagation in the atmosphere.

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

FiO

LS

16:45–18:15

FTu5D • Optical Technologies for Autonomy in Unstructured Environments

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

Panelists:

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

16:45–18:15

FTu5E • Topological Photonics

Presider: Simone Ferrari, University of Münster, Germany

FTu5E.1 • 16:45 **Invited**

Non-Hermitian Photonics: Lasers and Sensors, Mercedeh Khajavikhan¹; ¹Univ. of Central Florida, CREOL, USA. Abstract not available.

FTu5E.2 • 17:15 **Invited**

Towards Quantum Topological Photonics, Mohammad Hafezi¹; ¹Joint Quantum Inst., USA. I discuss two recent applications of topological photonics in the quantum regime: (1) strong light-matter interaction in topological photonic crystals (2) topological quantum source of light in silicon ring resonators.

FTu5E.3 • 17:45

Parity-Time (PT) symmetric photonic system based on Parametric Gain, Tong Lin¹, Avik Dutt¹, Xingchen Ji¹, Utsav Dave¹, Alexander Gaeta¹, Michal Lipson¹; ¹Columbia Univ., USA. We report the first demonstration of PT symmetry based on parametric gain, in a single Si₃N₄ microring. We observe the typical merging of eigenvalue branches as the gain/loss contrast between counterpropagating modes is increased.

FTu5E.4 • 18:00

Topological Photonics with Bichromatic Photonic Crystals, Filippo Alpeggiani¹, L. Kuipers¹; ¹TU Delft, Netherlands. We investigate the spectrum of bichromatic photonic crystals, a novel class of nanostructures which represent a photonic analog of topological insulators. Nontrivial topology is illustrated by the formation of topologically protected boundary states.

16:45–18:15

LTu5F • Extreme Laser Science II

Presider: Jorge Rocca; Colorado State University, USA

LTu5F.1 • 16:45 **Invited**

Title to be Determined, Agostino Marinelli¹; ¹SLAC National Accelerator Lab, USA. Abstract not available.

LTu5F.2 • 17:15

An intense soft X-ray harmonic super-continuum generated by a three-channel optical waveform synthesizer, Bing Xue¹, Yuxi Fu¹, Kotaro Nishimura^{1,2}, Oliver Mücke³, Akira Suda², Katsumi Midorikawa¹, Eiji J. Takahashi¹; ¹RIKEN, Japan; ²Tokyo Univ. of Science, Japan; ³Center for Free-Electron Laser Science, DESY, Germany. We report a soft X-ray super-continuum supporting 200 as isolated attosecond pulses at 60 eV generated using a TW-scale three-channel optical waveform synthesizer. The continuum soft X-ray pulse energy is beyond 0.2 μJ at the exit of the argon gas.

LTu5F.3 • 17:30 **Invited**

Probing Photoionization Dynamics by High-spectral-resolution Attosecond Spectroscopy, Shiyang Zhong¹, Marcus Isinger¹, Richard Squibb², David Busto¹, Anne Harth¹, David Kroon¹, Saikat Nandi¹, Cord Arnold¹, Miguel Miranda¹, J. M. Dahlström^{1,3}, Eva Lindroth³, Raimund Feifel², Mathieu Gisselbrecht¹, Anne L'Huillier¹; ¹Dept. of Physics, Lund Univ., Sweden; ²Dept. of Physics, Gothenburg Univ., Sweden; ³Dept. of Physics, Stockholm Univ., Sweden. Photoionization time delays are measured with two-color (XUV+IR) interferometric technique. The combination of attosecond temporal resolution and high spectral resolution from narrowband harmonics allows the study of ultrafast dynamics in both time and frequency domain.

LTu5F.4 • 18:00

Dissipative Soliton Resonance in a Figure-Eight Thulium-Doped Fiber Laser, Manuel Duran-Sanchez¹, Berenice Posada-Ramirez¹, Baldemar Ibarra-Escamilla¹, Hector Santiago-Hernandez¹, Ricardo Iván Alvarez-Tamayo³, Miguel Bello-Jiménez², Evgeny A. Kuzin¹; ¹INAOE, Mexico; ²IICO, UASLP, Mexico; ³Universidad Autónoma de Nuevo Leon, Mexico. We reported dissipative soliton resonance effects passively mode-locked figure-eight thulium doped fiber laser. At maximum pump power was achieved 85.18 ns pulse duration, a pulse energy of 206 nJ, a repetition rate of 1.19 MHz.

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

FIO

08:00–09:00

FW1A • The Coming of Age for Smart Glasses, AR and VR

Presider: Bernard Kress; Microsoft, USA

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

FW1A.1 • 08:10 **Invited**

User-centered Design of Head Worn Displays, Thad Starner¹; ¹*School of Interactive Computing, Georgia Inst. of Technology, USA*. Fashion and head weight are more important than field-of-view for on-the-go AR displays, and displays centered in line-of-sight may be rejected by on-the-go users due to safety perceptions. What other surprises might user-centered design reveal?

FW1A.2 • 08:35 **Invited**

Head-Mounted Displays for High Stress Occupations, James E. Melzer¹; ¹*Thales Visionix, Inc., USA*. Pilots, warfighters, first responders and medical personnel must maintain their situation awareness in times of high stress or risk harm to themselves, team members or those in their care. While we can't necessarily make them better at their job, perhaps we can give them a head-mounted (or helmet-mounted) display that can provide cognitively "pre-digested" information in a hands-free and timely manner that will reduce their workload? What are the requirements for maintaining situation awareness and reducing workload for these important occupations? How do these requirements translate into performance specifications for the head-mounted display?

09:15–10:00

FW2A • Visionary: Mark BolasFW2A.1 • 09:15 **VISIONARY**

Bending Light to Bend Reality, Mark Bolas¹; ¹*Microsoft Corp, USA*. As we dive head-first into the new medium of mixed reality, we find that the ability to bend light is central to the palette of mixed reality systems and content designers as they bend the reality that is ultimately formed in the user's mind. This talk will look backwards and forward in time to explore just how messy that process has been, and how much messier it will become.

08:00–09:00

FW1B • Novel Lasers and Photodetectors

Presider: Alexey Turukhin; TE SubCom, USA

FW1B.1 • 08:00

High-Speed Waveguide Integrated Si Photodetector on SiN-SOI Platform for Short Reach Optical Interconnect, Avijit Chatterjee¹, Saumitra S¹, Sujit K. Sikdar¹, Shankar K. Selvaraja¹; ¹*Indian Inst. of Science Bangalore, India*. We demonstrate high-speed Silicon pin photodetector integrated with SiN waveguide. Optimized waveguide-photodetector coupling yields maximum responsivity of 0.44A/W and highest ever bandwidth of 15.5GHz for waveguide integrated Silicon photodetector.

FW1B.2 • 08:15

10-Gb/s Floor-Free Transmission of a Hybrid III-V on Silicon Distributed Feedback Laser with Optical Feedback, Sandra Gomez¹, Heming Huang¹, Bewindin Sawadogo¹, Frederic Grillot^{1,2}; ¹*Telecom ParisTech, France*; ²*Univ. of New Mexico, USA*. A 10 Gb/s transmission by direct modulation of a distributed feedback semiconductor laser heterogeneously integrated onto silicon is studied with optical feedback. Its impact on the bit error rate and power penalty degradation is analyzed.

FW1B.3 • 08:30 **Invited**

III-V Membrane Buried Heterostructure Lasers on SiO₂/Si Substrate, Tomonari Sato¹; ¹*NTT Device Technology Labs, Japan*. A membrane buried heterostructure with a lateral p-i-n junction on SiO₂/Si substrate enables tight confinement of carriers and photons simultaneously, which enables us to achieve energy-efficient lasers.

08:00–09:00

FW1C • Nanophotonics I

Presider: Katarzyna Matczyszyn; Wroclaw University of Science and Techn., Poland

FW1C.1 • 08:00 **Invited**

Enabling Next-Generation Optical Microsystems, Gordon A. Keeler¹; ¹*DARPA, USA*. Integrated photonics promises revolutionary solutions for communications, sensing, and metrology. This talk describes DARPA efforts to develop technology through investments in components and materials, and highlights programs driving innovation.

FW1C.2 • 08:30

Multiplexing Soliton-Combs in Optical Microresonators, Erwan Lucas¹, Grigory Lihachev^{2,3}, Romain Bouchand¹, Nikolay Pavlov², Arslan S. Raja¹, Maxim Karpov¹, Michael Gorodetsky^{2,3}, Tobias Kippenberg¹; ¹*Ecole Polytechnique Fédérale de Lausanne, Switzerland*; ²*Russian Quantum Center, Russia*; ³*Moscow State Univ., Russia*. We simultaneously create stable solitons in up to 3 distinct mode families of a single crystalline MgF₂ microresonator. The resulting Kerr combs have distinct repetition rates, are mutually coherent allowing dual or future triple comb applications.

FW1C.3 • 08:45

In-situ Backpropagation in Photonic Neural Networks, Momchil Minkov¹, Tyler W. Hughes¹, Yu J. Shi¹, Ian Williamson¹, Shanhui Fan¹; ¹*Stanford Univ., USA*. Using the adjoint variable method, we derive an in-situ backpropagation procedure for training of photonic neural networks. Our method may also be of interest for experimental sensitivity analysis and optimization of reconfigurable optics platforms.

FiO

LS

08:00–09:00

FW1D • Quantum Sensing for Industry and Fundamental Physics I*Presider: To be Determined*FW1D.1 • 08:00 **Invited**

Enabling Technologies for Cold-Matter Based Quantum Systems, Evan A. Salim¹; ¹*ColdQuanta Inc., USA*. Quantum technologies exploit properties of matter to manage information, and to measure phenomena in ways that greatly exceed existing capabilities. We present on key technologies to enable quantum information science, sensing, and timekeeping.

FW1D.2 • 08:30 **Invited**

Quantum Enhanced Metrology with Trapped Ions, Dietrich Leibfried¹; ¹*National Inst. of Standards and Technology, USA*. Laser cooling and quantum logic allows us to prepare atomic and molecular ions into nearly pure quantum states of their internal degrees of freedom and external motion and subsequently interrogate them with high metrological precision.

08:00–09:00

FW1E • Nanophotonic Sensing and Optomechanics*Presider: Roel G. F. Baets; Ghent University INTEC, Belgium*

FW1E.1 • 08:00

Robust non-Hermitian sensors, Qi Zhong¹, Mohammad Hosain Teimourpour¹, Ramy El-Ganainy¹; ¹*Michigan Technological Univ., USA*. We introduce a new design concept for non-Hermitian photonic that combine robustness with sensitivity and demonstrate its utility for sensing applications.

FW1E.2 • 08:15

Quantum metrology for high-accuracy measurement of refractive index difference in original optical fibers, Florent Mazeas^{1,2}, Romain Dauliat^{3,4}, Djeylan Aktas⁵, Mattis Reisner^{1,2}, Panagiotis Vergyris^{1,2}, Philippe Roy^{3,4}, Raphael Jamier^{3,4}, Florian Kaiser^{5,7}, Laurent Labonté^{1,2}, Sébastien Tanzilli^{1,2}; ¹*Université Côte d'Azur, CNRS, France*; ²*Institut de Physique de Nice, France*; ³*Université de Limoges, France*; ⁴*XLIM, France*; ⁵*Univ. of Bristol, UK*; ⁶*Univ. of Stuttgart, Germany*; ⁷*3rd Inst. of Physics, Germany*. We report on a quantum-based measurement of index difference in original fibers. With an interferometric setup and a peculiar optical fiber structure, we demonstrate index difference measurements with a precision reaching the 10⁻⁵ - 10⁻⁶ level.

FW1E.3 • 08:30

Arrays of High Reflectivity SiN Photonic Crystal Membranes for Cavity Optomechanics, João Moura¹, Claus Gärtner^{1,2}, Wouter Haaxman¹, Richard A. Norte¹, Simon Gröblacher¹; ¹*Kavli Inst. of Nanoscience, Delft Univ. of Technology, Netherlands*; ²*Vienna Center for Quantum Science and Technology (VCQ), Univ. of Vienna, Austria*. We fabricate photonic crystal SiN membranes with reflectivity > 99.9% at 1550 nm. These form a platform for studying arrays of mechanical oscillators inside optical cavities, which can potentially reach strong single-photon optomechanical coupling.

FW1E.4 • 08:45

Demonstration of a Phonon Laser With a Nanosphere Levitated in an Optical Tweezer, Robert Pettit¹, Wen-chao Ge², Pardeep Kumar², Danika Luntz-Martin¹, Justin Schultz¹, Levi Neukirch³, Mishkat Bhattacharya², Anthony N. Vamivakas¹; ¹*Univ. of Rochester, USA*; ²*Rochester Inst. of Technology, USA*; ³*Los Alamos National Lab, USA*. A phonon laser based on the center-of-mass oscillations of a silica nanosphere, levitated in an optical tweezer under vacuum, is proposed and developed. The observed dynamics are shown to result from stimulated emission of phonons.

08:00–09:00

LW1F • Novel Lasers, Plasmonics, Nanophotonics I*Presider: Maiken Mikkelsen; University of California Berkeley, USA*LW1F.1 • 08:00 **Invited**

High Performance Flat Optics, Federico Capasso¹, Wei-Ting Chen¹; ¹*Harvard Univ., USA*. The talk will focus on metasurface optics including broadband achromatic and tunable metalenses, ultracompact spectrometers and polarimeters that match the performance of state-of-the-art ones and novel endoscopes for lung cancer detection.

LW1F.2 • 08:30 **Invited**

Nonreciprocal Photonics, Andrea Alu¹; ¹*Photonics Initiative, CUNY Advanced Science Research Center, USA*. We discuss opportunities to break reciprocity in photonics using mechanical motion, spatio-temporal modulation, and/or nonlinearities, and their impact in the context of integrated photonics, slow-light devices, and photonic topological insulators.

09:15–10:00

LW2B • Visionary: Mark Brongersma*Presider: Pieter G. Kik; University of Central Florida, USA*LW2B.1 • 09:15 **VISIONARY**

Activities Shaping the Wavefront of Nanophotonics, Mark Brongersma¹; ¹*Stanford Univ., USA*. In the field of nanophotonics we aim to manipulate the flow of light using optically resonant nanostructures. I will share my personal perspective on a number of exciting recent developments in the field that are transforming the way we create new optical materials and devices.

Science & Industry Showcase

10:15-11:15

Rapid Fire Oral Presentation III, Science & Industry Theater

President: Wei Lee; National Chiao Tung University, Taiwan

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

JOINT FIO + LS

10:00-12:00

JW3A • Poster Session III and Dynamic E Posters

JW3A.1 **E-Poster**

Fabrication of active microdisc resonators using solvent immersion imprint lithography, Priyanka Choubey¹, Shailendra Varshney¹, Shivakiran Bhaktha B. N.¹; ¹Indian Inst. of Technology Kharagpur, India. We present fabrication of active microdisc resonators for sensing platform based on whispering-gallery modes. The arrays of microdisc are fabricated from DCM laser dye-doped PVA using solvent immersion imprint lithography (SILL).

JW3A.2 **E-Poster**

Polarization Rotation Utilizing Berry's Phase in Asymmetric Silicon Waveguides, Ryan Patton¹, Ronald M. Reano¹; ¹Ohio State Univ., USA. We present a method to achieve polarization rotation in asymmetric silicon waveguides using Berry's phase. By exploiting periodic in-plane and out-of-plane sections, we achieve 90° polarization rotation in the presence of linear birefringence.

JW3A.3

Withdrawn

JW3A.4 **E-Poster**

Single-pixel three-dimensional profiling with a dual-comb fiber laser, Yihong Li¹, Xin Zhao¹, Qian Li¹, Jie Chen¹, Zheng Zheng^{1,2}; ¹School of Electronic and Information Engineering, Beihang Univ., China; ²Beijing Advanced Innovation Center for Big Data-based Precision Medicine, Beihang Univ., China. Using a single-cavity, dual-comb fiber laser, single-pixel 3D profiling is demonstrated with a simple and compact setup. Sub-millimeter resolution achievable with the dual-comb ranging scheme can be attractive to many applications.

JW3A.5 **E-Poster**

Quasi-monoenergetic Electron Beams from Mid-IR Laser Wakefield Acceleration in the Bubble Regime, Anastasia Korolov¹, Daniel C. Woodbury¹, Robert Schwartz¹, Howard Milchberg¹; ¹Institute for Research in Electronics & Applied Physics, USA. We present simulation results of laser plasma wakefield acceleration in the bubble regime driven by ultrashort mid-infrared laser pulses (30fs, $\lambda=3.9\mu\text{m}$, $3\times 10^{17}\text{ W/cm}^2$). We observe a quasi-monoenergetic accelerated electron bunch at ~20MeV.

JW3A.6 **E-Poster**

Enhanced resolution in remote sensing using UV filaments with long pulses, Ladan Arissian^{1,2}, Jean Claude Diels¹, Ali Rastegari¹, Brian Kamer¹; ¹CHTM, Univ. of New Mexico, USA; ²Univ. of Ottawa, Canada. We present high resolution spectroscopy of solid samples from 200ps UV filaments. The temperature gradient on the expanding plume results into self-absorption of the hot plasma by the surrounding colder regions improving the resolution.

JW3A.7 **E-Poster**

Signatures of Coherent Photon Transport in Nanowire Waveguides with Coupled Quantum Dots, Chelsea L. Carlson¹, Dan Dalacu², Robin L. Williams², Phillip J. Poole², Stephen Hughes¹; ¹Queen's Univ., Canada; ²National Research Council of Canada, Canada. We present theory and experiments of coupled quantum dots (QDs) in semiconductor nanowire waveguides. Depending upon the two QD spatial separation, we demonstrate pronounced spectral shifts, as well as strongly coupled super/sub-radiant states.

JW3A.8 **RAPID**

Amplitude Shifting Holography, Surya Gautam¹, Pramod Panchal¹, Dinesh N. Naik¹, C. S. Narayanamurthy¹, Rakesh K. Singh¹; ¹Physics, Indian Institute of Space Science & Technology, India. Amplitude Shifting Holography method for imaging complex value objects is based on the consideration that one point can be taken from the object as a reference and by shifting its amplitude to record the digital hologram.

JW3A.9 **RAPID**

Fabrication of Black Silicon using Laser Annealing, Sara Al Menabawy¹, Joumana El-Rifai¹, Mohamed M. Swillam¹; ¹American Univ. in Cairo, Egypt. A novel fabrication technique of Silicon nanowires using excimer laser is developed in this work. Using one-step and easily scalable method, array of nanowires with broadband absorption enhancement are formed without etching the deposited material.

JW3A.10 **RAPID**

High Efficiency Photon Sieves by Laser Direct Writing, Matthew Julian¹, David MacDonnell², Mool Gupta¹; ¹Univ. of Virginia, USA; ²NASA Langley Research Center, USA. We show that photon sieve focusing efficiencies can be increased 7-fold. Such sieves can be fabricated via standard laser direct writing techniques. By optimizing laser parameters, near diffraction limited performance is demonstrated.

JW3A.11

Mode-locking Fiber Laser Using SMS Fiber Structure as a Saturable Absorber, Yunxiu Ma^{1,2}, Xiushan Zhu¹, Luyun Yang², Jing Zhang³, Wei Shi⁴, Nasser Peyghambarian¹; ¹College of Optical Sciences, Univ. of Arizona, USA; ²Wuhan National Lab for Optoelectronics, Huazhong Univ. of Science and Technology, China; ³School of Science, Changchun Univ. of Science and Technology, China; ⁴College of Precision Instrument and Optoelectronics Engineering, Tianjin Univ., China. Mode-locking fiber laser by nonlinear Kerr effect of a single-mode-multimode-single-mode (SMS) fiber structure as saturable absorber was demonstrated. A 13.01 MHz mode-locking Tm³⁺-doped fiber laser operating at 1941.37 nm was obtained.

JW3A.12

Diffraction Fresnel Lens Fabrication with Femtosecond Bessel Beam Writing in Silica, Qi Sun¹, Timothy Lee¹, Ziqian Ding², Martynas Beresna¹, Gilberto Brambilla¹; ¹Optoelectronics Research Centre, Univ. of Southampton, UK; ²Huawei Technologies Co., Ltd., China. A 3-layer Fresnel lens with 52% diffraction efficiency was inscribed with a femtosecond Bessel beam in silica, with each layer being ~80 μm . An anomalous dispersion property was characterized with an RGB LED source.

JW3A.13

Material Selection for Generalized Achromatic Lenses Including Conventional, Gradient Index, and Diffractive Components, Guy Beadie¹, Joseph N. Mait²; ¹US Naval Research Lab, USA; ²US Army Research Lab, USA. Optimum material selection is discussed for unconventional achromatic lenses, including gradient index and diffractive optical elements. The approach is based on defining a figure of merit, and finding material combinations that maximize its value.

JW3A.14

Scintillation of Gaussian-, multi-Gaussian-, and non-uniformly-correlated beams, Milo W. Hyde¹, Svetlana Avramov-Zamurovic², Charles Nelson²; ¹Air Force Inst. of Technology, USA; ²USA Naval Academy, USA. We compute the mean intensities and scintillation indices for Gaussian-, multi-Gaussian-, and nonuniformly-correlated sources. Under the simulated conditions, we find no significant scintillation improvement over the Gaussian-correlated source.

JW3A.15

Symmetry Aspects of the Cesium D₂ Double Resonance Spectrum, Thomas Marty¹; ¹Thomas Marty (private), Switzerland. Dark resonance spectra were recorded with a σ^+ -polarized beam from a laser diode. Longitudinal magnetic fields reveal seven double resonances. In orthogonal magnetic fields fifteen double resonances appear. This indicates strong angular dependence.

JW3A.16

Multi-Plane, Learning Algorithm for Focal Volume Beam Shaping, Harry Burton¹, Ashish Bachavala¹, Christopher Debardeleben¹, Wafa Amir¹, Thomas A. Planchon¹; ¹Delaware State Univ., USA. A Multi-Plane Genetic Algorithm is developed to optimize the focal volume of a laser instead of its focal plane. Using a Spatial Light Modulator, non-diffracting beams are generated to demonstrate the validity of the approach.

JW3A.17

Simple Circular Beam Lattices via Phase Modulated Bessel Beams, Mariia Shutova¹, Aleksandr Goltsov^{1,2}, Anatoli Morozov³, Alexei Sokolov^{1,2}; ¹Inst. for Quantum Science and Engineering, Dept. of Physics and Astronomy, Texas A&M Univ., USA; ²Baylor Univ., USA; ³Princeton Univ., USA. We tailor Bessel beams generated by an axicon employing phase modulation. Resultant non-diffracting circular lattices create stable intensity channels, which, if modified according to experimental needs, offer an ideal instrument for plasma guiding.

JW3A.18

Linearly Polarized Generalized-Gaussian Laser Beams, Jessica P. Conry¹; ¹Arkansas Tech Univ., USA. Dominant and cross-polarization intensity profiles of Generalized Gaussian beams are produced of several orders and angle parameter using a spatial light modulator. The experimental and theoretical profiles are in agreement.

JW3A.19

Performance Evaluation of Infrared Thermographic Fever Screening Systems, Pejman Ghassemi¹, Joshua Pfefer¹, Jon Casamento¹, Quanzeng Wang¹; ¹Food and Drug Administration, USA. Methods to test stability and uniformity of infrared thermographs were evaluated and improvements were suggested. The study has provided significant insights toward the design of least burdensome standardized test methods.

JW3A.20

A Full-field Heterodyne Interferometer using for Modal Identification, Zong H. Chen¹, Wen Xiao¹, Feng Pan¹; ¹Beihang Univ., China. In this paper, a full-field heterodyne interferometer, is proposed for modal identification. The experiment results show a great agreement with data obtained from theoretical calculation and LDV.

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JW3A.21

Measurement of Centering Errors of Glass Molds and Casted Lenses for Production of Ophthalmic Lenses, Saharat Kaew-aram¹, Boonsong Sutapun¹; ¹Suranaree Univ. of Technology, Thailand. In this work, we discuss the instrument design challenges and preliminary results for the development of an apparatus for measurement of centering error of the assembled glass molds used for manufacturing of plastic ophthalmic lenses.

JW3A.22

Non-uniformly correlated partially coherent lasers, Xixiong Pu¹, Chengcheng Chang¹, Xudong Chen¹, Ziyang Chen¹; ¹Huaqiao Univ., China. We demonstrate a new kind of laser, called as a partially coherent digital laser, producing non-uniformly correlated partially coherent light (NUC-PCL) beams by "playing a video" inside the cavity directly.

JW3A.23

Low-loss BSO photonic waveguides, Florent Behague¹, Nadege Courjal¹, Florent Bassignot¹, Ludovic Gauthier-Manuel¹, Alexis Caspar¹, Venancio Calero Vila¹, Fadi Baida¹; ¹femto-st, France. We report for the first time the fabrication of low loss ridge-waveguides in Bismuth-Silicon-oxide by optical grade-dicing. This approach promises to be powerful for compact and highly sensitive E-field sensors, scintillators and laser applications.

JW3A.24

Design and Fabrication of Germanium-Zinc Sulfide Mid-IR Photonic Devices, Daniel Carney¹, Robert Magnusson¹; ¹Univ. of Texas at Arlington, USA. The mid-IR from 3 to 13 μm is an established region for scientific and industrial applications and may benefit from the introduction of photonic devices. Methods for the design and fabrication mid-IR devices are demonstrated.

JW3A.25

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

JW3A.26

2D Material Liquid Crystal Nanocomposites for Optoelectronic and Photonic Devices, Benjamin T. Hogan¹; ¹Univ. of Exeter, UK. We synthesise, characterise and move toward application of 2D material liquid crystalline nanocomposites for optoelectronic and photonic devices, focussing on those produced using graphene oxide, tungsten disulfide and boron nitride.

JW3A.27

Optical 3D μ -Printing of Polymer Whispering-Gallery-Mode Microcavity Lasers, Xia Ouyang¹, Jijun He¹, A. Ping Zhang¹, Hwa-Yaw Tam¹; ¹Electrical Engineering, The Hong Kong Polytechnic Univ., Hong Kong. A new optical printing technology for the fabrication of polymer whispering-gallery-mode microcavity lasers is presented. Polymer mushroom-like optical microresonators capped with a layer of dye-based gain film were shown for WGM laser applications.

JW3A.28

Spectroscopy Analysis for Real Time Application in Oil and Gas Instrumentation, Eduardo Perez¹; ¹DICIS, Mexico. Spectroscopy applied to technical innovation continues with the spectrometer, whose provides excellent optical design for sharper images and spectra for dramatically improved resolution and signal-to-noise ratio.

JW3A.29

Remote Detection of Radioactive Material using Optically Induced Air Breakdown Ionization, Joshua J. Isaacs¹, Phillip Sprangle¹; ¹Univ. of Maryland, USA. We model irradiated air to estimate the density of negative ions and use a set of coupled rate equations to simulate the subsequent laser-induced avalanche ionization for detection of radioactive materials remotely.

JW3A.30

Modeling the Formation of Nanometer-Scale High-Density Electron Bunches in Relativistic Laser-Solid Interaction: Effects of Numerical Resolution, Nicholas M. Fasano¹, Matthew Edwards¹, Julia Mikhailova¹; ¹Princeton Univ., USA. With numerical simulations we demonstrate that laser-driven electrons near solid targets bunch together and travel along a synchrotron-like trajectories. The effect of numerical resolution on the formation of these nanoscale bunches is studied.

JW3A.31

RAPID

Frequency Shifting Whispering Gallery Modes With Planar Dielectric Substrates, Patrick A. Devane¹, Madhuri Kumari¹, Luke Trainor¹, Harald G. Schwefel¹; ¹Univ. of Otago, New Zealand. We assess a proposed method of dielectric tuning for whispering gallery mode resonators using a set up that allows dielectric substrates to move into close proximity with a lithium niobate resonator and analyse the resulting frequency shifts.

JW3A.32

RAPID

Stationary Beam Synthesis From its Coherent Modes, Xi Chen¹, Jia Li¹, Mohammad Hashemi Rafsanjani¹, Olga Korotkova¹; ¹Univ. of Miami, USA. We introduce a technique for synthesis of stationary beams via superposition of coherent modes. Some stationary beams are generated from randomized sequences of ten Laguerre-Gaussian modes and analyzed on propagation in vacuum and atmosphere.

JW3A.33

RAPID

Modulated Photoluminescence of Germanium via Intense Terahertz Pulse Electric Fields, Mary Alvean B. Narreto¹, Chenxi Huang¹, David N. Purschke¹, Frank Hegmann¹; ¹Univ. of Alberta, Canada. We show a nonlinear effect of intense terahertz pulse electric fields (>200 kV/cm) on the photoluminescence of bulk germanium. Terahertz-pulse-induced direct-gap photoluminescence quenching is observed.

JW3A.34

RAPID

Lorenz-Mie Scattering in Terms of Complex Focus Fields, Rodrigo Gutiérrez-Cuevas¹, Nicole J. Moore², Miguel A. Alonso^{1,3}; ¹Univ. of Rochester, USA; ²Gonzaga Univ., USA; ³Aix Marseille Université, Centrale Marseille, Institut Fresnel, France. An analytic approach to the Mie scattering of highly focused fields is presented. By describing the incident field in terms of complex focus fields we can model the scattering and trapping properties of fields with many properties of interest.

JW3A.35

Withdrawn

JW3A.36

RAPID

Angle Dependent THz Absorption in Aligned RGO/Fe₃O₄ Nanocomposite, Nikita Porwal¹, Shivam V. Raval¹, Tridib Sinha¹, Samit K. Ray^{1,2}, Prasanta Kumar Datta¹; ¹IIT Kharagpur, India; ²SN Bose National Centre for Basic Sciences, India. We report a polarizing nature in aligned Fe₃O₄/RGO Nanocomposite of 10 nm size. The DOP of the nanocomposite varies from 0.51-0.04 for 0.4-1.6 THz, suggesting a good polarization effect for future polarizer applications.

JW3A.37

Diffusion of External Magnetic Field into Laser-produced Plasma Plume, Narayan Behera¹, Rajesh K. Singh¹, Ajai Kumar¹; ¹Inst. for Plasma Research, HBNI, India. The diffusive term of the generalized Ohm's law is calculated to understand how magnetic field diffuses into laser-produced plasma as it is useful to understand confinement and acceleration of the plasma plume and its dynamics.

JW3A.38

Single mode fibers for two stage higher-order soliton compression at 2 μm , Fumin Wang¹, Zihao Cheng¹, Qian Li¹; ¹PKU Shenzhen graduate school, China. We demonstrate design of single mode fibers for two-stage higher-order soliton compression at 2 μm . A compression factor of 79.9 has been achieved and the pedestal energy is only 51.54%.

JW3A.39

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

JW3A.40

RAPID

Coherent Anti-Stokes Raman Scattering Enhanced by MoS₂ Nanoparticles, Anton D. Shutov¹, Zhenhuan Yi¹, Jizhou Wang¹, Alexander M. Sinyukov¹, Zhe He¹, Chenwei Tang^{1,2}, Jiahao Chen^{1,2}, Zhedong Zhang¹, Esther J. Ocola³, Jaan Laane³, Alexei V. Sokolov^{1,4}, Dmitri V. Voronine⁵, Marlan O. Scully^{1,4}; ¹Inst. for Quantum Science and Engineering, Texas A&M Univ., USA; ²School of Science, Xi'an Jiaotong Univ., China; ³Dept. of Chemistry, Texas A&M Univ., USA; ⁴Baylor Research Innovative Center, Baylor Univ., USA; ⁵Univ. of South Florida, Dept. of Physics, USA. We demonstrate the surface enhancement of coherent anti-Stokes Raman scattering (CARS) on pyridine-ethanol solution by MoS₂ nanoparticles. The time resolved CARS measurements reveal increased dephasing rates of pyridine vibrational modes.

JW3A.41

RAPID

Continuous-Wave, Singly-Resonant Optical Parametric Oscillator Source of Vortex Beams Tunable in the Ultraviolet, Varun Sharma¹, Goutam K. Samanta¹, R.P. Singh¹, S. C. Kumar², M. Ebrahim-Zadeh^{2,3}; ¹PRL Ahmedabad, India; ²ICFO-Institut de Ciències Fotòniques, Mediterranean Technology Park, 08860 Castelldefels, Barcelona, Spain; ³Institució Catalana de Recerca i Estudis Avançats (ICREA), Spain. We report a continuous-wave source of ultraviolet radiation in vortex spatial intensity profile tunable across 332-344 nm based on a green-pumped optical parametric oscillator.

JW3A.42

Coherent Mid-infrared Supercontinuum Generation Using All Solid Hybrid Micro-structured Tellurite Fibers, Hoa P. Nguyen¹, Hoang Tuan Tong¹, Than Singh Saini¹, Luo Xing¹, Takenobu Suzuki¹, Yasutake Ohishi¹; ¹Toyota Technological Inst., Japan. We simulate supercontinuum generation using all solid hybrid micro-structured tellurite fibers. By controlling carefully the chromatic dispersion, a highly coherent and broad SC spectrum (0.78 μm – 4.8 μm) is obtained using a laser pumping at 2 μm .

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JW3A.43

Near-perfect terahertz wave amplitude modulation enabled by impedance matching in VO₂ thin films, Jiang Li¹; ¹*Inst. of Fluid Physics, CAEP, China*. A terahertz amplitude modulation method with near perfect E-field amplitude modulation depths of 97.6% that is based on impedance matching in VO₂ thin films during the thermally induced insulator-metal transition.

JW3A.44

Crumple Nanostructured Graphene for Mechanically Reconfigurable Plasmonic Resonances, Pilgyu Kang³, Kyoung-Ho Kim¹, Hong-Gyu Park¹, SungWoo Nam²; ¹*Dept. of Physics, Korea Univ., South Korea*; ²*Dept. of Mechanical Science and Engineering, Univ. of Illinois at Urbana-Champaign (UIUC), USA*; ³*Dept. of Mechanical Engineering, George Mason Univ., USA*. We present an innovative approach to achieve mechanically reconfigurable, strong plasmonic resonances via crumple nanostructured graphene. The mechanical reconfiguration of crumpled graphene enables broadband tunability from mid- to near-infrared.

JW3A.45

Effects of Spatial Confinement on Plasmon Modulated Photoluminescence, Robert D. Lemasters¹, Hayk Harutyunyan¹; *Emory Univ., USA*. Investigating the effects of spatial confinement of plasmon gap-modes on PL in nanometrically precise plasmonic nanostructures. Results show a linearly increasing nonlinear power law for pulsed laser excitation and linear power law for CW excitation.

JW3A.46

Laser Cooling of Crystalline Yb: YAG and Yb: KYW, Long Cheng¹, Laura Andre¹, Stephen C. Rand^{1,2}; ¹*EECS, Univ. of Michigan, USA*; ²*Physics, Univ. of Michigan, USA*. Laser cooling of a 3%Yb:YAG crystal by 4K is achieved under ambient temperature and pressure conditions in an open lab environment and laser cooling of 1%Yb:KYW is reported for the first time.

JW3A.47

Ultrafast Carrier Dynamics in Self-Assembled La_xSr_{1-x}MnO₃/SrTiO₃ Heterostructures, Joel E. Taylor¹, Rami A. Khoury², Kun Zhao¹, Mohammad Saghaeizhan¹, Louis Haber², Ward Plummer¹; ¹*Dept. of Physics & Astronomy, Louisiana State Univ., USA*; ²*Dept. of Chemistry, Louisiana State Univ., USA*. Optically excited carrier dynamics are observed for self-assembled La_xSr_{1-x}MnO₃/SrTiO₃ heterostructures using pump-probe reflectivity.

JW3A.48

Efficient Polarization Modulation by a Phase Change Material on Metal, Alain Hache¹, Tran Vinh Son¹, Truong Vo-Van², Phuong Ahn Do¹; ¹*Universite de Moncton, Canada*; ²*Physics, Concordia Univ., Canada*. The polarization state of light interacting with a layer of vanadium dioxide on metals undergoing phase transition is observed to change due to large variations in the material's refractive index.

JW3A.49

Second Harmonic Generation in CH₃NH₂PbI₃ Thin Films, Anna A. Popkova¹, Vladimir O. Bessonov¹, Irina V. Soboleva¹, Mehedi Hasan², Dmitry Lyashenko², Alex Zakhidov^{2,3}, Andrey A. Fedyanin¹; ¹*Lomonosov Moscow State Univ., Russia*; ²*MSEC, Texas State Univ., USA*; ³*Dept. of Physics, Texas State Univ., USA*. Second-harmonic generation in CH₃NH₂PbI₃ perovskite multidomain film is experimentally studied. The MAPI nonlinear second-order susceptibility is estimated. Polarization of MAPI SHG signal is observed and hyper-Rayleigh scattering angle is estimated.

JW3A.50

Image Transmission across a Nonchiral/chiral Boundary Based on Dispersive Fresnel Coefficients, Monish R. Chatterjee¹, Rajab Ataai¹; ¹*Univ. of Dayton, USA*. Fresnel coefficients for LCP/RCP modes are computed for s-polarized wave transmission across an achiral/chiral interface. 2D image transmission and recovery is examined using dispersive dielectric parameters, PCM encoding and discrete sideband analysis.

JW3A.51

Complex Mirror Symmetry in Optics, Li Ge¹; ¹*College of Staten Island, CUNY, USA*. We first show the existence of a novel non-Hermitian symmetry, i.e., complex mirror symmetry. We then demonstrate a recursive process that generates high-order non-Hermitian degeneracies based on this new symmetry, which can potentially increase the spontaneous emission rate and sensing sensitivity of optical devices by orders of magnitude.

JW3A.52

Broadband THz Spectral Characterization with THz Bandpass Filters, Yungjun Yoo^{1,2}, Dogeun Jang¹, Malik Kimbrue¹, Ki-Yong Kim¹; ¹*Univ. of Maryland at College Park, USA*; ²*Thorlabs Imaging Systems, USA*. Metal-mesh bandpass THz filters often exhibit undesired transmission at their block-band frequencies. By solving an inverse matrix problem with regularization, we overcome this limitation and correctly characterize THz radiation from 1 to 30 THz.

JW3A.53

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

JW3A.54

Frustrated Tunnel Ionization with Few-cycle Pulses, Rohan Glover², Dashavir Chetty², Bruno A. deHarak^{2,1}, Adam J. Palmer², Milad A. Dakka³, John L. Holdsworth⁴, Igor Litvinyuk², Andre N. Luiten³, Philip S. Light³, Robert T. Sang²; ¹*Physics Dept., Illinois Wesleyan Univ., USA*; ²*Centre for Quantum Dynamics, Griffith Univ., Australia*; ³*Inst. for Photonics and Advanced Sensing and School of Physical Sciences, The Univ. of Adelaide, Australia*; ⁴*School of Mathematical and Physical Sciences, Univ. of Newcastle, Australia*. We experimentally investigate frustrated tunnel ionization with few-cycle pulses. Our results indicate that frustrated tunnel ionization is more prevalent with few-cycle pulses and shows qualitative agreement with modelling.

JW3A.55

Non-Destructive Heterodyne Measurement of Number of Atoms in Cesium-Potassium Mixture, Jakub Dobosz¹; ¹*Univ. of Warsaw, Poland*. We present a setup of a heterodyne interferometer for measuring phase shift of light passing through atomic cloud mixture of cesium and potassium, to derive the number of atoms in the cloud with atom losses.

JW3A.56

Influence of an acoustic wave on particle trapped in optical tweezers in the air, Gabriela Mach¹, Lukasz Golacki², Jan Masajada¹; ¹*Optics and Photonics, Wroclaw Univ. of Science and Technology, Poland*; ²*Experimental Physics, Wroclaw Univ. of Science and Technology, Poland*. The phenomena of optical tweezers which causes the trapping is called photophoresis, which occurs to uniform distribution of temperature over the particle surface irradiated by a laser beam.

JW3A.57

Radiative interaction with arbitrary material bodies, Yu-Lin Xu¹; ¹*Univ. of Texas at El Paso/JETS, USA*. This work introduces an effective way to study radiative responses of bulk materials, in which a material body is regarded as an array of microscopic particles. Practical examples include the comparison between theory and experiment.

JW3A.58

Withdrawn

JW3A.59

Towards Sub-shot-noise Imaging using Squeezed Light from Four-Wave Mixing in Rubidium, Rory W. Speirs¹, Nicholas Brewer¹, Meng-Chang Wu^{1,2}, Paul Lett^{1,3}; ¹*Joint Quantum Inst., Univ. of Maryland, USA*; ²*Inst. for Physical Science and Technology, Univ. of Maryland, USA*; ³*National Inst. of Standards and Technology, USA*. We present progress towards the generation of sub-shot-noise images using two-mode intensity difference squeezed light beams produced by four wave mixing in rubidium vapour.

JW3A.60

Quantum Frequency Conversion of Ba⁺ Photons, John M. Hannegan^{1,2}, James Sivers^{2,1}, Qudsia Quraishi^{3,2}; ¹*Physics, Univ. of Maryland, College Park, USA*; ²*Joint Quantum Inst., USA*; ³*Army Research Lab, USA*. Hybrid quantum networks consisting of disparate memories require identical photons for entanglement distribution. Using frequency conversion of either single photons from Ba⁺ or resonant laser light, we generate 780 nm and 1260 nm light respectively.

JW3A.61

Photon-Phonon Pair Correlations in Sapphire, Kai B. Shinbrough¹, Bin Fang¹, Yanting Teng¹, Offir Cohen¹, Virginia O. Lorenz¹; ¹*Univ. of Illinois Urbana-Champaign, USA*. We measure the quantum-state purity of Stokes photons from sapphire, achieving a purity of 1.00±0.03 and quantitative agreement with a new theoretical model of photon-phonon correlations that includes dispersion and finite excitation lifetime.

JW3A.62

Withdrawn

JW3A.63 **RAPID**

Engineering a Noiseless and Broadband Raman Quantum Memory for Temporal Mode Manipulation, Thomas M. Hird^{1,2}, Sarah Thomas^{1,4}, Joseph Munns^{1,4}, Oscar Lazo Arjona¹, Shaobo Gao¹, Joshua Nunn³, Benjamin Brecht¹, Dylan Saunders¹, Patrick Ledingham¹, Ian A. Walmsley¹; ¹*Univ. of Oxford, UK*; ²*Dept. of Physics and Astronomy, Univ. College London, UK*; ³*Dept. of Physics, Univ. of Bath, UK*; ⁴*Blackett Lab, Imperial College London, UK*. The Raman quantum memory can manipulate temporal modes of light - a promising high-dimensional basis for quantum information processing. We demonstrate both temporal mode manipulation and a novel suppression scheme for four-wave mixing noise.

JW3A.64 **RAPID**

Twin-beam Intensity-difference Squeezing below 10 Hz from Dual-seeded Four-wave Mixing, Meng-Chang Wu¹, Bonnie Schmittberger¹, Nicholas Brewer¹, Rory W. Speirs¹, Paul Lett¹; ¹*Univ. of Maryland, College Park, USA*. We have obtained bright-beam intensity-difference squeezing below 10 Hz via four-wave mixing in a rubidium vapor. This was accomplished by increasing phase matching angle and using two seed beams to balance the power.

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JW3A.65 **RAPID**

Active Light Emission Control via Tunable Hybrid Epsilon-Near-Zero and Surface-Plasmon-Polariton Mode, Aleksei Anopchenko¹, Long Tao¹, Norbert Danz², Girish Agarwal^{3,4}, Howard Lee^{1,3}; ¹Baylor Univ., USA; ²Fraunhofer Inst. for Applied Optics and Precision Engineering IOF, Germany; ³Inst. for Quantum Science and Engineering, Texas A&M Univ., USA; ⁴Biological and Agricultural Engineering, Texas A&M Univ., USA. Field-effect tuning of strongly coupled epsilon-near-zero and surface-plasmon-polariton modes in ITO/oxide/Au heterostructure is shown. The tuning enables active control of emissive properties of quantum emitters coupled to the hybrid polariton mode.

JW3A.66 **RAPID**

Mutually unbiased bases for time-bin qudits, Joseph M. Lukens¹, Nurul T. Islam², Charles C. Lim³, Daniel J. Gauthier⁴; ¹Oak Ridge National Lab, USA; ²The Ohio State Univ., USA; ³National Univ. of Singapore, Singapore. We introduce a method for generation and detection of mutually unbiased bases for time-bin qudits employing electro-optic phase modulator -- coded fiber Bragg grating pairs. Our approach uses one spatial mode and can switch rapidly between bases.

JW3A.67

Towards Room-Temperature Single-Photon LEDs by FRET from Metal Nanoparticles to Exfoliated 2D Crystal Overlayers, Robin Puchert¹, Florian Steiner¹, Gerd Plechinger¹, Felix Hofmann¹, Philipp Nagler¹, Alexey Chernikov¹, Christian Schüller¹, Tobias Korn¹, Jan Vogelsang¹, Sebastian Bange¹, John Lupton²; ¹Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Germany. Localized surface-plasmon resonances enable efficient coupling to proximal resonant dipole transitions. By exploiting energy transfer from metal nanoparticles to monolayers of 2D crystals we point a way to generate single photons at room temperature.

JW3A.68

Two-mode intensity squeezing using OAM-carrying pump and probe beams, Nikunj Prajapati¹, Nathan Super¹, Irina Novikova¹; ¹Physics, College of William & Mary, USA. We investigate the transfer of optical angular momentum (OAM) and two-mode intensity squeezing in the four-wave-mixing process. We could control the OAM of the generated Stokes field in a wide range maintaining similar squeezing levels.

JW3A.69

What are the physical processes behind the evolution of spatial coherence out of incoherent light and particle beams? Chandra Roychoudhuri¹; ¹Univ. of Connecticut, USA. This paper raises the fundamental questions to explore the possible physical models behind the evolution of spatial coherence during the propagation of an incoherent EM wave beam or a particle beam.

JW3A.70

Room-Temperature Photon-Number-Resolved Detection Using A Two-Mode Squeezer, Elisha Siddiqui¹, Deepti Deepti Vaidyanathan², Kenji W. Arai³, Ryan T. Glasser³, Hwang Lee¹, Jonathan P. Dowling¹; ¹Physics and Astronomy, Louisiana State Univ., USA; ²Baton Rouge Magnet High School, USA; ³Dept. of Physics and Engineering Physics, Tulane Univ., New Orleans, LA 70118, USA; ⁴Reed College, USA. Intensity-intensity correlations signal ($\langle C \rangle$) at the output of a two-mode squeezing device with N-photon state and coherent light as inputs is studied. Photon-number is resolved from the jumps in $\langle C \rangle$ vs. N.

JW3A.71

Bowtie Plasmonic Nanoantennas with Nanocrystals: Photon Antibunching, Polarization Selectivity and Tunability, Svetlana G. Lukishova¹, Jeremy Staffa¹, Huiqing Zhu¹, Kevin Kuyk¹, Andreas Liapis³, Robert Boyd^{1,2}; ¹Univ. of Rochester, USA; ²Univ. of Ottawa, Canada; ³Harvard Medical School, USA. Photon antibunching was observed from NV-nanodiamonds and nanocrystal quantum dots within bowtie plasmonic nanoantennas. We also showed polarization selectivity of these nanoantennas. Numerical modeling was carried out for air and liquid crystals.

JW3A.72

Quantum State Engineering Using One-dimensional Discrete-time Quantum Walks, Luca Innocenti¹, Helena Majury¹, Taira Giordani², Nicolò Spagnolo², Fabio Sciarrino^{2,3}, Mauro Paternostro^{1,4}, Alessandro Ferraro¹; ¹Centre for Theoretical Atomic, Molecular, and Optical, School of Mathematics and Physics, Queen's Univ. Belfast, UK; ²Dipartimento di Fisica, Sapienza Università di Roma, Italy; ³Consiglio Nazionale delle Ricerche, Istituto dei sistemi Complessi (CNR-ISC), Italy; ⁴Laboratoire Kastler Brossel, ENS-PSL Research Univ., France. The capability of generating arbitrary quantum states is a fundamental task in many quantum information areas. Here we propose a scheme for quantum state engineering that exploits discrete-time quantum walk in the angular momentum of single-photons.

JW3A.73

Fluctuations Statistics in an Erbium Random Fiber Laser, Bismarck C. Lima¹, Pablo I. Pincheira¹, André L. Moura², Anderson S. Gomes¹, Leonardo d. Menezes¹, Ernesto P. Raposo³, Cid B. Araújo¹, Raman Kashyap⁴; ¹Departamento de Física, Universidade Federal de Pernambuco, Brazil; ²Grupo de Física da Matéria Condensada, NCEX, Campus Arapiraca, Universidade Federal de Alagoas, Brazil; ³Laboratório de Física Teórica e Computacional, Departamento de Física, Universidade Federal de Pernambuco, Brazil; ⁴Fabulas Lab, Dept. of Engineering Physics, Dept. of Electrical Engineering, Polytechnique Montreal, Canada. The mixed statistical regime of a Random Fiber Laser is experimentally and theoretically studied within the framework of the generalized extreme value and alpha stable distribution statistics.

JW3A.74

High Dimensional Quantum Key Distribution Based on Coherence Modulation and Orbital Angular Momentum, Paula A. López Higuera^{2,3}, Yezid Torres Moreno², William T. Rhodes¹; ¹Dept. of Computer & Electrical Engineering and Computer Science, Florida Atlantic Univ., USA; ²Grupo de Óptica y Tratamiento de Señales GOTS, Escuela de Física, Universidad Industrial de Santander, Colombia; ³Escuela de Ingenierías Eléctrica, Electrónica y de Telecomunicaciones, Universidad Industrial de Santander, Colombia. A QKD scheme based on coherence modulation of OAM beams, with an orthonormal basis of delays τ_n and charge l is proposed. The mutually unbiased set uses linear combination of wave trains of OAM beams.

JW3A.75

Radiation-reaction electromagnetic fields in metasurfaces, Michele Merano¹; ¹Università degli Studi di Padova, Italy. I derive the optical response of a metasurface starting from the microscopic description. Surprisingly the advanced potential solutions of the inhomogeneous Maxwell's equations are necessary to compute the macroscopic fields.

JW3A.76

Slow Light Generation in Decagonal Liquid Core Photonic Crystal Fiber, Rahul Kumar¹, Pooja Chauhan¹, Ajeet Kumar¹; ¹Delhi Technological Univ., India. Liquid Core PCF has been designed using carbon-disulphide as core and silica as cladding. Confinement loss has been plotted and a time delay of 166.70ns is calculated for maximum power of 102 mW at 1.55µm.

JW3A.77

100-Gb/s Doubly Differential QPSK System with Improved Receiver Sensitivity Using Polarization Switching, Tingting Zhang¹, Christian Sanchez², Andrew Ellis¹; ¹Aston Univ., UK. 0.7-dB receiver sensitivity improvement at 7% HD-FEC threshold is numerically demonstrated using polarization switching in 100-Gb/s doubly differential QPSK 80-km SSMF transmission system with simplified receiver-side DSP.

JW3A.78

Spectra of Raman scattering in Few Mode Fibers, Zhenzhen Zhang¹, Cheng Guo¹, Liang Cui¹, Ming Xu¹, Ylchi Zhang², Xiaoying Li¹; ¹Tianjin Univ., China; ²Fiberhome Telecommunication Technologies Co Ltd, China. We measure Raman scattering (RS) in polarization maintained few mode fiber (FMF) and common FMF, respectively, and show vector mode coupling of the degenerate modes affect the dependence of RS on polarization and spatial mode.

JW3A.79

Entanglement Concentration Service for the Quantum Internet, Laszlo Gyongyosi^{2,1}, Sandor Imre¹; ¹Budapest Univ. of Technology & Economic, Hungary; ²Univ. of Southampton, UK. A fundamental concept of the quantum Internet is quantum entanglement. The aim of our entanglement concentration service is to provide reliable, high-quality entanglement for a dedicated set of quantum nodes in the quantum Internet.

JW3A.80

Unequally Spaced Channel Allocation Algorithm in Hybrid DWDM System for Reduction of FWM, Yugnanda Malhotra¹, Ashutosh Singhal¹, Nisha Nisha¹; ¹Electronics and Communication Engineering, Bharati Vidyapeeth College of Engineering, India. We propose an Unequally Spaced Channel Allocation Algorithm in a 0.2nm, mixed bit rates, DWDM system, for FWM reduction. Overall performance in terms of covered optical bandwidth, reduced FWM products and received output power is reported.

JW3A.81

Femtosecond Pulse Propagation through Large Mode Area Tapered Fiber at 1.06 µm Wavelength, Mohd Rehan¹, Gyanendra Kumar¹, Vipul Rastogi¹, Rajesh Kumar¹; ¹IIT ROORKEE, India. We demonstrate femtosecond pulse propagation through large mode area tapered fiber at 1.06 µm wavelength. We obtain compression, soliton like propagation and dispersion of ultra-short pulses which can be utilized in medical applications.

JW3A.82

Flatness Optimization of Optical Frequency Combs Using an Adapted Differential Evolution Algorithm, Guilherme F. Pendiuk¹, Paulo D. Neves¹, Alexandre D. Pohl¹; ¹CPGEL, Universidade Tecnológica Federal do Paraná, Brazil. A Differential Evolution based algorithm is used to identify input driving parameters of a Dual-Parallel Mach-Zehnder Modulator to generate flat Optical Frequency Combs. Combs with 7 lines showing flatness of 0.03 dB can be obtained.

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JW3A.83 **RAPID**

Properties of the Effective Noise for the Nonlinear Fourier Transform-Based Transmission, Maryna Pankratova¹, Anastasiia Vasylychenkova¹, Jaroslav E. Prilepsky¹, Stanislav Derevyanko², ¹Aston Univ., UK; ²Dept. of Electrical and Computer Engineering, Ben-Gurion Univ. of the Negev, Israel. We investigate the correlation properties of optical noise in nonlinear Fourier domain for communication systems using the nonlinear Fourier transform. Effective covariance functions are obtained numerically and compared with theoretical predictions.

JW3A.84

Analysis of the evolution of the polarization states of a pumping source on an Erbium doped fiber, Karla E. Contreras-Vallejo¹, Julian Moises Estudillo Ayala¹, Roberto Rojas-Laguna¹, Daniel Jauregui-Vazquez¹, Juan C. Hernandez-García¹, Juan M. Sierra-Hernandez¹, Jose D. Filoteo-Razo¹, Manuel Toledano-Ayala², Ramon Martinez-Angulo¹; ¹Universidad de Guanajuato, Mexico; ²División de Investigación y Posgrado, Facultad de Ingeniería, Universidad Autónoma de Querétaro, Mexico. An analysis of the effects of the evolution of the polarization states on an Erbium doped fiber is presented; this it to optimize the development tunable fiber laser systems.

JW3A.85

Experimental Implementation of High-speed Balanced Homodyne Detector, Xiaoxiong Zhang¹, Yichen Zhang¹, Bingjie Xu², Song Yu¹, Hong Guo²; ¹Beijing Univ. of Posts and Telecommunications, China; ²Inst. of Southwestern Communication, China; ³Peking Univ., China. We present a high-speed balanced homodyne detector whose bandwidth is above 900 MHz and quantum to classical noise ratio reaches 12 dB respectively, which could be applied to the high-speed continuous variable quantum information.

JW3A.86

Simplified PAM4 optical signals combined with spatially multiplexed communication systems, Syed H. Mursheed¹, Han Wang¹, Gregory Lovell¹, Abhijit Charavarty¹, Ce Su¹, Bilas Chowdhury¹; ¹Florida Inst. of Technology, USA. Experimental eye diagram of a four-level simplified pulse amplitude modulation scheme is presented along with simulated results. The output is then used with two channel SDM system to generate PAM16 efficiency per fiber.

JW3A.87

The All Optical Magnetic Recording Head with Near-Infrared Enhancement, Zhihao Zeng¹, Haiwei Wang¹, Sicong Wang², Hongyun Li¹, Yuhao Zou¹, Lanlan Huang¹, Yao Xiao¹, Changsheng Xie¹; ¹Huazhong Univ of Science and Technology, China; ²Jinan Univ., China. We present a fabricated nanograting structured magnetic write head featuring near-infrared optical enhancement and low angle sensitivity, suitable for ultrafast magnetic switching, ultrahigh-density magnetic recording.

JW3A.88

Acoustical Response Characteristics of an Optomechanical Accelerometer, Ramgopal Madugani¹, Feng Zhou¹, Randall P. Wagner¹, Yiliang Bao¹, Jason J. Gorman¹, Thomas W. LeBrun¹; ¹National Inst. of Standards and Technology, USA. A Fabry-Perot microcavity-based accelerometer was tested in an anechoic chamber to measure the limiting noise for the device operating in air at room temperature. The acoustic response illustrates the design requirement for an optical microphone.

JW3A.89

Single Photon Optical Memory With Cavityless Levitated Optomechanics, Pardeep Kumar¹, Mishkat Bhattacharya¹; ¹Rochester Inst. of Technology, USA. We investigate a protocol to upload, store and retrieve a single photon quantum state from a mechanical mode in cavityless levitated optomechanics. A high fidelity in our results indicates efficient photon-phonon-photon transfer.

JW3A.90

The Super absorbing Ag-Au Metasurfaces for Surface-Enhanced Raman Spectroscopy Sensing of Drugs and Chemicals, Lyu Zhou¹, Nan Zhang¹, Dengxin Ji¹, Haomin Song¹, Youhai Liu¹, Qiaoqiang Gan¹; ¹State Univ. of New York at Buffalo, USA. We proposed a super absorbing metasurfaces with hybrid Ag-Au nanostructures, which enables efficient light trapping and result in enhanced SERS sensing performance.

JW3A.91

Fluorescence Enhancement and Quenching in Tip-Enhanced Fluorescence Spectroscopy, Justin Isaac¹, Huizhong Xu¹; ¹San Francisco State Univ., USA. Fluorescence enhancement and quenching is studied for a fluorophore near a metal tip above a glass substrate. Resonant behavior is observed as a function of tip-substrate distance and displays a strong dependence on tip dimensions.

JW3A.92

Linear Localization of Non-Hermitian Photonic Zero Modes, Bingkun Qi^{1,2}, Li Ge^{1,2}; ¹College of Staten Island, CUNY, USA; ²Graduate Center, CUNY, USA. A non-Hermitian photonic zero mode can exhibit an unusual behavior at the transition between extended and localized regimes: it displays a linearly decreasing amplitude spatially in a weakly coupled non-Hermitian reservoir.

JW3A.93

High-speed pulse control and optimization of quantum cascade laser using all-optical modulation, Chen Peng¹, Haijun Zhou², Tao Chen¹, Biao Wei², Zeren Li¹; ¹Inst. of Fluid Physics, China Academ, China; ²Chongqing Univ., China. Pulse control and optimization are demonstrated in a middle-infrared quantum cascade laser via an all optical approach. It has the potential for application in free space optical communication and high speed frequency modulation spectroscopy.

JW3A.94

Octave-spanning Supercontinuum Generation in Nanoscale Lithium Niobate Waveguides, Juanjuan Lu¹, Yuntao Xu¹, Joshua Surya¹, Hong Tang¹; ¹Yale Univ., USA. We demonstrate an octave-spanning supercontinuum (SC) generation in nanoscale lithium niobate (LN) waveguides with anomalous dispersion by a turn-key pulsed laser at 1560nm, which enables a simple and integrable SC source in LN nanophotonic platform.

JW3A.95

Dynamic Plasmonic Pixels, Nicholas J. Greybush¹, Kristin M. Charipar², Nicholas Charipar², Jeffrey A. Geldmeier², Jawad Naciri², Jake Fontana²; ¹National Research Council (NRC) Postdoctoral Research Associate, U.S. Naval Research Lab, USA; ²U.S. Naval Research Lab, USA; ³American Society for Engineering Education (ASEE) Postdoctoral Fellow, U.S. Naval Research Lab, USA. We demonstrate spectral, spatial, and temporal control of plasmonically generated color through alignment of Au nanorods by an applied electric field. Tailoring the nanorod aspect ratio enables operation across the visible and near-infrared spectrum.

JW3A.96

VO₂/ITO Hybrid Plasmonic High Performance Electro-Optical Modulator, Aya Amer¹, Mohamed Badr¹, Mohamed M. Swillam¹; ¹American Univ. in Cairo, Egypt. A hybrid plasmonic slot waveguide electro-optical modulator using VO₂ and ITO is proposed. An extinction ratio (ER) of 6.36 dB and an insertion loss (IL) of 1.13 dB are achieved at 1.55 μm wavelength.

JW3A.97

Graphene-based Slot Waveguide Photodetectors for Optical Communications, Kazuya Kikunaga^{1,2}, Zhizhen Ma¹, Rishi Maiti¹, Volker J. Sorger¹; ¹George Washington Univ., USA; ²National Inst. of Advanced Industrial Science and Technology, Japan. Here we report on a novel graphene-based plasmonic slot waveguide photodetector. The ultra-narrow 15 nm slot waveguide enables short carrier transitions times resulting in a gain-bandwidth product 5.3x10¹⁵ at I = 1.5 μm.

JW3A.98

Investigation of Si₃N₄ Microring Resonator for Bio-Chemical Sensing Applications, Subrata Das¹, Sarah C. Samudrala¹, Kyu Lee¹, Brett R. Wenner³, Jeffrey W. Allen², Monica S. Allen², Robert Magnusson¹, Michael Vasylev¹; ¹Univ. of Texas at Arlington, USA; ²Air Force Research Lab Munitions Directorate, USA; ³Air Force Research Lab Sensors Directorate, USA. We design and fabricate Si₃N₄ microring resonator for measuring refractive index change in aqueous environment. The experimentally observed sensitivity >72 nm/RIU indicates its suitability for biochemical sensing applications.

JW3A.99

Equilibrium Temperature of Wideband Perfect Light Absorbers Under Direct Solar Illumination, Jinnan Chen¹, Junpeng Guo¹; ¹Univ. of Alabama in Huntsville, USA. A new method is introduced to calculate equilibrium temperature by using dipole antenna model. It is found that the single dielectric layer absorbing structure gives the highest equilibrium temperature of 979 K.

JW3A.100

Optical Coupling in Dielectric Resonator Nanoantenna, Gilliard N. Malheiros-Silveira², Hugo E. Hernandez-Figueroa¹; ¹Univ. of Campinas, Brazil; ²São Paulo State Univ. (Unesp), Brazil. A theoretical study regarding to coupling efficiency between a dielectric resonator nanoantenna (DRNA) integrated to a metal-dielectric-metal-dielectric nanostrip waveguide (NW), and free space is evaluated.

JW3A.101

Plasmonic Blazing of a Wire-Grid Polarizer: How It Improves the Polarimetric Performance, Changhun Lee¹, Eunji Sim², Donghyun Kim¹; ¹Electrical and Electronic Engineering, Yonsei Univ., South Korea; ²Chemistry, Yonsei Univ., South Korea. We investigate the polarimetric performance of surface plasmon-enhanced blazed wire-grid polarizer (WGP) compared with conventional WGP. Highest extinction ratio was found to be 15,740 at 800 nm period which allows easier fabrication of WGP.

JW3A.102

Topology of High-k States in Quartic Metamaterials, Maxim Durach¹, Thomas Mulkey¹, Jimmy Dillies¹; ¹Georgia Southern Univ., USA. We study the short-wavelength waves in quartic metamaterials. The quartic k-surfaces feature from 0 to 4 cones, longitudinal polarization and perpendicular to k-vectors group velocities, which leads to negative refraction in quartic metamaterials.

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JW3A.103

Damage Detection in Bridge-Weigh-In-Motion Structures using Fiber Bragg Grating Sensors, Sravanthi Alamandala¹, Saiprasad R L N¹, Rathish Kumar P², Ravi Kumar M¹; ¹Dept. of Physics, National Inst. of Technology Warangal, India; ²Dept. of Civil Engineering, National Inst. of Technology, India. Fiber Bragg Grating (FBG) based Weigh-In-Motion system is proposed for the study of the health condition of structures. Artificial damage is created in the system, and the results were compared with those of undamaged.

JW3A.104

A 3D Nanostructure based SPR Sensor for Enhancement of Sensing Ability, Heesang Ahn¹, Hyerin Song¹, Kyujung kim¹, Taeyeon Kim¹, Yeji Lee¹; ¹Pusan National Univ., South Korea. We investigated localized surface plasmon resonance sensors based on 3D nanostructures array patterns. The enhancement of the near-field distribution on the 3D nanostructure is confirmed with calculation and experimental results.

JW3A.105

The Method and Mechanism of Tuning LSPR on The Biased Metallic Nanosphere, Lihui Gong¹, Xianyang Lyu¹; ¹Research Lab, School of Transportation, Nantong Univ., China. We propose a method for creating tunable localized surface plasmon resonance (LSPR) by applying a variable bias to metallic nanospheres. This method base on a different extinction equation and has been supported by experiments.

JW3A.106

Hybrid Vanadium Dioxide Plasmonic Electro-Optical Modulator based on Race-Track shaped Resonator, Mohamed Abdelatty^{1,2}, Mahmoud M. Elgarf¹, Mohamed M. Swillam¹; ¹Physics, American Univ. in Cairo, Egypt; ²Engineering / Basic sciences, The British Univ. in Egypt, Egypt. An optical modulator based race-track shaped resonator utilizing the phase change properties of Vanadium dioxide. An extinction ratio of 8.45 dB and an insertion loss of 1.85 dB is achieved at the telecommunications wavelength (1.55 μm).

JW3A.107

Radius Optimization of SOI based Rectangular Waveguide Ring Resonator Filter, Ritu Raj Singh¹, Soumya Kumari¹, Abhinav Gautam¹, Vishnu Priye¹; ¹Indian Institute of Technology, Dhanbad, India. The SOI ring resonator as a notch filter is analyzed by varying ring radius and performance parameters such as FSR, FWHM, finesse and Q-factor has been optimized for 220nm silicon height technology at C-band wavelengths.

JW3A.108

Scalable SERS by Activating "Passive" Hotspots in Multigap Nanoplasmonic Systems, Junyeob Song¹, Wonil Nam¹, Wei Zhou¹; ¹Electrical Engineering, Virginia Tech, USA. A partial removal of dielectric materials in nanogaps can activate "passive" hotspots in multigap nanoplasmonic systems for scalable high-performance Surface Enhanced Raman Spectroscopy (SERS) applications.

JW3A.109 **RAPID**

Boosting Local Field Enhancement by Synergistic Nanoantenna-Microcavity Coupling, Qinglan Huang¹, Jui-Nung Liu¹, Keng-Ku Liu², Srikanth Singamaneni², Brian Cunningham¹; ¹Dept. of Electrical and Computer Engineering, Dept. of Biengineering, Univ. of Illinois at Urbana-Champaign, USA; ²Dept. of Mechanical Engineering and Materials Science, Inst. of Materials Science and Engineering, Washington Univ. in St. Louis, USA. We theoretically and experimentally studied a photonic-plasmonic hybrid system integrating the dielectric photonic crystal slab (as a photonic microcavity) and gold nanorod (as a plasmonic nanoantenna) for highly cooperative near-field enhancement.

JW3A.110 **RAPID**

Calibration and imaging in acoustophoresis platforms by Digital Holography, Teresa Cacace^{1,2}, Pasquale Memmolo¹, Vittorio Bianco¹, Melania Paturzo¹, Massimo Vassalli³, Pietro Ferraro¹; ¹CNR-ISASI, Italy; ²Univ. of Campania "L. Vanvitelli", Italy; ³Istituto di Biofisica-CNR, Italy. We demonstrate that ultrasound field calibration and imaging are achievable in a vertical resonator using digital holography, showing that it is a flexible tool to assist the diffusion of acoustophoresis microfluidic devices.

JW3A.111

Imaging of cochlear cells through scattering bone, Marilisa Romito¹, Konstantina M. Stankovic², Demetri Psaltis¹; ¹Optics, Ecole Polytechnique Federale de Lausanne, Switzerland; ²Otolaryngology, Harvard Medical School, USA. Intracochlear imaging will be important for the assessment of hearing disorders. Currently, cochlear small size and encasement in bone prevent visualization of intracochlear microanatomy. We report a technique for imaging cochlear cells through bone.

JW3A.112

Imaging-Aided Temperature Measurements with a Single Optical Fiber for In-vivo Sensing Applications, Erik P. Schartner¹, Jiawen Li¹, Stefan Musolino¹, Bryden Quirk¹, Rodney Kirk¹, Robert McLaughlin¹, Heike Eberndorff-Heidpriem¹; ¹Univ. of Adelaide, Australia. We present a combined imaging and physical sensing probe based on optical coherence tomography and up-conversion fluorescence respectively, integrated into a single optical fiber enabling precise locating of the probe for in-vivo sensing applications.

JW3A.113

Combination digital breast tomosynthesis and diffuse optical tomography, Duchang Heo¹, Kee-Hyun Kim¹, Young-Min Bae¹, Young-Wook Choi¹, Sohail Sabir², Seungryong Cho², Hak Hee Kim²; ¹Korea Electrotechnology Research Inst., South Korea; ²Korea Advanced Inst. of Science and Technology, South Korea; ³Asan Medical Center, South Korea. We report a frequency domain DOT system with high-speed data acquisition to improve the diagnostic accuracy of DBT. We test the basic performance of the DOT system with optical phantom and can obtain DBT/DOT images using blood vessel mimic phantom.

JW3A.114

Withdrawn

JW3A.115

Large-scale Volumetric Imaging of Insects with Natural Color, Ming Lei¹; ¹Xi'an Inst. of Optics and Precision Mech, China. We present a structured illumination-based approach to get large-scale 3D images with full natural color, and high spatiotemporal resolution. With this approach, full-color volumetric images and morphological data of insect samples can be obtained.

JW3A.116

Tomographic phase microscopy for label-free imaging in biomedicine, Pietro Ferraro¹, Francesco Merola¹, Pasquale Memmolo¹, Lisa Miccio¹, Martina Mugnano¹, Massimiliano Villone², Pier Luca Maffettone²; ¹ISASI-CNR, Italy; ²DICMAPI, Federico II Univ., Italy. Full-tomography in phase contrast modality of both sick and healthy cells flowing in microchannels is demonstrated. The proposed method can open the way for real-world biomedical diagnosis by quantitative coherent imaging. Results on Red Blood Cells (RBC), diatoms and tumor cells are reported.

JW3A.117

Characterization and In Vivo Application of Mobile Phones for Near-Infrared Fluorescence Imaging of Tumors, Nitin Suresh¹, Qinggong Tang¹, Yi Liu¹, Joshua Pfefer², Yu Chen¹; ¹Fischell Dept. of Bioengineering, Univ. of Maryland - College Park, USA; ²Center for Devices and Radiological Health, U.S. Food and Drug Administration, USA. To elucidate the performance of near-infrared fluorescence imagers for cancer detection and localization, we performed imaging of phantoms and a rodent tumor model. Results provide insights into differences between mobile phone and CCD-based systems.

JW3A.118

Biomimetic Microvascular Tissue Phantoms Fabricated with Two-Photon 3D Printing, Hannah Horng¹, Yi Liu¹, Nitin Suresh¹, Pejman Ghassemi², Joshua Pfefer², Yu Chen¹; ¹Fischell Dept. of Bioengineering, Univ. of Maryland at College Park, USA; ²Center for Devices and Radiological Health, Food and Drug Administration, USA. Phantoms that simulate tissue microvasculature may provide tools to facilitate development and assessment of biophotonic devices. We evaluate the use of two-photon polymerization-based 3D printing to fabricate phantoms with biomimetic micro-channels.

JW3A.119

Flexible and Highly Effective Trapping Particles of Optical Tweezers in Nonlinear Optical Imaging, Qin Wu¹, Hang S. Chang¹, Feng X. Huang¹; ¹School of Science, Hangzhou Dianzi Univ., China. We demonstrate flexible and highly-effective single beam trapping particles by optical tweezers in nonlinear optical imaging system, achieve a diverse manipulation of the particles, increase the imaging depth and contrast of the particles.

JW3A.120

Withdrawn

JW3A.121

Improved Inverse Two-Layered Monte Carlo Fitting of In-vivo Skin Diffuse Reflectance Spectra, Chiao-Yi Wang¹, Ting-Xuan Lin¹, Kung-Bin Sung¹; ¹National Taiwan Univ., Taiwan. The objective of this study is to improve the inverse Monte Carlo fitting method to make the extraction of optical coefficients more reliable and precise. Some non-invasive in-vivo human skin measurements were done to validate the proposed approach.

JW3A.122

Time-resolved diffusion technique to probe protein-drug interaction, Masahide Terazima¹; ¹Kyoto Univ., Japan. A time-resolved diffusion method was applied to detections of the protein-protein interaction, protein-DNA interaction, and protein-small molecule. A number of examples show that this method is powerful to explore the protein-drug interaction.

JW3A.123

Photonic Neural Network Nonlinear Activation Functions by Electrooptic Absorption Modulators, Jonathan K. George¹, Armin Mehrabian¹, Rubab Amin¹, Tarek El-Ghazawi¹, Paul R. Prucnal², Volker J. Sorger¹; ¹George Washington Univ., USA; ²Dept. of Electrical Engineering, Princeton Univ., USA. We report on using the transfer function of electrooptic absorption modulators as nonlinear activation functions of photonic neurons and show 95% accuracy of MNIST classification inference on an AlexNet in optical artificial neural networks.

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JW3A.124

Achieving Invisibility in the Far Field with a 3D Carpet Cloak Design for Visible Light, Daniely G. Silva¹, Poliane A. Teixeira¹, Lucas H. Gabrielli², Mateus A. Junqueira¹, Danilo Spadoti¹; ¹Federal Univ. of Itajubá, Brazil; ²Univ. of Campinas, Brazil. This work presents new results for a 3D carpet cloak designed with transformation optics and quasi-conformal mapping. Simulations confirm the successful operation at optical frequencies for arbitrary propagation directions, and in far field region.

JW3A.125 **RAPID**

Differential Digital Holography of Distant Objects with the Use of Fiber Optics, Maciek Neneman¹, Michal Dolinski¹, Agnieszka Siemion¹, Michal Makowski¹; ¹Warsaw Univ. of Technology, Poland. A lensless setup capable of recording differential holograms over large distance is presented. Reference beam is propagated in optical fiber, allowing compact setup. Advantages of proposed solution allow detailed surface imaging in orbital devices.

JW3A.126

Optical simulation of curved 2D and 3D spaces, Jakub Belin¹, Dimitris Georgantzis Garcia¹, Gregory Chaplain², Tomas Tyc³, Christoph Englert¹, Johannes K. Courtial¹; ¹Univ. of Glasgow, UK; ²Dept. of Mathematics, Imperial college of London, UK; ³Dept. of Theoretical Physics and Astrophysics, Masaryk Univ., Czechia. A method for the optical simulation of curved spaces using so-called space-cancelling wedges is presented. We model, theoretically, devices for optical simulation of two- and three-dimensional curved manifolds.

JW3A.127

Improving the quality of ghost imaging system based on Wiener Filtering, Dongyue Yang¹, Junhui Li², Chen Chang¹, Guohua Wu¹, Bin Luo², Longfei Yin¹, Hong Guo³; ¹School of Electronic Engineering, Beijing Univ. of Posts and Telecommunications, China; ²State Key Lab of Advanced Optical Communication Systems and Networks, Beijing Univ. of Posts and Telecommunications, China; ³State Key Lab of Advanced Optical Communication Systems and Networks, Peking Univ., China. In ghost imaging with pseudo-thermal light, Wiener filter improves reconstructed image quality with the estimation of point spread function and a noise factor, which is well-fitted as proportional relation to noise amplitude in image.

JW3A.128

Optical System for Capturing 3D Images, Nikolai I. Petrov¹, Angela Storozheva¹, Maxim Khromov¹, Yuri Sokolov¹; ¹Scientific and Technological Center of Unique Instrumentation of Russian Academy of Sciences, Russia. An optical system for capturing 3D images and a method for capturing 3D images, in particular, for capturing 3D objects in real-time for video-conference and 3D image display using integral imaging technology are proposed.

JW3A.129

Polarization Imaging Through Highly turbid Water, Fei Liu^{1,2}, Pingli Han¹, Yi Wei¹, Guang Zhang², Dayu Li², Xiaopeng Shao¹; ¹Xidian Univ., China; ²Changchun Inst. of Optics, China. We present a polarization imaging method to image through highly turbid water based on the dependence of light scattering and the optical correlation theory. Experiments demonstrate its contribution to make "can't see" into "can see".

JW3A.130

High-energy 50-attosecond 'water window' X-ray driven by a high-energy infrared waveform synthesizer, Yuxi Fu¹, Hua Yuan², Pengfei Lan², Katsumi Midorikawa¹, Eiji J. Takahashi¹; ¹RIKEN, Japan; ²Huazhong Univ. of Science and Technology, China. Combining high-energy infrared laser, which are generated by a dual-chirped optical parametric amplification (DC-OPA) method, and an optical waveform synthesizer, strong 'water window' soft X-rays with 50-attosecond pulse duration can be obtained.

JW3A.131

Extraction of Laser Pulses from the Rejection Port of an All-PM Figure-eight Femtosecond Er-doped Fiber Laser, Jin-long Peng¹; ¹Industrial Technology Research Inst., Taiwan. An all-PM figure-eight femtosecond Er-fiber laser with a rejection port is demonstrated to deliver output power of 23 mW. This is the highest output power ever reported in all-PM Er-fiber lasers based on NOLM/NALM technique.

JW3A.132

Theoretical Analysis of High Efficiency Laser-diode-pumped Continuous-Wave Hemispherical Short Cavity Laser, Fumihiro Sugiki¹, Ryo Kobayashi¹, Tomoki Kanetake¹, Naoya Nakajima¹, Shunji Kataoka¹, Yuu Aoyagi², Kohei Tomizawa², Masashi Shibata², Shunya Maeda², Hiroki Yamakawa², Sakae Kawato^{3,4}; ¹Graduate School of Engineering, Univ. of Fukui, Japan; ²School of Engineering, Univ. of Fukui, Japan; ³Faculty of Engineering, Univ. of Fukui, Japan; ⁴Life Science innovation Center, Univ. of Fukui, Japan. We theoretically analyzed a optical-to-optical conversion efficiency of a CW hemispherical cavity Yb:YAG laser which pump source is a single-emitter-laser-diode. As a result, the maximum efficiency of 78.6% was obtained by high intensity pumping.

JW3A.133

PQ:DMNA/PMMA, a new material for recording volume Bragg grating for laser spectrum narrowing, Te-Yuan Chung¹, Yu-Hua Hsieh¹, Yu-Che Hsiao¹; ¹National Central Univ., Taiwan. PQ:DMNA/PMMA is a photopolymer sensitive to red light exposure. Volume Bragg gratings are successfully recorded in PQ:DMNA/PMMA and serve as external mirror of a 638 nm diode laser to achieve single longitudinal mode.

JW3A.134 **RAPID**

Radiation Balanced Ytterbium-doped Silica Double-Clad Fiber Amplifier, Esmail Mobini¹, Mostafa Peysokhan¹, Behnam Abaie¹, Arash Mafi¹; ¹Univ. of New Mexico, USA. Heat mitigation by radiative cooling is investigated in a fiber amplifier, where the amplifier temperature does not change substantially from the ambient, while amplifying 0.1 W of input signal power to 7.6 W.

JW3A.135

Effective Medium Model of Biochar - Iron Ore - Binder Powders Mixture for Enhanced Reduction of Iron, Leonid Butko¹, Anton Anzulevich¹, Igor Bychkov¹, Svetlana Anzulevich¹, Zhiwei Peng²; ¹Chelyabinsk State Univ., Russia; ²Central South Univ., China. A model of biochar-iron ore-binder powders mixture was studied at microwaves. The effective medium Bruggeman expression was expanded for three types of particles. Wave impedance dependency on concentration of iron ore was calculated.

JW3A.136

Power improvement in a CW THz polariton laser, Yameng Zheng¹, Andrew Lee¹, Helen Pask¹; ¹Macquarie Univ., Australia. An enhancement in the performance of an intracavity CW THz polariton laser is reported. THz output power of up to 23.1 μ W was detected at 1.66 THz, frequency tunability across 1.30 - 2.51 THz was achieved.

JW3A.137

Prepulse-Induced Three-Halves-Harmonic Generation as a Probe for Relativistic-Laser-Driven High-Density Plasmas, Alec R. Griffith¹, Matthew Edwards², Tim Bennett², Julia Mikhailova²; ¹Astrophysical Sciences, Princeton Univ., USA; ²Mechanical and Aerospace Engineering, Princeton Univ., USA. We examine three-halves-harmonic generation for femtosecond laser pulses under varying pulse intensity and contrast. Strong variation in the shape and relative magnitude of the three-halves harmonic is observed.

JW3A.138

A non-destructive method for measuring the absorption coefficient of a Yb-doped fiber, Mostafa Peysokhan¹, Esmail Mobini¹, Behnam Abaie¹, Arash Mafi¹; ¹Univ. of New Mexico, USA. A non-destructive method for measuring the absorption coefficient of the doped optical fiber is presented that is based on tuning the pump wavelength and measuring the spontaneous emission at two different locations along the fiber.

Science & Industry Showcase

13:00–14:00

Rapid Fire Oral Presentation IV, Science & Industry Theater

Presider: Wei Lee; National Chiao Tung University, Taiwan

Participating posters are noted in the list of poster for session JW4A with the icon RAPID. Each presenter will have 3 minutes and the order will be determined by poster number.

JOINT FiO + LS

13:00–15:00

JW4A • Poster Session IV and Dynamic E Posters

JW4A.1 E-Poster

THz Detection with Structured Plasmonic Channel, Kiana Montazeri¹, Pouya Dianat¹, Zhihuan Wang¹, Bahram Nabet¹; ¹Drexel Univ., USA. We are proposing a novel semiconductor based terahertz detector, using the plasma wave propagation in a structured 2DEG by electrically measuring the voltage across the channel in room temperature.

JW4A.2 E-Poster

All-Dielectric Polarization-Independent Metasurface Using Cross-Shaped Unit Cell, Mostafa Abdelsalam¹, Ahmed Mahmoud², Mohamed M. Swillam¹; ¹Dept. of Physics, American Univ. in Cairo, Egypt; ²Electronics and Communication Engineering Dept., The American Univ. in Cairo, Egypt. Metasurfaces depend on introducing a phase gradient across the interface. In this paper we show a novel polarization-independent all-dielectric metasurface, that is CMOS-compatible, showing beam steering capabilities with efficiency of 89%.

JW4A.3 E-Poster

Diagnosis of glioma brain cancer using visible resonance Raman spectroscopy, Yan Zhou², Binlin Wu¹, Cheng-hui Liu³, Xinguang Yu², Gangge Cheng², Kai Wang³, Chunyuan Zhang³, Lingyan Shi³, Robert Alfano³; ¹Southern Connecticut State Univ., USA; ²Air Force General Hospital, PLA, China; ³City College of New York, USA; ⁴Jilin Univ., China; ⁵Dept. of Chemistry, Columbia Univ., USA. Resonance Raman spectroscopy using 532nm excitation was used to distinguish normal brain tissue from different grades of glioma tissues. Principal component analysis was used to analyze the spectral data and achieved high accuracy.

JW4A.4 E-Poster

Non-Adiabatic Tapered Fibers for the Operation of a Switchable Multi-Wavelength Thulium-Doped Fiber Laser, Baldemar Ibarra-Escamilla¹, Marco V. Hernández-Arriaga¹, Manuel Durán-Sánchez², Hector Santiago-Hernández¹, Evgeny A. Kuzin¹; ¹INAOE, Mexico; ²INAOE, CONACYT, Mexico. A switchable multi-wavelength thulium-doped fiber laser based on non-adiabatic tapered fibers is experimentally demonstrated. The laser is switched from single to multi-wavelength by curving the tapers showing high stability output near 2 μ m region.

JW4A.5 E-Poster

Continuous Wave Laser Induced Damage Threshold of Ge₂₈Sb₁₂Se₆₀ at 1.07 microns, John E. McElhenny¹; ¹US Army Research Lab, USA. The continuous wave laser-induced damage threshold of chalcogenide glass, Ge₂₈Sb₁₂Se₆₀, is measured for a 5s exposure of 1.07 μ m light focused to a spot size with 1/e² diameter of 830 μ m, following the ISO standards.

JW4A.6 E-Poster

Engineering the Wavelength and Topological Charge of Non-diffracting Beams along their Axis of Propagation, Ahmed Dorrah¹, Michel Zamboni-Rached², Mo Mojahedi¹; ¹Dept. of Electrical and Computer Engineering, Univ. of Toronto, Canada; ²School of Electrical Engineering, Univ. of Campinas, Brazil. We report on class of non-diffracting beams where the wavelength and topological charge (orbital angular momentum) can be controlled along the beam's axis, thus addressing challenges in imaging, materials processing, and dense data communications.

JW4A.7 RAPID

Incoherent Propagation-Invariant Space-Time Light Sheets Produced from a Broadband Light Emitting Diode, Murat Yessenov¹, Hasan E. Kondakci¹, Monjurul F. Meem², Rajesh Menon², Ayman Abouraddy¹; ¹CREOL, Univ. of Central Florida, USA; ²Dept. of Electrical and Computer Engineering, Univ. of Utah, USA. We demonstrate the experimental synthesis of incoherent broadband diffraction-free space-time beams in the form of light sheets from an LED by introducing judicious spatio-temporal spectral correlations.

JW4A.8 RAPID

Experimental Ray Tracing – from simulation to reality, Tobias Binkle¹, David Hilbig¹, Ufuk Ceyhan², Gustavo Gutierrez³, Mahmoud Essameldin¹, Thomas Henning¹, Friedrich Fleischmann¹; ¹Univ. of Applied Sciences Bremen, Germany; ²BLF Optik Teknoloji Sanayi A.S., Turkey; ³Cofem S.A., Spain. Ray tracing is mostly known from simulation. However, Häusler et al. also proposed an experimental implementation of ray tracing. We have taken the proposal to real life and covered a lot of applications with it.

JW4A.9 RAPID

Improved Subaperture Stitching for the Measurement of Freeform Wavefront, kamal pant^{1,2}, Daliramu Burada¹, Amitava Ghosh², Gufran Khan¹, Chandra Shaker¹; ¹IDDC, IIT, India; ²IRDE, India. This paper presents an improved stitching technique for freeform metrology. The lateral misalignments are minimized using modified iterative closest point based registration. The method is applied to freeform measurement using Shack-Hartmann Sensor.

JW4A.10 RAPID

Extremely Compact and Broadband Polarization Beam Splitter Enabled by Customized Port Angles, Yannick D'Mello¹, Eslam El-Fiky¹, James Skoric¹, Yun Wang¹, Amar Kumar¹, David Patel¹, David V. Plant¹; ¹McGill Univ., Canada. We demonstrate a compact yet fabrication tolerant polarization beam splitter. Customized angles at each port facilitate a broadband response over 100 nm, including 3 dB insertion loss and 11.2 dB extinction ratio in the C-band.

JW4A.11 RAPID

A Tunable Low-pass Filter for Femtosecond Lasers Based on a Passive Cavity, Xiao Xiang¹, Feiyang Hou¹, Dongdong Jiao¹, Tao Liu¹, Shougang Zhang¹, Ruifang Dong¹; ¹National Time Service Center, CAS, China. We report a tunable optical low-pass filter for femtosecond lasers based on a passive cavity. The cutoff frequency can be tuned by stabilizing the cavity length to different secondary resonance peaks.

JW4A.12

Nonregular Three-Dimensional Polarization States, Jose J. Gil², Andreas Norrman³, Tero Setälä¹, Ari Tapio Friberg¹; ¹Univ. of Eastern Finland, Finland; ²Univ. of Zaragoza, Spain; ³Max Planck Inst. for the Science of Light, Germany. General three-dimensional (3D) states of polarization may be classified as regular and nonregular. We consider the concept of nonregularity and assess its characterization and consequences with applications to evanescent electromagnetic waves.

JW4A.13

Laser Temperature Sensor Based on a Core-offset Aluminum Coated Mach-Zehnder Interferometer, Javier A. Martin Vela¹, Eloisa Gallegos Arellano¹, Juan M. Sierra Hernandez¹, Daniel Jauregui Vazquez¹, Juan C. Hernandez-Garcia¹, Julian M. Estudillo-Ayala¹, Erika Silva Alvarado¹, Roberto Rojas-Laguna¹; ¹Education, Mexico. A laser temperature sensor based on a core-offset aluminum coated Mach-Zehnder interferometer is presented. The experimental results shown a temperature sensitivity of 28 pm/°C and a signal to noise ratio of 45 dB.

JW4A.14

A Simple and Robust Technique For Full Spatiotemporal Measurement of Ultrafast Laser Pulses, Daniel Adams¹, Henry C. Kapteyn¹, Seth L. Cousin²; ¹Physics, Univ. of Colorado, Boulder, USA; ²KMLabs, USA. We present a straightforward tool for routine evaluation of the spatiotemporal field of ultrafast pulses. We combine white light interferometry with reference-free wave-front-sensing and pulse-measurement in a single-scan to obtain 3D pulse profiles.

JW4A.15

Suppression of Back-Side Reflections with Broadband Elastomeric Light Trap, David Miller¹, Robert R. McLeod¹; ¹Univ. of Colorado at Boulder, USA. Using elastomeric material and a broadband absorber, we detail a method for broadband suppression of Fresnel reflections from the backside of transparent substrates. Applications include spectroscopic ellipsometry, holography, and lithography.

JW4A.16

LDLS Powered High Throughput Tunable Light Source, Xiaohua Ye¹, Alex Cutler¹, Qingsong Wang¹, Tseten Lungjangwa¹, Ron Collins¹, Matt Besen¹, Huiling Zhu¹; ¹Energetiq Inc., USA. High throughput tunable light sources (TLS) using an ultrahigh-brightness Laser-Driven Light Source (LDLS™) are developed for photonic applications. Measurement results of in-band fluxes and FWHM bandwidths, between 400nm and 1100nm, are presented.

JW4A.17

Tunable Stacks of Wedged Interferometers for Optical Communications and Spectroscopy, Marin Nenchev², Elena Stoykova¹, Margarita Deneva²; ¹Bulgarian Academy of Sciences, Bulgaria; ²Technical Univ. - Plovdiv Branch, Bulgaria. We propose a stack of two Fizeau interferometers for selection of a single continuously tunable within 10-50 nm resonance with a linewidth of 0.01 nm or less and utilization of such stacks for wavelength-division multiplexing.

JW4A.18

Anti-Reflecting Surfaces Using Two-layer Motheye Structures for Spinel Ceramic Windows, Chaoran Tu¹, Curtis Menyuk¹; ¹Univ. of Maryland Baltimore County, USA. We design and optimize a two-layer pyramid motheye structures for long wavelength MgAl₂O₄ spinel ceramic windows. We show that a two-layer pyramid motheye structure can achieve average transmission of 98.96% from 0.5 μ m to 5 μ m.

JW4A • Poster Session IV and Dynamic E Posters—Continued

JW4A.19

Photodarkening of kW-level Yb-doped Aluminosilicate ($\text{Al}_2\text{O}_3\text{-SiO}_2$) Fiber, Jiacheng Wu¹, Tianhong Qian¹, Kaijun Shu¹; ¹Anhui Univ. of Chinese Medicine, China. We reported on laser performance of a kW-level 20/400 Yb-doped aluminosilicate fiber. Laser running of 120 minutes at 1.2kW showed power degradation of 10.6% and slope efficiency degradation of 116%, directly justifying serious photodarkening effect.

JW4A.20

Camera and Inverse Camera System for Free-Space Optical Communications, Sajad Saghaye Polkoo^{1,2}, Christopher K. Renshaw^{1,2}; ¹Univ. of Central Florida, CREOL, USA; ²Physics, Univ. of Central Florida, USA. We introduce an imaging-based transceiver for FSO that enables precision beam steering over a wide field-of-regard using low-cost components with no moving parts. Passive beam steering provides dynamic beam-shaping and multiplexable communication.

JW4A.21

A Fabrication of Nanostructures with a Transmission Light and a Plasmonic Field at Different Z-axis Position, Taeyeon Kim¹, Heesang Ahn¹, Hyerin Song¹, Jong-ryul Choi², Kyujung Kim^{1,3}; ¹Dept. of Cogno-mechatronics Engineering, Pusan National Univ., South Korea; ²Medical Device Development Center, Dagu-Gyeongbuk Medical Innovation Foundation (DGMIF), South Korea; ³Dept. of Optics and Mechatronics Engineering, Pusan National Univ., South Korea. We fabricated two hole-array pattern masks and observed the differences between conventional photolithography and plasmonic lithography by controlling the gap distance between the mask and the photoresist.

JW4A.22

Non-scanning three-dimensional measurements using a chirped frequency comb interferometry with a multi-mode fiber bundle, Megumi Uchida^{1,2}, Takashi Kato^{1,2}, Yurina Tanaka^{1,2}, Kaoru Minoshima^{1,2}; ¹The Univ. of Electro-Communications (UEC), Japan; ²Japan Science and Technology Agency (JST), ERATO MINOSHIMA Intelligent Optical Synthesizer (IOS) Project, Japan. We developed a non-scanning three-dimensional measurement method using multi-mode fiber bundle. Based on ultrafast space-time-frequency conversion with the optical frequency comb, non-scanning 3D imaging with high power efficiency is demonstrated.

JW4A.23

Slit-Width Effects in a Double-Slit Experiment with a Partially-Coherent Source, Brett J. Pearson¹, Natalie Ferris¹, Ruthie Strauss¹, Hongyi Li¹, David P. Jackson¹; ¹Dickinson College, USA. We perform a Young's double-slit experiment using a partially-coherent light source. As compared to the standard theory, the data agree much more favorably with a calculation that fully accounts for the width of the slits.

JW4A.24

Fabrication of $\text{YAlO}_3\text{:Gd}^{3+}$ Thin Films for Nanoimaging, Mykyta Kolchiba¹, Wataru Inami², Yoshimasa Kawata²; ¹Graduate School of Science and Technology, Shizuoka Univ., Japan; ²Research Inst. of Electronics, Shizuoka Univ., Japan. We have fabricated $\text{YAlO}_3\text{:Gd}^{3+}$ perovskite thin films by RF magnetron sputtering as free-standing membranes for optical nanoimaging systems. Homogeneous, robust and bright scintillators emerge a perfect candidate in high-resolution imaging.

JW4A.25 **RAPID**

Two-Dimensional Reconstruction of The Fly *Drosophila Melanogaster* By Holographic Interferometry, Luis A. Marín¹, Evelyn A. Granzo¹; ¹Optics Lab, ESPOCH, Ecuador. Using the Matlab software, images obtained from the fly *Drosophila melanogaster* are shown in a holographic simulator designed with the objective of processing and reconstructing binary holograms. An unconventional system of teaching science.

JW4A.26

High-Resolution, High Speed Defect Detection of Curved Optics, Timothy A. Potts¹; ¹Dark Field Technologies, USA. Automated inspection of curved optics is a large industry need. Conventional laser/camera systems cannot deliver reliable inspection of curved surfaces. Solid State Laser Reflection (SSLR) technology solves the problem of curved optics inspection.

JW4A.27

Multimodal imaging Mueller polarimetric microscope on geometrical analysis of spherical microparticles, Thomas Sang Hyuk Yoo¹, Andrea Fernández², Fernando Moreno², Jose Maria Saiz², Razvigor Ossikovski¹, Enric Garcia-Caurel¹; ¹LPICM, Ecole Polytechnique, France; ²Dpto. de Física Aplicada, Universidad de Cantabria, Spain. We developed a multimodal imaging polarimetric microscope which images both in Fourier (back-focal) and real planes. We propose an application to study spherical microparticles showing size and shape dependent polarimetric properties.

JW4A.28

Toward Training a Deep Neural Network to Optimize Lens Designs, Geoffroi Côté¹, Jean-François Lalonde¹, Simon Thibault¹; ¹Université Laval, Canada. A deep neural network (DNN) is trained in an unsupervised manner, using RMS spot size, to output optimized lens designs from provided specifications.

JW4A.29

Synchronized Microphone Array for Single-shot Axial Profiles of Femtosecond Filaments, Ilia Larkin¹, Aaron Schweinsberg², Anthony Valenzuela³, Howard Milchberg¹; ¹IREAP, Univ. of Maryland, USA; ²Oak Ridge Inst. for Science and Education, USA; ³US Army Research Lab, Aberdeen Proving Grounds, USA. A synchronized array of microphones maps, in a single shot, the axial energy deposition profile from a femtosecond laser filament as a function of perturbations in input laser energy, pulse duration, and focusing geometry.

JW4A.30

High-sensitive Absorption Measurement in Silica and Quartz Crystal with Time-resolved Photo-thermal Common-path Interferometry, Ksenia V. Vlasova¹, Alexandre Makarov¹, Nikolai Andreev¹; ¹Inst. of Applied Physics RAS, Russia. The results of measurements of ultra-low ($\sim 10^{-7}\text{cm}^{-1}$) absorption of optical radiation ($\lambda=1.07\ \mu\text{m}$) in synthetic crystalline quartz and in fused quartz by time-resolved modification of a Photo-thermal common interferometry are presented.

JW4A.31

Coherent ultra-broadband wave-breaking radiation in a laser plasma accelerator, Bo Miao¹, Linus Feder¹, Howard Milchberg¹; ¹Univ. of Maryland at College Park, USA. Abstract: Electron self-injection in a laser plasma accelerator generates an ultra-broadband coherent radiation flash. We show that the flash spectrum reveals information on the plasma density and the electron injection process.

JW4A.32

Temporal and Polarization Symmetry Breaking in Ring Resonators, Francois Copie¹, Michael T. Woodley¹, Leonardo Del Bino¹, Jonathan M. Silver¹, Shuangyou Zhang¹, Pascal Del'Haye¹; ¹National Physical Lab, UK, UK. We study the occurrence of two symmetry breaking processes in ring resonators pumped by short pulses. Different scenarios are predicted depending on the input characteristics, including a complex dynamical interplay between the two mechanisms.

JW4A.33

Brillouin Comb Generation in a Highly Nonlinear Tellurite Single Mode Fiber, Luo Xing¹, Hoang Tuan Tong¹, Than Singh Saini¹, Hoa P. Nguyen¹, Takenobu Suzuki¹, Yasutake Ohishi¹; ¹Research Center for Advanced Photon Technology, Toyota Technological Inst., Japan. Brillouin comb generation in a ring cavity composed of a piece of tellurite single mode fiber was demonstrated. Cascaded stimulated Brillouin Stokes and anti-Stokes lines resulted in multi-wavelength Brillouin comb generation bi-directionally.

JW4A.34

Surface Modification of Additively Manufactured Titanium Components via Femtosecond Laser Micromachining, Nathan G. Worts¹, Jason Jones², Jeff Squier¹; ¹Colorado School of Mines, USA; ²Moog Inc., USA. Novel capabilities including surface roughness modification, nanogratings, and micro-cones are achieved through post-processing of additively manufactured parts by an amplified femtosecond laser. Applications of these surface features are discussed.

JW4A.35

Radiation detection with mid-IR laser breakdown of air, Daniel C. Woodbury¹, Robert Schwartz¹, Joshua Isaacs¹, Phillip Sprangle¹, Howard Milchberg¹; ¹Univ. of Maryland at College Park, USA. We demonstrate standoff detection of radioactive material based on avalanche breakdown of irradiated air with mid-IR laser pulses. With radiation present, breakdowns experience a temporal shift in their evolution, and can exhibit on-off sensitivity.

JW4A.36

Coherent Excitation of Phonon Polaritons in BaGa_2Se_4 by Terahertz Pulses, Bo Wang¹, Yiwen E¹, Jiyong Yao², Li Wang¹; ¹Beijing National Lab for Condensed Matter Physics, Inst. of Physics, Univ. of Chinese Academy of Sciences, Chinese Academy of Sciences, China; ²Key Lab of Functional Crystals and Laser Technology, Technical Inst. of Physics and Chemistry, Univ. of Chinese Academy of Sciences, Chinese Academy of Sciences, China. Phonon polaritons are generated in BaGa_2Se_4 by linear excitation of terahertz pulses, and probed using 800 nm femtosecond laser pulses. The observed phonon polaritons can be perfectly reproduced by a damped harmonic oscillator model.

JW4A.37

Third-Order Nonlinear Optical Properties of ALD Grown TiO_2 Films by Thermally Managed Z-scan Method, Isaac Basaldua¹, Paul Burkins¹, Robinson Kuis¹, Jaron Kropp¹, Theodosia Gougousi¹, Anthony M. Johnson¹; ¹Univ. of Maryland Baltimore County, USA. Thermally managed Z-scan performed on ALD grown TiO_2 films demonstrated n_2 values of 1.7×10^{-11} and $1.94 \times 10^{-10}\text{cm}^2/\text{W}$ for films grown at 100°C and 250°C, respectively – greater than 1000X that of other growth methods.

JW4A.38

Polarization and Entanglement in Mixed Classical States, Asma Al-Qasimi¹, Joseph H. Eberly¹; ¹Univ. of Rochester, USA. The relationship between polarization and entanglement [1] implies classical entanglement places limits on observable coherence properties. Here we study how the coherences affect each other in the case of mixed classical states.

JW4A • Poster Session IV and Dynamic E Posters—Continued

JW4A.39

Design and Modeling of a Chalcogenide Taper Fiber for High Average Power Supercontinuum Generation, Than Singh Saini¹, Hoa P. Nguyen¹, Hoang Tuan Tong¹, Luo Xing¹, Takenobu Suzuki¹, Yasutake Ohishi¹; ¹Toyota Technological Inst., Japan. Chalcogenide taper-fiber structure is reported for high-power broadband supercontinuum spectrum covering from 1.5–14 μm . The taper fiber was pumped with femtosecond laser pulse of an average power of 200 mW at 3.5 μm .

JW4A.40

Optical Switching and Thermal Recovery of Vanadium Dioxide, Marc Currie¹, Virginia Wheeler¹, Mario Ancona¹, Tatyana Feygelson¹, Karl Hobart¹; ¹US Naval Research Lab, USA. Vanadium dioxide films were grown on sapphire substrates as well as thin diamond membranes. Optical pump-probe experiments show large optical modulation in response to moderate optical excitation and follow a pure thermal model.

JW4A.41

Linear Localization of non-Hermitian Photonic Zero Modes, Li Ge¹, Bingkun Qi¹; ¹College of Staten Island, CUNY, USA. A non-Hermitian photonic zero mode can exhibit an unusual behavior at the transition between extended and localized regimes: it displays a linearly decreasing amplitude in space inside a weakly coupled non-Hermitian reservoir.

JW4A.42

Dark Soliton and Cnoidal Wave Frequency Combs in Microresonators by Second Harmonic Generation, Zhen Qi¹; ¹Univ. of Maryland Baltimore County, USA. We study dark solitons and cnoidal waves frequency combs generated by second harmonic generation in microresonators. We obtain stable dark solitons and cnoidal waves when fundamental frequency and second harmonic in oppositely dispersive regimes.

JW4A.43

THz Region Elastic Scattering from a Silica Microsphere, Suat Kurt¹, Nurperi Yavuz¹, Syed Sultan Shah Bukhari¹, Ali Serpengüzel¹; ¹Koc Univ., Turkey. Using GLMT, we investigated 0° transmission and 90° elastic scattering from a silica microsphere. The numerically observed mode spacing agrees well with the theoretically estimated value. Silica microspheres show promise for novel THz applications.

JW4A.44

Imaging with Thick Lenses using ABCD Matrices and under First-Order Material Dispersion, Monish R. Chatterjee¹, Salaheddeen Bugoffa¹; ¹Univ. of Dayton, USA. ABCD matrices for a thick lens are applied for imaging a colored 2D object under first-order material dispersion. Frequency-dependent dispersion of permittivity is incorporated in the analysis and results are compared with the non-dispersive problem.

JW4A.45

Warped Space-Time Optics, William B. Webb¹; ¹Energy Control Engineering, USA. Atoms are structured from Loopons; a variety of Photons. Loopon Electrons warp. Their speed-of-light is warped, producing a transparent material's Index of Refraction. Photons obliquely entering or leaving bend and change speeds outside the material.

JW4A.46 **RAPID**

Spatio-temporal observation of the Fermi-Pasta-Ulam recurrence in optical fibers, Corentin Naveau¹, Pascal Szriftgiser¹, Alexandre Kudlinski¹, Matteo Conforti¹, Stefano Trillo², Arnaud Mussot¹; ¹Université de Lille, France; ²Univ. of Ferrara, Italy. We report the spatio-temporal observation of the Fermi-Pasta-Ulam recurrence via non-destructive distributed measurements in phase and intensity of main frequency components of the frequency comb.

JW4A.47 **RAPID**

Development of high-precision mode decomposition devices for optical vortices, Keisaku Yamane¹, Yuho Watanabe¹, Isamu Wakisaka¹, Kazuhiko Oka², Yasunori Toda¹, Ryuji Morita¹; ¹Hokkaido Univ., Japan; ²Hirosaki Univ., Japan. New mode decomposition devices for optical vortices were developed. Their performances were experimentally verified and in good agreement with the corresponding simulations, showing precise spatial-phase control based on Pancharatnam-Berry phase.

JW4A.48 **RAPID**

Photokinetic effects in vector Bessel beams, Aaron Yevick¹, David G. Grier¹; ¹New York Univ., USA. Vector Bessel Beams are a conical superposition of polarized plane waves. The angular spectrum including polarizations is useful for identifying relationships among different polarization states, and understanding forces on small objects.

JW4A.49 **RAPID**

Ultrafast magnetization dynamics in nanoscale two-dimensional Permalloy annular antidot lattices, Nikita Pawal¹, Sucheta Mondal², Samiran Choudhury², Anulekha De², Jaivardhan Sinha², Anjan Barman², Prasanta Kumar Datta¹; ¹Indian Inst. of Technology Kharagpur, India; ²Dept. of Condensed Matter Physics and Material Sciences, S. N. Bose National Centre for Basic Sciences, Block JD, Sector III, Kolkata , India. The static and dynamic response of 2-D Ni₈₀Fe₂₀ annular antidot lattices has been investigated with varying bias magnetic field using TR-MOKE microscopy. Multiple frequency modes observed in experiment are verified by micromagnetic simulations.

JW4A.50 **RAPID**

Vector vortex beam from doubly-resonant nanosecond optical parametric oscillator, Varun Sharma¹, Goutam K. Samanta¹, S. C. Kumar², A Aadhi¹, H. Ye², M. Ebrahim-Zadeh^{2,3}; ¹PRL Ahmedabad, India; ²ICFO-Institut de Ciències Fotòniques, The Barcelona Inst. of Science and Technology, Spain; ³Instituto Catalana de Recerca i Estudis Avançats (ICREA), Spain. We demonstrate a novel experimental scheme to generate tunable vector vortex beam directly from an optical parametric oscillator (OPO). Using a nanosecond doubly-resonant OPO, we produce vector vortex beam tunable across 964-990 nm.

JW4A.51

Propagation of Vortex Pulsed Beams in Free Space, Nikolai I. Petrov¹; ¹Scientific and Technological Center of Unique Instrumentation of Russian Academy of Sciences, Russia. Propagation of spatiotemporal pulses in free-space taking into account nonparaxial effects is investigated. Non-invariance of the velocity of spatially localized vortex pulsed beams in vacuum is shown by rigorous calculation of the wave equation.

JW4A.52

Ultrafast Laser Micro-stressing for Correction of Thin Fused Silica Optics for Future X-Ray Space Telescopes, Heng Zuo^{1,2}, Brandon Chalifoux², Ralf Heilmann², Mark Schattenburg²; ¹Dept. of Aeronautics and Astronautics, MIT, USA; ²MIT Kavli Inst. for Astrophysics Research, USA. We present a novel application of ultrafast laser micromachining for figure correction of future light-weight high-resolution X-ray mirrors. Preliminary results of local deformation and stress changes in flat fused silica substrates are demonstrated.

JW4A.53

Interaction of Laser Beam with Plasmonic Nanoparticles, Avesh Kumar^{1,2}; ¹Bhim Rao Ambedkar Univ., India; ²AMOPH, Physical Research Lab, India. Interaction of input laser beams with colloidal suspensions of plasmonic nanoparticles is studied. It results in different types of structures after propagation through a suspension.

JW4A.54

Probing Vibration-Cavity Polariton Dynamics via Ultrafast Infrared Spectroscopy, Andrea B. Grafton^{2,1}, Adam Dunkelberger¹, Kenan Fears¹, Roderick Davidson^{2,1}, Blake Simpkins¹, Jeffrey Owrutsky¹; ¹U.S. Naval Research Lab, USA; ²National Research Council, USA. Time resolved IR pump-probe spectroscopy was used to measure the vibrational dynamics of strong chromophores in optical cavities. A fast component in the lifetime of W(CO)₆ in hexane was observed, but not in the other systems.

JW4A.55

Self-Compression of Ultrashort Pulses in Hollow Waveguide for High Harmonic Generation, Qiangdong Ran¹, Lifeng Wang², Lu Li², Hao Li², Ying Zhang²; ¹Nanyang Technological Univ., Singapore; ²Singapore Inst. of Manufacturing Technology, Singapore. Self-compression of pulses was observed in gas-filled waveguide. This can be used to enhance High Harmonic Generation (HHG). Here, 2cm hollow waveguide with inner diameter 150 μm was used. Bright HHG in water window was produced.

JW4A.56 **RAPID**

Probing Light-Metal Interaction with the Photon-Drag Effect, Jared Strait², Glenn Holland^{2,1}, B. Robert Illic², Amit Agrawal^{2,1}, Domenico Pacifici^{2,3}, Henri Lezec²; ¹Maryland NanoCenter, Univ. of Maryland, USA; ²Center for Nanoscale Science and Technology, NIST, USA; ³School of Engineering and Dept. of Physics, Brown Univ., USA. We demonstrate that the sign of the photon-drag effect in smooth metal films conflicts with the prevailing intuitive model of direct momentum transfer to free electrons, establishing the need for a new microscopic model of radiation pressure.

JW4A.57 **RAPID**

Multiplexing a Cavity-Enhanced Quantum Memory, Paul D. Kunz², Kevin Cox¹, David Meyer^{2,1}, Zachary A. Castillo^{2,1}; ¹Army Research Labs, USA; ²Physics, Univ. of Maryland, USA. We present ongoing work on a multiplexed atom-cavity quantum memory with the goal of achieving fast entanglement generation - one of the primary remaining hurdles to a functional quantum repeater.

JW4A.58 **RAPID**

Entanglement between Topological and Trivial Modes, Andrea Blanco-Redondo¹, Bryn A. Bell¹, Dikla Oren², Benjamin J. Eggleton¹, Mordechai Segev²; ¹Univ. of Sydney, Australia; ²Technion, Israel. We report the experimental observation of biphoton entanglement between topologically and trivially localized modes in a nanophotonic lattice of coupled silicon waveguides.

JW4A.59 **RAPID**

Sensitivity-bandwidth Enhancement of Gravitational Wave Detector Without Using Dispersive Medium, Minchuan Zhou¹, Zifan Zhou¹, Selim M. Shahriar¹; ¹Northwestern Univ., USA. We show that via small changes in the parameters of the existing signal-recycled interferometric gravitational wave detector, it is possible to achieve an enhancement on the order of 10 in the sensitivity-bandwidth product.

JW4A.60

Generation and Storage of Entanglement between Two All-Optical Quantum Memories, Fumiya Okamoto¹, Yosuke Hashimoto¹, Jun-ichi Yoshikawa¹, Rei Sakakibara¹, Peter v. Loock², Akira Furusawa¹; ¹The Univ. Of Tokyo, Japan; ²Johannes Gutenberg Univ. Mainz, Germany. We experimentally demonstrate generation and storage of entanglement between two concatenated cavity memories. The logarithmic negativity is 0.150 \pm 0.006 even at 400 ns storage time.

JW4A • Poster Session IV and Dynamic E Posters—Continued

JW4A.61

Optimized Cooling of Atoms in Optical Lattice for High Rate Quantum Memory Operation, Michal J. Piotrowicz², Thomas G. Akin³, John Reintjes², Alex Kuzmich⁴, Adam T. Black¹, Mark Bashkansky¹; ¹Optical Sciences Division, U.S. Naval Research Lab, USA; ²KeyW Corporation, USA; ³NRC Postdoctoral Research Associate, USA; ⁴Dept. of Physics, Univ. of Michigan, USA. We present an optimized cooling sequence for Rb atoms in a 1D optical lattice for quantum memory experiments. We show an increase in number of memory write and read events per one lattice load.

JW4A.62

Dual-Seeded Four-Wave Mixing in Portable Quantum Light Source, Nicholas Brewer¹, Meng-Chang Wu¹, Rory W. Speirs¹, Paul Lett²; ¹Univ. of Maryland, USA; ²National Inst. of Standards and Technology, USA. The noise spectrum of intensity-difference squeezed light exhibits excess noise at high frequencies when a tapered amplifier is used as a pump beam. Our dual-seed technique corrects this noise.

JW4A.63

Complete characterization of optical multi-temporal-mode quantum states, Kan Takase¹, Masanori Okada¹, Takahiro Serikawa¹, Shuntaro Takeda^{1,2}, Jun-ichi Yoshikawa¹, Akira Furusawa¹; ¹applied physics, the Univ. of Tokyo, Japan; ²JST, PRESTO, Japan. We propose and demonstrate a method useful to characterize optical multi-temporal-mode Fock states typified by quantum error correction code states using a simple experimental setup and data analysis procedure.

JW4A.64

Two Opto-Atomic Devices for Classical and Quantum Communication, David H. Meyer¹, Kevin C. Cox², Zachary A. Castillo¹, Paul D. Kunz²; ¹Dept. of Physics, Univ. of Maryland at College Park, USA; ²U.S. Army Research Lab, USA. We present ongoing developments of two atomic devices to improve optical communication rates in the classical and quantum regimes: a Rydberg atomic receiver for classical data and a ring-cavity atomic memory for long distance quantum communication.

JW4A.65

Carrier Dynamics in Monolayer WS₂ via Time-Resolved Terahertz Spectroscopy, Jon K. Gustafson¹, Michael Hayden¹; ¹Physics, UMBC, USA. We investigate the ultrafast dynamics of photogenerated charge carriers in the two-dimensional material WS₂ via time-resolved terahertz spectroscopy. We report on the behavior of excitons, trions, and unbound electrons/holes in this material.

JW4A.66

Reduced Decoherence of Macroscopic States Using Squeezing and Anti-Squeezing, Richard A. Brewster¹, James Franson¹; ¹Univ. of Maryland, Baltimore County, USA. The decoherence of macroscopic quantum states due to loss can be reduced by squeezing before transmission, followed by amplification and anti-squeezing to restore the original amplitude. This approach does not decrease the data transmission rate.

JW4A.67

Picosecond Pulse Pumped Supercontinuum Generation in Silicon-on-insulator Waveguide with a Weak Continuous Wave Trigger, Guangkuo Li¹, Qian Li¹; ¹Peking Univ., China. We investigate the effect of a weak continuous-wave trigger on picosecond pulse pumped supercontinuum generation in silicon-on-insulator waveguide. A spectrally broadened and highly coherent supercontinuum is achieved.

JW4A.68

Correlation Properties of Polarization Dynamics in Quantum Dot Lasers with Optical Feedback, Chen Yang¹, Salim Ourari¹, Hong Lin¹; ¹Bates College, USA. Dynamics of polarized states are examined for a quantum dot laser subject to polarization-rotated feedback. Correlations of different polarizations are studied by evaluating cross correlation functions.

JW4A.69

Rectangular Core Dispersion Engineered Photonic Crystal Fiber for Supercontinuum Generation, Pooja Chauhan¹, Ajeet Kumar¹, Yogita Kalra¹, Than Singh Saini²; ¹Delhi Technological Univ., India; ²Toyota Technological Inst., Japan. Design of a rectangular core photonic crystal fiber in Ge₂₀Sb₁₀Se₆₄ chalcogenide glass is presented for mid-IR. Our simulation results include the study of dispersion, nonlinearity and fundamental effective mode area.

JW4A.70

Blu-ray DVD as SERS substrate for reliable detection and quantification of urea, Nabadweep Chamuah¹, Ankita Saikia¹, Pabitra Nath¹; ¹Tezpur Univ., India. Herein development SERS substrate using blu-ray DVD and subsequent use for detection of urea is demonstrated. The substrate yields reproducibility with RSD value of 14.33%. Urea concentration of 0.06µg/dL can be detected reliably with this substrate.

JW4A.71

Anderson Localization in Subwavelength Plasmonic Structures, Ali Ghoreyshi¹, R. H. Victora¹; ¹Univ. of Minnesota, USA. We used the FDTD simulation to study photon propagation in arrays of plasmonic particles. In such systems, structural randomness can lead to localization of light in the deep subwavelength regime, similar to Anderson localization of electrons.

JW4A.72

Free-Space Daylight Quantum Key Distribution without Source Side Channel Effects, Heasin Ko¹, Chun Ju Youn¹; ¹Electronics and Telecommunications Research Inst., South Korea. We study the performance of a free-space quantum key distribution system operated at the clock rate of 400MHz in daylight without source side channel effects. Noise photons from sunlight were effectively eliminated with filtering techniques.

JW4A.73

Strong-Coupling Model for Pulsed Light Propagation and Quantum Kinetics of Electron-Hole Plasmas in Quantum Wire Arrays, Jeremy R. Gully¹, Danhong Huang²; ¹Dept. of Physics, Kennesaw State Univ., USA; ²Space Vehicles Directorate, Air Force Research Lab, USA. A quantum-kinetic model is proposed for ultrafast carrier-scattering dynamics in quantum wires coupled to resonant scattering of ultrashort light pulses. The model includes effects from transverse, longitudinal, and applied DC fields on the wires.

JW4A.74

Probing Dynamics In Quantum Magnetism With Ultracold Atoms, Araceli Venegas Gomez¹, Andrew J. Daley¹, Wolfgang Ketterle²; ¹Univ. of Strathclyde, UK; ²MIT, USA. The macroscopic control over cold atoms in optical lattices offers an excellent platform to study the out-of-equilibrium behaviour of strongly correlated systems, such as spin models, which are usually motivated by solid state physics.

JW4A.75

Tunable Stub Plasmonic Structures for Terahertz Detectors and Sources, Michael Shur^{1,2}, Gregory Aizin³, John Mikalopas³; ¹Rensselaer Polytechnic Inst., USA; ²Electronics of the Future, Inc., USA; ³Kingsborough College, USA. Plasmonic boom terahertz devices could increase the generated power and detection sensitivity by orders of magnitude. They require tuning conditions at heterodimensional interfaces and slow plasmons. These requirements are met using plasmonic stubs.

JW4A.76

Effective photonic potential for TM waves, Alessandro Alberucci¹, Chandroth P. Jisha², Stefan Nolte^{1,3}; ¹Friedrich-Schiller-Universität Jena, Germany; ²Universidade do Porto, Portugal; ³Fraunhofer Inst. of Applied Optics and Precision Engineering, Germany. We use an effective photonic potential to describe light confinement of TM waves in sub-wavelength structures, such as GRIN and slot waveguides. The predictions of the model are confirmed by FDTD simulations.

JW4A.77

Aluminum Gallium Arsenide as a High-Reflectivity Coating Material for Interferometric Gravitational-wave Detectors, Gregory M. Harry¹, Steve Penn², Garrett Cole³, GariLynn Billingsley⁴, Matthew Evans⁵, Geoffrey Lovelace⁶; ¹American Univ., USA; ²Hobart and William Smith Colleges, USA; ³Crystalline Mirror Solutions, USA; ⁴LIGO Lab, California Inst. of Technology, USA; ⁵LIGO Lab, MIT, USA; ⁶Physics, California State Univ. Fullerton, USA. Substrate-transferred single-crystal semiconductor heterostructures are effective as low-thermal-noise optical coatings for small beams. We discuss progress in developing GaAs/AlGaAs coatings at a size for gravitational wave detectors such as LIGO.

JW4A.78

Solitary wave solutions in nonlinear media with quartic and quadratic dispersion—implications for high-power lasers, Kevin K. Tam¹, Tristram J. Alexander¹, Andrea Blanco-Redondo¹, C. Martijn de Sterke¹; ¹Univ. of Sydney, Australia. We consider solutions to the nonlinear Schrödinger equation with quadratic and quartic dispersion, and discover a temporal soliton family that includes recently discovered pure quartic solitons and solitons with only quadratic dispersion.

JW4A.79

Electro-Optic Temporal Optical Systems for Spectral Shaping of Quantum Light, Filip Sosnicki¹, Maciej Galka^{1,2}, Michal Mikołajczyk¹, Alex O. Davis³, Valérian Thiel³, Brian J. Smith^{3,4}, Michal Karpinski^{1,3}; ¹Uniwersytet Warszawski, Poland; ²Cavendish Lab, Univ. of Cambridge, UK; ³Clarendon Lab, Univ. of Oxford, UK; ⁴Dept. of Physics and Oregon Center for Optical, Molecular, and Quantum Science, Univ. of Oregon, USA. We experimentally show spectral-temporal (ST) modification of single-photon pulses by a system of two electrooptic time lenses. Our work enables ST shaping of quantum light for mode matching in quantum networks and for quantum information processing.

JW4A.80

An Effective Suppression of Relative Intensity Noise for Fiber-Optic Gyroscopes with Harmonics Demodulation, Yulin Li¹, Fang Ben¹, Rongya Luo¹, Sheng Deng¹, Fangyuan Chen¹, Dong He¹, Chao Peng¹, Zhengbin Li¹; ¹State Key Lab of Advanced Optical Communication Systems and Networks, Peking Univ., China. A relative intensity noise suppression method is demonstrated for interferometric fiber-optic gyroscopes with harmonics demodulation by processing the interference and reference signals electronically, which decreases the angular random walk by 40%.

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JW4A.81

400 Gbps PM-QPSK Transmission for Metro-DCI Applications Employing 20 Gbaud Transmitter, Lakshmi Narayanan Venkatasubramani¹, Aneesh Sobhanan¹, Deepa Venkitesh¹, David Koilpillai¹; ¹INDIAN INST. OF TECHNOLOGY, MADRAS, India. A PM-QPSK super-channel transmission is experimentally demonstrated for 400-Gbps data center interconnects, based on 20-Gbaud transmitter and coherent receiver technology, yielding a spectral efficiency of 4-b/s/Hz.

JW4A.82

Impact of Dispersion on the Relative Cross-Talk of WDM Channels in Multicore Fiber Systems., Monica Lopez-Coyote¹, Ramon Gutierrez-Castrejon¹, Daniel E. Ceballos-Herrera¹; ¹Inst. of Engineering, Universidad Nacional Autónoma de México UNAM, Mexico. We report a numerical analysis of the group velocity dispersion impact on the relative inter-core cross-talk among WDM channels in a two-core fiber transmission system by considering simultaneously Four-Wave Mixing and Stimulated Raman Scattering.

JW4A.83

Method for High-Speed Optical Modulator Characterization Using Only DC Measurements, lam Bui¹; ¹School of Engineering and Technology, Central Queensland Univ., Australia. A novel technique to obtain the frequency response of high-speed optical modulators is presented. The proposed technique uses only DC measurements which greatly simplify the setup and reduce the time and cost of device characterization.

JW4A.84

Modal Analysis of Dielectric Chiral Optical Fibers by Immersed Interface Method, Yusheng Cao¹; ¹Ningxia Univ., China. We describe a mode solver for dielectric chiral optical fibers, with the immersed interface method utilized to treat the discontinuity of medium parameters across the core-cladding interface, which produce a second order accuracy.

JW4A.85

FBG Based Optical Surveillance Network for Oil and Gas Pipelines, Abhinav Gautam¹, Ritu Raj Singh¹, Amitesh Kumar¹, Jaishing Thangaraj¹, Vishnu Priye¹; ¹Indian Inst. of Technology (ISM), India. A FBG based pipeline surveillance architecture is proposed. An array of FBGs, having unique reflection wavelength is used to spot location of any pressure or temperature variation, which is smartly sensed using optical heterodyning technique.

JW4A.86

Observation of Optical Multistability in directional coupler with negative index material channel, Kanagaraj Nithyanandan^{2,1}; ¹Universite de Bourgogne, India; ²Laboratoire Interdisciplinaire de Physique, Université de Grenoble Alpes, France. We observe multistability in directional couplers with negative index material channel. The emergence of multiple stable states is a result of the action of nonlinear saturation and opposite directionality of phase velocity and energy flow in the ODC.

JW4A.87

Tuning of the Free Spectral Range of a Fiber Optic Notch Filter Using a Dispersive Link, Luis A. González Mondragón¹, Ignacio E. Zaldivar Huerta¹, Leidy J. Quintero Rodríguez², Ana G. Correa Mena¹, Jorge Rodríguez Asomoza², Alejandro García Juárez³, Ana L. Leal Cruz³; ¹INAOE, Mexico; ²UDLAP, Mexico; ³Universidad de Sonora, Mexico. Theoretical and experimentally is demonstrated that the free spectral range of a fiber optic notch filter can be tuned by adjusting the length of the optical link. A series of numerical simulations validate this proposal.

JW4A.88

Off-Axis Parabolic Mirrors Based Multiplexer Design for Spatial Domain Multiplexing, Syed H. Murshid¹, Ce Su¹; ¹Florida Inst. of Technology, USA. CAD based model to multiplex the input of MIMO based spatially multiplexed optical communications system is presented. The design uses off the shelf components and allows better coupling efficiency and reduces insertion loss.

JW4A.89

RAPID

Quantum Measurement of Time Difference in an Unbalanced Fiber Mach-Zehnder Interferometer, Yiwei Zhai^{1,2}, Runai Quan^{1,2}, Yue Zhang^{1,2}, Tao Liu^{1,2}, Shougang Zhang^{1,2}, Ruifang Dong^{1,2}; ¹National Time Service Center, China; ²Univ. of Chinese Academy of Sciences, China. We report a novel way for measuring the time difference in an unbalanced fiber Mach-Zehnder interferometer based on the second-order quantum interference of the frequency entangled light source.

JW4A.90

A Fiber-Pigtailed Hemispherical Fabry-Pérot Microcavity for Accelerometry and Sensing, Feng Zhou¹; ¹NIST, USA. A novel hemispherical Fabry-Pérot microcavity with high finesse, good optical performance and compact packaging is developed for potential applications in optomechanical accelerometry and precision sensing.

JW4A.91

Highly Sensitive Plasmonic Metasensor with Wide Detection Range, Rifat Ahmmed Aoni¹, Mohsen Rahmani¹, Lei Xu², Rajib Ahmed³, Dragomir Neshev¹, Andrey Miroshnichenko²; ¹Nonlinear Physics Centre, Research School of Physics and Engineering, Australian National Univ., Australia; ²School of Engineering and Information Technology, Univ. of New South Wales, Australia; ³Bio-Acoustic MEMS in Medicine (BAMM) Lab, School of Medicine, Stanford Univ., USA. We propose a highly sensitive plasmonic metasensor for the detection of wide range of analyte refractive index (RI) from 1 to 1.60. The proposed metasensor shows the average sensitivity of 630 nm/RIU with high linearity of 0.9998.

JW4A.92

Non-Reciprocal Transport in Floquet Photonic Resonators: High Frequency Expansion, Huanan Li¹, Boris Shapiro², Tsampikos Kottos¹; ¹Wesleyan Univ., USA; ²Technion - Israel Inst. of Technology, Israel. We develop a systematic high-frequency expansion of the scattering matrix of Floquet periodically-driven photonic systems. The method unveils the critical role of micro-motion for non-reciprocal transport in such systems.

JW4A.93

Withdrawn

JW4A.94

Photonic Crystals Band Diagrams Computation by Using Extreme Learning Machine, Adriano da Silva Ferreira², Gilliard N. Malheiros-Silveira¹, Hugo E. Hernandez-Figueroa²; ¹São Paulo State Univ. (Unesp), Brazil; ²DECOM, Univ. of Campinas, Brazil. We modeled Extreme Learning Machine feed-forward Artificial Neural Network for estimating band diagrams of tri-dimensional photonic crystals and demonstrated a simple approach for speedy computations.

JW4A.95

Improved Acetylene-Filled Photonic Bandgap Fiber Cells Fabricated using a Tapering Method, Sajed Hosseini¹, Manasadevi Thirugnanasambandam¹, Kushan Weerasinghe¹, Kristan Corwin¹, Brian Washburn¹; ¹Kansas State Univ., USA. Gas-filled photonic microcells (PMC) have been produced by tapering the end of photonic bandgap fibers. This method improves cell transmission and reduces etalon-like effect. PMC contamination was determined by fitting the measured absorption lines.

JW4A.96

Integration of TMDCs Layer on a Silicon Micro-ring Resonator for Photonic Applications, Rishi Maiti¹, Rohit Hemnani¹, Rubab Amin¹, Volker J. Sorger¹; ¹GEORGE WASHINGTON UNIV., USA. Here we report on the integration of 2D TMDCs materials on Silicon microring to tune the rings resonance as a function of coverage length. This hybrid platform can be used for versatile photonic device applications.

JW4A.97

All-dielectric integrated photonic devices based on multimode interference of Bloch surface waves, Dmitry N. Gulin¹, Kirill Safronov¹, Ksenia Abrashitova^{1,2}, Ilya Antropov¹, Aleksandr Frolov¹, Vladimir O. Bessonov¹, Andrey A. Fedyanin¹; ¹Lomonosov Moscow State Univ., Russia; ²manuel Kant Baltic Federal Univ., Russia. The multimode interference of the Bloch surface wave devices in 1D photonic crystal was experimentally and numerically studied. Photonics devices based on this phenomena were demonstrated.

JW4A.98

Highly Sensitive Nanogap-Based Surface Plasmon Resonance Biosensing through Light-Matter Colocalization, Changhai Lee¹, Eunji Sim², Donghyun Kim¹; ¹Electrical and Electronic Engineering, Yonsei Univ., South Korea; ²Chemistry, Yonsei Univ., South Korea. We present characteristics of surface plasmon resonance biosensing with nanogap-based light-matter colocalization. Optical signature was shown to increase by nearly 15 times than conventional detection with high sensitivity at a relatively large gap.

JW4A.99

Residual Intensity Modulation Analysis of Multifunction Integrated Optic Circuit, Jiaqi Liu¹, Chunxi Zhang¹, Jingming Song¹, Dewei Yang¹, Wei Cai¹, Chunxiao Wu¹; ¹Beihang Univ., China. The reasons for residual intensity modulation (RIM) in APE LiNbO₃ MIOC are theoretical analyzed. The linear and nonlinear part are evaluated quantitatively. The RIM of a high PER MIOC with spatial filters is tested.

JW4A.100

Withdrawn

JW4A.101

RAPID

Fabrication of Nano Arrays on Chromium Coated Optical Fibre Tip, Meher Wan¹, Saawan Kumar Bag¹, Rajat K. Sinha¹, Shailendra Varshney¹, B. Lahiri¹, chacko Jacob¹, Cheruvu S. Kumar¹; ¹Indian Inst. of Technology-Kharagpur, India. We report the creation of chromium-coated optical fiber meta-tip using Focused-Ion-Beam Lithography. A 2D nano array is designed and fabricated on standard optical fiber tip and supports the localized surface plasmon resonance.

JW4A.102

SPR based fiber optic pH sensor using polyaniline as a sensing layer, Vivek Semwal¹, Banshi D. Gupta¹; ¹Indian Inst. of Technology, Delhi, India. In the present work, we report a surface plasmon resonance based fiber optic pH sensor utilizing polyaniline as a sensing layer. The sensor works for the pH range from 3 to 11.

JW4A.103

ULI based single-mode multimode single-mode waveguide structure as a highly sensitive refractive index sensor: Design and simulation, Parvinder Kaur¹, M. R. Shenoy¹; ¹Dept. of Physics, Indian Inst. of Technology Delhi, India. We propose the design of a highly sensitive refractive index sensor based on ULI single-mode multimode single-mode waveguide structure. The VE multimode waveguide sensor has refractive index sensitivity ~ 10⁴ nm/RIU.

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JW4A.104

Transmission Control in Photonics Crystal Slab Using Transparent Conductive Oxide, Vishal Vashistha¹, Andriy Serebryannikov¹, Maciej Krawczyk¹; ¹Physics, Adam Mickiewicz Univ. in Poznan, Poland. We proposed to control the propagation of light through PhC slab by imposing a lossy boundary condition from the direction perpendicular to plane of propagation using transparent conducting oxides.

JW4A.105

ITO-Si heterojunction solar cell with nanocrystal line CdTe thin films, Andrii Pocherpailo¹, Sergii Kondratenko¹; ¹Taras Shevchenko National Univ., Ukraine. ITO-Si heterojunction solar cell with nanocrystal line CdTe thin films grown by magnetron sputtering is studied. The electrical and optical properties of these solar cell devices were studied by current-voltage and photovoltage spectroscopy.

JW4A.106

Effects of spectral shift on ultrashort pulse propagation in AZO/ZnO multilayered metamaterials at epsilon-near-zero, Priscilla Kelly¹, Lyuba Kuznetsova¹; ¹San Diego State Univ., USA. Numerical FDTD study of ultrashort (100 fs) pulse propagation shows strong pulse shaping for central frequencies smaller than the epsilon-near-zero (ENZ) point, and soliton-like propagation (up to 500 nm) for central frequencies larger than ENZ.

JW4A.107

Rectangular Waveguide based SOI Toluene Gas Sensor, Anumeha Varma¹, Dhananjay De¹, Ritu Raj Singh¹, Vishnu Priye¹; ¹Indian Institute of Technology, Dhanbad, India. The Silicon on insulator (SOI) rectangular waveguide as a toluene gas sensor is designed. Change in confinement factor and sensitivity of the sensor against the low fraction of toluene is reported at 1550nm operating wavelength.

JW4A.108

Surface Plasmon Resonance as a biosensing technique for possible development of a point of care diagnostic tool., Rudzani Malabi^{1,2}, sello Manoto¹, Saturnin OmbindaLemboumba¹, Patience Mthunzi-Kufa¹; ¹CSIR National Laser Centre, South Africa; ²Physics, UNISA, South Africa. Surface Plasmon Resonance is an optical sensing technique with the ability to monitor molecular binding in real-time for biological and chemical sensing applications.

JW4A.109

Instantaneous Quantum Description of Photonic Wavefronts for Phase-Sensitive Amplification, Andre Vatarescu¹; ¹R&D, Fibre-Optic Transmission of Canberra, Australia. Pure photonic quantum states consist of two consecutive number states, enabling evaluation of instantaneous amplitudes and phases of wavefront distributions of photons Sub-Poissonian distributions are shaped without the need for quasi-probabilities.

JW4A.110

Optical Responses of Asymmetrical Ag Nano-particles in Graphene Environment, Shivani Bhardwaj¹, R.P. Sharma¹; ¹Indian Inst. of Technology, Delhi, India. Scattering and absorption efficiencies of the Oblate and ortho-Oblate Ag nano-particles has been calculated by the numerical experiment named as Discrete Dipole Approximation (DDA) against the quasi-static approximation in Graphene environment.

JW4A.111

Optical Sum Frequency Generation Spectroscopy and Microscopy of Starch in Rice Grain as a Function of Developing Stage, Akira Matsubara¹, Goro Mizutani¹, Khuat Thi Thu Hien¹, Wataru Kouyama¹, Sultana Sharmin¹, Yasunori Nakamura²; ¹Japan Adv. Inst. of Sci. and Tech., Japan; ²Akita Prefectural Univ., Japan. The change of the molecular structure of sugar chains in rice seeds at different growth stages after flowering using a confocal sum frequency generation microscope. The starch structure in the developing rice endosperm was estimated by SFG spectra.

JW4A.112

Quantitative Analysis of Glucose Concentration Using NIR Spectroscopy, Selvy U. Hepriyadi¹, Iwan C. Setiadi¹, Aulia Nasution¹; ¹Engineering Physics, Institut Teknologi Sepuluh Nopember, Indonesia. The quantitative evaluations were carried out using PLS model. The collected absorbance data was pre-processed before calibration. From the data acquisition, it can be obtained the good model for predicting glucose concentration.

JW4A.113

A Custom Multi-Pixel Photodetector Probe and Partial Least Squares Regression for the Efficient Identification of Optical Tissue Properties, Callie M. Woods¹, Ozlem Senlik¹, Nan M. Joraker¹; ¹Electrical and Computer Engineering, Duke Univ., USA. Diffuse reflectance spectroscopy performed using a custom photodetector array combined with partial least squares regression increases the accuracy of optical tissue property extraction. Prediction accuracies of 4.15% (u_r), 9.02% (u_i) are reported.

JW4A.114 **RAPID**

Near-real time evaluation of live and dead bacterial concentration using the optrode – a portable fluorimeter, Fang Ou¹, Cushla McGoverin¹, Simon Swift², Frédérique Vanholsbeeck¹; ¹The Dodd-Walls Centre for Photonic and Quantum Technologies, Dept. of Physics, The Univ. of Auckland, New Zealand; ²School of Medical Sciences, The Univ. of Auckland, New Zealand. We describe a method to determine live and dead bacterial concentration that take advantage of an inexpensive fibre-based fluorimeter, the optrode, which can measure fluorescence intensity in bacterial solutions in challenging working environments.

JW4A.115

Two-photon fluorescence microscopy and selective laser ablation through multimode fibers, Eirini Kakava¹, Donald Conkey¹, Damien Loterie¹, Christophe Moser¹, Demetri Psaltis¹; ¹Ecole Polytechnique Federale de Lausanne, Switzerland. Using wavefront shaping, we deliver a focus spot through a multimode fiber (MMF) with a maximum peak power of $\sim 1 \times 10^{13} \text{ W/cm}^2$, sufficient to perform two-photon fluorescence (TPF) imaging and laser ablation (LA) of a variety of samples.

JW4A.116

Simultaneous Two-layer Two-photon Imaging with Confocal Strategy, Qinglei Hu¹, Pei Li¹, Yu Wang¹, Yuma Xiong¹, Xiaohua Lv¹, Shaoqun Zeng¹; ¹Huazhong Univ. of Science and Technology, China. To simultaneously record images from two planes at different axial positions, a two-photon imaging method was proposed in which signal demultiplexing is implemented using confocal strategy.

JW4A.117

High-throughput Light Sheet Tomography Platform for Fast Imaging of Whole Mouse Brain, Xiong Yang¹, Qi Zhang¹, Fei Huang¹, Longhui Li¹, Yongsheng Zhang¹, Xiaofeng Cheng¹, Shaoqun Zeng¹, Xiaohua Lv¹; ¹Huazhong Univ. of Science and Technology, China. Here we develop a high-throughput light-sheet tomography platform (HLTP), by which an aligned three-dimensional image dataset of a whole mouse brain can be obtained within 5 hours.

JW4A.118

Enhanced Discrimination of Cervical Cancer by Application of PCA with SVM on Time-Resolved Fluorescence Decay, Gyana Sahoo¹, Asima Pradhan^{1,2}; ¹Physics, Indian Inst. of Technology Kanpur, India; ²CELP, Indian Inst. of Technology Kanpur, India. Time-resolved fluorescence decay of normal and abnormal cervical tissue is seen to display better discrimination on application of PCA, which captures subtle changes in fluorophore environment and the application of SVM quantifies the discrimination.

JW4A.119

A White Random Laser, Chia-Tse Tai¹, Yu-Ming Liao¹, Shu-Wei Chang¹, Wei-Cheng Liao¹, Shih-Yao Lin¹, Wei-Ju Lin¹, Cheng-Han Chang¹, Hung-I Lin¹, Packiyaraj Perumal¹, Golam Haider¹, Tai-Yuan Lin¹, Yang-Fang Chen¹; ¹National Taiwan Univ., Taiwan. The hope of next-generation illuminants goes on random laser. Random laser is naturally endowed with two key superiorities, namely, laser-level intensity and broad-angular emissions, which are mutually exclusive in common light sources and lasers.

JW4A.120

Lens free microscope with an Arduino monochrome camera module, Camila de Paula D'Almeida¹, Patrick Oliveira Feitosa¹, Sebastião Pratavieira¹; ¹Instituto de Física de São Carlos (IFSC), Brazil. Lens free microscope is an emerging portable and simple image device. In this paper, we present our version of this microscope, which make use of an Arduino camera module.

JW4A.121

Purity Analysis of Adulterated Vegetable Oils by Raman and FTIR Spectroscopy, Shyju Bhaskar¹, Spandana K. U¹, Krishna K. Mahato¹, Nirmal Mazumder¹; ¹Manipal Academy of Higher Education, India. Raman and Fourier transfer infrared (FTIR) spectroscopy have been used to compute the purity and investigate the adulteration in edible oils which are commonly used.

JW4A.122

Dual Pulsed Laser Stimulation to the Auditory Nerve in Vivo, Muqun Yang¹, Tian Guan¹, Yonghong He¹; ¹Graduate School at Shenzhen, TSINGHUA UNIV., China. We demonstrated a system of dual pulsed laser stimulation could successfully induce auditory response. We analyze its characterization and mechanism for future artificial cochlea.

JW4A.123

Displaying 3D Images on Mobile Phones, Nikolai I. Petrov¹, Vladislav G. Nikitin¹, Yuri Sokolov¹, Maxim Khromov¹; ¹Scientific and Technological Center of Unique Instrumentation of Russian Academy of Sciences, Russia. Multiview 3D display system consisting of mobile phone screen and optical screen consisting of microlens array film is designed. 3D image files are created and images are demonstrated on different smartphones with high resolution displays.

JW4A • Poster Session IV and Dynamic E Posters—Continued

JW4A.124 **RAPID**

Sub-Rayleigh Limit Localization with a Spatial Mode Analyzer, Jeremy Hassett¹, Tanya Malhorta³, Miguel Alonso¹, Robert Boyd^{1,2}, Mohammad Hashemi Rafsanjani¹, Anthony N. Vamivakas^{1,3}; ¹Optics, Univ. of Rochester, USA; ²Physics, Univ. of Ottawa, Canada; ³Physics, Univ. of Rochester, USA. A spatial mode analyzer based on a generalized Michelson interferometer is applied to the estimation of sub-Rayleigh limit incoherent point source separations. Proof-of-principle experimental measurements of a single shifted source are presented.

JW4A.125 **RAPID**

Rapid detection of variability and adulteration of diesel oils, Boniphace E. Kanyathare¹, Buratin Khampirat², Kai E. Peiponen³, Boonsong Sutapun¹; ¹Electronic Engineering, Suranaree Univ. of Technology, Thailand; ²School of General Education, Inst. of Social Technology, Suranaree Univ. of Technology, Thailand; ³Physics and Mathematics, Univ. of Eastern Finland, Finland. Adulteration and smuggling of diesel oils are serious problems. Vis-NIR and PCA were applied to study samples from same oil fields and refinery process. Variability and adulteration were both detected rapidly.

JW4A.126

Weak-measurement-enhanced Metrology in the Presence of CCD Noise and Saturation, Liang Xu¹, Zexuan Liu¹, Lijian Zhang¹; ¹Nanjing Univ., China. We experimentally demonstrate that the measurement using weak value amplification offers metrological advantages over the conventional measurement in the presence of classical noise and detection saturation with a generic scientific CCD.

JW4A.127

Naked-Eye Full-Screen Resolution Stereoscopic Imaging Based on Amplitude-Polarization Imager and Passive Distant Binocular Filter with Complementary Liquid Crystal Layers, Vasily A. Ezhov¹, Peter Ivashkin¹, Alexander Galstian¹; ¹GPI RAS, Russia. The described method of the naked-eye stereoscopic imaging is flicker-free at 60 Hz frame rate due to simultaneous reproducing both full-screen view images. High separation contrast is due to complementarity of LC layers of the imager and the filter.

JW4A.128

Using adaptive window and non-uniform sampling model to improve autofocus performances, Jie Cao¹, Yuqing Xiao¹, Qun Hao¹, Yang Cheng¹; ¹School of Optics and Photonics, Beijing Inst. of Technology, China. An adaptive autofocus method based adaptive sampling window and non-uniform sampling model is proposed. Model verification is carried out. The autofocus time under 8× using Laplacian (LAP) autofocus function reduces from 1670ms to 1240ms.

JW4A.129

Large field of view imaging based on compound and human hybrid eye using non-uniform curved microlens array, Yang Cheng¹, Jie Cao¹, Fanghua Zhang¹, Qun Hao¹; ¹Beijing Key Lab. for Precision Optoelectronic Measurement Instrument and Technology, School of Optics and Photonics, Beijing Inst. of Technology, China. A large field of view (FOV) imaging system based on compound and human hybrid eye using non-uniform curved microlens array is proposed. Model verification is carried out. The FOV of this system is up to 96°.

JW4A.130

Automatic snow grain size measurement method based on adaptive minimum circumscribed rectangle, Xintong Fan¹, Lingjia Gu¹, Ruizhi Ren¹, Haoyang Fu¹; ¹Jilin Univ., China. Snow grain size affects the brightness temperature of snow. At present, snow grain size is mainly based on manual measurement. In this paper, a method of automatic snow grain size measurement is proposed.

JW4A.131

Three-Dimensional Digital Reconstruction Methodology Specialized in Human Skulls, Andrés L. González¹, Jaime E. Meneses¹; ¹Universidad Industrial de Santander, Colombia. This paper presents a three-dimensional reconstruction strategy (3DR) specialized in the digital reconstruction of Human Skulls. The strategy is based on the fringe projection technique.

JW4A.132

Shadow Detection and Removal from Buildings in UAV Data, Tingting Zhou¹, Haoyang Fu¹; ¹Jilin Univ., China. Considering the problem that UAV data is susceptible to shadow interference, shadow detection and removal algorithms are used for buildings in UAV data in this paper.

JW4A.133

Low-rank Constrained Image Enhancement For Ghost Imaging, Tiaohua Li¹, Bin Luo¹, Dongchu Han¹, Junhui Li¹, Dongyue Yang¹, Guohua Wu¹, Hong Guo²; ¹Beijing Univ of Posts & Telecom, China; ²Peking Univ., China. Low-rank constraint improves image quality of ghost imaging, for both correlation and compressive sensing approaches. Image by correlation plus low-rank constraint can even surpass that by compressive sensing when under-sampling.

JW4A.134

Image compression in real-time holographic projection in color, Paula A. Kochanska¹, Michal Makowski¹, Izabela Ducin¹, Karol Kakarenko¹, Jaroslaw Suszek¹, Marcin Bieda¹, Adam Kowalczyk¹; ¹Faculty of Physics, Warsaw Univ. of Technology, Poland. In the paper we present holographic projection system used in holographic real-time transmission in color between Poland and Japan. We discuss visually-lossless data compression of CGH on the fly with client-adjustable compression ratios.

JW4A.135

Imaging Through Scattering Layers with Extension of Memory Effect Range Driven by Prior Information, Wei Li¹, Jiannan Wang¹, Jietao Liu¹, Xueying Sun¹, Guo Chengfei¹, Xiaopeng Shao¹; ¹Xidian Univ., China. We demonstrate numerically and experimentally that by exploiting a known object, or even a point as prior information, the speckle correlation imaging method can be used to observe the extended object exceeding the memory-effect range.

JW4A.136

Imaging through haze utilizing a multi-aperture coaxial polarization imager, Xuan Li¹, Pingli Han¹, Fei Liu¹, Yi Wei¹, Xiaopeng Shao¹; ¹Xidian Univ., China. This study focused on a polarization-based dehazing technology based on the multi-aperture coaxial polarization imager. By solving the image displacement problem accompanied with the imager, instant polarization dehazing is possible.

JW4A.137

Intramolecular Charge Transfer Probed by Femtosecond Stimulated Raman Spectroscopy, Sebok Lee¹, Myungsam Jen¹, Kooknam Jeon¹, Joonwoo Kim¹, Yoonsoo Pang¹; ¹Gwangju Inst of Science & Technology, South Korea. Distinct Raman spectra of the locally excited and charge transferred conformers of DCM were resolved from femtosecond stimulated Raman measurements and a twisted geometry was proposed for the intramolecular charge transfer state.

JW4A.138

Passively Q-switched Laser Performance of Nd_{0.01}Gd_{0.89}La_{0.1}NbO₄ Mixed Crystal, Haiyue Sun¹, Yufei Ma¹, Shoujun Ding², Zhenfang Peng¹, Ying He¹, Fang Peng², Xin Yu¹, Qingli Zhang²; ¹Harbin Inst. of Technology, China; ²Chinese Academy of Sciences, Hefei, China. Diode-pumped continue-wave and passively Q-switched lasers with novel Nd_{0.01}Gd_{0.89}La_{0.1}NbO₄ mixed crystals were demonstrated. The maximum peak power was 1.13 kW with the pulse width of 32 ns and the repetition rate of 24.5 kHz.

JW4A.139

Quantum-Classical Intersection from Perspective of Spatially-Resolved Intensity Interferometry, Piotr F. We-grzyn¹, Lukasz Zinkiewicz¹, Radek Lapkiewicz¹; ¹Faculty of Physics, Univ. of Warsaw, Poland. We present an extension to the intensity interferometry, which is an example of the intersection of quantum and classical theory. We believe that obtained results would contribute to deeper understanding of correspondence between those theories.

JW4A.140

Dynamic Laser Speckle applied to the determination of the specific surface area of clays, Ruth D. Mojica Sepulveda¹, Mendoza Herrera Luis Joaquin², Bertolini Guillermo³, Cabello Carmen I.³, Soria Delia B.¹, Trivi Marcelo²; ¹CEQUINOR, Argentina; ²Centro de Investigaciones Ópticas, Argentina; ³Centro De Investigacion Y Desarrollo En Ciencias Aplicadas, Argentina. Dynamic laser speckle (DLS) is proposed as a complementary technique to determine the specific surface area of natural and chemically modified bentonite. To verify this approach, we compared DLS technique with the standard physicochemical methods.

JW4A.141

Relativistic Single-Cycle Tunable Infrared Pulses Generated from a Tailored Plasma Density Structure, Zan Nie¹, Chih-Hao Pai¹, Jianfei Hua¹, Chaojie Zhang², Wei Lu¹, Hsu-Hsin Chu³, Jyhpyng Wang^{3,4}, Warren Mori², Chan Joshi²; ¹Tsinghua Univ., China; ²Univ. of California Los Angeles, USA; ³National Central Univ., Taiwan; ⁴Inst. of Atomic and Molecular Sciences, Academia Sinica, Taiwan. A new scheme capable of generating tunable relativistically intense, single-cycle pulses in the spectral range of 5-14 μm with a 1.7% conversion efficiency through asymmetric self-phase modulation in a tailored plasma density structure is proposed.

15:00–16:30

FW5A • AR and VR Ecosystems Developments*President: Jim Melzer; Thales Visionix; USA*FW5A.1 • 15:00 **Invited**

The Opportunities and Challenges of Creating Artificial Perception Through Augmented and Virtual Reality, Barry Silverstein¹; ¹*Optics and Display, Facebook Reality Labs., USA*. Researchers are beginning to create and deliver realistic artificial human inputs. These inputs of sight, sound, motion, and touch are being woven together into virtual and augmented reality systems that can emulate convincing human perception.

FW5A.2 • 15:30 **Invited**

Smart Glasses and AR Headsets for Enterprise and Consumer Markets, John Haddock¹; ¹*Osterhout Design Group, USA*. Abstract not available.

FW5A.3 • 16:00 **Invited**

The Age of Light: From an Electronic to a Photonic Society, Tish Shute^{1,2}; ¹*Dir. AR/VR, Huawei, USA, USA*; ²*Co-Founder, Augmented World Expo & Augmented Reality Org, USA*. This talk will look at the transformation from Electronics to Photonics and the important role AR/VR/MR will play in creating a Photonic Society and a better life for all.

15:00–16:30

FW5B • Optical Communications*President: Greg Raybon; Nokia Bell Labs, USA*FW5B.1 • 15:00 **Invited**

Rate-Adaptive Modulation Schemes for High Spectral Efficiency Optical Communications, Junho Cho¹, Sethumadhavan Chandrasekhar¹, Peter J. Winzer¹; ¹*Nokia Bell Labs, USA*. We review various rate-adaptive modulation schemes for optical communications that maximize the spectral efficiency for any channel condition, and analyze their benefits and weaknesses.

FW5B.2 • 15:30

Ultra-wideband parametric amplification in telecom wavelengths with an optimally mode-matched PPLN waveguide, Yong Meng Sua¹, Jia-Yang Chen¹, Yu-Ping Huang¹; ¹*Stevens Inst. of Technology, USA*. Ultra-wideband parametric amplification over 14 THz in the telecom band is realized via cascaded nonlinear processes in an optimally mode-matched PPLN waveguide. With a tailored waveguide cross-section, we observe a maximum gain of 38.3 dB.

FW5B.3 • 15:45

Generation of Phase-correlated Parametric Frequency Combs Spaced at 10GHz Based on Injection Locking, Jing Chen¹, Juanjuan Yan¹, Linnan Li¹; ¹*Beihang Univ., China*. We demonstrate a phase-correlated parametric frequency comb generator using injection locking. A frequency comb spaced at 10GHz is experimentally generated in a span of 3nm.

FW5B.4 • 16:00

Scaling Bandwidths of Optical Frequency Combs Generated in Silicon Modulators through Heterodyne Optical Frequency Locking., Nagarjun KP¹, Vikram B.S.¹, Roopa Prakash¹, Vadivukkarasi Jeyaselvan¹, Shankar K. Selvaraja¹, Supradeepa V.R.¹; ¹*IISc, Bangalore, India*. We demonstrate bandwidth-scaling of frequency combs in silicon charge-injection modulators by linking two 10GHz combs (8 lines) through heterodyne optical frequency-locking within 6.6MHz resulting in a broadened comb of 13 lines in a 30dB band.

FW5B.5 • 16:15

Free-Space Optical Stealth Communication Based on Wideband Noise, Yang Qi¹, Ben Wu¹; ¹*Electrical & Computer Engineering, Rowan Univ., USA*. We demonstrate a free-space optical (FSO) stealth communication system to protect the privacy of FSO channels. The signal is hidden in the phase randomness of wideband optical noise generated by spontaneous emission.

15:00–16:30

FW5C • Quantum Systems*President: Gordon A. Keeler; DARPA, USA*FW5C.1 • 15:00 **Invited**

A Dissipative Phase Transition in a Two-photon-driven Array of Kerr Resonators, Vincenzo Savona¹; ¹*Ecole Polytechnique Federale de Lausanne, Switzerland*. We show that an array of coupled Kerr resonators, with two-photon drive and dissipation, behaves as a quantum simulator of the quantum XY spin model with transverse field. We study the associated quantum phase transition and its universality class.

FW5C.2 • 15:30

Implementing Majorana Fermions in a Cold-Atom Honeycomb Lattice with Textured Pairings, Ruizhi Pan¹, Charles Clark¹; ¹*Univ. of Maryland, College Park, USA*. We propose a model to create unpaired Majorana fermions at one edge of a pseudospin-state dependent, time-reversal symmetry noninvariant honeycomb lattice by generalizing a topologically nontrivial Haldane model and introducing textured pairings.

FW5C.3 • 15:45

Self-trapping of light via the Pancharatnam-Berry phase, Chandroth P. Jisha², Alessandro Alberucci¹, Stefan Nolte^{1,3}; ¹*Friedrich-Schiller-Universität Jena, Germany*; ²*Universidade do Porto, Portugal*; ³*Fraunhofer Inst. of Applied Optics and Precision Engineering, Germany*. We discover a new type of light self-trapping based upon the Pancharatnam-Berry phase. These waves need a rotation of the optical axis dependent on the input light intensity, such as liquid crystals.

FW5C.4 • 16:00

Light Superfluidity in Hot Atomic Vapors, Quentin Fontaine¹, Alberto Bramati¹, Quentin Glorieux¹, Tom Bienaimé¹; ¹*Laboratoire Kastler Brossel, France*. We investigate the dispersion relation of small amplitude density waves propagating on top of a photon fluid. We also present two ongoing experiments to study dispersive shock waves and observe superfluidity of light.

FW5C.5 • 16:15

Goos-Hänchen shift in a two-dimensional atomic crystal, Michele Merano¹; ¹*Università degli Studi di Padova, Italy*. It is widely known that the Goos-Hänchen shift in three dimensional materials is proportional to the wavelength of the incident light. In freestanding two-dimensional crystals instead, it is proportional to their surface susceptibility.

15:00–16:30

FW5D • Quantum Sensing for Industry and Fundamental Physics II*Presider: To be Determined*FW5D.1 • 15:00 **Invited**

Commercialization of Quantum Sensing Technologies, Nils Hempler¹; ¹*M Squared Lasers, UK*. The presentation will describe M Squared's mission to transfer the demonstrated potential of quantum technologies from lab based demonstrator systems to fully engineered products that will benefit a wide range of industries.

FW5D.2 • 15:30 **Invited**

Time for Quantum Technologies: Optical Clocks for Users, Stephan Ritter¹; ¹*TOPTICA Photonics, Germany*. High-precision clocks are one of the first and most prominent examples of quantum technology. Optical clocks employ narrow-band optical transitions in atoms or ions as frequency standards, with applications ranging from synchronization and navigation to the measurement of height differences. As with other quantum technologies, optical clocks have to be brought out of the laboratory and into the hands of users in order to exploit their full application potential. To this end, a consortium of six companies, two universities, one research and one federal institute have teamed up to realize a robust, long-lasting and easy-to-use demonstrator device for an optical single-ion clock. The project, led by TOPTICA Photonics and the Physikalisch-Technische Bundesanstalt (PTB) and partially funded by the German Federal Ministry of Education and Research, will run for three years. It will on the one hand help to transfer scientific research results into industry and on the other hand leverage industrial expertise in project management, engineering, and system integration. In the talk, we will give an overview of the clock system and explain how the necessary development of key technologies will also benefit other quantum technologies. Related developments at TOPTICA will be sketched and we will review how this fits into the broader picture of a primarily quantum-enabling company.

15:00–16:30

FW5E • Plasmonic and Nanophotonic Materials*Presider: Mercedeh Khajavikhan; University of Central Florida, USA*FW5E.1 • 15:00 **Invited**

The Next Generation of Colloidal Quantum Emitters for Nanophotonics and Plasmonics, David Norris¹; ¹*ETH Zurich, Switzerland*. New quantum emitters with improved properties for nanophotonics will be discussed. Examples include lanthanide-doped nanocrystals, semiconductor nanoplatelets, and perovskite nanocrystals.

FW5E.2 • 15:30

Purcell Enhancement in 1-D ITO-slot Photonic Crystal Nanobeam Cavity, Rubab Amin¹, Mohammad H. Tahersima¹, Zhizhen Ma¹, Can Suer¹, Ke Liu¹, Rishi Maiti¹, Volker J. Sorger¹; ¹*The George Washington Univ., USA*. We report Si-slot waveguide with active-ITO layer 1D photonic crystal nanobeam cavity delivering 3.4 nm tuning keeping Q-factor moderately high. The subdiffraction limited mode volume ($0.1(\lambda/2n)^3$) facilitates a high Purcell factor exceeding 4000.

FW5E.3 • 15:45

Interactions of Hexagonal Boron Nitride with the Insulator-Metal Phase Transition in Vanadium Dioxide, Samuel T. White¹, Alireza Fali², Thomas G. Folland², Joshua D. Caldwell², Yohannes Abate², Richard F. Haglund¹; ¹*Vanderbilt Univ., USA*; ²*Physics, Univ. of Georgia, USA*; ³*Mechanical Engineering, Vanderbilt Univ., USA*. Phonon polaritons in hexagonal boron nitride (hBN) reflect and refract at phase domains in underlying vanadium dioxide (VO₂) crystals, a potential reconfigurable metasurface. Also, hBN slows the VO₂ phase transition via thermal or strain effects.

FW5E.4 • 16:00

MIR spin angular momentum detection by a chiral graphene plasmonic nanostructure, Jingyang Peng¹, Benjamin P. Cumming¹, Min Gu¹; ¹*School of Science, RMIT Univ., Australia*. A graphene-chiral plasmonic nanostructure photodetector that can detect MIR spin angular momentum (SAM) has been designed, modelled and fabricated. We demonstrate circular dichroism of 30% and absorption of 65% at a wavelength of 3.9 μm.

FW5E.5 • 16:15

Active photonic integrated circuits combining Si₃N₄ microresonators with 2D materials for applications in the visible wavelength range, Clément Javerzac-Galy¹, Junqiu Liu¹, Arslan S. Raja¹, Tobias Kippenberg¹, Domenico De Fazio², Alisson Cadore², Ioannis Paradeisanos², Giancarlo Soavi², Gang Wang², Andrea Ferrari²; ¹*Ecole Polytechnique Federale de Lausanne, Switzerland*; ²*Cambridge Graphene Centre, Univ. of Cambridge, UK*. We present air-cladded silicon nitride microresonators at visible wavelengths compatible with 2D material transfer, fabricated using the photonic Damascene reflow process. Quality factors of 1 million have been measured at 765 nm.

15:00–16:30

LW5F • Novel Lasers, Plasmonics, Nanophotonics II*Presider: Federico Capasso; Harvard University, USA*LW5F.1 • 15:00 **Invited**

Infrared Nanophotonics Based on Phonon Polaritons in Boron Nitride, Rainer Hillenbrand¹; ¹*Nanogune, Spain*. Thin hexagonal boron nitride layers host ultra-confined and long-lived phonon polaritons, which allow for manipulating mid-infrared light on the nanometer scale. We discuss our recent progress including phonon-enhanced molecular vibrational sensing and hyperbolic metasurfaces.

LW5F.2 • 15:30 **Invited**

Resolving Multipolar Transitions and Directional Metasurface Light Emission with Momentum-Resolved Spectroscopy, Jon Schuller¹; ¹*Univ. of California Santa Barbara, USA*. In momentum-resolved spectroscopy, researchers measure or control light's momentum content. Using momentum-resolved spectroscopy, we demonstrate multipolar light emission in layered perovskites and directional light emission in GaN metasurfaces.

LW5F.3 • 16:00 **Invited**

Plasmonic Metasurfaces: Combinatorial Colors and High-Speed Photodetection, Maiken Mikkelsen¹; ¹*Duke Univ., USA*. Plasmonic film-coupled nanocubes are used to demonstrate large-area perfect absorbers, pixel arrays and ~10,000 combinatorial colors. By integrating a pyroelectric thin-film, we also demonstrate a high-speed, spectrally-selective thermal photodetector operating at room temperature.

16:45–18:45

FW6A • New Optical Hardware is Key to Next Generation AR and MR

Presider: Patricia Shute; Huawei, USA

FW6A.1 • 16:45 **Invited**

Recreating Reality: Enabling Immersive VR/AR Experience on Mobile Platforms, Behnam Bastani¹; ¹Oculus, USA. The talk outlines how a full system integration, from content creation, to transmission to display optics play an important role on delivering an immersive experience in head-mounted displays. It highlights the challenges in the industry especially as customer would like to have a more realistic experience on standalone devices.

FW6A.2 • 17:15 **Invited**

Meta-Resonant Waveguide-Gratings - Monochromatic Diffraction to AR, Guillaume Basset¹; ¹Resonant Screens, Switzerland. Meta-Resonant Waveguide-Gratings can be engineered to have selective and tunable diffraction, while being manufactured with high throughput methods. This enables new optical combiners for AR being affordable, compact and providing a better immersion.

FW6A.3 • 17:45 **Invited**

Is LCOS the Display of Choice for AR?, Poking Li¹; ¹Himax, Taiwan. Abstract not available.

16:45–18:15

FW6B • Novel Optical Fibers and Modulators

Presider: Lyuba Kuznetsova; San Diego State University; USA

FW6B.1 • 16:45 **Invited**

High Performance Chalcogenide Photonic Crystal Fibers Pumped in the Short Wave Infrared, Camille-Sophie Bres¹; ¹Ecole Polytechnique Federale de Lausanne, Switzerland. We present recent advances in Chalcogenide photonic crystal fibers for use in the short wave infrared. Results on fiber quality, nonlinear parametric effects and supercontinuum generation are covered.

FW6B.2 • 17:15

Photonic crystal fiber metalens-enabled by geometric phase optical metasurfaces, Jingyi Yang¹, Indra Ghimire¹, Pin Chieh Wu², Sudip Gurung¹, Catherine Arndt¹, Din Ping Tsai², Howard Lee^{1,3}; ¹Dept. of Physics, Baylor Univ., USA; ²Research Center for Applied Sciences, Academia Sinica, Taiwan; ³The Inst. for Quantum Science and Engineering, Texas A&M Univ., USA. We demonstrate an in-fiber chromatic metalens that can focus light upon exiting the fiber with numerical-aperture of 0.3714 at wavelength of 1550 nm by integrating geometric phase metasurface on the end-facet of photonic crystal fiber.

FW6B.3 • 17:30

Virtual Draw of Tubular Hollow-Core Fibers, Gregory T. Jasion¹, John R. Hayes¹, Natalie V. Wheeler¹, Yong Chen¹, Thomas D. Bradley¹, Reza Sandoghchi¹, Marco Petrovich¹, Francesco Poletti¹, David Richardson¹; ¹Optoelectronics Research Centre, Univ. of Southampton, UK. A numerical model that accurately predicts the fabricated geometry of tubular hollow-core fibers is presented and experimentally validated. Such a model can be invaluable in driving design decisions for yield upscaling and loss reduction.

FW6B.4 • 17:45

Composite Material Hollow Core Optical Fiber Electro-Modulation, Adam Lewis¹, Francesco De Lucia¹, Walter Belardi¹, Chung-Che Huang¹, John R. Hayes¹, Francesco Poletti¹, Dan Hewak¹, Pier Sazio¹; ¹Univ. of Southampton, UK. We demonstrate the integration of the Transition Metal Dichalcogenide (TMDC) materials WS₂ and MoS₂ into hollow core anti-resonant fibers. We show the potential to use such structures as all fiber electro-optical modulators.

16:45–18:15

FW6C • Solid State Quantum Optics

Presider: Vincenzo Savona; Ecole Polytechnique Federale de Lausanne, Switzerland

FW6C.1 • 16:45 **Invited**

Deterministic Coupling of Quantum Emitters in Two-dimensional Materials to Optical Cavities, Stefan Strauf¹; ¹Stevens Inst. of Technology, USA. We review our recent work on deterministic coupling of site controlled quantum emitters in WSe₂ to plasmonic nanocavities as well as integration schemes for quantum emitters in boron nitride to metallo dielectric antennas.

FW6C.2 • 17:15

Charge-Tunable Quantum Dots in Monolayer WSe₂, Mauro Brotons-Gisbert¹, Artur Branny¹, Santosh Kumar¹, Raphael Picard¹, Raphael Proux¹, Brian Gerardot¹; ¹Heriot-Watt Univ., UK. We demonstrate Coulomb blockade in monolayer WSe₂ quantum dots. Further, gate tunable hybridization of the localized and continuum of electron states in a Fermi sea is observed due to strong tunnel interaction.

FW6C.3 • 17:30

A Silicon Photonic On-Chip Filter for Quantum Emitters, Shahriar Aghaeimebodi¹, Je-Hyung Kim², Mustafa Atabey Buyukkaya¹, Chang-Min Lee¹, Christopher J. Richardson³, Richard P. Leavitt³, Edo Waks^{1,4}; ¹Electrical and Computer Engineering, Univ. of Maryland, USA; ²Dept. of Physics, Ulsan National Inst. of Science and Technology, South Korea; ³Lab for Physical Sciences, Univ. of Maryland, USA; ⁴Joint Quantum Inst., Univ. of Maryland, USA. We demonstrate on chip filtering of single photons using a hybrid integrated device that contains III/V quantum dots and a silicon-on-insulator photonic disk resonator.

FW6C.4 • 17:45

Enhancing Two-Photon Emission From Epitaxially Grown Quantum Dot With Nanoantennas, Andrzej Gajewski¹, Karolina Slowik¹, Jakob Straubel², Carsten Rockstuhl¹; ¹Nicolaus Copernicus Univ., Poland; ²Karlsruhe Inst. of Technology, Germany. We present the result of broad analysis of enhancement and control of emission of an entangled two-photon pair from the epitaxially grown quantum dot (InAs/InP) by the mean of nanoantennas.

16:45–18:15

FW6D • Quantum Computing with Atoms and Photons I*Presider: To be Determined*FW6D.1 • 16:45 **Invited**

Photonic Integrated Circuits for Scalable Quantum Networks, Dirk Englund¹; ¹MIT, USA. Photonic integrated circuits (PICs) have become increasingly important in classical communications applications over the past decades, including as transmitters and receivers in long-haul, metro and datacenter interconnects. Many of the same attributes that make PICs attractive for these applications — compactness, high bandwidth, and the ability to control large numbers of optical modes with high phase stability — also make them appealing for quantum information processing. The first part of this talk will review our recent progress in adapting one of the leading PIC architectures—silicon photonics—for various quantum secure communications protocols. The second part of the talk will describe how photonic integrated circuits technology can extend the reach of quantum communications through all-optical and memory-based quantum repeater protocols.

FW6D.2 • 17:15 **Invited**

Quantum Control and Metrology with Trapped Ions, Michael Biercuk¹; ¹Univ. of Sydney, Australia. In this talk we provide an overview of the field of quantum control engineering and the tools we have built to enhance the performance of quantum devices for applications in quantum computing and quantum sensing. We introduce the concept of the filter function, a simple heuristic tool to characterize the decoherence-sensitivity of arbitrary quantum operations performed on single or multi-qubit devices. We perform experiments with trapped ions to validate the predictive power of the filter functions and demonstrate how they can enable quantum control solutions addressing major challenges in both error suppression for quantum computing and narrowband detection for quantum sensing. These concepts form the fundamental tools at the heart of our venture-backed quantum technology startup Q-CTRL.

16:45–18:15

FW6E • Meta- and Nanophotonic Devices for Imaging and Applications*Presider: David Norris; ETH Zurich, Switzerland*FW6E.1 • 16:45 **Invited**

Medical Device Applications of Silicon Photonics, Roel G. F. Baets¹, Yanlu Li¹; ¹Ghent Univ., INTEC and IMEC, Belgium. Silicon photonics enables compact and cost-effective photonic integrated circuits, based on manufacturing in CMOS fabs. It can serve point-of-care medical device applications. Here we focus on multi-beam laser Doppler vibrometry circuits for cardiovascular disease monitoring.

FW6E.2 • 17:15

Symmetric cladding thin film waveguides – from lossy media to disordered metasurfaces, Karsten Pufahl¹, D. Boyaciyan², Jan Heckmann¹, Philipp Franz¹, Nicolai B. Grosse¹, Regine v. Klitzing², Ulrike K. Woggon¹; ¹Technische Universität Berlin, Germany; ²TU Darmstadt, Germany. Symmetric cladding thin film waveguides (SCTW) are investigated with respect to nonlinear response and propagation length. Enhancement of both is demonstrated on thin metal films and functionalized metasurfaces (Au nanoparticles in a polymer brush).

FW6E.3 • 17:30

Dynamic Pulse Shaping by Metasurfaces, Shawn Divitt^{1,2}, Wenqi Zhu^{1,2}, Cheng Zhang^{1,2}, Henri Lezec², Amit Agrawal^{1,2}; ¹Univ. of Maryland College Park, USA; ²National Inst. of Standards and Technology, USA. Metasurfaces offer the ability to shape optical pulses with unprecedented resolution. Here, we demonstrate dynamic shaping of <15 femtosecond ultrafast laser pulses using a Taylor series system in conjunction with silicon metasurfaces.

FW6E.4 • 17:45

A Broadband Achromatic Metalens, Yi-Teng Huang², Hsin Yu Kuo¹, Pin Chieh Wu²; ¹National Taiwan Univ., Taiwan; ²California Institute of Technology, USA. Metalens suffers from chromatic aberration issue, which limits its applications on color images. Here we demonstrate the first broadband achromatic metalens in visible wavelength based on the concept of integrated-resonant unit elements (IRUEs).

16:45–18:15

LW6F • Novel Lasers, Plasmonics, Nanophotonics III*Presider: Andrea Alu; University of Texas at Austin, USA*

LW6F.1 • 16:45

Active-Cavity Optomechanics: A Self-Cooling Laser, John Lawall¹, Adarsh Ganesan¹, Justin Foley¹, Weijian Yang², Christopher Chase³; ¹NIST, USA; ²Electrical and Computer Engineering, Univ. of California at Davis, USA; ³Bandwidth 10, Inc., USA. We demonstrate interferometrically that a laser with a mechanically compliant output coupler can optically self-cool its fundamental mechanical mode from room temperature to an effective temperature of 30 K.

LW6F.2 • 17:00

Quantum-Well Diode Lasers for Frequency Comb Generation, Mark Dong¹, Herbert G. Winful¹, Steven T. Cundiff¹; ¹Univ. of Michigan, USA. We experimentally demonstrate single-section InGaAsP/InP quantum-well diode lasers for frequency comb generation at 1.5 μm and 1.3 μm wavelengths. Their optical and RF spectra are measured and analyzed.

LW6F.3 • 17:15

Low-Threshold Lasing From Monolithic Nanostructured Porous Silicon Hybrid Microcavities, Giuseppe Barillaro¹; ¹Information Engineering, Univ. of Pisa, Italy. Here we demonstrate low-threshold lasing from fully-transparent nanostructured porous silicon (PSi) monolithic microcavities (MCs) infiltrated with a polyfluorene derivative that supports single-mode blue lasing at 466 nm, with line width of ~ 1.3 nm and lasing threshold of 5 nJ (i.e. fluence of 15 $\mu\text{J}/\text{cm}^2$).

LW6F.4 • 17:30

Observed Phase-locking Between a Rubidium Raman Laser and its Pump Laser, Nicholas Condon^{1,2}, Devin Hileman^{1,2}, Shih Tseng^{1,2}, Zifan Zhou¹, Selim M. Shahriar¹; ¹Northwestern Univ., USA; ²Digital Optics Technologies, USA. We have observed that the beat-note between a rubidium Raman ring laser and its gain pump is much narrower than the spectral width of the pump laser itself, indicating that they are mutually phase-locked.

LW6F.5 • 17:45

Novel free space and fiber laser cavities demonstrating extreme sensitivities in Intracavity Phase Interferometry systems, James Hendrie¹, Hanieh Afkhamiardakani¹, Luke Horstman¹, Matthias Lenzner¹, Ladan Arissian¹, Jean Claude Diels¹; ¹Univ. of New Mexico, USA. A method to enhance the sensitivity of sensors based on Intracavity Phase Interferometry by a factor of up to 10,000 is demonstrated in a free space laser. This technique is then implemented in fiber lasers.

FiO

FW6A • New Optical Hardware is Key to Next Generation AR and MR—Continued**FW6B • Novel Optical Fibers and Modulators—Continued****FW6C • Solid State Quantum Optics—Continued****FW6B.5 • 18:00**

Integrated Visible-Light Liquid-Crystal Phase Modulator, Milica Notaros¹, Manan Raval¹, Jelena Notaros¹, Michael R. Watts¹; ¹*MIT, USA*. An integrated liquid-crystal phase modulator for applications within the visible wavelength range is demonstrated. A threshold voltage of ± 1.2 V is shown and 24π phase shift is achieved within ± 2.5 V in a 500- μ m-long modulator.

FW6C.5 • 18:00

Field Effect Transistors Deploying Anisotropic Two-Dimensional Materials for Light Generation and Detection, Ergun Simsek¹, Mengqing Yuan², Qing H. Liu²; ¹*Electrical Engineering and Computer Science, Exponent, USA*; ²*Electrical and Computer Engineering, Duke Univ., USA*; ³*Wave Computation Technologies, USA*. Photodetector sensitivity and photoluminescence efficiency of ReS₂ coated SiO₂/Si substrates are studied. For ultra-thin applications, metal nanoparticles embedded in Si yield maximum enhancement.

FW6A.4 • 18:15 **Invited**

Stereo, Parallax, Wavefronts, and Immersion - Where is the Value?, Joel S. Kollin¹; ¹*Microsoft, USA*. The dominant display paradigm (smart phones) prioritizes convenience over performance, and wrist- and head-mounted displays have yet to gain traction. How do we ensure that HMD doesn't follow stereoscopic video into niche markets or irrelevance?

18:15–19:00 Dinner break on your Own

19:00–21:00 Postdeadline Papers (View Conference Updated Sheet for list of talks and locations.)

FiO

LS

FW6D • Quantum Computing with Atoms and Photons—Continued

FW6E • Meta- and Nanophotonic Devices for Imaging and Applications—Continued

FW6E.5 • 18:00

Dynamic Transmission Control Based on All-Dielectric Huygens Metasurfaces, Austin A. Howes¹, Wenyi Wang¹, Ivan Kravchenko², Jason Valentine¹; ¹*Vanderbilt Univ., USA*; ²*Oak Ridge National Lab, USA*. Dielectric metasurfaces exhibit low-loss modes, but their volumetric field profiles make them difficult to dynamically tune. We overcome this issue by coupling resonators to an epsilon-near-zero mode in a thin film to actively modulate transmittance.

LW6F • Novel Lasers, Plasmonics, Nanophotonics III—Continued

LW6F.6 • 18:00

A Free-space Brillouin Laser Using Diamond, Zhenxu Bai¹, Robert Williams¹, Ondrej Kitzler¹, Soumya Sarang¹, David Spence¹, Richard Mildren¹; ¹*MQ Photonics Research Centre, Dept. of Physics and Astronomy, Macquarie Univ., Australia*. Continuous-wave lasing in a free-space crystal Brillouin laser is demonstrated using CVD diamond. For a <111> polarized pump a threshold of 125 W is obtained, which corresponds to a gain coefficient of 60 cm/GW.

18:15–19:00 Dinner break on your Own

19:00–21:00 Postdeadline Papers (View Conference Updated Sheet for list of talks and locations.)

FiO

08:00–09:00

FTh1A • Vision Comfort as a Key to AR Mass Adoption

Presider: Barry Silverstein; Oculus, USA

FTh1A.1 • 08:00 **Invited**

Optimizing Head mounted Light Field Displays for Quality and Comfort, Hong Hua¹; ¹Univ. of Arizona, USA. In this presentation, we describe a generalized framework to model the image formation process of light-field display methods and present a systematic method to characterize the retinal image and the accommodation response rendered by a light field display. We further employ this framework to investigate engineering guidelines for designing a 3D light field displays with a balance of quality and view comfort.

FTh1A.2 • 08:30 **Invited**

Title to be Determined, Edward Tang¹; ¹Avegant Corporation, USA. Abstract not available.

08:00–09:00

FTh1B • Quantum Information

Presider: Momchil Minkov; Stanford University, USA

FTh1B.1 • 08:00 **Invited**

Silicon Photonics for Generating and Manipulating Entangled Photons, Shayan Mookherjee¹, Chaoxuan Ma¹, Xiaoxi Wang¹; ¹Univ. of California San Diego, USA. Review of recent advances, future challenges and the state-of-the-art in integrated silicon photonics for quantum optical communications and other applications of heralded single and entangled photons.

FTh1B.2 • 08:30

High-precision phase noise estimation for continuous-variable quantum key distribution, Yijia Zhao¹, Yichen Zhang¹, Yundi Huang¹, Song Yu¹, Hong Guo²; ¹Beijing Univ of Posts & Telecom, China; ²Peking Univ., China. We propose a high-precision phase noise estimation for continuous-variable quantum key distribution to reduce the phase noise caused by inaccurate estimation. The phase noise is reduced below 1/10 by using modified reference data.

FTh1B.3 • 08:45

Unsupervised Machine Learning Control of Quantum Gates in Gate-Model Quantum Computers, Laszlo Gyongyosi^{2,1}, Sandor Imre¹; ¹Budapest Univ of Technology & Economic, Hungary; ²Univ. of Southampton, UK. The precise and stable working of quantum gates in quantum computers is essential for any quantum computations. We define a machine learning-based framework for the unsupervised control of entangled quantum gates in gate-model quantum computers.

08:00–09:00

FTh1C • Shaping Light and Design of Quantum Devices

Presider: Greg Gbur; University of North Carolina at Charlotte, USA

FTh1C.1 • 08:00 **Invited**

Framework for Complex Quantum State Generation and Coherent Control Based on On-Chip Frequency Combs, Piotr Roztock¹, Christian Reimer^{1,3}, Stefania Sciar^{1,4}, Luis Romero Cortés¹, Yanbing Zhang¹, Benjamin Wetzl^{1,5}, Mehedi Islam¹, Alfonso Cino⁶, Sai Chu⁶, Brent Little⁷, David Moss⁸, Lucia Caspani⁹, Jose Azaña¹, Michael Kues^{1,10}, Roberto Morandotti^{1,2}; ¹INRS-Energie Mat & Tele Site Varennes, Canada; ²National Research Univ. of Information Technologies, Mechanics and Optics, Russia; ³Harvard Univ., USA; ⁴Univ. of Palermo, Italy; ⁵Univ. of Sussex, UK; ⁶City Univ. of Hong Kong, China; ⁷Chinese Academy of Science, China; ⁸Swinburne Univ. of Technology, Australia; ⁹Univ. of Strathclyde, UK; ¹⁰Univ. of Glasgow, UK. Integrated frequency combs introduce a scalable framework for the generation and manipulation of complex quantum states (including multi-photon and high-dimensional states), using only standard silicon chip and fiber telecommunications components.

FTh1C.2 • 08:30 **Invited**

Connecting Quantum Systems through Optimized Photonics, Jelena Vuckovic¹; ¹Stanford Univ., USA. Our inverse design approach offers a powerful tool to implement classical and quantum photonic circuits with superior properties, including robustness to errors in fabrication and temperature, compact footprints, novel functionalities, and high efficiencies. We illustrate this with a number of demonstrated devices in silicon and in diamond.

09:00–09:15 Break

09:15–10:00

FTh2A • Visionary: Sir Peter Knight

Presider: Kartik Srinivasan; National Inst of Standards & Technology, USA

FTh2A.1 • 09:15 **VISIONARY**

Quantum Technology for a Networked World, Peter L. Knight¹; ¹Kavli Royal Society International Ctr, UK. I will describe the worldwide efforts to develop quantum technology, exploiting coherence and superposition. A second quantum revolution is emerging with electronic and photonic devices that use quantum science, harnessing our ability to interact with atoms, photons and electrons with exquisite level of control and with transformative potential for technology.

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

08:00–09:00

FTh1D • Quantum Computing with Atoms and Photons II*Presider: To be Determined*FTh1D.1 • 08:00 **Invited**

Quantum computing with Neutral Atoms, David Weiss¹; ¹*Dept. of Physics, Penn State Univ., USA*. I will describe our approach to neutral atom quantum computing using a 3D optical lattice. We have previously demonstrated perfect filling of 5x5x2 and 4x4x3 arrays and site-addressed single qubit gates with 0.997 fidelity and low cross talk. Most recently, we have achieved lossless state detection with fidelities exceeding 0.999.

FTh1D.2 • 08:30 **Invited**

Reconfigurable and Programmable Ion Trap Quantum Computer, David Moehring, Jungsang Kim; *IonQ, USA*. Trapped atomic ion qubits present a fundamentally scalable approach to quantum computation. All qubits are identical, and interactions can be faithfully replicated and measured with near-perfect efficiency. Unlike many other approaches to quantum hardware, trapped ion qubits operate effectively at room-temperature, and even allow for reconfigurable quantum circuits. This flexibility will likely allow ion trap quantum computers to express the super-set of all known quantum computation operations, and thus efficiently target any type of application that arises.

08:00–09:00

FTh1E • Computational/Transformation Optics and Optics in Computing*Presider: Simon Horsley; Exeter University, United Kingdom*FTh1E.1 • 08:00 **Invited**

Topology and the optical Dirac equation, S. A. R. Horsley¹; ¹*Univ. of Exeter, UK*. Maxwell's equations can be written as an effective Dirac equation (the 'optical Dirac equation'), which can be a useful tool to classify electromagnetic materials. This analogy can be provide a new way to relate the integral of the Berry curvature (the Chern number) to the number of interface states. In contrast to the common approach we show that the Chern number can be computed without knowledge of how the material parameters depend on frequency.

FTh1E.2 • 08:30

Optical Convolutional Neural Networks with Optimized Phase Masks for Image Classification, Julie Chang¹, Vincent Sitzmann¹, Gordon Wetzstein¹; ¹*Electrical Engineering, Stanford Univ., USA*. Convolutional neural networks excel in many computer vision applications but exert high computational demands. We propose a zero-power optical convolutional layer that can be incorporated for increased efficiency and show its potential in simulation.

FTh1E.3 • 08:45

Deep Neural Networks for Information Recovery Through Multimode Fibers, Eirini Kakkava¹, Navid Borhani¹, Christophe Moser¹, Demetri Psaltis¹; ¹*Ecole Polytechnique Federale de Lausanne, Switzerland*. Image classification and reconstruction from the intensity speckle patterns at the distal end of a multimode fiber (MMF) was demonstrated using Deep Neural Networks (DNNs). Handwritten digits were recovered after propagation in 1 km long MMF.

08:00–09:00

LTh1F • Precision Laser Spectroscopy*Presider: Konstantin Vodopyanov; University of Central Florida CREOL, USA*LTh1F.1 • 08:00 **Invited**

Development of Cryogenic Strontium Optical Lattice Clocks and their Applications, Masao Takamoto¹, Ichiro Ushijima^{2,1}, Hidetoshi Katori^{2,1}; ¹*RIKEN, Japan*; ²*The Univ. of Tokyo, Japan*. The recent progress of optical lattice clocks has improved the accuracies to 10⁻¹⁸, which outperforms the realization of the SI second. We will present the development of the clocks and their applications in geodetic measurements.

LTh1F.2 • 08:30

Laser system to laser-cool and trap cadmium: towards a cadmium optical lattice clock, Daniel T. Schussheim¹, Kurt Gibble¹; ¹*The Pennsylvania State Univ., USA*. We use frequency doubling and summing to generate >1 W of 326 nm to laser cool cadmium. Other wavelengths, 361, 468, and 480 nm, are also generated from the high power fiber amplifier. We developed an FPGA controller to automatically lock the system.

LTh1F.3 • 08:45

Optimization of acousto-optic frequency combs for multi-heterodyne spectroscopy, Kanagaraj Nithyanandan¹, Leao Djevarhidjian¹, Vicente Duran¹, Come Schnébelin¹, Samir Kassi¹, Guillaume Mejean¹, Daniele Romanini¹, Guillet de Chatellus Hugues¹; ¹*CNRS / Université Grenoble Alpes, France*. Acousto-optic frequency combs provide more than 1000 mutually-coherent lines, and are a valuable tool for multi-heterodyne coherent spectroscopy. We present and validate a simple model of acousto-optic frequency combs, and discuss their limitations.

09:00–09:15 Break

09:15–10:00

LTh2B • Visionary: David DeMille*Presider: Nathan Newbury; NIST, USA*LTh2B.1 • 09:15 **VISIONARY**

Activities Shaping the Wavefront of Nanophotonics, David DeMille¹; ¹*Yale Univ., USA*. Remarkably, certain ultra-precise spectroscopic measurements are sensitive to the existence of certain new, yet-undiscovered particles whose mass far exceeds that of the recently discovered Higgs boson. This talk will describe ongoing and future examples of such measurements, including the ACME experiment, a search for the electron's electric dipole moment.

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

10:30–12:30

FTh3A • AR/VR Applications for Enterprise and Consumer Markets

President: Hong Hua; University of Arizona, USA

FTh3A.1 • 10:30 **Invited**

Waveguide Manufacturing for AR Displays, Past, Present and Future, Jonathan Waldern¹; ¹DigiLens, USA. Current AR waveguide fabrication processes, including Surface Relief Gratings (SRG), holographic and cascaded mirrors, are reviewed. We present DigiLens's Switchable Bragg Grating (SBG) based process, a manufacturing method based on classical holographic contact copy, which today is used for both large and small AR displays including a range of displays suitable for HUD and XR applications.

FTh3A.2 • 11:00 **Invited**

Augmented Reality Smart Glasses: Disruption or Distraction?, Kayvan Mirza¹; ¹Optinvent, France. The destiny of mobile AR has been inextricably linked to the success of Smart Glasses. Although there is some traction in the enterprise space, consumer adoption has remained elusive. Will the next generation of Smart Glasses be more successful than their predecessors in bringing AR to the masses?

FTh3A.3 • 11:30 **Invited**

Use of AR and smart glasses at Erie Insurance, Brett McCorkle¹; ¹Erie Insurance, USA. The insurance industry is rooted in legacy technology and business practices. Introducing technologies like smart glasses and AR is challenging due to change resistance and technical uncertainty. Using human-focused design in your implementation helps you engage users and increase the likelihood of adoption.

10:30–12:30

FTh3B • Quantum Electronics

President: Shayan Mookherjea; University of California San Diego, USA

FTh3B.1 • 10:30 **Invited**

Quantum-state Generation and Frequency-Domain Manipulation using Nanophotonics, Kartik Srinivasan¹; ¹NIST, USA. I will review experiments on the generation and frequency-domain manipulation of photonic quantum states using scalable nanophotonic devices, and discuss their relevance to several applications in photonic quantum information science.

FTh3B.2 • 11:00

On-demand four-wave mixing parametric processes in periodically-tapered waveguides, Mohammed F. Saleh¹; ¹Heriot Watt Univ., UK. I show using Fourier-series analysis how sinusoidally-tapered waveguides can be employed as efficient quasi-phase-matching schemes in third-order nonlinear media for on-demand four-wave mixing parametric processes, such as third-harmonic generation.

FTh3B.3 • 11:15

Complementarity of Vectorial Quantum Light, Andreas Norrman¹, Kasimir Blomstedt², Tero Setälä², Gerd Leuchs^{1,3}, Ari Tapio Friberg²; ¹Max Planck Inst. for the Science of Light, Germany; ²Univ. of Eastern Finland, Finland; ³Univ. of Erlangen-Nuremberg, Germany. We study partial coherence and polarization in double-pinhole interference and establish two general complementarity relations for genuine vectorial quantum-light fields. The framework uncovers new fundamental aspects of photon wave-particle duality.

FTh3B.4 • 11:30

Increasing Sensitivity of an Atom Interferometer to the Heisenberg Limit using Enhanced Quantum Noise, Renpeng Fang¹, Resham Sarkar¹, Selim M. Shahriar¹; ¹Northwestern Univ., USA. We show how, by using a Schrodinger Cat state, the sensitivity of an atomic interferometer can be increased, to the Heisenberg limit, while enhancing the quantum noise, thereby suppressing strongly the effect of excess noise.

FTh3B.5 • 11:45

Self-similar Pulse Compression in the Tapered Silicon Waveguide, Jiayao Huang¹, Aruna Gandhi M S¹, Qian Li¹; ¹Peking Univ., China. We demonstrate self-similar pulse compression in the tapered silicon waveguide. The initial 1 ps pulse can be compressed to 76.4 fs, and the corresponding peak power is 7.1 times compared to the initial pulse.

10:30–12:30

FTh3C • Optical Comb Metrology

President: Judith Dawes; Macquarie University, Australia

FTh3C.1 • 10:30 **Invited**

Spatio-temporal Manipulation of Light Waves by use of Optical Frequency Combs, Kaoru Minoshima^{1,2}, Akifumi Asahara^{1,2}; ¹Univ. of Electro-Communications, Japan; ²JST ERATO MINOSHIMA Intelligent Optical Synthesizer (IOS), Japan. Relative carrier envelope phase control in the dual-comb was utilized to generate an advanced light source for versatile spatiotemporal phase manipulation. Optical vortex comb is experimentally demonstrated with application for optical tweezers.

FTh3C.2 • 11:00

Efficient Non-Linear Optical Spectroscopy with Multiple High-Frequency Modulated Optical Frequency Combs, Ayan Chattopadhyay¹, Alexei Goun¹, Herschel Rabitz²; ¹Princeton Univ., USA. High signal-to-noise detection of the non-linear polarization is obtained, utilizing multiple high-frequency modulated optical frequency combs that place the observed polarization in the field-free region within comb line structure.

FTh3C.3 • 11:15

Bridging Telecom Wavelengths to Alkali Atomic Transitions with Tunable Kerr Frequency Combs, Su-Peng Yu^{1,2}, Travis C. Briles^{1,2}, Gregory T. Moille³, Xiyuan Lu³, Scott A. Diddams^{1,2}, Kartik Srinivasan³, Scott B. Papp^{1,2}; ¹Time and Frequency Division, NIST Boulder, USA; ²Dept. of Physics, Univ. of Colorado, USA; ³Center for Nanoscale Science and Technology, NIST Gaithersburg, USA. We report a silicon-nitride microresonator frequency comb platform that provides coverage from the telecom L band to the 780 nm range. Arbitrary design and generation of Kerr-soliton combs enables continuous fine-tuning across the entire bandwidth.

FTh3C.4 • 11:30

Progress Towards a Three-Node Free-Space Clock Network, Paritosh Manurkar¹, Sarah Stevenson¹, Isaac Khader¹, Jean-Daniel Deschenes², William Swann¹, Nathan R. Newbury¹, Laura Sinclair¹; ¹NIST Boulder, USA; ²Octosig Consulting, Canada. We report the latest progress towards the development of a three-node free-space clock network. We will demonstrate clock comparison between two optical nodes via coherent time/frequency transfer through a third node.

FTh3C.5 • 11:45

Towards Isolated Attosecond Pulses at 100 kHz for Electron-Ion Coincidence Spectroscopy, Federico J. Furch¹, Tobias Witting¹, Felix Schell¹, Mikhail Osolodkov¹, Claus Peter Schulz¹, Marc J. Vrakking¹; ¹Max Born Inst., Germany. We report on the progress towards isolated attosecond pulses in the extreme ultraviolet at 100 kHz with high photon flux. The system will be used in pump-probe experiments detecting electrons and ions in coincidence

10:30–12:30

FTh3D • Quantum Communications and the Future Quantum Internet*Presider: To be Determined*FTh3D.1 • 10:30 **Invited**

Quantum Dot Based Devices for Telecom Wavelength Quantum Networks, Joanna Skiba-Szymanska¹, Tina Müller¹, Andrey Krysa², Jan Huwer¹, Ginny Shooter¹, Mathew Anderson¹, Martin Felle¹, Ian Farrer², Richard Pentz³, Richard M. Stevenson¹, Jon Heffernan², David Ritchie³, Andrew Shields¹; ¹Toshiba Research Europe Ltd., UK; ²Univ. of Sheffield, UK; ³Univ. of Cambridge, UK. Quantum networks rely on robust and secure distribution of quantum states to share entanglement between connected technologies. We demonstrate quantum dot based devices that use photons as flying qubits within existing fibre optics infrastructure.

FTh3D.2 • 11:00 **Invited**

Quantum Computation and Quantum Information, Ian Walmsley¹; ¹Univ. of Oxford, UK. Hybrid light-matter networks offer the promise for delivering robust quantum information processing technologies, from sensor arrays to quantum simulators. New sources, circuits, detectors and memories illustrate progress towards building a resilient, scalable photonic quantum network.

FTh3D.3 • 11:30 **Invited**

Quantum Communication Experiments with Telecom-band Photonics Technologies, Hiroki Takesue¹; ¹NTT Basic Research Labs, Japan. We present our effort to realize basic functions for advanced quantum communication systems using telecom-band photonics technologies, including entanglement sources using nano-scale silicon devices and quantum logic gate for time-bin qubits based on electro-optic modulators.

10:30–12:30

FTh3E • Information Processing, Information Display and Optical Device*Presider: Michael Klug; Magic Leap, USA*FTh3E.1 • 10:30 **Invited**

Optics for Wearable Spatial Computing Systems, Michael Klug¹; ¹Magic Leap, USA. Spatial Computing requires visual system and wearable display compatibility for accurate perception, user comfort, and effective interaction. We present optical approaches that balance these goals with demands for manufacturability and practicality.

FTh3E.2 • 11:00

Digitally designed HOE lens arrays for large size see-through head up displays, Jackin Boaz Jessie¹, Lode Jorissen², Ryutaro Oi¹, Koki Wakunami¹, Yasuyuki Ichihashi¹, Philippe Bekaert², Kenji Yamamoto¹; ¹National Inst of Information & Comm Tech, Japan; ²Expertise Center for Digital Media, Hasselt Univ.-tUL, Belgium. See-through head-up 3D display which uses a commercial projector and holographic lens array is reported. The display system is significantly simplified and a 3D scene of size 20cm x 10cm x 5 cm (Depth) is successfully reconstructed.

FTh3E.3 • 11:15

Depth-induced Cellular Automata for Light Field Saliency, Yongri Piao¹, Xiao Li¹, Miao Zhang¹; ¹Dalian Univ. of Technology, China. A Depth-induced Cellular Automata (DCA) is proposed to optimize light field saliency maps. DCA is robust to challenging scenes because it considered interactions and complementarities of intrinsic structure among the abundant cues on light field.

FTh3E.4 • 11:30

Iterative Forward-Backward Algorithm for Optical Diffraction Tomography, Shengli Fan¹, Seth D. Smith-Dryden¹, Guifang Li¹, Bahaa Saleh¹; ¹Univ. of Central Florida, CREOL, USA. An iterative forward-backward algorithm for optical diffraction tomography is proposed for imaging phase objects with large refractive index contrast. Numerical results demonstrate accurate and robust reconstructions with sub-wavelength resolution.

FTh3E.5 • 11:45

Deep Neural Network for Low Light Phase Recovery, Alexandre Goy¹, Kwabena Arthur¹, Shuai Li¹, George Barbastathis^{1,2}; ¹Mechanical Engineering, MIT, USA; ²Singapore-MIT Alliance for Research and Technology Centre, Singapore. Poisson noise severely impacts imaging systems in low light conditions. We demonstrate the use of deep neural networks applied to phase retrieval and show successful phase recovery with only 10 photons per detector pixel.

10:30–12:30

LTh3F • Advances in Molecular Spectroscopy*Presider: Nathan Newbury; National Institute of Standards and Technology, USA*LTh3F.1 • 10:30 **Invited**

Optical Pulse Shaping, From Nanoseconds to Femtoseconds, and Its Roles in Coherent Molecular Spectroscopy and Medical Imaging, Warren S. Warren¹; ¹Duke Univ., USA. I will discuss the evolution of pulse shaping and pulse train modulation technologies over many different timescales, with modern applications for characterizing materials and diagnosing disease.

LTh3F.2 • 11:00 **Invited**

Cavity-enhanced Ultrafast Spectroscopy: Enabling Transient Absorption Spectroscopy of Dilute Species in Molecular Beams, Melanie Reber¹, Nicholas Cooper¹, Ramesh Basnet¹, Kayla Warren¹; ¹Univ. of Georgia, USA. Coupling ultrafast frequency combs to external enhancement cavities increases the sensitivity of transient absorption spectroscopy by several orders of magnitude. This enables femtosecond transient absorption of dilute species in molecular beams, such as hydrocarbon radicals.

LTh3F.3 • 11:30 **Invited**

Massively Parallel Sensing of Trace Molecules with Broadband Mid-Infrared Subharmonic Frequency Combs, Konstantin L. Vodopyanov¹, Andrey Muraviev¹, Viktor O. Smolski³, Zachary E. Loparo²; ¹CREOL, College of Optics and Photonics, Univ. Cent. Florida, USA; ²Mechanical and Aerospace Engineering, Univ. Cent. Florida, USA; ³Mid-Infrared Lasers, IPG Photonics, USA. We use a pair of mutually-coherent frequency-divide-by-two OPOs with instantaneous span 3.1–5.5 μ m to demonstrate fast acquisition of 350,000 mode-resolved spectral data points and perform parallel detection in a mixture of 22 molecular species.

FTh3A • AR/VR Applications for Enterprise and Consumer Markets—Continued
FTh3A.4 • 12:00 **Invited**

AR UI for Lunar and Martian Energy Operations, Micah TinklePaugh¹; ¹EPRI Inst., USA. Astronauts and utility workers need better visual tools than afforded by static screens and current interfaces. 'Holograms' in remote terrain, space capsules, control rooms, and storm affected environments might make them more effective and efficient.

FTh3B • Quantum Electronics—Continued
FTh3B.6 • 12:00

Simulation of nonlinear photonic crystals by modified finite difference frequency domain method, Tamás Szarvas¹, Zsolt Kis²; ¹BME Dept. of Atomic Physics, Hungary; ²HAS Wigner Research Center for Physics, Hungary. We have worked out a true vectorial numerical method for the simulation of second harmonic generation by extending the finite difference frequency domain method. As an application we have simulated an array of nonlinear cylinders.

FTh3B.7 • 12:15

Nonlinear optical studies of new bioprobes, Katarzyna Matczyszyn¹; ¹Wroclaw Univ. of Science and Techn., Poland. Two-photon fluorescent dyes and bistable molecular photoswitches are key components in the ongoing quest toward increasingly sophisticated, selective, sensitive, and versatile biological procedures and constitute an ideal mean to manipulate a wide range of bio-events.

FTh3C • Optical Comb Metrology—Continued
FTh3C.6 • 12:00

Gallium Phosphide Microresonator Frequency Combs, Dalziel Wilson^{2,1}, Simon Hönl², Katharina Schneider², Miles Anderson¹, Tobias Kippenberg¹, Paul Seidler²; ¹Ecole Polytechnique Federale de Lausanne, Switzerland; ²IBM Research, Zurich, Switzerland. We demonstrate the first microresonator frequency combs in GaP, a III-V semiconductor transparent above 549 nm. High Kerr nonlinearity ($\sim 10^{17}$ m²/W) yields THz combs at 1550 nm with a 3-mW power threshold and >100-nm bandwidth.

FTh3C.7 • 12:15

Revealing the quantum nature of a free electron in an attosecond laser pulse, Ori Reinhardt¹, Ido Kaminer¹; ¹Technion, Israel. Free electrons interacting with the frequency comb of an attosecond laser pulse follow intricate quantum dynamics. We present an analytic treatment of the interaction and use it to shape the electron energy spectrum.

FTh3D • Quantum Communications and the Future Quantum Internet—Continued**FTh3D.4 • 12:00** **Invited**

Quantum Key Distribution: From Technology to Real-World Implementation, Bruno Huttner¹; ¹*ID Quantique, Switzerland*. The quantum computer is now seen as a credible threat to cybersecurity. Companies world-wide understand that upgrading to quantum-safe security is required. Quantum technologies, and especially quantum key distribution, provide a solution, which can be implemented today, and will contribute to a new cybersecurity infrastructure.

FTh3E • Information Processing, Information Display and Optical Device—Continued**FTh3E.6 • 12:00**

Electro-Optical Response of Nonconventional Cholesteric Liquid Crystal with Refined Uniform Lying Helix Alignment, Yueh-Chern Lin¹, Po-Chang Wu¹, Wei Lee¹; ¹*College of Photonics, National Chiao Tung Univ., Taiwan*. We demonstrate a well-aligned and stable uniform lying helix structure by adding bent-core molecules into a cholesteric liquid crystal. The frequency-dependent electro-optic response is characterized by flexoelectricity-induced dielectric relaxation.

FTh3E.7 • 12:15

Synthesis of Broadband Space-Time Diffraction-Free Wave Packets Using Transmissive Phase Plates, Murat Yessenov¹, Hasan E. Kondakci¹, Monjurul F. Meem², Danielle Reyes¹, Daniel Thul¹, Shermineh R. Fairchild^{1,3}, Martin C. Richardson¹, Rajesh Menon², Ayman Abouraddy¹; ¹*CREOL, Univ. of Central Florida, USA*; ²*Dept. of Electrical and Computer Engineering, Univ. of Utah, USA*; ³*Physics and Space Sciences, Florida Inst. of Technology, USA*. We demonstrate the synthesis of broadband diffraction-free space-time pulsed light sheets using transmissive phase plates. We produce propagation-invariant wave packets having a bandwidth of 30~nm from a multi-terawatt femtosecond laser.

LTh3F • Advances in Molecular Spectroscopy—Continued**LTh3F.4 • 12:00** **Invited**

Probing Soot Formation and Chemical Evolution during Combustion, Hope A. Michelsen¹; ¹*Combustion Research Facility, Sandia National Labs, USA*. Large gaps in the understanding of soot formation during combustion are predominantly attributable to a limited ability to probe relevant particle parameters during formation. This talk will describe approaches to developing appropriate diagnostics.