Room A1	Room A2	Room A3	Room A4
CLEO: Science & Innovations	CLEO: QELS-Fundamental Science	JOINT	CLEO: Science & Innovations

08:00–10:00 Plenary and Awards Session II, *Civic Auditorium*

10:00-17:00 Exhibits Open, *Exhibit Halls 1, 2 and 3*

10:00–10:30 Coffee Break, *Exhibit Halls 1, 2 and 3*

10:30–12:30
CW1A • Nonlinear Optics in Nanophotonic Structures I
John Heebner, Lawrence Livermore National Labs, USA, *Presider*

CW1A.1 • 10:30
First Demonstration of Quasi-Phase-Matched Four-Wave-Mixing in Silicon Waveguides, Jeffrey B. Driscoll[1,2], Noam Ophir[2], Richard Grote[1,2], Jerry I. Dadap[1,2], Nicolae Panoiu[3], Keren Bergman[2], Richard Osgood[1,2]; *[1]Microelectronics Sciences Laboratories, Columbia University, USA; [2]Electrical Engineering, Columbia University, USA; [3]Department of Electronic and Electrical Engineering, University College London, United Kingdom.* We demonstrate quasi-phase-matched four-wave-mixing in silicon nanowires with sinusoidally modulated width. We observe ~11 dB conversion efficiency enhancement for targeted wavelengths >100 nm away from the edge of the 3-dB conversion bandwidth.

CW1A.2 • 10:45
Wavelength Conversion with Large Signal-Idler Separation using Discrete Four-Wave Mixing in a Silicon Nanowire, Hao Hu[1], Christophe Peucheret[1], Minhao Pu[1], Hua Ji[1], Michael Galili[1], Kresten Yvind[1], Jørn M. Hvam[1], Palle Jeppesen[1], Leif K. Oxenløwe[1]; *[1]DTU Fotonik, Technical university of Denmark, Denmark.* We have demonstrated wavelength conversion over 468 nm based on discrete bands phase matching in a silicon nanowire. CW light is converted from 1258 nm to 1726 nm with a CW pump at 1455 nm.

CW1A.3 • 11:00
Silicon-Chip-Based Octave-Spanning Frequency Comb, Yoshitomo Okawachi[1], Kasturi Saha[1], Jacob S. Levy[2], Y. Henry Wen[1], Michal Lipson[2,3], Alexander Gaeta[1,3]; *[1]School of Applied and Engineering Physics, Cornell University, USA; [2]School of Electrical and Computer Engineering, Cornell University, USA; [3]Kavli Institute at Cornell for Nanoscale Science, Cornell University, USA.* We demonstrate an octave-spanning frequency comb via parametric four-wave mixing in a monolithic, high-Q silicon nitride microring resonator. The comb is generated from a single-frequency pump laser and spans 180 THz with a 226-GHz spacing.

10:30–12:30
QW1B • Plasmonic Oligomers
Harald Giessen, UniversitÃ¤t Stuttgart, Germany, *Presider*

QW1B.1 • 10:30
Classical analog of electromagnetically induced absorption in plasmonics, Richard Taubert[1], Mario Hentschel[1,2], Jürgen Kästel[3], Harald W. Giessen[1]; *[1]University of Stuttgart, Germany; [2]Max-Planck-Institut für Festkörperforschung, Germany; [3]Deutsches Zentrum für Luft- und Raumfahrt, Institut für Technische Physik, Germany.* We present the classical analog of electromagnetically induced absorption which is achieved by tuning the coupling phase between a bright and a dark plasmonic resonance in the intermediate regime and thus obtaining constructive interference.

QW1B.2 • 10:45
Near-field Study of Plasmonic Oligomers, Thorsten Weber[1,2], Felix von Cube[1,2], Stephan Irsen[2], Stefan Linden[1,3]; *[1]Physikalisches Institut, Universität Bonn, Germany; [2]Research center caesar, Germany; [3]Institut für Nanotechnologie, Karlsruher Institut für Technologie (KIT), Germany.* We use electron energy loss spectroscopy to characterize the near-field of plasmonic oligomers. Systematic parameter studies allow for a deeper understanding of how these plasmonic structures interact in the near-field.

QW1B.3 • 11:00
Fano-resonant electrically connected metasurfaces with high quality factors, Alexander B. Khanikaev[1], S. Hossein Mousavi[1], Chihhui Wu[1], Nima Dabidian[1], Kamil Alici[1], Gennady Shvets[1]; *[1]Physics, The University of Texas at Austin, USA.* We introduce electrically connected Fano-resonant metasurfaces consisting of a periodic array of antennas connected to wires. Possibility of the direct interaction among the antennas by the charge transfer allows for high quality Fano resonances.

10:30–12:30
JW1C • Symposium on Space Optical Systems: Opportunities and Challenges I
David Caplan, MIT Lincoln Lab, USA, *Presider*

JW1C.1 • 10:30 Invited
Design and Performance of the Herschel Space Telescope, Dominic Doyle[1]; *[1]The European Space Research and Technology Centre (ESTEC), Denmark.* This presentation describes the challenges of design, fabrication and testing of the 3.5m diameter European Space Agency (ESA) Herschel Space Telescope orbiting since May 2009 around L2. Examples of its outstanding performance are also presented.

JW1C.2 • 11:00 Invited
Space-Based Laser Communication Systems and Future Trends, Morio Toyoshima[1], Yoshihisa Takayama[1]; *[1]Space Communication Systems Laboratory, National Institute of Information and Communications Technology, Japan.* Trends of fiber-based and space-based laser communication systems are presented and compared with respect to the data rates and the sensitivities for optical communication systems. The applicability to micro-satellites is described in this paper.

10:30–12:30
CW1D • Pulse Synthesis
Günter Steinmeyer, Max-Born-Institut, Germany, *Presider*

CW1D.1 • 10:30
Single-Cycle Optical Pulses from Coherently Combined Independent Mode-locked Lasers, William P. Putnam[1], Jonathan A. Cox[1], Alexander Sell[2], Alfred Leitenstorfer[2], Franz X. Kaertner[1,3]; *[1]Massachusetts Institute of Technology, USA; [2]University of Konstanz, Germany; [3]University of Hamburg, Germany.* The repetition-rate and carrier-envelope offset of two independent mode-locked oscillators are locked. The resulting coherent optical pulse-train is compressed, and the pulse duration is measured to be 3.7 fs, about 1.1 cycles of the optical field.

CW1D.2 • 10:45
Coherent synthesis of ultra-broadband optical parametric amplifiers, Cristian Manzoni[1], Shu-Wei Huang[2], Giovanni Cirmi[2], Jeffrey Moses[2], Franz X. Kaertner[2,3], Giulio Cerullo[1]; *[1]IFN-CNR Politecnico di Milano, Italy; [2]Department of Electrical Engineering and Computer Science and Research Laboratory of Electronics, Massachusetts Institute of Technology, USA; [3]Center for Free-Electron Laser Science, DESY and University of Hamburg, Germany.* We report on coherent synthesis of two broadband optical parametric amplifiers, resulting in 500-1000 nm spectra supporting nearly single-cycle <4-fs pulse duration. Synthesized pulse timing is locked to sub-300-as by a balanced cross-correlator.

CW1D.3 • 11:00 Invited
Reliable Carrier-Envelope Phase Control for Current and Future Attosecond Experiments, Fabian Lücking[1,2], Oleg Pronin[2,3], Jonathan Brons[2], Andreas Assion[1], Alexander Apolonski[2,3], Ferenc Krausz[2,3]; *[1]Femtolasers Produktions GmbH, Austria; [2]Ludwig-Maximilians-Universität München, Germany; [3]Max-Planck-Institut für Quantenoptik, Germany.* Feed-forward carrier-envelope phase (CEP) stabilization yields few-cycle pulses with unparalleled long-term precision. We show first results on the CEP control of pulses from a thin-disk laser, representing possible future attosecond driver sources.

Wednesday, 9 May

Room A5 | Room A6 | Room A7

CLEO: QELS-Fundamental Science | **CLEO: Science & Innovations**

08:00–10:00 Plenary and Awards Session II, *Civic Auditorium*

10:00-17:00 Exhibits Open, *Exhibit Halls 1, 2 and 3*

10:00–10:30 Coffee Break, *Exhibit Halls 1, 2 and 3*

10:30–12:30
QW1E • Novel Phenomena
Roberto Morandotti, INRS-Energie Mat & Tele Site Varennes, Canada, *Presider*

QW1E.1 • 10:30 Invited
Demonstration of Temporal Cloaking, Moti Fridman[1], Alessandro Farsi[1], Yoshitomo Okawachi[1], Alexander Gaeta[1]; [1]*Applied Physics, Cornell University, USA.* We present the first experimental demonstration of cloaking an event in the time domain. Our temporal cloaking scheme is based on the time-space duality and the use of novel split time-lenses.

QW1E.2 • 11:00
Negative frequency resonant radiation, Daniele Faccio[1], Eleonora Rubino[2], Joanna McLenaghan[3], Susanne Kehr[3], Francesco Belgiorno[5], Dave Townsend[1], Sven Rohr[3], Chris Kuklewicz[1], Ulf Leonhardt[3,4], Friedrich Konig[3]; [1]*School of Engineering and Physical Sciences, Heriot-Watt University, United Kingdom;* [2]*Dipartimento di Scienza e Alta Tecnologia, University of Insubria, Italy;* [3]*School of Physics and Astronomy, University of St. Andrews, United Kingdom;* [4]*University of Vienna, Austria;* [5]*Physics, University of Milano, Italy.* Soliton resonant radiation emission is predicted to lead to a second mode that originates from the negative frequency branch of the dispersion relation. Measurements in both bulk media and photonic crystal fibres confirm our predictions.

10:30–12:30
QW1F • Strong-Field and Short-Wavelength Interactions
John Nees, University of Michigan, USA, *Presider*

QW1F.1 • 10:30
High-order harmonic generation in solid argon, Shambhu Ghimire[1], Georges Ndabashimiye[1], David A. Reis[1]; [1]*PULSE Institute, Stanford University, USA.* We report on the generation of high-order harmonics in bulk solid argon at the highest laser intensity of 3 x 1013 w/cm2 without damage. The measured 7th and 9th order harmonics have similar strengths.

QW1F.2 • 10:45
Revealing multiphoton resonant ionization in solid density plasmas with an x-ray free electron laser, Byoung-ick Cho[1], Kyle Engelhorn[1], Sam Vinko[2], Justin Wark[2], Roger Falcone[1,3], Philip Heimann[4]; [1]*Lawrence Berkeley Natl Lab, USA;* [2]*Department of Physics, University of Oxford, United Kingdom;* [3]*Department of Physics, Univerisity of California, USA;* [4]*SLAC Natl Accelerator Lab, USA.* Interaction of intense x-ray and solid density Al plasma is studied via K-shell emission spectroscopy. A high fluence, high-intensity x-ray pulse from an x-ray free-electron laser unveils multiphoton ionization pathway and drives hidden resonances.

QW1F.3 • 11:00
Sub-Cycle Strong-Field Influences in X-ray Photoionization, James M. Glownia[1,2], Abbas Ourmazd[3], Russell Fung[3], James Cryan[1,2], Adi Natan[1], Ryan Coffee[2], Phil Bucksbaum[1]; [1]*Stanford PULSE Institute, SLAC National Accelerator Lab, USA;* [2]*LCLS, SLAC National Accelerator Lab, USA;* [3]*Department of Physics, University of Wisconsin-Milwaukee, USA.*We report the first evidence for strong field laser effects in x-ray ionization at LCLS. Experiments using a strong field optical-frequency laser and x-rays have revealed asymmetries in N2 fragmentation patterns that indicate sub-cycle dynamics.

10:30–12:30
CW1G • Bioreactors and Biosensing
Presider TBD

CW1G.1 • 10:30
Optofluidic hollow-core photonic crystal fiber coupled to mass spectrometry for rapid photochemical reaction analysis, Sarah Unterkofler[1], Ruth J. McQuitty[2], Tijmen G. Euser[1], Nicola J. Farrer[2], Peter J. Sadler[2], Philip S. Russell[1]; [1]*Division for Photonics and New Materials, Max Planck Institute for the Science of Light, Germany;* [2]*Department of Chemistry, University of Warwick, United Kingdom.* Optofluidic hollow-core photonic crystal fibers facilitate both efficient excitation of photochemical reactions and instantaneous feeding of the products into a mass spectrometer for rapid molecular structure determination using low sample volumes.

CW1G.2 • 10:45
Plasmon Enhanced Cultivation of Cyanobacteria for Bioenergy, Matthew Ooms[1], Vincent Sieben[2], Scott Pierobon[1], David Sinton[1]; [1]*University of Toronto, Canada;* [2]*Schlumberger Ltd, Canada.* A method of cell cultivation is presented in which photosynthetic cyanobacteria cells are grown by coupling of their photocenters to a plasmon enhanced evanescent field on the surface of thin gold films.

CW1G.3 • 11:00
Novel Approach in Algae Biofuel Production using Advanced Photonics, Eunjung Jung[1], Michael Kalontarov[1], Devin Doud[2], Largus Angenent[2], David Sinton[3], David Erickson[1]; [1]*Sibley school of Mechanical and Aerospace Engineering, Cornell University, USA;* [2]*Biological and Environmental Engineering, Cornell University, USA;* [3]*Mechanical and Industrial Engineering, University of Toronto, Canada.* Utilization of evanescent fields for photosynthetic bacteria to produce biofuel can lead to thousandfold decrease in the volume of photobioreactors. We demonstrate the growth of bacteria enabled by the evanescent excitation using planar waveguides.

Room A8	Room B2 & B3	Room C1 & C2	Room C3 & C4
CLEO: Applications & Technology	JOINT	CLEO: Science & Innovations	

08:00–10:00 Plenary and Awards Session II, *Civic Auditorium*

10:00-17:00 Exhibits Open, *Exhibit Halls 1, 2 and 3*

10:00–10:30 Coffee Break, *Exhibit Halls 1, 2 and 3*

10:30–12:30
AW1H • Advanced Fabrication & Characterization Technologies
Eric Mottay, Amplitude Systemes, France, *Presider*

AW1H.1 • 10:30
Deposition of elements for a thermoelectric generator via laser-induced forward transfer, Matthias Feinaeugle1, Collin L. Sones1, Elena Koukharenko2, Behrad Gholipour1, Dan W. Hewak1, Robert W. Eason1; 1Optoelectronics Research Centre, University of Southampton, United Kingdom; 2School of Electronics and Computer Science, University of Southampton, United Kingdom. Films of thermoelectric bismuth selenide and bismuth telluride have been transferred by laser-induced forward transfer onto glass and polymer substrates. Influence of transfer on thermoelectric properties and morphology of the material was compared.

AW1H.2 • 10:45
Laser-Induced Electrode Fabrication by Photo-Thermochemical Reaction of Metal Compounds, Bongchul Kang[1], Minyang Yang[1]; [1]*KAIST Institute for Optical Science and Technology, Korea Advanced Institute of Science and Technology, Republic of Korea.* We present a new laser direct patterning method that selectively deposits metal track on various substrates by photo-thermochemical reaction of air-stable metal compound. Finally, the fine electrode with high conduction and quality is achieved.

AW1H.3 • 11:00 Invited
Laser Plasmas for Spectrochemistry, Rick Russo[1]; [1]*Lawrence Berkeley National Lab, USA.* A single laser pulse can ablate any sample into an optical plasma that revels the chemical constituents of that material. Spectral interrogation of the plasma light provides real-time elemental, isotopic and molecular classification.

10:30–12:30
JW1I • Symposium on Quantum Engineering and Architectures I: Condensed Matter Systems
Bill Munro; NTT Basic Research Laboratories, Japan, *Presider*

JW1I.1 • 10:30 Invited
Design of a Superconducting Quantum Computer, John Martinis[1]; [1]*Univ. of California Santa Barbara, USA.* Current research in superconducting qubits shows that the basic hardware requirements for a quantum computer can likely be met in the next few years. I will discuss the design of a superconducting quantum computer based on a surface-code architecture.

JW1I.2 • 11:00
Tunable coupling cavity QED with a superconducting artificial atom, Srikanth Srinivasan[1], Anthony Hoffman[1], Yanbing Liu[1], Jay Gambetta[2], Andrew Houck[1]; [1]*Electrical Engineering, Princeton University, USA;* [2]*IBM T. J. Watson Research Center, USA.* We present a tunable coupling qubit (TCQ), which has independent and fast control over the qubit energy and the coupling strength to a superconducting microwave cavity in a circuit quantum electrodynamics architecture.

10:30–12:30
CW1J • Frequency-Comb Assisted Sensing
Gerard Wysocki, Princeton University, USA, *Presider*

CW1J.1 • 10:30 Invited
Adaptive Dual-comb Spectroscopy with Free-running Lasers and Resolved Comb Lines, Antonin Poisson[1,2], Takuro Ideguchi[2], Guy Guelachvili[1], Nathalie Picqué[2,1], Theodor Hänsch[2,3]; [1]*Université Paris-Sud, France;* [2]*Max Planck Institut fur Quantenoptik, Germany;* [3]*Ludwig-Maximilians-Universitat, Germany.* A new scheme of real-time dual-comb spectroscopy, only uses free-running femtosecond lasers provides distortion-free Fourier spectra with resolved comb lines across the full spectral span of Er-doped fiber lasers without a posteriori data processing.

CW1J.2 • 11:00
Comb-assisted Swept Laser Spectroscopy with a Mode-Hop-Free Tunable External Cavity QCL, Kevin Knabe[1], Fabrizio R. Giorgetta[1], Chris M. Armacost[2], Michael B. Radunsky[2], Samuel Crivello[2], Timothy Day[2], Paul A. Williams[1], Nathan R. Newbury[1]; [1]*NIST, USA;* [2]*Daylight Solutions, USA.* We demonstrate sub-MHz spectral resolution of N2O absorption spectra acquired with a swept external-cavity quantum cascade laser (QCL) over 0.87 THz. The QCL frequency is monitored by sum-frequency generation with an optical fiber frequency comb.

10:30–12:30
CW1K • Integrated Photonic Circuits
Andrew Weiner, Purdue University, USA, *Presider*

CW1K.1 • 10:30 Tutorial
Single-chip Integrated Transmitters and Receivers, Larry A. Coldren[1], Leif Johansson[1], Mingzhi Lu[1]; [1]*University of California, Santa Barbara, USA.* Photonic integrated circuits are emerging into practical commercial products with advantages not only in size, weight and power, but also in cost and performance. Recent advances in semiconductor-based devices will be reviewed.

Larry A. Coldren is the Kavli Professor of Optoelectronics and Sensors at UC-Santa Barbara, CA. After receiving his Ph.D. from Stanford University and spending 13 years in research at Bell Labs, he joined UCSB where he now holds appointments in Materials and ECE. He has co-founded successful VCSEL and tunable laser companies. At Bell Labs Coldren worked on SAW filters and later on tunable lasers using novel RIE technology. At UCSB he continued work on multiple-section tunable lasers, in 1988 inventing the widely-tunable multi-element mirror concept, which is now used in numerous commercial products. He also made seminal contributions to efficient VCSEL designs. Prof. Coldren's group contines efforts on high-performance InP-based PICs and high-speed VCSELs. He has co-authored numerous papers, book chapters, patents and a textbook. He is a Fellow of the IEEE, OSA, and IEE, a recipient of the 2004 John Tyndall and 2009 Aron Kressel Awards, and a member of the National Academy of Engineering.

Marriott San Jose Salon I & II | Marriott San Jose Salon III | Marriott San Jose Salon IV

CLEO: Science & Innovations

08:00–10:00 Plenary and Awards Session II, *Civic Auditorium*

10:00-17:00 Exhibits Open, *Exhibit Halls 1, 2 and 3*

10:00–10:30 Coffee Break, *Exhibit Halls 1, 2 and 3*

10:30–12:30 CW1L • Novel Light-emitting Materials

Linda Romano, Epi-consulting, USA, *Presider*

CW1L.1 • 10:30
Strong nonradiative energy transfer from the nanopillars of quantum wells to quantum dots: Efficient excitonic color conversion for light emitting diodes, Burak Guzelturk[1], Sedat Nizamoglu[1], Dae-Woo Jeon[2], In-Hwan Lee[2], Hilmi Volkan Demir[1,3]; [1]*Electrical and Electronics Engineering, Bilkent University, Turkey;* [2]*School of Advanced Materials Engineering, Chonbuk National University, Democratic People's Republic of Korea;* [3]*School of Electrical and Electronics Engineering, Nanyang Technological University, Singapore.* Efficient nonradiative energy transfer is observed from nanopillars of InGaN/GaN quantum wells to colloidal CdSe/ZnS quantum dots up to 83% efficiency. Nanostructured architecture is shown to promote excitonic color conversion for LED applications.

CW1L.2 • 10:45
ZnSe:Mn/ZnS High Temperature Nanophosphors with Very High Quantum Efficiency for White LEDs, Brian A. Akins[1], Antonio C. Rivera[1], Nathaniel C. Cook[1], Gennady A. Smolyakov[1], Marek Osinski[1]; [1]*Center for High Technology Materials, University of New Mexico, USA.* We have synthesized ZnSe:Mn/ZnS doped core/shell nanocrystals with 91% quantum efficiency at the 497 nm emission with 453 nm excitation. Combined with their high temperature stability, this makes them very attractive as nanophosphors for white LEDs.

CW1L.3 • 11:00 Invited
GaN Based Nanorod Technology for Solid State Lighting, Andreas Waag[1]; [1]*TU Braunschweig, Germany.* This talk will give an overview on the state of the art of our 3D GaN research for solid state lighting, particularly focusing on MOCVD growth and 3D characterization. Potential advantages and challenges of this exciting new strategy towards low cost high efficiency solid state lighting will also be discussed.

10:30–12:30 CW1M • Optomechanical Systems I

Tobias Kippenberg, Ecole Polytechnique Federale de Lausanne (EPFL) and Max Planck Inst. of Quantum Optics (MPQ), Switzerland, *Presider*

CW1M.1 • 10:30 Invited
Optomechanical Crystals for Quantum Photon and Phonon Circuits, Oskar Painter[1]; [1]*California Institute of Technology, USA.* In this talk I will describe recent advances to realize radiation pressure effects within coupled, nanoscale photonic and phononic crystal circuits (dubbed optomechanical crystals).

CW1M.2 • 11:00
Synchronization of Coupled Optomechanical Oscillators, Mian Zhang[1], Gustavo Wiederhecker[1,4], Michal Lipson[1,3], Sasikanth Manipatruni[1], Arthur Barnard[2], Paul L. McEuen[2,3]; [1]*School of Electrical and Computer Engineering, Cornell University, USA;* [2]*Laboratory of Atomic and Solid State Physics, Cornell University, USA;* [3]*Kavli Institute at Cornell, Cornell University, USA;* [4]*Instituto de Fisica Gleb Wataghin, Universidade Estadual de Campinas, Brazil.* We demonstrate experimentally the synchronization of two coupled micro-optomechanical oscillators. The mutual coupling is purely optical and fully tunable. Upon synchronization, the phase noise drops in agreement with the prediction.

10:30–12:30 CW1N • Mode-locked /Short Pulse Lasers

Lukas Chrostowski, University of British Columbia, Canada, *Presider*

CW1N.1 • 10:30
257 MHz Pulse Repetition Rate from a Mod-elocked VECSEL, Christian A. Zaugg[1], Martin Hoffmann[1], Wolfgang P. Pallmann[1], Oliver D. Sieber[1], Valentin J. Wittwer[1], Mario Mangold[1], Matthias Golling[1], K. J. Weingarten[2], Bauke W. Tilma[1], Thomas Sudmeyer[1], Ursula Keller[1]; [1]*Institute for Quantum Electronics, ETH Zurich, Switzerland;* [2]*Time-Bandwidth-Products, Switzerland.* With a multi-pass cavity we avoid modelocking instabilities of low-repetition rate VECSELs due to short gain lifetime. We achieve a record-low repetition rate of 257 MHz which we could not realize with the conventional cavity.

CW1N.2 • 10:45
First MIXSEL with a Quantum Well Saturable Absorber: Shorter Pulse Durations and Higher Repetition Rates, Valentin J. Wittwer[1], Oliver D. Sieber[1], Mario Mangold[1], Martin Hoffmann[1], Clara Saraceno[1], Matthias Golling[1], Bauke W. Tilma[1], Thomas Sudmeyer[1], Ursula Keller[1]; [1]*D-PHYS/IQE, ETH Zürich, Switzerland.* We present the first Modelocked Integrated eXternal-Cavity Surface Emitting Laser (MIXSEL) based on a quantum well absorber, achieving 4.8-ps pulses at a repetition rate of 2.9 GHz and 6.8-ps pulses at 20.8 GHz.

CW1N.3 • 11:00
Ultra-wideband wavelength tunable optical short pulse generation from hybrid mode-locked quantum dot optical frequency comb laser, Naokatsu Yamamoto[1], Kouichi Akahane[1], Tetsuya Kawanishi[1], Hideyuki Sotobayashi[2], Yuki Yoshioka[3,1], Hiroshi Takai[3]; [1]*National Institute of Information and Communications Technology, Japan;* [2]*Aoyama Gakuin University, Japan;* [3]*Tokyo Denki University, Japan.* The generation of ps-order-short and gigahertz high-repetition optical pulses in the ultra-wideband wavelength tuning range on a 1.2- to 1.3-μm band was successfully demonstrated using a hybrid mode-locked quantum dot optical frequency comb laser.

Room A1

CLEO: Science & Innovations

CW1A • Nonlinear Optics in Nanophotonic Structures I—Continued

CW1A.4 • 11:15
Efficient Continuous-Wave Four-Wave Mixing and Self-Phase Modulation in a Bandgap-Engineered AlGaAs Waveguide, Jeremiah J. Wathen[1,2], Paveen Apiratikul[1], Brice M. Cannon[1,3], Tanvir Mahmood[1,3], William Astar[1], Christopher J. K. Richardson[1], Gyorgy A. Porkolab[1], Gary M. Carter[3,1], Thomas E. Murphy[2,1]; [1]*Laboratory for Physical Sciences, USA;* [2]*University of Maryland, USA;* [3]*University of Maryland Baltimore County, USA.* By engineering the bandgap to suppress two-photon absorption, we achieve efficient continuous-wave four-wave mixing in an AlGaAs waveguide. The conversion efficiency (-5.5 dB) is among the highest reported for semiconductor waveguides.

CW1A.5 • 11:30
SHG in a Low-Loss Orientation Patterned GaAs Waveguide, Ksenia A. Fedorova[1], Andrew D. McRobbie[2], Grigorii S. Sokolovskii[1], Peter G. Schunemann[3], Edik Rafailov[1]; [1]*Engineering, Physics and Mathematics, University of Dundee, United Kingdom;* [2]*Selex Galileo Inc., United Kingdom;* [3]*BAE Systems, USA.* We demonstrate second harmonic generation at 1621 nm in a low-loss orientation-patterned GaAs waveguide pumped by an optical parametric oscillator system. The losses were estimated to be 2.12 dB/cm.

CW1A.6 • 11:45
Generation of CW tunable visible light by SHG of QD laser in a PPKTP waveguide, Ksenia A. Fedorova[1], Grigorii S. Sokolovskii[1], Phil R. Battle[2], Igor L. Krestnikov[3], Daniil A. Livshits[3], Edik Rafailov[1]; [1]*Engineering, Physics and Mathematics, University of Dundee, United Kingdom;* [2]*AdvR Incorporation, USA;* [3]*Innolume GmbH, Germany.* We demonstrate a CW tunable compact all- Room-temperature laser system in the visible spectral region from 567.7nm to 629.1nm, by frequency doubling in a periodically-poled KTP waveguide crystal using a tunable quantum-dot external-cavity diode laser.

CW1A.7 • 12:00
Silica Microfibres for Broadband Third Harmonic Generation, Timothy Lee[1], Yongmin Jung[1], Christophe A. Codemard[2], Ming Ding[1], Gilberto Brambilla[1], Neil G. Broderick[3]; [1]*Optoelectronics Research Centre, University of Southampton, United Kingdom;* [2]*SPI Lasers, United Kingdom;* [3]*Physics Department, University of Auckland, New Zealand.* We report broadband third harmonic generation via intermodal phase matching in silica microfibres of several centimetres. A 5 dB conversion bandwidth exceeding 36 nm was recorded, with harmonic power detected over a 150 nm range.

Room A2

CLEO: QELS-Fundamental Science

QW1B • Plasmonic Oligomers—Continued

QW1B.4 • 11:15
Signature of a Fano Resonance in the Local Density of States of a Plasmonic Meta-Molecule, Martin Frimmer[1], Toon Coenen[1], Femius A. Koenderink[1]; [1]*Center for Nanophotonics, FOM Institute AMOLF, Netherlands.* We experimentally study the local density of optical states of a plasmonic meta-molecule exhibiting plasmon induced transparency. We identify the potential of narrow bright sub-radiant modes for spontaneous emission control with optical antennas.

QW1B.5 • 11:30 Invited
Plasmon Induced Transparency with Asymmetric π-Shaped Metamaterials, Arif E. Cetin[1,2], Alp Artar[1,2], Mustafa Turkmen[1,2], Ahmet A. Yanik[1,2], Hatice Altug[1,2]; [1]*Electrical and Computer Engineering, Boston University, USA;* [2]*Photonics Center, Boston University, USA.* We propose a planar metamaterial composed of asymmetric π-shaped structures that exhibits plasmon induced transparency (PIT). The system enables fine tuning of PIT behavior and near field enhancement control and provides smaller mode volumes.

QW1B.6 • 12:00
Tunable Resonance in Flexible Plasmonic Nanostructures, Venkata Ananth Tamma[1], Yonghao Cui[1], Jianhong Zhou[1], Wounjhang Park[1]; [1]*Department of Electrical, Computer and Energy Engineering, University of Colorado, USA.* We demonstrate tuning of coupled plasmon resonances caused by stretching PDMS embedded gold nanorod heptamers. The nature of resonance depended on orientation of nanorods within heptamer. We present theoretical analysis to explain observed behaviors.

Room A3

JOINT

JW1C • Symposium on Space Optical Systems: Opportunities and Challenges I—Continued

JW1C.3 • 11:30 Invited
Laser Interferometry in Space for Gravitational Wave Detection and Geodesy, Karsten Danzmann[1]; [1]*AEI Hannover, University Hannover, Germany.* Laser interferometry between drag-free satellites has been under development for 20 years. It will be used for the observation of low-frequency gravitational waves in LISA. Similar technology will be employed for the GRACE Follow-on Geodesy mission.

JW1C.4 • 12:00
A digital phasemeter for precision length measurements, Malcolm Gray[1], Terry McRae[1], Magnus Hsu[1], Jan Herrmann[1], Daniel Shaddock[2]; [1]*National Measurement Institute, Australia, Australia;* [2]*Centre for Gravitational Physics, The Australian National University, Australia.* We report on a digital phasemeter for application in precision length measurement using laser interferometry. Our interferometer demonstrates a length sensitivity of 0.5pm/√Hz above 5Hz, and a cyclic error of better than 50pm.

Room A4

CLEO: Science & Innovations

CW1D • Pulse Synthesis—Continued

CW1D.4 • 11:30
Femtosecond pulse spectral synthesis using coherently combined multi-channel fiber chirped pulse amplifiers, Wei-Zung Chang[1], Tong Zhou[1], Leo Siiman[1], Almantas Galvanauskas[1]; [1]*Center for Ultrafast Optical Science, University of Michigan, USA.* We synthesize femtosecond pulses by coherently combining spectra from three fiber chirped pulse amplifiers. Multi-channel spectral synthesis offers a way to overcome gain narrowing limitations in a single fiber amplifier.

CW1D.5 • 11:45
All-linear-optical technique for intracavity stabilization of CEP drift, Peter Jojart[1,2], Adam Borzsonyi[1,2], Mark Mero[3], Karoly Osvay[1]; [1]*Dept. Optics, University of Szeged, Hungary;* [2]*CE Optic s Kft., Hungary;* [3]*Research Group on Laser Physics, HAS, Hungary.* The slow carrier envelope phase drift of a 50nm bandwidth femtosecond oscillator is stabilized with an accuracy better than 140mrad with an intracavity isochronic wedge pair driven by a stabilized spectrally resolved multiple beam interferometer.

CW1D.6 • 12:00
Carrier-envelope phase double stabilization with eight attosecond residual timing jitter, Bastian Borchers[1], Sebastian Koke[1], Anton Husakou[1], Joachim Herrmann[1], Gunter Steinmeyer[1]; [1]*Max Born Institute, Germany.* We present a novel setup for carrier-envelope phase stabilization combining a feedback loop with a feed-forward type stabilization technique to push the residual timing down to 8 attoseconds, setting a new record in stabilization performance.

Room A5 | Room A6 | Room A7

CLEO: QELS-Fundamental Science

QW1E • Novel Phenomena—Continued

QW1E.3 • 11:15
One-Dimensional Massless Dirac-Particles in Waveguide Arrays with Alternating Coupling, Julia M. Zeuner[1], Nikolaos K. Efremidis[2], Robert Keil[1], Felix Dreisow[1], Andreas Tünnermann[1], Stefan Nolte[1], Alexander Szameit[1]; *[1]Institute of Applied Physics, Friedrich-Schiller-University, Germany; [2]Department of Applied Mathematics, University of Crete, Greece.* We experimentally realized a waveguide device with alternating positive/negative coupling and show that this setting is an optical simulator of the conditions found for massless relativistic particles described by the one-dimensional Dirac-equations.

QW1E.4 • 11:30
Experimental demonstration of the geometric spin Hall effect of light in highly focused vector beams, Martin Neugebauer[1,2], Peter Banzer[1,2], Thomas Bauer[1,2], Norbert Lindlein[2], Andrea Aiello[1,2], Christoph Marquardt[1,2], Jan Korger[1,2], Gerd Leuchs[1,2]; *[1]Max Planck Institute for the Science of Light, Germany; [2]Institute of Optics, Information and Photonics, Germany.* We demonstrate the geometric spin Hall effect of light by focusing a specially polarization tailored beam of light, resulting in the generation of purely transverse angular momentum in the focal plane.

QW1E.5 • 11:45
Superluminal Images and the Arrival of Spatial Information in Optical Pulses with Negative Group Velocity, Ulrich Vogl[1], Ryan T. Glasser[1], Paul Lett[1]; *[1]Laser cooling and trapping group, NIST, USA.* We generate superluminal pulses via four-wave-mixing in Rubidium 85 vapor and imprint images on the pulses. This allows us to resolve experimentally the arrival time of the spatial information imprinted on the pulses.

QW1E.6 • 12:00
Generation of pulses with negative group velocities via four-wave mixing in 85Rb., Ryan Glasser[1], Paul Lett[1], Ulrich Vogl[1]; *[1]Quantum Measurement Division, National Institute of Standards and Technology, USA.* We generate pairs of superluminal pulses via four-wave mixing. A relative pulse peak advancement of the seed pulses of > 50% is demonstrated. Generated conjugate pulses can propagate with negative group velocities of up to vg = −c/880.

QW1F • Strong-Field and Short-Wavelength Interactions—Continued

QW1F.4 • 11:15
Ultrafast X-ray probe of Nucleobase Photoprotection, Joe Farrell[1,2], Brian McFarland[3,2], Nora Berrah[4], C. Bostedt[5], John Bozek[5], Phil Bucksbaum[1,2], Ryan Coffee[5], James Cryan[1,2], L. Fang[4], Raimund Feifel[6], Kelley Gaffney[2], James M. Glownia[3,2], Todd Martinez[7,2], M. Mucke[6], Brendan Murphy[4], S. Miyabe[2,7], Adi Natan[2], Timor Osipov[5], Vladimir Petrovic[2,1], S. Schorb[5], Th. Schultz[8], Limor Spector[2,3], F. Tarantelli[9], Ian Tenney[1], Song Wang[1,2], W. White[5], James White[3,2], Markus Guehr[2]; *[1]Stanford Univ Physics Dept, USA; [2]PULSE Institute, SLAC National Accelerator Laboratory, USA; [3]Stanford Univ Applied Physics Dept, USA; [4]Western Michigan University, Physics Dept., USA; [5]LCLS, SLAC National Accelerator Laboratory, USA; [6]Dept. of Physics, Uppsala University, Sweden; [7]Dept. of Chemistry, Stanford University, USA; [8]Max-Born-Institute, Germany; [9]Dipartimento di Chimica, Universita di Perugia, and ISTM-CNR, Italy.* We will present first results of a uv-pump X-ray-probe study of the photoprotection mechanism of thymine. The experiment used element specific Auger spectroscopy and was carried out at the LCLS.

QW1F.5 • 11:30
Multiple ionization of atoms and molecules by an intense isolated attosecond pulse, Eiji Takahashi[1], Pengfei Lan[1], Katsumi Midorikawa[1]; *[1]Extreme Photonics Research Group, RIKEN, Japan.* We investigated multiple ionization process in atoms and molecules by an intense isolated attosecond pulse. Observed Ne2+ signal guarantees that our IAP sources are strong enough to create the nonlinear phenomena.

QW1F.6 • 11:45
Temperature Measurements of Cluster Fusion Plasmas using D-3He or CD4-3He mixtures on the Texas Petawatt, Woosuk Bang[1], Marina Barbui[2], Aldo Bonasera[2,4], Gilliss Dyer[1], Hernan Quevedo[1], Kris Hagel[2], Katarzyna Schmidt[2], Fabrizio Consoli[3], Riccardo D. Angelis[3], Pierluigi Andreoli[3], Erhard Gaul[1], Ted Borger[1], Aaron Bernstein[1], Mikael Martinez[1], Michael Donovan[1], Matteo Barbarino[2], Sachie Kimura[4], Jozef Sura[4], Joseph Natowitz[2], Todd Ditmire[1]; *[1]Texas Center for High Intensity Laser Science, University of Texas at Austin, USA; [2]Cyclotron Institute, Texas A&M University, USA; [3]ENEA, Italy; [4]INFN, Italy.* We present a novel way of determining the plasma temperature in a laser-cluster fusion experiment on the Texas Petawatt laser, which uses the ratio of the 2.45 MeV neutron and 14.7 MeV proton yields.

QW1F.7 • 12:00 Invited
Strong-field Effects in Solid, David A. Reis[1,2]; *[1]Stanford PULSE Institute, SLAC National Accelerator Laboratory MS, USA; [2]Photon Science and Applied Physics, Stanford University, USA.* We present results of non-perturbative high-order harmonic generation and photon-assisted tunneling driven by intense mid-infrared laser in solids. These strong-field effects occur in a limit where the laser-field competes with crystal bonding.

CLEO: Science & Innovations

CW1G • Bioreactors and Biosensing—Continued

CW1G.4 • 11:15
A Scalable Evanescent Light-based Photobioreactor, Scott Pierobon[1], Matthew Ooms[1], Vincent Sieben[2], David Sinton[1]; *[1]University of Toronto, Canada; [2]Schlumberger Ltd., Canada.* The evanescent growth of photosynthetic cyanobacteria on an LED-lit PMMA waveguide is demonstrated as modularly scalable photobioreactor architecture.

CW1G.5 • 11:30
Independent Particle Detection and Tunable Spectral Filtering on Optofluidic Chip, Damla Ozcelik[1], Brian Phillips[2], Philip Measor[1], Aaron Hawkins[2], Holger Schmidt[1]; *[1]School of Engineering, University of California, Santa Cruz, USA; [2]Department of Electrical and Computer Engineering, Brigham Young University, USA.* Integration of a tunable optofluidic notch filter with a biosensing section on a single liquid-core waveguide chip is demonstrated. The filter response was fluidically tuned by 90nm with up to a 43dB rejection ratio.

CW1G.6 • 11:45
An Ultrasensitive Optofluidic Nucleic Acid Biosensor, Philip Measor[1], Yue Zhao[2], Aaron Hawkins[2], Holger Schmidt[1]; *[1]School of Engineering, University of California, USA; [2]Electrical and Computer Engineering, Brigham Young University, USA.* Amplification-free nucleic acid testing using molecular beacon detection on an optofluidic chip is reported. A limit of detection at the single molecule detection level (10pM) and excellent specificity (single nucleotide mismatches) is observed.

CW1G.7 • 12:00
Ultrasensitive, Optofluidic Biomolecular Fluorescence Detection Using Flow-through, Multi-Hole Capillary, Yunbo Guo[1], Maung Kyaw Khaing Oo[1], David Hoyt[1], Dax Lamar[1], Karthik Reddy[1], Xudong Fan[1]; *[1]Biomedical Engineering, University of Michigan, USA.* A novel fluorescence detection platform is developed using a flow-through,multi-hole capillary,which provides integrated fluidic channels for efficient analyte delivery and large surface area for ultrasensitive(subfemotomolar) biomolecular detection.

Room A8

CLEO: Applications & Technology

AW1H • Advanced Fabrication & Characterization Technologies—Continued

AW1H.4 • 11:30
Solid-Immersion-Lens-Enhanced Nonlinear Frequency-Variation Mapping of a Silicon Integrated-Circuit, Keith A. Serrels[1], Carl Farrell[2], Ted R. Lundquist[1], Derryck T. Reid[2], Praveen Vedagarbha[1]; *[1]DCG Systems, USA; [2]Heriot-Watt University, United Kingdom.* By inducing two-photon absorption within the active layer of a proprietary silicon test chip, we demonstrate solid-immersion-lens-enhanced nonlinear frequency-variation mapping of a 500-MHz ring oscillator circuit.

AW1H.5 • 11:45
Defect Tolerant Extreme Ultraviolet Lithography, Lukasz Urbanski[1], Artak Isoyan[2], Aaron Stein[3], Jorge Rocca[1], Carmen Menoni[1], Mario Marconi[1]; *[1]CSU, USA; [2]Synopsys Inc., USA; [3]CFN, Brookhaven National Laboratory, USA.* We report on defect tolerant, extreme ultraviolet (EUV) lithography technique. We envision that our technique will impact both the quality and the cost of nano-fabrication with coherent EUV light.

AW1H.6 • 12:00
Paper Parameter Estimation Using Time-Domain Terahertz Spectroscopy, Payam Mousavi[1], Ian R. Bushfield[1], Stephane Savard[2], Frank Haran[2], Steven Dodge[1]; *[1]Physics, Simon Fraser University, Canada; [2]Honeywell ASCa Inc., Canada.* We demonstrate a time-domain terahertz technique for measuring thickness, moisture and basis weight of paper. We validate our technique for a sample compressed to different thicknesses and establish uncertainty limits using Monte Carlo simulations.

Room B2 & B3

JOINT

JW1I • Symposium on Quantum Engineering and Architectures I: Condensed Matter Systems—Continued

JW1I.3 • 11:15
Coherent Transfer of Time-bin Photons to Electron Spins in a Semiconductor, Hideo Kosaka[1], Takahiro Inagaki[1], Ryuta Hitomi[1], Fumishige Izawa[1], Yoshiaki Rikitake[2], Hiroshi Imamura[3], Yasuyoshi Mitsumori[1], Keiichi Edamatsu[1]; *[1]Research Institute of Electrical Communication, Tohoku university, Japan; [2]Department of Information Engineering, Sendai National College of Technology, Japan; [3]Nanosystem Research Institute, AIST, Japan.* We demonstrate that the time-bin coherence of photons can be directly transferred to the spin coherence of electrons in a semiconductor by synchronizing the time separation to the precession period of either electrons or holes.

JW1I.4 • 11:30 Invited
The Nitrogen-vacancy Center: Controlling Quantum Registers in Diamond, Lilian Childress[1,2], Lucio Robledo[3], Hannes Bernien[3], Bas Hensen[3], Paul Alkemade[3], Matthew Markham[4], Daniel Twitchen[4], Ronald Hanson[3]; *[1]Department of Physics and Astronomy, Bates College, USA; [2]Department of Physics, Yale University, USA; [3]Kavli Institute of Nanoscience Delft, TU Delft, Netherlands; [4]Element Six, United Kingdom.* Using the resonant optical transitions associated with individual nitrogen-vacancy defect centers, we demonstrate techniques for single-shot readout and quantum-optical connection of spin-based quantum registers in diamond.

JW1I.5 • 12:00
Quantum Information Device Based on NV Diamond Centers for Quantum Network, Kae Nemoto[1], Mark S. Everitt[1], Simon Devitt[1], Ashley Stephens[1], Michael Trupke[2], Joerg Schmiedmayer[2]; *[1]National Institute of Informatics, Japan; [2]Vienna Center for Quantum Science and Technology, Austria.* We propose a model of quantum information devices based on an optical cavity with an NV centre. These devices can be easily modified to accommodate imperfections such as photon loss, maintaining the feasibility and scalability.

Room C1 & C2

CLEO: Science & Innovations

CW1J • Frequency-Comb Assisted Sensing—Continued

CW1J.3 • 11:15
Real-time Dual-comb Spectroscopy of Iodine in the Visible, Takuro Ideguchi[1], Antonin Poisson[1,2], Guy Guelachvili[2], Theodor Hänsch[1,3], Nathalie Picqué[1,2]; *[1]Max-Planck-Institute of Quantum Optics, Germany; [2]Institut des Sciences Moléculaires d'Orsay, CNRS, France; [3]Ludwig-Maximilians-Universität München, Germany.* Dual-comb spectroscopy is extended to the visible range. The dense rovibronic spectrum of iodine around 520 nm is measured within 12 ms at Doppler-limited resolution with a scheme that only uses free-running lasers.

CW1J.4 • 11:30 Tutorial
Frequency Comb Spectroscopy from Mid-Infrared to Extreme Ultraviolet, Jun Ye[1]; *[1]JILA, NIST and Univ. of Colorado, USA.* With our recent development of novel frequency combs in the mid infrared and extreme ultraviolet, we have opened the door for sensitive and high-resolution spectroscopy in these spectral regions. I will report these advances.

Jun Ye is a Fellow of JILA and Physics Professor Adjoint at the University of Colorado. He is also a Fellow NIST, a Fellow of APS, a Fellow of OSA, and a member of the National Academy of Sciences. His research includes precision measurement, ultracold atoms and molecules, ultrafast science and quantum control. Honors include Frew Fellowship (Australian Academy of Science), I. I. Rabi Prize, European Frequency & Time Forum Award, Carl Zeiss Award, W. F. Meggers Award, A. Lomb Medal, A. S. Flemming Award, Presidential Early Career Award, Gold Medals (U.S. Commerce Department), F. W. Bessel Award (Humboldt Foundation), S. W. Stratton Award.

Room C3 & C4

CW1K • Integrated Photonic Circuits—Continued

CW1K.2 • 11:30
Improved Performance of Optical Beam Steering through an InP Photonic Integrated Circuit, Weihua Guo[1], Pietro Binetti[1], Chad Althouse[1], Huub Ambrosius[2], Leif Johansson[1], Larry A. Coldren[1]; *[1]Electrical and Computer Engineering Department, University of California Santa Barbara, USA; [2]Electrical Engineering Department, Eindhoven University of Technology, Netherlands.* Optical beam steering through an InP photonic integrated circuit has been improved in term of side-lobe suppression (13dB from -14° to 14° around the peak) and steering angle (10° by 28nm wavelength tuning).

CW1K.3 • 11:45
A Highly Integrated Optical Phase-locked Loop with Single-sideband Frequency Sweeping, Mingzhi Lu[1], Hyunchul Park[1], Eli Bloch[2], Abirami Sivananthan[1], Ashish Bhardwaj[3], Leif Johansson[1], Mark Rodwell[1], Larry A. Coldren[1], Zach Griffith[4]; *[1]ECE, University of California, Santa Barbara, USA; [2]Electrical Engineering, Technion-Israel Institute of Technology, Israel; [3]JDSU, USA; [4]Teledyne Scientific Imaging Company, USA.* An optical phase-locked loop with a frequency detector and a single-sideband mixer has been proposed and demonstrated for the first time. Continuous frequency sweeping has been achieved.

CW1K.4 • 12:00
An All-Silicon Passive Optical Diode, Li Fan[1], Jian Wang[1], Leo Varghese[1], Hao Shen[1], Ben Niu[1], Yi Xuan[1], Andrew Weiner[1], Minghao Qi[1]; *[1]Purdue University, USA.* We demonstrate an optical diode with up to 28dB transmission contrast at telecommunication wavelengths. It is based on strong optical nonlinearity in two resonance-matched silicon microrings. No external assistance other than input light is required.

CW1L • Novel Light-emitting Materials—Continued

CW1L.4 • 11:30
Improvement of Angular-dependent CCT Uniformity by ZrO2 Nano-particles in Remote Phosphor White LEDs, Hsin-Chu Chen[1], Kuo-Ju Chen[1], Chao-Hsun Wang[1], Hsin-Han Tsai[1], Chien-Chung Lin[2], Min-Hsiung Shih[3], Hao-Chung Kuo[1]; [1]*Photonic, Electro-Optical Engineering, National Chiao Tung University, Taiwan;* [2]*Photonic System, National Chiao Tung University, Taiwan;* [3]*Research Center for Applied Sciences, Taiwan.* The superior uniformity of angular-dependent CCT white LEDs have been investigated by ZrO2-type remote phosphor structure. This novel structure reduces angular-dependent CCT deviations from 1000K to 420K in range of -70 to 70 degrees.

CW1L.5 • 11:45
A Full-Color, White Light Emission of Quantum-Dot-Based Display Technology Using Pulsed Spray Method with Distributed Bragg Reflector, Kuo-Ju Chen[1], Hsin-Chu Chen[1], Chien-Chung Lin[2], Hsin-Han Tsai[1], Kai-An Tsai[3], Shih-Hsuan Chien[1], Yung-Jung Hsu[3], Min-Hsiung Shih[4], Hao-Chung Kuo[1], Chih-Hao Tsai[5], His-Hsin Shih[5]; [1]*Department of Photonic, Institute of Electro-Optical Engineering, National Chiao Tung University, Taiwan;* [2]*Institute of Lighting and Energy Photonics, National Chiao Tung University, Taiwan;* [3]*Department of Materials Science and Engineering, National Chiao Tung University, Taiwan;* [4]*I Research Center for Applied Sciences, Academia Sinica, Taiwan;* [5]*Cilin Technology, Taiwan.* A colloidal quantum dot light-emitting multi-layer structure with HFO2/SiO2 distributed Bragg reflector is manufactured by pulse spray method. A pure white light with strong enhancement due to better utilization of UV pump was demonstrated.

CW1L.6 • 12:00
Triplet management in organic light emitting diodes and lasers, Yifan Zhang[1], Michael Slootsky[1], Stephen R. Forrest[1,2]; [1]*Physics, University of Michigan, USA;* [2]*Electrical Engineering and Computer Science and Materials Science and Engineering, University of Michigan, USA.* By doping a molecule with low triplet energy in the active regions of organic light emitting diodes and lasers, we demonstrate suppressed triplet-induced losses, thus overcoming a significant obstacle to electrically pumped organic lasers.

CW1M • Optomechanical Systems I—Continued

CW1M.3 • 11:15
A hybrid on-chip optonanomechanical transducer for ultra-sensitive force measurements, Emanuel Gavartin[1], Pierre Verlot[1], Tobias Kippenberg[1,2]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland;* [2]*Max-Planck-Institut for Quantum Optics, Germany.* We realize an integrated hybrid optonanomechanical transducer for the detection of weak forces. We propose and demonstrate with our system that dissipative feedback dramatically decreases the averaging time necessary to detect an incoherent force.

CW1M.4 • 11:30
GHz Optomechanical Wheel and Disk Resonators with High Mechanical *Q* Factors in Air, Xiankai Sun[1], Xufeng Zhang[1], King Yan Fong[1], Chi Xiong[1], Wolfram Pernice[1], Hong X. Tang[1]; [1]*Yale Univ., USA.* Wheel- and disk-shaped Si optomechanical resonators are demonstrated with frequency up to 1.75 GHz and mechanical Q factors as high as 4370 at 1.41 GHz measured in air. Displacement sensitivity of 4.16×10−17 m/Hz1/2 is achieved.

CW1M.5 • 11:45
A Platform for On-Chip Silica Optomechanical Oscillators with Integrated Waveguides, Karen E. Grutter[1], Alejandro Grine[1], Myung-Ki Kim[1], Niels Quack[1], Tristan Rocheleau[1], Clark T. Nguyen[1], Ming C. Wu[1]; [1]*Electrical Engineering and Computer Science, University of California, Berkeley, USA.* We present a new phosphosilicate glass photonic integrated circuit platform for optomechanical systems. Wafer-scale reflow enables high-Q (1.5x106) resonators and closely-spaced (250nm) waveguides. Optomechanical resonance (71.9MHz) is demonstrated.

CW1M.6 • 12:00
Parametric oscillations and phase noise of an optomechanical air-slot photonic crystal cavity, Jiangjun Zheng[1], Ying Li[1], Mehmet S. Aras[1], Aaron Stein[2], Ken L. Shepard[3], Chee Wei Wong[1]; [1]*Mechanical Engineering, Columbia University, USA;* [2]*Brookhaven National Laboratory, USA;* [3]*Electrical Engineering, Columbia University, USA.* We demonstrated the above-threshold behavior of an air-slot photonic crystal cavity. The experimental optomechanical coupling rate gom/2π is about 154 GHz/nm. The parametric Oscillations and phase noise are shown.

CW1N • Mode-locked /Short Pulse Lasers—Continued

CW1N.4 • 11:15
Ultralow 192 Hz RF linewidth optoelectronic oscillator based on the optical feedback of mode-locked laser diodes, Mohsin Haji[1], Lianping Hou[1], Anthony E. Kelly[1], Jehan Akbar[1], John H. Marsh[1], John M. Arnold[1], Charles N. Ironside[1]; [1]*School of Engineering, University of Glasgow, United Kingdom.* We present an ultralow RF linewidth (192 Hz) and subpicosecond phase noise (260 fs) using a passively mode-locked quantum-well laser with feedback via a dual optical fiber loop.

CW1N.5 • 11:30
490-fs Pulse Generation from a Passively Mode-Locked Laser with an Integrated Passive Waveguide Using Quantum well intermixing, Lianping Hou[1], Mohsin Haji[1], John H. Marsh[1], Ann C. Bryce[1]; [1]*School of Engineering, University of Glasgow, United Kingdom.* We report for the first time 490 fs pulse duration at a repetition frequency ~38 GHz from a passive C-band two-section AlGaInAs/InP mode-locked laser with a monolithically integrated passive waveguide made by quantum well intermixing.

CW1N.6 • 11:45
Timing Jitter Measurements of a 130 GHz Passively Mode Locked QDash Laser from its Optical Spectrum, Ricardo Rosales[1], Kamel Merghem[1], Anthony Martinez[1], Alain Accard[2], Francois Lelarge[2], Abderrahim Ramdane[1]; [1]*CNRS-LPN, France;* [2]*III-V Lab, France.* Timing jitter measurements from the optical spectrum of single-section QDash-lasers validate an analytical expression relating its diffusion constant to the mode linewidths. 2.6 fs pulse-to-pulse timing jitter is extracted from a 130 GHz device.

CW1N.7 • 12:00
High average power (200 mW) 40 GHz mode-locked DBR lasers with integrated tapered optical amplifiers, Jehan Akbar[1], Lianping Hou[1], Mohsin Haji[1], Rafal Dylewicz[1], Michael J. Strain[1], John H. Marsh[1], Ann C. Bryce[1], Anthony E. Kelly[1]; [1]*School of Engineering, University of Glasgow, United Kingdom.* We report 40 GHz passively mode-locked 1.55 µm AlGaInAs/InP lasers with integrated tapered semiconductor optical amplifiers producing nearly transform limited pulses with a pulse width of 4.3 ps and average output power of 200 mW.

Room A1

CLEO: Science & Innovations

CW1A • Nonlinear Optics in Nanophotonic Structures I—Continued

CW1A.8 • 12:15
Diamond photonic devices for non-linear optics, Birgit Hausmann[1], Parag B. Deotare[1], Irfan Bulu[1], Marko Loncar[1]; [1]*Harvard University-SEAS, USA.* We demonstrate integrated on-chip ring resonators on a single crystal diamond on insulator substrate with wide band operation around 1550nm with quality factors as large as 15000 for TE and TM modes.

Room A2

CLEO: QELS-Fundamental Science

QW1B • Plasmonic Oligomers—Continued

QW1B.7 • 12:15
Effect of Substrate and Topology on the collective response of Fano-Resonant Systems, S. Hossein Mousavi[1], Alexander B. Khanikaev[1], Burton Neuner III[1], David Y. Fozdar[1], Gennady Shvets[1]; [1]*The University of Texas at Austin, USA.* Critical effects of substrate and topology of the metamolecules on their collective response are studied. Spatial dispersion of the resonances can be substantially changed by these effects resulting in weakening their dependence on incidence angle.

Room A3

JOINT

JW1C • Symposium on Space Optical Systems: Opportunities and Challenges I—Continued

JW1C.5 • 12:15
Multi-Gigahertz-Spaced Frequency Comb Generation Using Optical Pulse Synthesizer for Extra-Solar Planet Finder, Yosuke Mizuno[1], Ken Kashiwagi[1], Hiroyuki Isizu[1], Jun Nishikawa[2], Hiroshi Suto[2], Motohide Tamura[2], Takashi Kurokawa[1]; [1]*Graduate School of Engineering, Tokyo University of Agriculture and Technology, Japan;* [2]*National Astronomical Observatory of Japan, Japan.* We propose a novel frequency comb generation method using an optical pulse synthesizer. A 12.5GHz-spaced optical frequency comb spanning ~ 300 nm was generated.

Room A4

CLEO: Science & Innovations

CW1D • Pulse Synthesis—Continued

CW1D.7 • 12:15
Interferometric Carrier Envelope Phase Control, Bruno E. Schmidt[1], Andrew D. Shiner[2], Giulio Vampa[2], Jean Claude Kieffer[1], Paul B. Corkum[2], David M. Villeneuve[2], François Légaré[1]; [1]*ALLS - Institut National de la Recherche Scientifique INRS, Canada;* [2]*Joint Laboratory for Atto-Second Science, University of Ottawa/NRC, Canada.* Interferometric CEP control in a white light seeded optical parametric amplifier is demonstrated by relative phase shifting between white light and pump beam prior to their difference frequency generation, resulting in CEP controlled Idler pulses.

11:00–13:00 Market Focus Session III: Energy/Environment: Development of Cost Competitive Solar Energy, *Exhibit Hall 3*

12:00–13:30 VIP Industry Leaders Networking Event: Connecting Corporate Executives, Young Professionals and Students, *Exhibit Hall 3*

12:30–13:30 Unopposed Exhibit Only Time, *Exhibit Halls 1, 2 and 3 (concessions available)*

NOTES

Room A5

Room A6

Room A7

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

QW1E • Novel Phenomena—Continued

QW1E.7 • 12:15
Temporally nonlocal dual delay electro-optic phase dynamics, and its bifurcation scenario, Laurent Larger[1], Lionel Weicker[2], Maxime Jacquot[1], Yanne K. Chembo[1], Thomas Erneux[2]; [1]*FEMTO-ST / Optics, Univeristy of Franche-Comte, France;* [2]*Optique Nonlineaire Theorique, Universite Libre de Bruxelles, Belgium.* Unusual bifurcation sequence exhibited in a nonlinear delay electro-optic phase dynamics setup, is explored both in experiment and analytics. Strong agreements indicate well-controlled dynamical complexity can be useful in many emerging applications.

QW1F • Strong-Field and Short-Wavelength Interactions—Continued

CW1G • Bioreactors and Biosensing—Continued

CW1G.8 • 12:15
Highly selective colorimetric differentiation of organic liquids in 3D photonic crystals, Ian B. Burgess[1,2], Kevin P. Raymond[2,3], Natalie Koay[2,3], Anna V. Shneidman[4], Mathias Kolle[1], Qimin Quan[1], Joanna Aizenberg[1,2], Marko Loncar[1]; [1]*School of Engineering and Applied Sciences, Harvard University-SEAS, USA;* [2]*Wyss Institute for Biologically Inspired Engineering, Harvard University, USA;* [3]*University of Waterloo, Canada;* [4]*Department of Chemistry and Chemical Biology, Harvard University, USA.* We present a colorimetric indicator that distinguishes organic liquids, projecting small differences in wettability into visually distinct color patterns. Photonic crystals serve as both selective carriers for liquids and sources of responsive color.

11:00–13:00 Market Focus Session III: Energy/Environment: Development of Cost Competitive Solar Energy, *Exhibit Hall 3*

12:00–13:30 VIP Industry Leaders Networking Event: Connecting Corporate Executives, Young Professionals and Students, *Exhibit Hall 3*

12:30–13:30 Unopposed Exhibit Only Time, *Exhibit Halls 1, 2 and 3 (concessions available)*

NOTES

Wednesday, 9 May

Room A8

CLEO: Applications & Technology

AW1H • Advanced Fabrication & Characterization Technologies—Continued

AW1H.7 • 12:15

High-Performance Organic Optoelectronic Devices Enabled by Laser Fine Patterning, Hong-Bo Sun[1]; [1]*State Key Laboratory on Integrated optoelectronics, Jilin University, China.* Laser nanofabrication is used for finely structuring functional layers in organic optoelectronic devices since lithography is no more applicable, as enables devices from single-crystalline DFB lasers to OLEDs with greatly enhanced efficiency.

Room B2 & B3

JOINT

JW1I • Symposium on Quantum Engineering and Architectures I: Condensed Matter Systems—Continued

JW1I.6 • 12:15

Design of Diamond Photonic Devices for Spintronics, Thomas M. Babinec[1], Helmut Fedder[2], Jennifer Choy[1], Irfan Bulu[1], Marcus Doherty[3], Philip Hemmer[4], Joerg Wrachtrup[2], Marko Loncar[1]; [1]*Applied Physics, Harvard University-SEAS, USA;* [2]*University of Stuttgart, Germany;* [3]*University of Melbourne, Australia;* [4]*Texas A&M University, USA.* We design photonic devices for the purpose of optimizing the optically detected magnetic resonance - including overall spin polarization, read-out contrast, and detection sensitivity - with the Nitrogen-Vacancy center in diamond.

Room C1 & C2

CLEO: Science & Innovations

CW1J • Frequency-Comb Assisted Sensing—Continued

Room C3 & C4

CW1K • Integrated Photonic Circuits—Continued

CW1K.5 • 12:15

Electro-optical silicon isolator, Hugo L. Lira[2,1], Zongfu Yu[4], Michal Lipson[3], Shanhui Fan[4]; [1]*Divisão de Fotônica, IEAv, Brazil;* [2]*School of Electrical and Computer Engineering, Cornell University, USA;* [3]*Kavli Institute at Cornell for Nanoscale Science, Cornell University, USA;* [4]*Department of Electrical Engineering, Stanford University, USA.* We show the first non-magnetic CMOS-compatible optical isolator on silicon chip,achieving 3dB isolation. It is based on indirect interband photonic transition, created by electrically-driven dynamic refractive index modulation on a two-mode waveguide

11:00–13:00 Market Focus Session III: Energy/Environment: Development of Cost Competitive Solar Energy, *Exhibit Hall 3*

12:00–13:30 VIP Industry Leaders Networking Event: Connecting Corporate Executives, Young Professionals and Students, *Exhibit Hall 3*

12:30–13:30 Unopposed Exhibit Only Time, *Exhibit Halls 1, 2 and 3 (concessions available)*

Exhibit Hall 3

JOINT

13:30–15:00
JW2A • Poster Session I

JW2A.1

Dynamics of coherent optical phonons in a Bi2Se3 crystal, Katsura Norimatsu[1,2], Jianbo Hu[1,2], Arihiro Goto[1,2], Kyushiro Igarashi[1], Takao Sasagawa[1], Kazutaka G. Nakamura[1,2]; [1]*Materials and Structures Laboratory, Tokyo Institute of Technology, Japan;* [2]*CREST, Japan Science and Technology Agency, Japan.* Coherent A1g1, A1g2, and Eg2 phonons in Bi2Se3 are observed using ultrafast spectroscopy. Their initial phases suggest different coupling strengths with photo-excited electrons. Their decay rates per oscillations are almost the same.

JW2A.2

Coherence of Fine-Structure States of an InAs Quantum Dot Ensemble Studied with 2D Fourier-Transform Spectroscopy, Rohan Singh[1,2], Galan Moody[1,2], Hebin Li[1], Ilya Akimov[3,4], Manfred Bayer[3], Dirk Reuter[5], Andreas Wieck[5], Steven T. Cundiff[1,2]; [1]*JILA, University of Colorado/NIST, USA;* [2]*Department of Physics, University of Colorado, USA;* [3]*Experimentelle Physik 2, Technische Universität Dortmund, Germany;* [4]*A. F. Ioffe Physical-Technical Institute, Russian Academy of Sciences, Russian Federation;* [5]*Lehrstuhl fuer Angewandte Festkoerperphysik, Ruhr-Universitaet Bochum, Germany.* Coherence decay times of and between fine-structure states is obtained from an InAs quantum dot ensemble using optical 2D Fourier-transform spectroscopy. This technique allows us to investigate properties of QDs within the ensemble.

JW2A.3

Efficient low-power autocorrelation measurement with carbon nanotube photoconductors, Barmak Heshmat[1], Hamid Pahlevaninezhad[1], Thomas Darcie[1]; [1]*Electrical and Computer Eng., University of Victoria, Canada.* We investigate carbon nanotube based photoconductive devices for autocorrelation measurement. The device shows superior signal level (more than double) for optical powers less than 100μW compared to similar devices fabricated on SI-GaAs and InGaAs.

JW2A.4

Ultrafast spectroscopy of poly-thiophene derivative by using sub-10 fs visible pulse, Atsushi Yabushita[1], Yu-Hsien Lee[2], Chain Shu Hsu[3], Sheng Hsiung Yang[4], Chih Wei Luo[1], Kaung-Hsiung Wu[1], Takayoshi Kobayashi[6,5]; [1]*Department of Electrophysics, National Chiao-Tung University, Taiwan;* [2]*Industrial Technology Research Institute, Taiwan;* [3]*Department of Applied Chemistry, National Chiao-Tung University, Taiwan;* [4]*Institute of Lighting and Energy Photonics, National Chiao-Tung University, Taiwan;* [5]*JST-CREST, Japan;* [6]*Department of Applied Physics and Chemistry, University of Electro-Communications, Japan.* Ultrafast spectroscopy was performed for a poly(3-hexylthiophene) (P3HT) film changing pump power. The result clarified the femtosecond time constant for generation and relaxation of the bound polaron pair in the film

JW2A.5

Observation of Antiferromagnetic Magnons in Manganese Oxide by THz-TDS, Toshiro Kohmoto[1], Takeshi Moriyasu[1], Suguru Wakabayashi[1]; [1]*Graduate School of Science, Kobe University, Japan.* We observed the antiferromagnetic resonance in MnO by terahertz time-domain spectroscopy (THz-TDS). The temperature dependences of the magnon frequency, the relaxation rate, and the magnetostrictive contribution to refractive index are discussed.

JW2A.6

Theoretical investigation for coherent phonon generation studied with first-principles calculation, Yasushi Shinohara[1,2], Kazuhiro Yabana[1,3], Tomohito Otobe[4], Jun-Ichi Iwata[5], George F. Bertsch[6]; [1]*Graduate School of Pure and Applied Sciences, University of Tsukuba, Japan;* [2]*Graduate School of Systems and Information Engineering, University of Tsukuba, Japan;* [3]*Center for Computational Sciences, University of Tsukuba, Japan;* [4]*Kansai Photon Science Institute, JAEA, Japan;* [5]*Department of Applied Physics, University of Tokyo, Japan;* [6]*Department of Physics, University of Washington, USA.* We investigate mechanisms of coherent phonon generation in time-dependent density functional theory. It is shown that stimulated Raman and displacive excitation mechanisms are understood in a unified way.

JW2A.7

Picosecond Carrier Lifetime Measurements on a Single GaAs Nanowire, Patrick Parkinson[1], Hao Wang[1], Qiang Gao[1], Hark Hoe Tan[1], Chennupati Jagadish[1]; [1]*Electronic Materials Engineering, Australian National University, Australia.* The photocarrier lifetime within semiconductor nanowires is a critical parameter for optoelectronic applications. Here, we present a technique to determine the lifetime with picosecond resolution, revealing a 7.5 ps lifetime for GaAs nanowires.

JW2A.8

Ultra-fast inter-subband relaxation and non-thermal carrier distribution in Ge/SiGe quantum wells, Alexej Chernikov[1], Verena Bornwasser[1], Niko S. Koester[1], Ronja Woscholski[1], Sangam Chatterjee[1], Eleonora Gatti[2], Emanuele Grilli[2], Mario Guzzi[2], Daniel Chrastina[3], Giovanni Isella[3]; [1]*Department of Physics, Philipps-Universität Marburg, Germany;* [2]*L-NESS and Dipartimento di Scienza dei Materiali, Università di Milano-Bicocca, Italy;* [3]*L-NESS and Dipartimento di Fisica, Politecnico di Milano, Italy.* A systematic study of carrier relaxation in Ge quantum wells is performed applying photoluminescence and pump-probe spectroscopy. Intersubband-relaxation on a 100 fs time-scale and the presence of a non-thermal carrier distribution are identified.

Marriott San Jose
Salon I & II

Marriott San Jose
Salon III

Marriott San Jose
Salon IV

CLEO: Science & Innovations

CW1L • Novel Light-emitting Materials—Continued

CW1L.7 • 12:15
Direct band-gap electroluminescence from strained n-doped germanium diode, Philippe Velha[1], Kevin Gallacher[1], Derek C. Dumas[1], Maksym Myronov[2], David R. Leadley[2], Douglas J. Paul[1]; [1]*School of Engineering, University of GLasgow, United Kingdom;* [2]*Department of physics, University of Warwick, United Kingdom.* The fabrication and characterisation of LED structures made of Ge grown on Si is reported. An average power levels at 1.7 micron of 10 micro-Watt, many orders of magnitude larger than the nW previously reported.

CW1M • Optomechanical Systems I—Continued

CW1M.7 • 12:15
Photonic crystal paddle nanocavities for optomechanical torsion sensing, Marcelo Wu[1,2], Aaron C. Hryciw[2], Behzad Khanaliloo[1,2], Mark R. Freeman[2,3], John P. Davis[3], Paul E. Barclay[1,2]; [1]*Physics and Astronomy, University of Calgary, Canada;* [2]*National Institute for Nanotechnology, NRC, Canada;* [3]*Physics, University of Alberta, Canada.* Photonic crystal nanocavities with suspended central elements suitable for optomechanical detection of torsional forces are designed and fabricated. This ``floating” low mass nanocavity may be mechanically coupled to nanomagnetic structures.

CW1N • Mode-locked /Short Pulse Lasers—Continued

CW1N.8 • 12:15
Monolithically Integrated 10-GHz Ring Colliding Pulse Mode-Locked Laser for On-Chip Coherent Communications, Stanley T. Cheung[1], Francisco Soares[1], Jong-Hwa Baek[1], Binbin Guan[1], Fredrik Olsson[2], Sebastian Lourdudoss[2], S. J. Ben Yoo[1]; [1]*Electrical and Computer Engineering, University of California, Davis, USA;* [2]*School of Information and Communication Technology, Royal Institute of Technology, Sweden.* We report a 10-GHz ring-resonator colliding-pulse-mode-locked laser with tunable-couplers for InP-based monolithically-integrated optical-coherent-communication systems. Hybrid-mode-locking resulted in a pulse-width of 10.1ps for 6-nm spectral-width.

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12:30–13:30 Unopposed Exhibit Only Time, *Exhibit Halls 1, 2 and 3 (concessions available)*

Exhibit Hall 3

JOINT

JW2A • Poster Session I—Continued

JW2A.9
Ultrafast x-ray spectroscopic and scattering studies of nanoscale superionic phase transitions, Timothy A. Miller[1,2], Aaron Lindenberg[1,2], Joshua S. Wittenberg[1,3], Haidan Wen[4]; [1]*Materials Science, Stanford University, USA;* [2]*PULSE, SLAC National Lab, USA;* [3]*SIMES, SLAC National Lab, USA;* [4]*Advanced Photon Source, Argonne National Lab, USA.* Ultrafast x-ray absorption spectroscopy and diffraction techniques are used to directly record the superionic structural phase transition in nanoscale copper sulfide.

JW2A.10
Optical Probes of Ultrafast Electron Dynamics in Photoexcited Ferroelectrics, John Goodfellow[1,3], Dan Daranciang[2,3], Aaron Lindenberg[1,3]; [1]*Materials Science and Engineering, Stanford University, USA;* [2]*Department of Chemistry, Stanford University, USA;* [3]*PULSE/SIMES, SLAC National Accelerator Laboratory, USA.* THz emission spectroscopy and time resolved second harmonic generation are used to probe transient electron dynamics in ferroelectric PbTiO3 and multiferroic BiFeO3.

JW2A.11
High quantum efficiency, low emittance electron beam from multifilamentary cathodes, Fernando Ardana Lamas[1,2]; [1]*Paul Scherrer Institut, Switzerland;* [2]*Ecole Polytechnique Fedarale de Lausanne, Switzerland.* We present a new type of metallic cathode, reaching quantum efficiency of 10^−3. This value together with the estimated emittance, gives a brilliance of 2.8x10^13 m^2, making this cathode an excellent candidate for an ultrashort electron source.

JW2A.12
Control over Two-dimensional Vibrational Trajectory by Phase-shaped Infrared Pulses, Satoshi Ashihara[1], Kaori Enomoto[1], Toshiya Arakaki[1]; [1]*Applied Physics, Tokyo Univ. of Agriculture and Technology, Japan.* Phase-shaping of mid-infrared pulses was applied to control the relative phase of two vibrational excitations in a metal di-carbonyl compound in condensed phases. This corresponds to control over 2D vibrational trajectories at the initial stage.

JW2A.13
Direct Observation of the Spatial and Temporal Dynamics of Thermal Diffusion in Clathrate Compounds, Tetsuo Watanabe[1], Takeshi Moriyasu[1], Hidekazu Okamura[1], Koichiro Suekuni[2], Takahiro Onimaru[2], Toshiro Takabatake[2], Toshiro Kohmoto[1]; [1]*Graduate School of Science, Kobe University, Japan;* [2]*Hiroshima University, Japan.* The diffusion dynamics of the optically induced lattice distortion in clathrate compounds is studied by the pump-probe technique. The direct observation of the spatial and temporal dynamics of thermal diffusion is demonstrated.

JW2A.14
Observation of a Photon Echo in GaMnAs, Murat Yildirim[1], Sam March[1], Reuble Mathew[1], Angela Gamouras[1], Xinyu Liu[2], Margaret Dobrowolska[2], Jacek Furdyna[2], Kimberley C. Hall[1]; [1]*Physics and Atmospheric Science, Dalhousie University, Canada;* [2]*Physics, University of Notre Dame, USA.* Four-wave mixing experiments on GaMnAs reveal a strong decrease in the interband dephasing time with the incorporation of Mn. The nonlinear response is characterized by a photon echo, despite the strong influence of disorder.

JW2A • Poster Session I—Continued

JW2A.15

Time resolved X-ray studies in semiconductor nanostructures, Andrius Jurgilaitis[1], Maher Harb[1], Henrik Enquist[1], Ralf Nuske[1], Anna Persson[1], Jorgen Larsson[1]; [1]*Atomic Physics Division, Department of Physics, Lund University, Sweden.* Time resolved X-ray diffraction has been used to study acoustic oscillations in InAs/Sb nanowires with diameters of 80 nm and 40 nm in order to determine the speed of sound in the wires.

JW2A.16

Blind Bias Compensation in Speckle Imaging, Jeremy Bos[1], Brandoch Calef[2], Stacie Williams[3]; [1]*Electrical and Computer Engineering, Michigan Technological University, USA;* [2]*Boeing LTS, Boeing Corporation, USA;* [3]*Directed Energy Directorate, Air Force Research Lab, USA.* We present a method for blind bias compensation of the bispectrum in speckle-imaging applications using EMCCDs.Image reconstructions using this blind method are found to compare favorably with those produced without compensation.

JW2A.17

Experimental Implementation of Oblivious Transfer in the Noisy Storage Model, Chris Erven[1], Stephanie Wehner[2], Raymond Laflamme[1,3], Gregor Weihs[4]; [1]*Physics - Institute for Quantum Computing, University of Waterloo, Canada;* [2]*Center for Quantum Technologies, National University of Singapore, Singapore;* [3]*Perimeter Institute, Canada;* [4]*Institut fur Experimentalphysik, Universitat Innsbruck, Austria.* We report on the first experimental implementation of 1-2 random oblivious transfer in the noisy storage model using a modified entangled quantum key distribution (QKD) system implementing Schaffner's simple protocol.

JW2A.18

Terahertz spectra through ultrafast electro-optic modulation, Zhiyuan Chen[1], Matthew F. DeCamp[1]; [1]*Department of Physics and Astronomy, University of Delaware, USA.* Ultrafast electro-optic modulation on narrow band optical pulses is utilized to spectrally resolve coherent THz radiation. This technique utilizes standard optical components, providing a method of direct spectral reconstruction of THz radiation.

JW2A.19

A short-standoff bistatic lidar system for aerosol cloud backscatter cross section measurement, Randal L. Schmitt[1], Crystal C. Glen[1], Shane M. Sickafoose[1], Richard N. Shagam[1], Josh Santarpia[1], John E. Brockman[1], Thomas A. Reichardt[2], Michael V. Pack[1], Victor Chavez[1], Craig Boney[1], Brandon Servantes[1]; [1]*Sandia National Laboratories, USA;* [2]*Sandia National Laboratories, USA.* A short-standoff bistatic lidar system coupled with an aerosol chamber was built to measure aerosol optical backscatter and laser induced fluorescence cross-sections. Results show good sensitivity across all channels with high signal-to-noise ratio.

JW2A.20

Dual-Frequency Laser Doppler Velocimeter for Speckle Noise Reduction, Chih-Hao Cheng[1], Chia-Wei Lee[1], Tzu-Wei Lin[1], Fan-Yi Lin[1]; [1]*Department of Electrical Engineering/Institute of Photonics Technologies, National Tsing Hua University, Taiwan.* We develop a dual-frequency laser Doppler velocimeter based on an optically-injected semiconductor laser. Spectral broadening suffered from the speckle noise is much suppressed benefitted by the longer effective wavelength.

JW2A.21

FM-to-AM effect caused by beam propagation using smoothing by spectral dispersion, Rui Zhang[1,2], Jingqin Su[1]; [1]*Research Center of Laser Fusion, CAEP, China;* [2]*Department of Optics and Optical Engineering, University of Science and Technology of China, China.* Spatial and temporal modulations caused by beam propagation after using smoothing by spectral dispersion are studied. Experimental results agree with the deduced analytical model, suggesting minimizing free-space propagation and adopting image relay.

JW2A.22

Polarization Characteristics of a Two-Mirror Azimuth and Elevation Laser Beam Scanner, Anna Petrova-Mayor[1]; [1]*Physics, CSU Chico, USA.* A miniature lidar beam steering unit was developed and used to determine the effect of the mirror coatings on the transmitted state of polarization. Results will be presented for pairs of mirrors with different coatings.

JW2A.23

Barium Nitrate Raman Laser for CO_2 Detection, Oliver Lux[1], Hanjo Rhee[1], Hans J. Eichler[1]; [1]*Institute of Optics and Atomic Physics, Technical University of Berlin, Germany.* Frequency conversion of a single longitudinal mode Nd:YAG laser operating at 1.064 µm is realized by an external third order Stokes barium nitrate Raman laser providing narrowband radiation at 1.599 µm applied for CO2 detection.

JW2A.24

Diode-pumped Passively Q-switched Nd:YAG/BaWO4/KTP Yellow Laser, Xu Huihua[1], Zhang Xingyu[1], Wang Qingpu[1], Wang Weitao[1], Wang Cong[1], Li Lei[1], Cong Zhenhua[1], Liu Zhaojun[1], Chen Xiaohan[1], Fan Shuzhen[1], Jin Guofan[1], Zhang Huaijin[2]; [1]*School of Information Science and Engineering and Shandong Provincial Key Laboratory of Laser Technology, Shandong University, China;* [2]*State Key Laboratory of Crystal Materials, Shandong University, China.* A diode-pumped passively Q-switched Nd:YAG/BaWO4/KTP yellow laser is presented for the first time. The obtained maximum average output power, conversion efficiency, pulse energy were 1.21 W, 9.06%, and 68.5 µJ, respectively.

JW2A.25

Efficient Amplification of Nd3+/Cr3+:YAG Ceramic Lasers Based on Cross-Relaxation under Solar-Pumping, Taku Saiki[1]; [1]*Kansai University, Japan.* Efficient lasers as energy transfer devices from broadband solar light to coherent laser light have been developed recently. Research on efficient amplification of Nd3+/Cr3+:YAG ceramics based on cross-relaxation pumped by white light was performed.

JW2A.26

Dual Color Beam Recycling Optical Cavity Development, Chunning Huang[1], Yun Liu[1]; [1]*Oak Ridge National Laboratory, USA.* Dual color beam recycling optical cavity was proposed to provide 402.5MHz 50ps UV laser pulses with a MW level peak power applicable to the laser assisted H- beam stripping for the Spallation Neutron Source.

JW2A.27

High Peak Power Passively Q-switched Yb:YAG Micro-Lasers, Masaki Tsunekane[1], Takunori Taira[1]; [1]*Laser research center, Institute for Molecular Science, Japan.* A QCW diode end-pumped, high peak power passively Q-switched Yb:YAG/Cr:YAG micro-laser was demonstrated. An output pulse energy of 0.8mJ was obtained with a duration of 4ns. The peak power is 200kW. An M2 value was <1.1.

JW2A.28

Wavelength Tunable Q-switch Laser in Visible Region with Pr3+-doped Fluoride-glass Fiber Pumped by GaN Diode Lasers, Fumihiko Kannari[1], Jyuichiro Kojyo[1]; [1]*Dept. of Electronics & Electrical Engineering, Keio University, Japan.* Q-switching of wavelength tunable Pr3+-doped fluoride-glass fiber laser pumped by high-power GaN laser diodes is demonstrated. Highest laser peak power of 102 W with 20 ns pulsewidth is obtained for 607 nm at 8.3 kHz.

JW2A.29

The Q-factor of a Continuous-wave Laser, Marc Eichhorn[1], Markus Pollnau[2]; [1]*French-German Research Institute of Saint-Louis ISL, France;* [2]*MESA+ Institute for Nanotechnology, University of Twente, Netherlands.* We define the finite Q-factor of a continuous-wave lasing resonator as the energy of coherent photons stored in the resonator at a given time over the energy of these coherent photons lost per oscillation cycle.

JW2A.30

High-aspect-ratio Plasma Target for Raman Backscattering in Exawatt Laser Development, Victor Yanovsky[1], Franklin Dollar[1], Anatoly Maksimchuk[1], John A. Nees[1], Alexander Thomas[1], Karl Krushelnick[1]; [1]*eecs, university of Michigan, USA.* We design a scalable plasma target with uniform density and sharp boundaries for Raman backscattering for Exawatt laser development.

JW2A.31

Simultaneous Lasing on the D1 and D2 Lines of Sodium, John D. Hewitt[1], J. G. Eden[1]; [1]*Electrical and Computer Engineering, University of Illinois at Urbana-Champaign, USA.* Lasing at both 589.0 nm and 589.6 nm in Na has been realized by photoassociating Na-rare gas pairs.

JW2A.32

Vector Bessel-Gaussian Beam Generation from a c-cut Nd:YVO4 Crystal with an Annular-Shaped Gain, Ryushi Takeuchi[1], Yuichi Kozawa[1], Shunichi Sato[1]; [1]*Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, Japan.* The generation of an annular-shaped, higher-order vector Bessel-Gaussian beam is demonstrated by a c-cut Nd:YVO4 crystal with an annular-shaped gain. The polarization of the generated beam is controlalbe by changing the cavity length.

JW2A.33

Optoenergy Storage and Broadband Optical Amplification in Er3+ Doped PLZT Ceramics, Jingwen W. Zhang[1,2], Long Xu[1], Hua Zhao[1], Xiudong Sun[1]; [1]*Physics, Harbin Institute of Technology, China;* [2]*Boston Applied Technologies, Inc., USA.* Broadband optical amplification in Er3+ doped PLZT ceramic plates was observed when they were exposed to a corona atmosphere. The optoenergy storage and plasma-induced structural variation seems responsible for the broadband amplification.

JW2A.34

Recent Advances in the PW Beamline for SG-II-U Laser Facility, Tao Wang[1], Dawei Li[2], Zhaoyang Li[1], Guang Xu[2], Yaping Dai[1]; [1]*Shanghai Institute of Laser Plasma, China;* [2]*Shanghai Institute of Optics and Fine Mechanics, the Chinese Academy of Sciences, China.* The SG-II upgrade laser facility includes a Petawatt beamline for fundamental physics and advanced applications. The program has been implemented since 2007. We report on the recent progress and the highlights of the engineering campaigns.

JW2A.35

Application of Chromatic Aberration pre Compensation Techniques in Large Aperture Petawatt-class Laser Systems, Oleg Chekhlov[1], Chris J. Hooker[1], Cristina Hernandez-Gomez[1], Pattathil Rajeev[1]; [1]*Central Laser Facility, STFC Rutherford Appleton Laboratory, United Kingdom.* Different optical designs for compensation of radial pulse front delay in optical systems of broadband chirped pulse amplifiers have been analyzed. The results for compensating doublet lens and hybrid element will be presented.

JW2A.36

Optical Generation of Microwave Signals with a Dual-Phase-Shifted Al_2O_3:Yb^{3+} Distributed-Feedback Laser, Edward H. Bernhardi[1], Rezaul Khan[2], Chris Roeloffzen[2], Henk van Wolferen[3], Kerstin Wörhoff[1], Rene M. de Ridder[1], Markus Pollnau[1]; [1]*Integrated Optical MicroSystems Group, University of Twente, Netherlands;* [2]*Telecommunication Engineering Group, University of Twente, Netherlands;* [3]*Transducers Science and Technology Group, University of Twente, Netherlands.* We demonstrate the optical generation of stable microwave signals from a dual-wavelength distributed-feedback waveguide laser in ytterbium-doped alumina. The microwave beat signal was produced at ~15 GHz with a frequency stability of ±2.5 MHz.

JW2A.37

13-mJ, Single Frequency, Sub-nanosecond Nd:YAG Laser at kHz Repetition Rate with Near Diffraction Limited Beam Quality, Danail Chuchumishev[1], Alexander Gaydardzhiev[1], Anton Trifonov[1], Ivan C. Buchvarov[1]; [1]*Department of Physics, Sofia University, Bulgaria.* Near diffraction limited, single frequency, passively Q-switched Nd:YAG laser (240-µJ, 830-ps at 0.5-kHz) is amplified up to 13-mJ in a three-stage diode pumped amplifier whilst preserving pulse duration, beam quality and linear polarization.

JW2A.38

Dual Beam Operation of the Astra-Gemini High Power Laser and Upgrades to the Ti:Sapphire Amplifiers, Bryn Parry[1], Yunxin Tang[1], Chris J. Hooker[1]; [1]*CLF, STFC, United Kingdom.* Special considerations of operating the dual beam facility Gemini are presented. Amplifiers in Astra have been upgraded to improve the contrast, stability and performance with wedged Ti:Sapphire crystals and spatial filtering.

JOINT

JW2A • Poster Session I—Continued

JW2A.39
New Scheme of Faraday Isolator with Simultaneous Compensation of Thermally Induced Depolarization and Thermal Lens, Ilya L. Snetkov[1], Oleg Palashov[1], Efim Khazanov[1]; [1]*Institute of Applied Physics, Russian Federation.* Investigate the method of simultaneous compensation of thermally induced depolarization and lens in the Faraday isolators. The isolation degree of used FI was enhanced from 25dB to 31dB and thermal lens has been weakened by 1.25 times.

JW2A.40
Resonantly pumped, Q-Switched Nd:YLF Laser, Bhabana Pati[1]; [1]*Q Peak Inc., USA.* We developed a compact, efficient Nd:YLF laser that produced 25-mJ of energy in a 8-ns pulse at 20 Hz. By resonantly pumping at 863 nm, 10% improvement in the slope efficiency was obtained.

JW2A.41
Intracavity Terahertz Generation in Laser Output Coupler Made from Stacked GaP Plates, Pu Zhao[1], Srinivasa Ragam[1], Yujie J. Ding[1], Ioulia B. Zotova[2]; [1]*Electrical & Computer Engineering, Lehigh University, USA;* [2]*ArkLight, USA.* Efficient terahertz pulses are emitted from stacked GaP plates used as an output coupler for a Q-switched solid-state laser. Such a novel intracavity configuration is exploited to achieve an enhancement of two orders of magnitude.

JW2A.42
Strong-Coupling Behavior of THz Sub-wavelength Directional Couplers, Tzu-Fang Tseng[1], Chih-Hsien Lai[2], Jen-Tang Lu[1], Yuan-Fu Tsai[1], Yuh-Jing Hwang[3], Chi-Kuang Sun[1,4]; [1]*National Taiwan University, Graduate Institute of Photonics and Optoelectronics, Taiwan;* [2]*Electrical Engineering, Hwa Hsia Institute of Technology, Taiwan;* [3]*Institute of Astronomy and Astrophysics, Academia Sinica, Taiwan;* [4]*Molecular Imaging Center and Graduate Institute of Biomedical Electronics and Bioinformatics, Taiwan.* We investigated the strongly-coupled mode characteristic of THz sub-wavelength directional couplers. It provides superior performance to transfer power to the coupled arm with only 0.2dB insertion loss, or with a record-short 38 λ coupling length.

JW2A.43
Broadband stopband filter for terahertz wave based on multi-layer metamaterial microstructure, Zhongyang Li[1], Yujie J. Ding[1]; [1]*Electrical & Computer Engineering, Lehigh University, USA.* We show that a multi-layer microstructure consisting of stacked rectangular ring resonators exhibit characteristics of broadband stopband filters having a bandwidth of 1.1 THz and a quality factor of 1.6.

JW2A.44
Polarization controlled THz wave generation from GaP waveguides via collinear phase-matched difference frequency mixing, Kyosuke Saito[1], Tadao Tanabe[2], Yutaka Oyama[1]; [1]*Department of Material Science, Graduate school of Engineering, Tohoku University, Japan;* [2]*Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, Japan.* THz radiation from GaP waveguides via collinear phase-matched difference frequency mixing of two near-infrared lasers is demonstrated. TE and TM mode THz wave are generated from the waveguides selectively by adjusting polarization of incident lasers.

JW2A.45
Fabrication of Thin Metallic-film Subwavelength-Grating Polarizers for Terahertz Region by the Imprinting Method, Kazuo Shiraishi[1], Misako Kofuji[1], Yuta Inagawa[1], Hidehiko Yoda[1], Chen S. Tsai[2]; [1]*Utsunomiya University, Japan;* [2]*University of California, USA.* Fabrication of metallic-film subwavelength-grating polarizers is simplified by employing the imprinting technique. The extinction ratio of polarizers fabricated is 45dB together with an insertion loss lower than 0.5dB at around 2.3THz.

JW2A.46
Absorption Bleaching in Silicon via High-Power Terahertz Pulses: Carrier Dependence, Gargi Sharma[1], Ibraheem Al-Naib[1], Hassan Hafez[1], Roberto Morandotti[1], Tsuneyuki Ozaki[1]; [1]*INRS-EMT, Canada.* We present optical-pump / high-power THz probe measurements for undoped silicon at different optical pump fluences. We observe an absorption bleaching of intense terahertz (THz) pulses, which decreases with increasing optical pump fluence.

JW2A.47
Polarization State Measurements of Terahertz Time-Domain Pulses, Mohammad Neshat[1], N. Peter Armitage[1]; [1]*Department of Physics and Astronomy, Johns Hopkins University, USA.* A method for polarization measurements of THz pulses is presented. A calibration scheme is applied to correct for the impact of the non-idealities of the detector. Experimental results show excellent sub-degree angular accuracy with this method.

JW2A.48
Terahertz tomographic imaging of topical drugs, Hyeongmun Kim[1], Kyung Won Kim[2], Joo-Hiuk Son[1], Joon Koo Han[2]; [1]*Physics, University of Seoul, Republic of Korea;* [2]*Department of Radiology, Seoul National University Hospital, Republic of Korea.* THz technology can be good modality for studying transdermal drug delivery due to their chemical identification and imaging capabilities. We demonstrate THz reflection and tomographic imaging to visualize the distribution of topically applied drugs.

JW2A.49
Multi-Cavity Far Infrared 2D Plasmonic Phenomena with Inhomogeneous Screening, Gregory C. Dyer[1], Gregory Aizin[2], S. James Allen[3], J. M. Hensley[4], B. D. Casse[4], Albert Grine[1], John Reno[1], Eric Shaner[1]; [1]*Sandia National Laboratories, USA;* [2]*Kingsborough College, The City University of New York, USA;* [3]*Institute for Terahertz Science and Technology, UC Santa Barbara, USA;* [4]*Physical Sciences Inc., USA.* We have observed coherent interaction of coupled far infrared 2D plasma cavities in a GaAs/AlGaAs FET. These results have been modeled with a transmission line formalism that treats both unscreened and screened 2D plasmons.

JW2A.50
Rectified Diode Response of a Quantum Cascade Laser Integrated Terahertz Transceiver, Gregory C. Dyer[1], Christopher Nordquist[1], Michael Cich[1], Albert Grine[1], Charles Fuller[1], John Reno[1], Michael C. Wanke[1]; [1]*Sandia National Laboratories, USA.* We characterized the rectified response of a diode integrated on a terahertz quantum cascade laser transceiver. The diode response is consistent with its I-V characteristics and reflects the complex Fabry-Perot laser cavity mode spectrum.

JW2A.51
Engineering the Response of Terahertz Metasurfaces by Spatial Arrangement of Split-Ring Resonators, Ibraheem Al-Naib[1], Ranjan Singh[2], Mostafa Shalaby[1], Tsuneyuki Ozaki[1], Roberto Morandotti[1]; [1]*INRS-EMT, Canada;* [2]*Center for Integrated Nanotechnologies, Materials Physics and Applications Division, Los Alamos National Laboratory, USA.* We demonstrate the effect of spatial arrangement of split-ring resonators (SRR) in a macrocell with two SRRs. The diagonal scheme presents the optimal coupling and constructively interfering scattered fields, in turn enhancing the quality factor.

JW2A.52
Enhanced THz Transmission Through Periodic Subwavelength Aperture Arrays Fabricated in Graphite, Shuchang Liu[1], Tho D. Nguyen[2], Z. Valy Vardeny[2], Ajay Nahata[1]; [1]*Electrical and Computer Engineering, University of Utah, USA;* [2]*Department of Physics and Astronomy, University of Utah, USA.* We demonstrate that graphite is an attractive medium for plasmonics applications at THz frequencies. We accomplish this by measuring the complex dielectric properties of planar and periodically perforated graphite films using THz-TDS.

JW2A.53
Direct Measurement of Surface Plasmon Properties on Different Metals using Terahertz Time-Domain Spectroscopy, Shashank Pandey[1], Ajay Nahata[1]; [1]*Electrical and Computer Engineering, University of Utah, USA.* We directly measure the dielectric properties of different metals relevant to plasmonics using THz time-domain spectroscopy. The computed permittivity values differ significantly from published data, but agree well with other measured parameters.

JW2A.54
High-efficient THz electric pulse generation via optical rectification by suppressing stimulated Raman scattering, Masaya Nagai[1], Eiichi Matsubara[1], Masaaki Ashida[1]; [1]*Graduate School of Engineering Science, Osaka University, Japan.* We demonstrate high-efficient THz pulse generation with optical rectification in LiNbO3. Narrowed spectral bandwidth of subpicosecond optical pulse suppresses stimulated Raman scattering, leading to the highest energy conversion efficiency of 0.21 %.

JW2A.55
Rapid Scan Mode with THz OSCAT Spectrometer, Rafal Wilk[1], Thomas Hochrein[2], Michael Mei[1], Ronald Holzwarth[1]; [1]*Menlo Systems GmbH, Germany;* [2]*SKZ KFG GmbH, Germany.* We present OSCAT laser systems as a general tool for pump and probe experiments. The current development offers unlimited temporal scanning range using the intracavity motor and a rapid scan mode with a range of 100 ps.

JW2A.56
Forward and backward THz-wave difference frequency generations from a rectangular nonlinear waveguide, Yenchieh Huang[1], Tsongdong Wang[1], Yenhou Lin[1], Chinghan Lee[1], Mingyuen Chuang[1], Yenyin Lin[1], Fan-Yi Lin[1]; [1]*National Tsinghua University, Taiwan.* We measured enhanced forward and backward THz-wave difference frequency generations at 1.5 and 0.6 THz, respectively, from a PPLN rectangular waveguide. A theory accounting for large mode mismatch is derived to explain the experimental result.

Wednesday, 9 May

JW2A • Poster Session I—Continued

JW2A.57
THz Emission from a-plane InGaN, Nathaniel T. Woodward[1], Grace D. Metcalfe[1], Ryan W. Enck[1], Chad S. Gallinat[1], Hongen Shen[1], Michael Wraback[1]; [1]*Sensors and Electron Devices Directorate, Army Research Laboratory, USA.* Terahertz emission from high stacking fault density a-plane InGaN utilizing in-plane drift fields is shown to produce considerable improvement over c-plane InGaN under identical excitation conditions.

JW2A.58
Tellurite Composite Microstructured Optical Fibers with Ultra-flattened, Near-zero Dispersion Profile for Nonlinear Applications, Zhongchao Duan[1], Meisong Liao[1], Xin Yan[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Optical Functional Materials Laboratory, Toyota Technological Institute, Japan.* We report tellurite composite microstructured optical fibers with small core surrounded by air holes and two glass claddings with low refractive index. In which near zero, ultra-flattened dispersion is realized.

JW2A.59
Tunable polarization-maintaining single-mode fiber laser based on a MEMS processor, Xiao Chen[1], Kui-zhi Huang[2], Yi-quan Wang[1], Feijun Song[1], Gen-xiang Chen[3], Xin-zhu Sang[2], Bin-bin Yang[2], Xiao Feng[4], Kamal Alameh[4]; [1]*College of Science, Minzu University of China, China;* [2]*State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Posts and Telecommunications, China;* [3]*School of Electronic and Information Engineering, Beijing Jiaotong University, China;* [4]*Electron Science Research Institute, Edith Cowan University, Australia.* A tunable from the C-band polarization-maintaining single-mode fiber laser is proposed based on a MEMS processor. The MEMS processor can select any part of the gain spectrum from the EDFA into a fiber ring, leading to a high-quality laser output.

JW2A.60
Dark Pulses Observed in a Mode-locked Long Ring Cavity with Single-mode Tellurite Fiber, Weiqing Gao[1], Meisong Liao[1], Hiroyasu Kawashima[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Toyota Technological Institute, Japan.* The dark pulses are demonstrated in a long ring cavity with single-mode tellurite fiber. The pulse widths of the dark pulses change with the polarization states. The multiple dark pulses are observed by polarization controlling.

JW2A.61
Er3+-doped ZBLAN fiber laser Q-switched by Fe:ZnSe, Chen Wei[1], Xiushan Zhu[1], Robert Norwood[1], Nasser Peyghambarian[1]; [1]*College of Optical Sciences, University of Arizona, USA.* A highly erbium ion-doped ZBLAN fiber laser passively Q-switched by a Fe:ZnSe crystal is reported. Mid-infrared pulses at 2.78 µm with a repetition rate of 70.4 kHz and a pulse duration of 5.8 µs were generated.

JW2A.62
Freely Triggerable 266 nm Picosecond Pulses Generated from a Fiber-Amplified Gain-Switched Laser Diode, Thomas Schoenau[1], Kristian Lauritsen[1], Thomas Eckhardt[1], Dietmar Klemme[1], Romano Härtel[1], Rainer Erdmann[1]; [1]*PicoQuant GmbH, Germany.* UV 65 ps pulses are generated via a 2-stage SHG starting from 1062 nm radiation. A gain-switched laser diode is fiber amplified and converted to pJ-energy pulses at 266 nm, freely triggerable up to 80 MHz.

JW2A.63
All-fiber Tm-doped wavelength-swept laser, Jihong Geng[1], Qing Wang[1], Jiafu Wang[1], Shibin Jiang[1], Kevin Hsu[2]; [1]*AdValue Photonics, USA;* [2]*Micron Optics, USA.* We report, for the first time, an all-fiber Tm-doped wavelength-swept laser based on a fiber Fabry-Perot tunable filter, which can be continuously tuned over 200nm from 1840nm to 2040nm in a short period of time.

JW2A.64
Visible Supercontinuum Generation in All-Solid Photonic Bandgap Fiber, Aimin Wang[1], Huifeng Wei[2], Bin Zhang[3], Jing Hou[3], Weijun Tong[2], Jie Luo[2], Zhigang Zhang[1]; [1]*School of Electronics Engineering and Computer Science, Peking University, China;* [2]*State Key Laboratory of Optical Fiber and Cable Manufacture Technology at Yangtze Optical Fiber and Cable Company Ltd., China;* [3]*College of Opto-electronic Science and Engineering, National University of Defense Technology, China.* An all-solid photonic bandgap fiber with the first bandgap from 450-900nm was designed for visible supercontinuum generation. Sub-nanosecond pulses from 532nm microchip laser pumped this fiber with the achieved spectrum from 532-900nm.

JW2A.65
Distributed 100-W side launching by using single laser diode stack, Chieh-Wei Huang[1], Chun-Lin L. Chang[1], Ding-Wei Huang[1], Sheng-Lung Huang[1]; [1]*Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taiwan.* A novel distributed multi-fiber side coupling scheme was integrated on single laser diode stack (LDS) by using the grating coupler. The launched power was 100.2 W from a 231.6 W continuous-wave LDS at 976 nm.

JW2A.66
Laser demonstration in short length single-mode Nd-doped silica fiber fabricated by zeolite method, Motoichiro Murakami[1], Hiroyuki Shiraga[1], Yasushi Fujimoto[1], Shinji Motokoshi[2], Tatsuhiro Sato[3], Hirofumi Kan[4]; [1]*Osaka University, Institute of Laser Engineering, Japan;* [2]*Institute of Laser Technology, Japan;* [3]*Shin-Etsu Quartz Products Co., Ltd., Japan;* [4]*Hamamatsu Photonics K. K., Japan.* We present a laser oscillation in the shortest Nd-doped silica fiber, an only 4-cm singlemode Nd-doped silica fiber. This fiber-core glass was fabricated by the zeolite method, and the Nd2O3 concentration is 12,500 ppm.

JW2A.67
Dispersion Measurement of Infrared Specialty Fibers, Dmitry Klimentov[1,2], Nikolai Tolstik[1], Vladimir Kalashnikov[4], Vladislav V. Dvoyrin[1,3], Irina T. Sorokina[1]; [1]*Physics, (NTNU) Norges teknisk-naturvitenskapelige universitet, Norway;* [2]*Natural Sciences Center, General Physics Institute of RAS, Russian Federation;* [3]*Fiber Optics Research Center, General Physics Institute of RAS, Russian Federation;* [4]*Institut fur Photonik, TU Wien, Austria.* We demonstrate broadband (>250nm) dispersion measurements and theoretical calculations in a set of short-length specialty fibers in the 2.16-2.41µm wavelength range for femtosecond mid-IR applications using an ultrabroadband Cr:ZnS laser as a source.

JW2A.68
Overcoming Multimodal Effects in Optical Fiber Tip CMOS-Compatible Fabry-Pérot Sensors, Xuan Wu[1], Olav Solgaard[1]; [1]*Electrical Engineering, Stanford University, USA.* The challenges in multimode fiber sensors of modal interference and averaging over modes are presented and mitigation is discussed. Multimode fiber-tip pressure sensors were fabricated using a CMOS-compatible process, assembled, and characterized.

JW2A.69
Cr^{4+}:YAG Single-Crystal Fiber Laser Widely Tunable Using Birefringent Filter, Shigeo Ishibashi[1], Kazunori Naganuma[1]; [1]*NTT Photonics Laboratories, NTT Corporation, Japan.* A Cr4+:YAG single-crystal fiber CW laser with 180-nm tunablility using a birefringent filter was achieved, by means of a control of oscillation polarization by stress birefringence generated using fiber-holding blocks with designed grooves.

JW2A.70
Generation of 32nd harmonic in passively mode-locked erbium-doped laser with graphene saturable absorber, Bo Fu[1], Wei Zhang[2], Lili Gui[1], Xiaosheng Xiao[1], Hongwei Zhu[2], Changxi Yang[1]; [1]*Department of Precision Instruments, Tsinghua University, China;* [2]*Department of Mechanical Engineering, Tsinghua University, China.* We report passive mode locking of a soliton erbium-doped fiber laser based on graphene saturable absorber at repetition rate continuously scalable up to 500 MHz. The supermodes are suppressed by 50 dB at 32nd harmonic.

JW2A.71
Impact of Angular Deviation of Specular Reflection on Few-Mode Fiber Near Brewster Angle Cut, Dong-Yo Jheng[1], Kuang-Yu Hsu[1], Sheng-Lung Huang[1,2]; [1]*Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taiwan;* [2]*Department of Electrical Engineering, National Taiwan University, Taiwan.* Reflection of a few-mode fiber cut near the Brewster angle is analyzed with the angular spectrum method. The minimum reflection loss deviates from the Brewster angle significantly, when the core is less than 10 µm.

JW2A.72
Graphene passively Q-switched two-micron fiber lasers, Fengqiu Wang[1], Felice Torrisi[1], Zhe Jiang[1], Daniel Popa[1], Tawfique Hasan[1], Zhipei Sun[1], Wonbae Cho[1], Andrea C. Ferrari[1]; [1]*Engineering Department, Cambridge University, United Kingdom.* We demonstrate a passively Q-switched thulium fiber laser, using a graphene-based saturable absorber. The laser is based on an all-fiber ring cavity and produces ~2.3µs pulses at 1884nm, with a maximum pulse energy of 70nJ.

JW2A.73
Low-repetition-rate fiber femtosecond laser oscillator, Yunseok Kim[1], Seungman Kim[1], Seunghwoi Han[1], Sanguk Park[1], Jiyong Park[1], Seung-Woo Kim[1]; [1]*KAIST, Republic of Korea.* We demonstrate a ring type, mode-locked all-normal-dispersion ytterbium-doped fiber laser which have 9.8 MHz repetition rate through the combination of saturable absorber mirror and nonlinear polarization evolution (NPE) phenomena.

JW2A.74
Photodarkening mechanisms in ytterbium fiber lasers; a comparison of UV-induced losses in glass and crystalline materials, Sara C. Rydberg[1], Magnus Engholm[1]; [1]*ITM, Sweden.* UV-induced absorption is investigated for three different ytterbium doped laser materials. It is found that the induced transmission loss originates from the formation of Yb^{2+}-ions and hole-related defects.

JW2A.75
Tunable dual-wavelength double-ring fiber laser and its application in highly sensitive temperature sensing, Yi Dai[1], Qizhen Sun[1,2], Jiejun Zhang[1], Jianghai Wo[1], Deming Liu[1,2]; [1]*Huazhong University of Science and Technology, China;* [2]*National Engineering Laboratory for Next Generation Internet Access System, China.* A novel tunable dual-wavelength double-ring fiber laser with single longitudinal mode operation is proposed and demonstrated. By beating the dual-wavelength lasing output at different temperature, a high sensitivity of 1.4750 GHz/K is achieved.

JW2A.76
Mode-locked 2 µm Thulium-doped Fiber Laser with Graphene Oxide Saturable Absorber, Jiang Liu[1], Sida Wu[2], Jia Xu[1], Qian Wang[1], Quan-Hong Yang[2], Pu Wang[1]; [1]*Institute of Laser Engineering, Beijing University of Technology, China;* [2]*School of Chemical Engineering and Technology, Tianjin University, China.* Few-layer graphene oxide depositing on broadband reflective mirror as a novel saturable absorber for mode-locking of a thulium-doped fiber laser at 2007 nm, which generated 0.56 nJ single pulse energy at 3.17 MHz repetition rate.

JW2A.77
Closed-form Approximations for DFB Laser Designs, Tristan Kremp[1], Kazi S. Abedin[1], Paul S. Westbrook[1]; [1]*OFS Laboratories, USA.* Generalizing earlier results, we derive useful approximations for the threshold gain, detuning and power splitting ratio of distributed feedback laser cavities with uniform grating strength and a variable phase shift at a variable position.

JOINT

JW2A • Poster Session I—Continued

JW2A.78
A Compact Optical Microfiber Based PZT Phase Modulator, Mohammad Belal[1], Xueliang Zhang[1,2], George Chen[1], Zhangqi Song[2], Gilberto Brambilla[1], Trevor P. Newson[1]; *[1]Optoelectronics Research Centre, University of Southampton, United Kingdom; [2]College of Optoelectronic Science and Engineering, National University of Defense Technology, China.* A compact piezoelectric transducer (PZT) phase modulator is manufactured with optical microfiber. Its frequency response efficiency is measured, proving that frequencies higher than 1 MHz frequency can be reached.

JW2A.79
Femtosecond Er-doped Fiber Lasers Mode-locked with Graphene Oxide Saturable Absorber, Jia Xu[1], Sida Wu[2], Jiang Liu[1], Qian Wang[1], Quanhong Yang[2], Pu Wang[1]; *[1]Beijing University of Technology, China; [2]Tianjin University, China.* We demonstrated an erbium-doped fiber laser in which graphene oxide was used as saturable absorber to generate stable 900 fs pulse trains with 1nJ single pulse energy at 17.5 MHz.

JW2A.80
Over an Octave of Infrared Supercontinuum Generation in Robust Multi-material Chalcogenide Nano-Tapers, Soroush Shabahang[1], Guangming Tao[1], Ayman F. Abouraddy[1]; *[1]CREOL, The College of Optics & Photonics, University of Central Florida, CREOL, USA.* We demonstrate infrared supercontinuum generation over more than one octave (0.85 - 2.35 µm) produced using a low-power 1.5-µm picosecond laser in robust multi-material step-index chalcogenide fiber nano-tapers with high index contrast.

JW2A.81
Burst-mode Yb fiber amplifier producing 30 µJ individual pulse energy, Hamit Kalaycioglu[1], Burak Eldeniz[2], F. Oemer Ilday[1], Koray Eken[3]; *[1]Department of Physics, Bilkent University, Turkey; [2]Department of Electronics Engineering, Ankara University, Turkey; [3]FiberLAST Inc., Turkey.* We report 30-µJ individual pulse energy for 100-ns long amplified bursts with homogenized energy distribution from a 1-kHz Yb-fiber amplifier. Initial results on micromachining using burst-mode femtosecond pulses are presented for the first time.

JW2A.82
Pulse Distortion in Saturated Fiber Optical Parametric Chirped Pulse Amplification, Zohreh Lali-Dastjerdi[1], Francesco Da Ros[1], Karsten Rottwitt[1], Michael Galili[1], Christophe Peucheret[1]; *[1]DTU Fotonik, Department of Photonics Engineering,, Technical University of Denmark, Denmark.* Fiber optical parametric chirped pulse amplification is compared for chirped pulses in the picosecond regime. The amplified chirped pulses show distortion appearing as pedestals after recompression when the amplifier is operated in saturation.

JW2A.83
A Discrete Master Equation for Dispersion-Tuned Fiber Lasers, Bryan Burgoyne[1], Alain Villeneuve[1]; *[1]Genia Photonics Inc., Canada.* We developed a discrete master equation labeling pulse propagation through various components of dispersion-tuned fiber lasers, which cannot be achieved using average models. The model is validated through numerical simulations and experimental data.

JW2A.84
All Optical Passive Stabilization of a Two-Section InAs/InP Based Quantum-Dash Mode-Locked Laser with Simultaneous CW Injection-Locking and Selective Optical Feedback, Ehsan Sooudi[1,2], Cristina De Dios Fernandez[3], Guillaume Huyet[1,4], John G. McInerney[1,2], Francois Lelarge[5], Ricardo Rosales[6], Kamel Merghem[6], Anthony Martinez[6], Abderrahim Ramdane[6], Stephen P. Hegarty[1,4]; *[1]Optoelectronics, Tyndall National Institute, Ireland; [2]Physics, University College Cork, Ireland; [3]Optoelectronics and Laser Technology Group (GOTL),, University Carlos III, Spain; [4]Centre for Advanced Photonics and Process Analysis (CAPPA), Cork Institute of Technology, Ireland; [5]a joint Laboratory of "Alcatel Lucent Bell Labs", "Thales Research and Technology", and "CEA-LETI", III-V Lab, France; [6]Laboratory for Photonics and Nanostructures, CNRS, France.* We demonstrate narrow pulses with low RF linewidth from two-section InP quantum-dash mode-locked lasers. Simultaneous CW injection-locking and selective optical feedback lead to ≈ 50 times RF linewidth and 1.5 times time-bandwidth product reduction.

JW2A.85
High Power Mode Locked Quantum Dash 1.5 µm Laser With Asymmetrical Cladding, Mickael Faugeron[1,2], Michael Tran[3], Francois Lelarge[3], Mourad Chtioui[1], Yannick Robert[3], Eric Vinet[3], Alain Enard[3], Joel Jacquet[2], Frederic Van Dijk[3]; *[1]Thales Air Systems, France; [2]SUPELEC LMOPS, France; [3]III-V lab, France.* We present a quantum dash laser with more than 120 mW/facet at 1.2 A based on an asymmetrical cladding. Passive mode-locking with an RF -3dB linewidth of 3.2 kHz at 20.7 GHz has been demonstrated.

JW2A.86
Super-linear performance of Dual-upper-state Quantum-Cascade Lasers, Kazuue Fujita[1], Masamichi Yamanishi[1], Shinich Furuta[1], Atsushi Sugiyama[2], Tatsuo Dougakiuchi[1], Tadataka Edamura[1]; *[1]Central Research Labs.,, Hamamatsu Photonics KK, Japan; [2]Laser Device R&D Group, Hamamatsu Photonics KK, Japan.* Intrinsic super-linear performance of dual-upper-state quantum-cascade lasers is reported. The super-linear slope efficiency is ascribed to the absorption quenching due to the decrease of electron populations in injectors.

JW2A.87
Frequency Stabilization of a DFB laser to Molecular Cesium at 852nm by polarization-rotated optical feedback, Kang Ying[1], Dijun Chen[1], Haiwen Cai[1], Ronghui Qu[1]; *[1]Shanghai Institute of Optics and Fine Mechanics,Chinese Academy of Sciences, China.* A new polarization-rotated optical feedback (PROF) laser frequency stabilization method is proposed and demonstrated. The linewidth reduction and frequency stabilization to Cesium saturated absorption peaks of 852nm DFB laser were obtained.

JW2A.88
On-Off Keyed Microwave Signal Optically Generated Using an Optically-Injected Fabry-Perot Semiconductor Laser, Michael C. Pochet[1], Timothy P. Locke[1], Nicholas G. Usechak[2]; *[1]Electrical and Computer Engineering, Air Force Institute of Technology, USA; [2]US Air Force Research Laboratory, USA.* Large-signal direct-modulation of a diode laser optically-injected into period-one operation is shown to produce an on-off keyed microwave signal. The signal is highly tunable and transmitted over 50 km, suitable for radio-over-fiber applications.

JW2A.89
Phase noise characterization of injection locked semiconductor lasers to a 250 MHz optical frequency comb, David S. Wu[1], Radan Slavík[1], Giuseppe Marra[2], David J. Richardson[1]; *[1]Optoelectronics Research Centre, University of Southampton, United Kingdom; [2]National Physical Laboratory, United Kingdom.* Two lasers are simultaneously injection locked to the same comb mode and the injection locking quality is assessed in terms of phase noise and phase variance (1 kHz-10 MHz) for various injected powers.

JW2A.90
Thermal and Electrical Beam Steering on a GaInAs/GaAs Slow-light Bragg Waveguide Amplifier, Xiaodong Gu[1], Toshikazu Shimada[1], Ayumi Fuchida[1], Akihiro Matsutani[1], Akihiro Imamura[1], Fumio Koyama[1]; *[1]Tokyo Institute of Technology, Japan.* Thermal beam steering over 7° is realized on a slow-light waveguide amplifier with a narrow divergence angle below 0.3°. Measured data well agrees with theoretical calculations. Also we present electro-thermal beam steering by current injection.

JW2A.91
Designs of GaN-based Terahertz Quantum Cascade Lasers for Higher Temperature Operations, Hiroaki Yasuda[1], Iwao Hosako[1], Kazuhiko Hirakawa[2]; *[1]National Institute of Information and Communications Technology, Japan; [2]University of Tokyo, Japan.* We propose a novel GaN-based two-well terahertz quantum cascade laser unaffected by the subband level broadenings and confirm that it has an adequate gain even at 300 K by using the non-equilibrium Green's function method.

JW2A.92
Semiconductor Mode-locked Lasers: Harnessing the Gain Bandwidth, Michael J. Strain[1], Marco Zanola[1], Gabor Mezosi[1], Marc Sorel[1]; *[1]School of Engineering, University of Glasgow, United Kingdom.* A set of passively mode-locked Distributed Bragg Reflector lasers on a single chip, are shown to exhibit stable mode-locking across a 40nm bandwidth. Integration of two gratings in a single device shows dual band locking.

JW2A.93
Analytical Modeling of Quantum Cascade Lasers: A Study of the Transport and Lasing Characteristics, Yu Song[1], Yamac Dikmelik[2], Claire Gmachl[1], Jacob B. Khurgin[2]; *[1]Princeton University, USA; [2]Johns Hopkins University, USA.* An analytical model for Quantum Cascade lasers based on rate equations adequately reproduces major transport and lasing characteristics, including the reduction of the differential resistance at threshold, saturation, and temperature performance.

JW2A • Poster Session I—Continued

JW2A.94
Monolithic Beam Steering Device employing Slow-light Waveguide and Tunable MEMS VCSEL, Masanori Nakahama[1], Xiaodong Gu[1], Toshikazu Shimada[1], Fumio Koyama[1]; *[1]P&I Lab., Tokyo Institute of Technology, Japan.* We propose a monolithic beam steering device consisting of Bragg reflector slow-light waveguide amplifier and tunable micro-electro-mechanical VCSEL. Continuous beam steering of over 30° and the maximum output power over 10 mW are predicted.

JW2A.95
Withdrawn

JW2A.96
Tunable Master-Oscillator Power Amplifier Using All Chirped Quantum-Dot Structures, Ying Ding[1], Ali Alhazime[1], Daniil I. Nikitichev[1], Ksenia A. Fedorova[1], Myke Ruiz[2], Michael Tran[2], Yannick Robert[2], Alexandros Kapsalis[4], Hercules Simos[4], Charis Mesaritakis[4], Tianhong Xu[3], Paolo Bardella[3], Mattia Rossetti[3], Igor L. Krestnikov[5], Daniil A. Livshits[5], Ivo Montrosset[3], Dimitris Syvridis[4], Maria Ana Cataluna[1], Michel Krakowski[2], Edik Rafailov[1]; *[1]Electronic Engineering, Physics & Renewable Energy, University of Dundee, United Kingdom; [2]III-V Lab, France; [3]Dipartimento di Elettronica, Politecnico di Torino, Italy; [4]Department of Informatics and Telecommunications, National and Kapodistrian University of Athens, Greece; [5]Innolume GmbH, Germany.* A tunable master-oscillator power-amplifier (MOPA) picosecond optical pulse source using all chirped quantum dot (QD) structures is demonstrated (60nm tunability). Under fundamental mode-locked operation, the highest peak power of 4.39 W is achieved.

JW2A.97
Thermal management in high-power vertical-external-cavity surface-emitting lasers, Alexej Chernikov[1], Jens Herrmann[1], Maik Scheller[1], Martin Koch[1], Bernardette Kunert[1], Wolfgang Stolz[1], Sangam Chatterjee[1], Stephan W. Koch[1], Tsuei-Lian Wang[2], Yushi Kaneda[2], Mike J. Yarborough[2], Jörg Hader[2], Jerome V. Moloney[2]; *[1]Department of Physics, Philipps-Universität Marburg, Germany; [2]College of Optical Sciences, The University of Arizona, USA.* Thermal properties of vertical-external-cavity surface-emitting lasers are studied in the high-power regime. The influence of pump profiles is investigated by spacially resolved temperature measurements. Optimized cooling provides 72 W output power.

JW2A.98
250 MHz Repetition Rate Monolithically Integrated Modulated Mode-Locked Semiconductor Laser, Xuhan Guo[1], Vojtech Olle[1], Adrian H. Quarterman[1], Adrian Wonfor[1], Richard Penty[1], Ian White[1]; *[1]Engineering, University of Cambridge, United Kingdom.* We present the first monolithically integrated semiconductor pulse source consisting of a mode-locked laser diode, Mach-Zehnder pulse picker, and semiconductor optical amplifier. Pairs of 5.6 ps pulses are generated at 250 MHz repetition rate.

JW2A.99
Polarization control of a quantum cascade laser, Devnath Dhirhe[1], Thomas J. Slight[2], Barry M. Holmes[1], David C. Hutchings[1], Charles N. Ironside[1]; *[1]School of Engineering, University of Glasgow, United Kingdom; [2]CST global Ltd, United Kingdom.* By integrating a polarization mode converter we have obtained significant amount of Transverse Electric light from a quantum casacde laser. first results indicate uo to around 18% TE light in an elliptically polarized output.

JW2A.100
Mid-IR Optical Amplifications using Resonant Gain of Quantum Cascade Lasers, Dingkai Guo[1], Xing Chen[1], Liwei Cheng[1], Alexey Belyanin[2], Sudhir Trivedi[3], Fow-Sen Choa[1]; *[1]University of Maryland, Baltimore County, USA; [2]Texas A&M University, USA; [3]Brimrose Corporation, USA.* Using quantum-cascade-lasers (QCL) as resonant optical amplifiers, active filters, and detectors with gain, we demonstrated signal amplification in the mid-IR wavelength range. Optical gain of >10dB and electrical gain of >28dB were achieved.

JW2A.101
Switchable Aperiodic Distributed Feedback Lasers: Time Domain Modelling and Experiment, Subhasish Chakraborty[1], Chen-Wei Hsin[1], Owen Marshall[1], Md Khairuzzaman[1]; *[1]School of EEE, University of Manchester, United Kingdom.* We present a perturbative aperiodic distributed feedback grating embedded within a Fabry-Pérot cavity. Modelling revealed electronic switching, occurring only in the presence of facet reflections. The switching behaviour was experimentally verified.

JW2A.102
Femtosecond Semiconductor Laser Emitting High Average Power 175-GHz Pulse Train, Keith G. Wilcox[1], Adrian H. Quarterman[1], Vasileios Apostolopoulos[1], Oliver J. Morris[1], C. Robin Head[1], Andrew P. Turnbull[1], Harvey E. Beere[2], Ian Farrer[2], David A. Ritchie[2], Anne C. Tropper[1]; *[1]Physics & Astronomy, University of Southampton, United Kingdom; [2]Cavendish Laboratory, University of Cambridge, United Kingdom.* We describe a SESAM-mode-locked surface-emitting quantum well laser producing 400-fs pulses, with repetition frequency 175 GHz corresponding to the 117th harmonic of the external laser cavity, and average power 300 mW.

JW2A.103
Facetless Tunable Lasers Coupled to Passive Waveguides, Brendan Roycroft[1], James O'Callaghan[1], Kevin Thomas[1], Emanuele Pelucchi[1], Frank Peters[1,2], Brian Corbett[1]; *[1]Tyndall National Institute, University College Cork, Ireland; [2]Department of Physics, University College Cork, Ireland.* Facetless tunable lasers coupled to a lower waveguide in a monolithic regrowth-free design are demonstrated. Tuning range is 3 THz and coupler efficiency is greater than 80%.

JW2A.104
Tunable Microwave Generation by Photonic Integrated Distributed Feedback Lasers, Chien-chung Lin[1], Chih-Wei Lin[1], Chen-Yu Chien[1], Hao-Chung Kuo[2]; *[1]Institute of Photonic System, National Chiao Tung University, Taiwan; [2]Department of Photonics, Institute of Electro-Optical Engineering, National Chiao Tung University, Taiwan.* We demonstrated a novel air/semiconductor mirrors integrated distributed feedback lasers by focused ion beam technology. When two DFB lasers are powered together, an injection-locking operation can produce strong microwave signals up to 25.5 GHz.

JW2A.105
Glucose Biosensor Based on Raman Spectroscopy and Liquid-filled Photonic Crystal Fiber, Xuan Yang[1,2], Alissa Zhang[1], Damon Wheeler[1], Tiziana C. Bond[2], Claire Gu[1], Yat Li[1]; *[1]UCSC, USA; [2]LLNL, USA.* We present the first quantitative glucose Raman detection in the physiological concentration range with a low laser power, a short integration time, and an extremely small sampling volume using the liquid-filled photonic crystal fiber probe.

JW2A.106
Characterization of gas phase temperatures in dependence of particle presence in the flame spray pyrolysis process, Sascha R. Engel[1,2], Yi Gao[1,2], Andreas F. Koegler[1], Daniel Kilian[3], Thomas Seeger[2,4], Wolfgang Peukert[3], Alfred Leipertz[1,2]; *[1]Institute of Engineering Thermodynamics, University of Erlangen, Germany; [2]Erlangen Graduate School in Advanced Optical Technologies, University of Erlangen, Germany; [3]Institute of Particle Technology, University of Erlangen, Germany; [4]Institute of Engineering Thermodynamics, University of Siegen, Germany.* We introduce a novel strategy to acquire gas phase temperatures by O2 pure rotational CARS during flame spray pyrolysis for silica production. Temperatures in the particle regime show significantly lower flame temperatures for particle-laden flames.

JW2A.107
Error Analysis and Selection of Optimal Excitation Parameters for the Sensing of CO2 and O2 from Space in a Proposed ASCENDS Mission Implementation, Denis Pliutau[1], Narasimha S. Prasad[1]; *[1]NASA Langley Research Center, USA.* Simulation studies to optimize sensing of CO2 and O2 from space are described. Uncertainties in line-by-line calculations unaccounted for in previous studies identified. Multivariate methods are employed for measurement wavelengths selection.

JW2A.108
A 1550-nm time-of-flight laser ranging system based on 1-GHz sine-wave gated InGaAs/InP APD, Min Ren[1], Yan Liang[1], Xiaorong Gu[1], Weibin Kong[1], E. Wu[1], Guang Wu[1], Heping Zeng[1]; *[1]State Key Laboratory of Precision Spectroscopy, Easr China Normal University, China.* We demonstrated a single-photon laser ranging system working at 1550 nm with a 1-GHz sine-wave gated InGaAs/InP avalanche photodiode detector. By using time-of-flight measurement, 9-cm depth resolution was achieved under daylight background.

JW2A.109
Evanescent Waveguide Absorption Spectroscopy of Trace Gases, Todd H. Stievater[1], Marcel W. Pruessner[1], Doewon Park[1], Scott A. Holmstrom[2], R. A. McGill[1], William S. Rabinovich[1]; *[1]Naval Research Laboratory, USA; [2]University of Tulsa, USA.* We demonstrate the detection of water vapor adsorbed into a sorbent polymer layer coated onto highly evanescent SiN rib waveguides by measuring the change in absorption as a function of wavelength, polarization, and analyte concentration.

JW2A.110
Mass Sensing with Optomechanical Oscillation, Fenfei Liu[2], Shoufeng Lan[1], Mani Hossein-Zadeh[1]; *[1]Electrical and computer Engineering, University of New Mexico, USA; [2]Physics, University of New Mexico, USA.* We demonstrate the application of optomechanical oscillator as a high-resolution mass sensor. Preliminary experimental results and theoretical analysis show that the optomechanical oscillator can function as a mass sensor with sub-pg sensitivity.

JW2A.111
Simulation for Estimating Spatial Resolution in Distributed Measurement of Brillouin Dynamic Grating by Correlation Domain Technique, Rodrigo K. Yamashita[1], Zuyuan He[1], Kazuo Hotate[1]; *[1]Department of Electrical Engineering and Information Systems, The University of Tokyo, Japan.* We propose a simulation method to calculate reflection spectra of Brillouin dynamic grating localized by the correlation domain technique. Simulation results match with experiments and the spatial localization of the dynamic grating can be estimated.

JW2A.112
Stimulated Raman Scattering in a microfluidic channel via integrated optical waveguides, Claudia Hoffmann[1], Matthias Pospiech[1], Moritz Emons[1], Günter Rinke[2], Uwe Morgner[1,3]; *[1]Institut für Quantenoptik, Leibniz Universität Hannover, Germany; [2]Institut für Mikroverfahrenstechnik, Karlsruher Institut für Technologie, Germany; [3]Laser Zentrum Hannover, Germany.* We present SRS in a microfluidic channel. The excitation pulses are delivered by a non-collinear optical parametric amplifier (NOPA) driven by an amplified Yb:KYW oscillator and guided via waveguides to the channel.

JW2A.113
Refraction of Evanescent Waves at an Air and Optically Pumped Ti:Sapphire Interface, Weiguo Yang[1], Joshua S. Deaver[1], Mesfin Woldeyohannes[2], Micheal A. Fiddy[3]; *[1]Engineering and Technology, Western Carolina University, USA; [2]Chemistry and Physics, Western Carolina University, USA; [3]Center for Optoelectronics and Optical Communications, University of North Carolina at Charlotte, USA.* The refraction of evanescent waves at an air and optically pumped Ti:Sapphire interface is investigated. The experimental results qualitatively support the theory of optical gain-assisted evanescent wave conversion at a passive/active boundary.

JOINT

JW2A • Poster Session I—Continued

JW2A.114
Refractive Index Sensor using a Two-Core Optical Fiber, Jose R. Guzman-Sepulveda[1], Daniel Lopez-Cortes[2], Ivan Hernandez-Romano[2], Walter Margulis[3], Daniel A. May-Arrioja[1]; *[1]Ingenieria Electrica, Universidad Autonoma de Tamaulipas, Mexico; [2]Optics, INAOE, Mexico;[3]Fiber Photonics, ACREO, Sweden.* A refractive index sensor based on a Two-Core fiber, which response and sensitivity can be adjusted by controlling an etching process on the fiber, is demonstrated. The RI sensor exhibits a sensitivity exceeding 2,100 nm/RIU.

JW2A.115
Microfluidic integrated hollow photonic crystal cavities for single particle and resonant field interaction, Nicolas Descharmes[1], Ulagalandha Perumal Dharanipathy[1], Zhaolu Diao[1], Romuald Houdré[1]; *[1]SB/ICMP/LOEQ, EPFL, Switzerland.* A microfluidic-integrated single particle sensor based on hollow photonic crystal cavities is reported. The interaction relies on the reversible resonance frequency shift induced by a dielectric particle near the cavity.

JW2A.116
Curvature Sensor based on a Two-Core Optical Fiber, Jose R. Guzman-Sepulveda[1], Rene Dominguez-Cruz[1], José J. Sánchez-Mondragón[2], Daniel A. May-Arrioja[1]; *[1]Ingenieria Electrica, Universidad Autonoma de Tamaulipas, Mexico; [2]Optics, INAOE, Mexico.* A curvature sensor based on a Two-Core fiber is demonstrated. The proposed sensor exhibits a highly linear response with a sensitivity of -137.8763 nm/m-1 for radius of curvature ranging from 0 to 0.27 m-1.

JW2A.117
Fiber Optic Vibration Sensor based on Multimode Interference Effects, Jose R. Guzman-Sepulveda[1], Ivan Hernandez-Romano[2], Miguel Torres-Cisneros[3], Daniel A. May-Arrioja[1]; *[1]Ingenieria Electrica, Universidad Autonoma de Tamaulipas, Mexico; [2]Optics, INAOE, Mexico; [3]Universidad de Guanajuato, Mexico.* A fiber optic vibration sensor based on Multimode Interference effects is demonstrated. Frequencies in the range from 0 to 2.5 kHz were measured with a difference exceeding 30dB between the main frequency and its harmonics.

JW2A.118
A Brillouin gain based fast light fiber laser sensor, Selim M. Shahriar[1], Jacob Scheuer[2], Xue Liu[1]; *[1]Northwestern University, USA; [2]Tel Aviv University, Israel.* We present a novel Brillouin fiber laser based "fast-light" super-sensor. Sensitivity enhancement of more than two orders of magnitude compared to conventional laser sensors can be attained by proper design of the laser parameters.

JW2A.119
Broadband QEPAS with IR-LEDs, Stefan Böttger[1], Ulrike Willer[2], Wolfgang Schade[1,2]; *[1]Fiber Optical Sensor Systems, Fraunhofer Heinrich-Hertz-Institute, Germany; [2]Energie-Forschungszentrum Niedersachsen, Germany.* An IR-LED at 3.4 µm and an off-beam QEPAS cell as detector are utilized for absorption spectroscopy. For 10 cm absorption path a detection limit of 382 ppm is achieved for methane.

JW2A.120
Surface Optomechanics: Calculation of Love Surface Acoustic Waves on Microresonators, John D. Zehnpfennig[1,2], Matthew R. Letarte[1], Robert W. Sadowski[2,1], James J. Raftery[1,2]; *[1]Photonics Research Center, US Military Academy, USA; [2]Electrical Engineering and Computer Science, US Military Academy, USA.* We calculate optomechanically excited Love waves on the surface of a silica whispering-gallery microresonator surrounded by air and pollutants. We show a method for sensing and distinguishing type or concentration of pollutant via frequency shift.

JW2A.121
Simultaneous Detection of Different Substances by Multiplexed Excitation of Ensembles of Fluorescent Bacteria, Yossi Kabessa[1], Victor Kouruma[1], Har'el Ilan[1], Aharon Agranat[1]; *[1]Applied Physics, The Hebrew University, Israel.* A scheme for simultaneous selective detection of the fluorescent signals emitted by a whole-cell biosensor array using one photomultiplier is presented. Experimental proof of concept is demonstrated in a four channel system.

JW2A.122
Silicon-on-sapphire Waveguides Design for Mid-IR Evanescent Field Absorption Gas Sensors, Yuewang Huang[1], Salih K. Kalyoncu[1], Qi Song[1], Ozdal Boyraz[1,2]; *[1]EECS, UC,Irvine, USA; [2]Istanbul Sehir University, Turkey.* We investigate three types of SOS waveguides suitable for evanescent field absorption based gas sensing in mid-IR. Rib and slot waveguide shows greater quasi-TE evanescent field than strip waveguide. 1.33ppm resolution is achievable.

JW2A.123
Laser-Driven Low-Power Fiber Sensor Network Integrated with Wireless Sensors, Yosuke Tanaka[1], Masaaki Kinoshita[1], Takashi Kurokawa[1]; *[1]Tokyo University of Agriculture and Technology, Japan.* A novel fiber optic sensor network integrated with wireless sensors is proposed. Optically driven nodes for wireless sensing are experimentally demonstrated. Each node is operated with low laser power of less than 5 mW.

14:30–16:30 Market Focus Session IV: Industrial: Next Generation Materials Processing Applications in the Automobile, Heavy Industry and Machine Tool Marketplace, *Exhibit Hall 3*

15:00–16:30 Coffee Break (15:00–15:30) and Unopposed Exhibit Only Time, *Exhibit Halls 1, 2 and 3*

Room A1

CLEO: Science & Innovations

16:30–18:30
CW3A • Applications of Laser Processing
Richard F. Haglund, Vanderbilt University, USA, *Presider*

CW3A.1 • 16:30
High Peak Power Laser Pulses for Industrial Applications, David Ashkenasi[1], Andreas Lemke[1], Tristan Kaszemeikat[1], Norbert Mueller[1], Matthias Schmidt[1], Daniel Jahns[1], Hans Joachim Eichler[1,2]; [1]*LMTB GmbH, Germany;* [2]*Technische Universität Berlin, Germany.* Ultra-short laser pulses find numerous industrial applications. High peak power induces non-linear optical effects, yielding additional potential for fabrication quests as internal structuring, precision drilling, processing of wafers and thin films.

CW3A.2 • 16:45
Micro-void and spherical dome formation in polycarbonate with nanojoule energy femtosecond laser pulses, Trevor Meunier[1], Arnaud Weck[1]; [1]*University of Ottawa, Canada.* We report on the shape of micro-voids formed inside polycarbonate samples upon irradiation with a femtosecond laser. Void shape is controlled by a change in laser focal point due to the formation of a microlens at the sample surface.

CW3A.3 • 17:00
Microlaser from Self-Assembled Hemispherical Resonator, Duong Ta[1], Rui Chen[1], Handong Sun[1]; [1]*Nanyang Technological University, Singapore.* High quality Whispering Gallery Mode lasing from dye-doped hemispherical microresonator formed by hydrophobic effect is presented. Owing to a simple fabrication, doping flexibility, our finding boosts a convenient implementation of microlasers.

Room A2

16:30–18:30
CW3B • Trace Gas Sensing
Mark Phillips, Pacific Northwest National Laboratory, USA, *Presider*

CW3B.1 • 16:30
In-Line Reference Cell for Real-Time Calibration of Laser Absorption Spectrometers, Clinton J. Smith[1], Mohammad A. Khan[2], Mark A. Zondlo[2], Gerard Wysocki[1]; [1]*Electrical Engineering, Princeton University, USA;* [2]*Civil and Environmental Engineering, Princeton University, USA.* We discuss a novel method of tunable diode laser sensor calibration using an in-line reference gas cell. The technique employs wavelength modulation spectroscopy at higher harmonics to simultaneously probe the sample and reference spectra.

CW3B.2 • 16:45
Compact Multi-pass Cell based Faraday Rotation Spectrometer for Nitric Oxide detection, Yin Wang[1], Michal Nikodem[1], Brian E. Brumfield[1], Gerard Wysocki[1]; [1]*Electrical Engineering, Princeton University, USA.* Nitric oxide sensing based on a 3.5 m Herriott cell-enhanced Faraday rotation spectrometer is reported. A minimum detection limit of 3.2 ppb/Hz1/2 is achieved using NO R(8.5) e transition at 1906.14cm-1 and 100 Gauss field.

CW3B.3 • 17:00
Faraday Rotation Spectroscopy of Oxygen Using a Cylindrical Mirror Multi-Pass Cell and Rare-Earth Magnets, Brian E. Brumfield[1], Gerard Wysocki[1]; [1]*Electrical Engineering, Princeton University, USA.* A multi-pass cell enclosed by rare-earth magnets has been developed for sensitive FRS spectroscopy of oxygen. The FRS signals are generated by laser wavelength modulation and detected using a balanced photodetector and lock-in amplifier.

Thank you for attending CLEO: 2012. Look for your post-conference survey via email and let us know your thoughts on the program.

Room A3

JOINT

16:30–18:30
JW3C • Symposium on Space Optical Systems: Opportunities and Challenges II
Iain McKinnie, Lockheed Martin Coherent Technologies, USA, *Presider*

JW3C.1 • 16:30 Invited
Preparing for Future EO Innovations: the NASA Earth Science Technology Program, George J. Komar[1]; [1]*NASA ESTO, USA.* NASA's Earth Science Technology Office (ESTO) supports a broad range of technology developments. This paper summarizes program investments in electro-optical systems, and highlights progress in two key measurements: column CO2 and wind profiles.

JW3C.2 • 17:00
Micro-integrated, high power, narrow linewidth master oscillator power amplifier for precision quantum optics experiments in space Anja Kohfeldt[1], Max Schiemangk[2], Stefan Spiessberger[1], Andreas Wicht[1], Achim Peters[2,1], Götz Erbert[1], Günther Tränkle[1]; [1]*Diode Lasers, Ferdinand-Braun-Institut, Germany;* [2]*Institut für Physik, AG Optische Metrologie, Humboldt Universität zu Berlin, Germany.* We present a micro-integrated master-oscillator-power-amplifier diode laser system with more than 1W output power at 780.2 nm and narrow linewidth emission. The laser is designed for Rubidium Bose-Einstein condensate experiments in space.

Room A4

CLEO: Science & Innovations

16:30–18:30
CW3D • Pulse Shaping and Timing Control
Daniel Kane, Mesa Photonics, USA, *Presider*

CW3D.1 • 16:30
Fully Programmable Ultra-Complex 2-D Pulse Shaping, Andrew J. Metcalf[1], Victor Torres-Company[1,2], V. R. Supradeepa[1,3], Daniel Leaird[1], Andrew Weiner[1]; [1]*ECE, Purdue University, USA;* [2]*Department of Physics, Universitat Jaume I, Spain;* [3]*OFS research laboratories, USA.* We demonstrate programmable control of a pulse shaper that achieves both fine resolution and broad bandwidth operation by dispersing light into two dimensions. We show line-by-line pulse shaping at 5 GHz in a closed-loop configuration.

CW3D.2 • 16:45
Polarization spectral line-by-line pulse shaping, Chi-Cheng Chen[1], I-Chun Hsieh[1], Shang-Da Yang[1], Chen-Bin Huang[1]; [1]*Institute of Photonics Technologies, National Tsing Hua University, Taiwan.* Spectral line-by-line pulse shaping is extended to full-vectorial capabilities for the first time to our best knowledge. We experimentally demonstrate polarization shaped optical waveforms extending a 50-ps time window.

CW3D.3 • 17:00
Broadband Operation of High-Damage-Threshold Phase and Polarization Binary Beam Shapers, Christophe Dorrer[1]; [1]*Laboratory for Laser Energetics, USA.* Near-field binary beam shapers based on error diffusion have demonstrated a damage threshold higher than 30 J/cm2. Their fabrication tolerance and operation with broadband pulses are investigated for application to short-pulse high-energy lasers.

Room A5	Room A6	Room A7
CLEO: QELS-Fundamental Science		JOINT

16:30–18:30
QW3E • Optomechanics and Optofluidics
Zhigang Chen, San Francisco State University, USA, *Presider*

QW3E.1 • 16:30 Invited
Towards optical manipulation of Casimir force using free-standing membranes with engineered optical and mechanical properties, Eiji Iwase[1], Pui-Chuen Hui[1], David Woolf[1], Alejandro Rodriguez[1,2], Mughees Khan[3], Steven G. Johnson[2], Federico Capasso[1], Marko Loncar[1]; [1]*School of Engineering and Applied Sciences, Harvard University, USA;* [2]*Dept of Mathematics, MIT, USA;* [3]*Wyss Institute, Harvard University, USA.* By engineering supporting beams of a thin opto-mechanical membrane, we are able to reduce the stress-induced deflection, and realize devices that feature strong optical force for probing the Casimir force.

QW3E.2 • 17:00
Light-Induced Shock Waves in Dense Colloidal Suspensions, Elad Greenfield[1], Mordechai Segev[1], Ramy El-Ganainy[2], Demetrios N. Christodoulides[2]; [1]*Physics, Technion Institute of Technology, Israel;* [2]*CREOL - College of Optics & Photonics, University of Central Florida, USA.* We demonstrate theoretically and experimentally gradient-force induced nanoparticle shock waves forming in dense colloidal suspensions. These 'spear-shaped' wavefronts allow locally concentrating and transporting masses of particles in the fluid.

16:30–18:30
QW3F • Laser Plasma Accelerators and Plasma in High Fields
Csaba Toth, Lawrence Berkeley National Laboratory, USA, *Presider*

QW3F.1 • 16:30
Generation of Dark-current-free Quasi-monoenergetic 1.25 GeV Electrons by Laser Wakefield Acceleration, Xiaoming Wang[1], Rafal Zgadzaj[1], Watson Henderson[1], Neil Fazel[1], Yen-Yu Chang[1], Rick Korzekwa,[1], Austin S. Yi[1], Vladimir Khudik[1], Hai-En Tsai[1], Chih-Ho Pai[1], Zhengyan Li[1], Hernan Quevedo[1,2], Gilliss Dyer[1,2], Erhard Gaul[1,2], Mikael Martinez[1,2], Aaron Bernstein[1,2], Teddy Borger[1,2], Michael Spinks[1,2], Michael Donovan[1,2], Gennady Shvets[1], Todd Ditmire[1,2], Michael C. Downer[1]; [1]*Physics, Univ. of Texas Austin, USA;* [2]*Center for High Energy Density Science, Univ. of Texas Austin, USA.* We report electron acceleration to 1.25 GeV by laser-driven wakefield acceleration at plasma density 5x1017 cm-3. Electron beams are dark-current-free, quasi-monoenergetic, highly collimated, contain tens of pC and have excellent pointing stability.

QW3F.2 • 16:45
High-repetition Rate Wakefield Electron Source Driven by Few-millijoule Ultrashort Laser Pulses, Zhaohan He[1], Bixue Hou[1], James Easter[1], Karl Krushelnick[1], John A. Nees[1], Alexander Thomas[1]; [1]*University of Michigan, USA.* 10 mJ ultrafast laser pulses acting on gas flow from capillary nozzles generate stable 100 keV electron beams at 500 Hz. Particle-in-cell simulations indicate that slow high amplitude plasma waves form and accelerate the electron beams.

QW3F.3 • 17:00 Invited
Dynamics of Electron Acceleration in Plasmas, Laszlo Veisz[1], Alexander Buck[1,2], Maria Nicolai[3], Karl Schmid[1], Chris M. Sears[1], Alexander Saevert[3], Julia Mikhailova[1], Malte Kaluza[3,4], Ferenc Krausz[1,2]; [1]*Max-Planck-Institut fuer Quantenoptik, Germany;* [2]*Ludwig-Maximilians-Universitaet, Germany;* [3]*Institut fuer Optik und Quantenelektronik, Friedrich-Schiller-Universitaet, Germany;* [4]*Helmholtz-Institut Jena, Germany.* We report the first direct temporal observation of self-injected and shock-front injected laser-driven electron acceleration. The dynamics of the plasma wave and an electron bunch duration of 6 fs is obtained.

16:30–18:30
JW3G • Nonlinear Microscopy
Siavash Yazdanfar, GE Global Research, USA, *Presider*

JW3G.1 • 16:30
High-Speed Two-Dimensional Multiphoton Microscope using Spatial Modulation, David G. Winters[1], John Speirs[2], Erica Block[2], Randy Bartels[1], Jeff A. Squier[2]; [1]*Colorado State University, USA;* [2]*Colorado School of Mines, USA.* We demonstrate, for the first time, a multimodal multiphoton microscope using chirped intensity modulation to construct line images from a single element detector.

JW3G.2 • 16:45
Nonlinear Cross-Phase Modulation Microscopy Using Spectral Shifting, Jesse W. Wilson[1], Prathyush Samineni[1], Martin C. Fischer[1], Warren S. Warren[1,2]; [1]*Chemistry, Duke University, USA;* [2]*Biomedical engineering, Duke University, USA.* Nonlinear phase contrast may be acquired by measuring spectral shifting of an ultrafast pulse due to cross phase modulation. This technique is used to obtain structural details in a pigmented cell from a melanoma biopsy.

JW3G.3 • 17:00 Invited
In Vivo Multi-Harmonic Generation Biopsy of Human Skin and Mucosa, Chi-Kuang Sun[1,2]; [1]*National Taiwan University, Taiwan;* [2]*Academia Sinica, Taiwan.* We review our development of in vivo multiharmonic generation biopsy for deep tissue noninvasive imaging with a high spatial resolution. Recent clinical trials indicate high sensitivity and specificity to differentiate malignancy histopathologically.

Room A8

CLEO: QELS-Fundamental Science

16:30–18:30
QW3H • Nanofabrication and Plasmonic Detectors
Igal Brener, Sandia National Labs, USA, *Presider*

QW3H.1 • 16:30 Invited
Parallel Laser Printing of Nanoparticles, Spas N. Nedev[1], Alexander S. Urban[1], Andrey A. Lutich[1], Frank Jäckel[1], Jochen Feldmann[1]; [1]*LMU Munich, Germany.* We report on 'optical force stamping' lithography [1], a new approach that employs optical forces on single nanoparticles and allows for parallel nanoparticle printing with precision at least 5x better than the diffraction limit.

QW3H.2 • 17:00
Assembly of Quantum Optical Hybrid Devices via a Scanning Probe Pick-and-Place Technique, Andreas W. Schell[1], Janik Wolters[1], Günter Kewes[1], Tim Schröder[1], Thomas Aichele[1], Oliver Benson[1]; [1]*Nano-Optics, Humboldt-Universität zu Berlin, Germany.* Combination of pre-selected nanoparticles with micro- and nanostructures is a crucial task in building hybrid quantum optical devices. Here a scanning probe based pick-and-place technique is introduced.

Room B2 & B3

JOINT

16:30–18:30
JW3I • Symposium on Quantum Engineering and Architectures II: Optics and Atoms
Prem Kumar, Northwestern University, USA, *Presider*

JW3I.1 • 16:30 Invited
Photonic Quantum Computing, Andrew White[1]; [1]*University of Queensland, Australia.* NQuantum correlations in both space and time allow a clear advantage over classical approaches: we discuss our recent results in engineering correlations for emulating topological phases of matter, simulating quantum chemistry, and performing semi-device-independent QKD.

JW3I.2 • 17:00
Synchronizing single photons with quantum memories, Josh Nunn[1], Nathan K. Langford[3], Tessa Champion[1], Michael R. Sprague[1], Patrick Michelberger[1], K. C. Lee[1], Xian-Min Jin[2,1], Duncan G. England[1], Steven Kolthammer[1], Ian A. Walmsley[1]; [1]*Physics, Oxford University, United Kingdom;* [2]*Center for Quantum Technologies, National University of Singapore, Singapore;* [3]*Physics, Royal Holloway, University of London, United Kingdom.* Without deterministic single photon sources, multiphoton rates fall exponentially with the number of photons required, making practical photonics unfeasible. We show how quantum memories improve multiphoton rates by many orders of magnitude.

Room C1 & C2

CLEO: Applications & Technology

16:30–18:30
AW3J • Ultrafast Laser Applications
Emma Springate, Rutherford Appleton Laboratory, UK, *Presider*

AW3J.1 • 16:30 Tutorial
Enabling Science at the Advanced Light Source X-Ray Facility, Roger Falcone[1]; [1]*Lawrence Berkeley National Lab (LBNL), USA.* X-ray light sources, including synchrotrons as well as free-electrons lasers and plasma sources, are enabling a broad range of science, extending from basic research to applications, under static to dynamic conditions. I will discuss experiments and technology in this field.

Roger Falcone is a physics professor at UC Berkeley, and directs the Advanced Light Source Synchrotron at LBNL. He has degrees from Princeton and Stanford, where he was the Chodorow Fellow before joining Berkeley. Falcone is a Fellow of the APS, OSA, and AAAS. He was jointly awarded the APS Szilard Lectureship Award and the Halbach Prize at the ALS. He was a Distinguished Traveling Lecturer of the APS Laser Science Topical Group and a NSF Presidential Young Investigator. Falcone is the author of over 130 papers in the fields of lasers, atomic and solid state physics, and ultrafast phenomena. He serves on the S&T Committee for LLNS and LANS, directs the UC Institute for Materials Dynamics at Extreme Conditions, and chairs the Faculty Advisory Committee to the Lawrence Hall of Science. Falcone has served on the school board and library foundation of his hometown.

Room C3 & C4

CLEO: Science & Innovations

16:30–18:30
CW3K • Nonlinear Optics in Microcavities
Valdas Pasiskevicius, KTH, Sweden, *Presider*

CW3K.1 • 16:30
Observations of temporal regenerative oscillations in high-Q heterostructured photonic crystal cavities, Jinghui Yang[1], Tingyi Gu[1], Jiangjun Zheng[1], Xiaodong Yang[2], Mingbin Yu[3], Patrick (Guo-Qiang) Lo[3], Dim-Lee Kwong[3], Chee Wei Wong[1]; [1]*Mechanical Engineering, Columbia University, USA;* [2]*Missouri University of Science and Technology, USA;* [3]*The Institute of Microelectronics, Singapore.* Self-induced oscillation is observed in photonic crystal cavities with intrinsic quality factor more than 500k. The results are well-explained by nonlinear coupled mode theory including dynamics of free carriers, temperature and photon population.

CW3K.2 • 16:45
Generation of Low Phase-noise Mid-Infrared Optical Frequency Combs from Crystalline Microresonators, Christine Wang[1,2], Tobias Herr[2], Pascal Del'Haye[1,3], Albert Schliesser[1,2], Ronald Holzwarth[1,3], Theodor Hänsch[1,4], Nathalie Picqué[1,5], Tobias Kippenberg[1,2]; [1]*Max-Planck Institut für Quantenoptik, Germany;* [2]*Ecole Polytechnique Federale de Lausanne, Switzerland;* [3]*Menlo Systems GmbH, Germany;* [4]*Physik, Ludwig-Maximilians-Universität München, Germany;* [5]*Institut des Sciences Moléculaires d'Orsay, CNRS, France.* We present mid-infrared frequency comb generation from crystalline MgF2 microresonators, with mode spacing of 50-150 GHz around the 2.5 µm-wavelength CW-pump. Low phase-noise is verified by beating the comb modes with a narrow linewidth CW laser.

CW3K.3 • 17:00
Observation of 4-overbar-quasi-phasematched second-harmonic generation in a GaAs microdisk cavity, Paulina S. Kuo[1], Glenn S. Solomon[1]; [1]*Joint Quantum Institute, National Institute of Standards and Technology-University of Maryland, USA.* We observed singly-resonant, 4-overbar-quasi-phasematched, second-harmonic generation in a GaAs microdisk cavity. By pumping at the 1985.4-nm fundamental resonance, we observed (5.2±0.4)×10-5/mW conversion efficiency.

Marriott San Jose
Salon I & II

JOINT

16:30–18:30
JW3L • Wide Bandgap Light-emitting Diodes
Maxim Shatalov, SET Inc., USA and Jonathan Wierer, Sandia National Laboratories, USA, *Presiders*

JW3L.1 • 16:30
Internal quantum efficiency in light-emitting diodes based on the width of efficiency-versus-carrier-concentration curve, Guan-Bo Lin[1], Qifeng Shan[2], Andrew J. Birkel[2], Jaehee Cho[1], E. Fred Schubert[1,2], Daniel D. Koleske[3], Mary H. Crawford[3]; [1]*Department of Electrical, Computer and Systems Engineering, Rensselaer Polytechnic Institute, USA;* [2]*Department of Physics, Applied Physics, and Astronomy, Rensselaer Polytechnic Institute, USA;* [3]*Sandia National Laboratories, USA.* Based on the ABC model, we derive a relationship between the internal quantum efficiency (IQE) and the width of the efficiency-versus-carrier-concentration curve. We determine the IQE of LEDs at temperatures ranging from 100K to 300K.

JW3L.2 • 16:45
Asymmetry of carrier transport leading to efficiency droop in GaInN based light-emitting diodes, David S. Meyaard[1], Guan-Bo Lin[1], Qifeng Shan[2], Jaehee Cho[1], E. Fred Schubert[1,2], Hyun Wook Shim[3], Min-Ho Kim[3], Cheolsoo Sone[3]; [1]*Electrical, Computer, and Systems Engineering, Rensselaer Polytechnic Institute, USA;* [2]*Physics, Applied Physics, and Astronomy, Rensselaer Polytechnic Institute, USA;* [3]*R&D Institute, Samsung LED, Republic of Korea.* We present experimental evidence that the asymmetry in carrier concentration and mobility cause efficiency droop in GaInN/GaN pn-junction LEDs. Efficiency droop is measured for a wide range of temperatures, showing increased droop at 80 K.

JW3L.3 • 17:00
Effects of Strain Relaxation on the Photoluminescence of Semipolar InGaN, Grace D. Metcalfe[1], Chad S. Gallinat[1], Hongen Shen[1], Michael Wraback[1], Steven Wienecke[2], Erin Young[3], James S. Speck[3]; [1]*Sensors and Electron Devices Directorate, U.S. Army Research Laboratory, USA;* [2]*Electrical and Computer Engineering Department, University of California, Santa Barbara, USA;* [3]*Materials Department, University of California, Santa Barbara, USA.* We present the effects of partial strain relaxation on the optical properties in lattice mismatched semipolar (11-22) InGaN using polarization-dependent photoluminescence measurements to probe the strain dependent band mixing of the valence bands.

Marriott San Jose
Salon III

CLEO: Science & Innovations

16:30–18:30
CW3M • Optomechanical Systems II
Oskar Painter, California Institute of Technology, USA, *Presider*

CW3M.1 • 16:30
Femtogram Doubly-Clamped Nanomechanical Resonator Embedded in a High-Q Two-Dimensional Photonic Crystal Nanocavity, Xiankai Sun[1], Jiangjun Zheng[2], Menno Poot[1], Chee Wei Wong[2], Hong X. Tang[1]; [1]*Yale Univ., USA;* [2]*Columbia Univ., USA.* We present a nano-optomechanical system consisting of a 25-fg nanomechanical resonator embedded in a high-Q (Qo~10,000) defect nanocavity supported by 2D photonic crystal. Optically transduced flexural nanomechanical motion is demonstrated at 1 GHz.

CW3M.2 • 16:45
A versatile scheme for read-out and actuation of nanomechanical motion using silica microspheres, Leonhard Neuhaus[1], Emmanuel van Brackel[1], Emanuel Gavartin[1], Pierre Verlot[1], Tobias Kippenberg[1,2]; [1]*EPFL, Switzerland;* [2]*Max-Planck-Institut für Quantenoptik, Germany.* We employ silica microspheres to detect and actuate nanomechanical motion. With SiN-nanostrings, we achieve significant passive cooling by radiation pressure. Feedback cooling enables us approaching the quantum-backaction dominated regime.

CW3M.3 • 17:00
Enhanced Optical Forces in Hybrid Plasmonic Devices, Xiaodong Yang[1,2], Yongmin Liu[1], Rupert Oulton[1], Xiaobo Yin[1,2], Xiang Zhang[1,2]; [1]*University of California, Berkeley, USA;* [2]*Lawrence Berkeley National Laboratory, USA.* We demonstrate that the optical force exerted on a suspended dielectric waveguide coupled to a metallic substrate is greatly enhanced compared to dielectric substrate, due to subwavelength optical energy confinement in the hybrid plasmonic mode.

Marriott San Jose
Salon IV

16:30–18:30
CW3N • VCSEL/N-Cavity Lasers
Amr Helmy, University of Toronto, Canada, *Presider*

CW3N.1 • 16:30 Invited
Metal-Cavity Quantum-Dot Surface-Emitting Microlaser, Chien-Yao Lu[1], Shun L. Chuang[1], Dieter Bimberg[2], Freidhelm Hopfer[2]; [1]*Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign, USA;* [2]*Institut für Festkörperphysik, Technische Universität Berlin, Germany.* Fabrication and experimental data are reported for electrical injection metal-cavity quantum-dot surface-emitting microlasers at room temperature. Submonolayer quantum dots are used as the active medium with lasing wavelengths near 980nm.

CW3N.2 • 17:00
1.3µm High-Power Short-Cavity VCSELs for High-Speed Applications, Michael Mueller[1], Christian Grasse[1], Kai Saller[1], Tobias Gründl[1], Gerhard Böhm[1], Markus Ortsiefer[2], Markus C. Amann[1]; [1]*Walter Schottky Institut, Technische Universität München, Germany;* [2]*Vertilas GmbH, Germany.* InP-based 1.3µm VCSELs employing two dielectric DBRs are presented. Because of reduced internal losses in the DBRs, slope-efficiencies above 70%, and output-powers of 4.8mW are reported. The same devices feature modulation bandwidths beyond 12GHz.

CLEO: Science & Innovations

CW3A • Applications of Laser Processing—Continued

CW3A.4 • 17:15
Off-resonance plasmonic enhanced laser (ORPEL) nanoprocessing: fundamentals and application to cell transfection, Michel Meunier[1], Judith Baumgart[1], Laure Humbert[2], Etienne Boulais[1], Remi Lachaine[1], Jean-Jacques Lebrun[2]; [1]*Eng. Physics, Ecole Polytechnique, Canada;* [2]*Medecine, McGill University, Canada.* ORPEL nanoprocessing is based on the production of a highly localized plasma due to the enhanced scattering field. Using a 800 nm fs laser, ORPEL was employed to efficiently perforate cell membranes and transfect cells.

CW3A.5 • 17:30
Laser Induced Forward Transfer-printing of pre-machined crystalline magneto-optic garnet discs, Collin L. Sones[1], Matthias Feinaeugle[1], Behrad Gholipour[1], Alberto Sposito[1], Robert W. Eason[1]; [1]*Optoelectronics Research Centre, University of Southampton, United Kingdom.* We present femtosecond laser-induced forward transfer of focussed ion beam pre-machined crystalline magneto-optic Yttrium Iron Garnet films. Debris-free circular micro-disks with smooth edges and surface uniformity have been successfully printed.

CW3A.6 • 17:45
Light-Matter interactions in Atomic Cladding Wave Guides, Liron Stern[1], Boris Desiatov[1], Ilya Goykhman[1], Uriel Levy[1]; [1]*Applied Physics, The Hebrew University of Jerusalem, Israel.* We experimentally demonstrate light-matter interactions on a chip, consisting of a silicon nitride wave-guide integrated with rubidium vapor cladding. The measured absorption spectra provide indications for low light nonlinear interactions.

CW3B • Trace Gas Sensing—Continued

CW3B.4 • 17:15
A Compact CW Quantum Cascade Laser based QEPAS Sensor for Sensitive Detection of Nitric Oxide, Rafal Lewicki[1], Lei Dong[1], Yufei Ma[1], Frank K. Tittel[1]; [1]*Electrical and Computer Engineering, Rice University, USA.* The development of a compact NO QEPAS-based sensor platform employing a CW DFB-QCL will be reported. A detection sensitivity of 4 ppbv was achieved with a 1-sec averaging time for the 1900.08 cm-1 NO line.

CW3B.5 • 17:30
Trace Level Multi-gas Sensing of Methane and Carbon Monoxide in a Quaternary Hollow-core Bragg Fiber, Lichao Shi[1], Wei Zhang[1], Jie Jin[1], Yidong Huang[1], Jiangde Peng[1]; [1]*Department of Electronic Engineering, Tsinghua University, China.* we experimentally realized trace level multi-gas sensing of methane and carbon monoxide in a single hollow-core photonic crystal fiber by utilizing a mid-infrared multi-wavelength transmission quaternary hollow-core Bragg fiber.

CW3B.6 • 17:45
Novel Spherical Mirror Multipass Cells with Improved Spot Pattern Density for Gas Sensing, Stephen So[1], David Thomazy[1]; [1]*Sentinel Photonics, USA.* We describe simulations of novel patterns in spherical two-mirror axially-aligned multipass cells typically used in Herriott configuration for gas sensing. Mirror spot fill factors are increased dramatically, while still avoiding beam overlap.

JOINT

JW3C • Symposium on Space Optical Systems: Opportunities and Challenges II—Continued

JW3C.3 • 17:15
Stabilized Lasers for Space Applications: A High TRL Optical Cavity Reference System, Robert Pierce[1], Michelle Stephens[1], Jim Leitch[1], Paul Kaptchen[1], David Bender[1], William M. Folkner[2], William M. Klipstein[2], Daniel Shaddock[2], Robert Spero[2], Robert Thompson[2], Nan Yu[2], Micheal Watkins[2]; [1]*Ball Aerospace and Technologies Corporation, USA;* [2]*Jet Propulsion Laboratory, USA.* We have developed a laser stabilization system capable of measuring nm-level distance variations between satellites separated on orbit by 250 km. We describe construction of the reference cavity, show performance results and environmental tests.

JW3C.4 • 17:30 Invited
Qualification of Lasers For NASA Space-Based Remote Sensing Missions: Applying Lessons Learned from CALIPSO to ICESat-2, Floyd Hovis[1]; [1]*Fibertek, Inc., USA.* The successful operation of the lasers in the CALIPSO mission since May 2006 has validated their design. We are applying the key lessons learned from CALIPSO to the transmitters that we are building for ICESat-2.

CLEO: Science & Innovations

CW3D • Pulse Shaping and Timing Control—Continued

CW3D.4 • 17:15
High Power Ultrashort Bessel-Gauss Wavepacket Directly Generated From a Fiber Laser System, Chen Xie[1], Minglie Hu[1], Peng Qin[1], Wei Yan[1], Hao He[1], Bowen Liu[1], Ching-yue Wang[1]; [1]*Tianjin University, China.* We demonstrated a femtosecond fiber laser directly delivering high power diffraction-resistant wavepacket. Bessel-Gauss reshaping was obtained by an integrated shaper fabricated on fiber-end by focused ion beam combined with a spherical lens.

CW3D.5 • 17:30
Real-Time Optical Spectrum Fourier Transformation, Antonio Malacarne[1], Yongwoo Park[2], Ming Li[1], Sophie LaRochelle[3], José Azaña[1]; [1]*INRS-EMT, Canada;* [2]*Automated Precision Inc., USA;* [3]*Center for Optics, Photonics and Laser (COPL), Canada.* A novel concept for real-time and single-shot analog Fourier transformation of an arbitrary broadband optical energy spectrum is introduced and experimentally validated.

CW3D.6 • 17:45
Self-Characterizing Ultrafast Pulse Shaper for Rapid Pulse Switching, Brett J. Pearson[1], Thomas C. Weinacht[2]; [1]*Physics and Astronomy, Dickinson College, USA;* [2]*Physics and Astronomy, Stony Brook University, USA.* We use an acousto-optic modulator at the input to a two-dimensional, Fourier-domain pulse shaper to achieve built-in characterization of the output pulses with spectral interferometry. The device is capable of rapid switching between pulse shapes.

Room A5 | Room A6 | Room A7

CLEO: QELS-Fundamental Science

QW3E • Optomechanics and Optofluidics—Continued

QW3E.3 • 17:15
Anomalous optical forces on a Mie-particle in a transverse Poynting vector flow, Shima Fardad[1,2], Alessandro Salandrino[3], Zhigang Chen[2], Demetrios N. Christodoulides[1]; [1]*CREOL, University of Central Florida, USA;* [2]*Physics and Astronomy, San Francisco State University, USA;* [3]*Mechanical Engineering, University of California, Berkeley, USA.* We show how a superposition of non-interfering plane waves can generate a transverse Poynting vector, which in turn leads to transverse optical forces on a fully isotropic dielectric scatterer, in contrast with conventional radiation-pressure forces.

QW3E.4 • 17:30
A high-energy chirped laser system for fast manipulation of gases, Alexandros Gerakis[1], Nicolas Coppendale[1], Conor Maher-McWilliams[1], Peter Douglas[1], Peter Barker[1]; [1]*Physics and Astronomy, University College London, United Kingdom.* We describe a high-energy, frequency chirped laser system designed for optical acceleration of neutral particles and gas phase diagnostics. This system produces pulse amplified beams (700 mJ) for durations of 20 ns - 10 ms and chirp of up to 1.2 GHz.

QW3E.5 • 17:45
Observation of self-induced transparency in nano-suspensions with negative polarizability, Michael Lau[1], Ze Zhang[1,3], Weining Man[1], Jai Prakash[1], Peng Zhang[1], Demetrios N. Christodoulides[2], Zhigang Chen[1,4]; [1]*Department of Physics and Astronomy, San Francisco State Univ, USA;* [2]*CREOL/College of Optics, University of Central Florida,, USA;* [3]*3National Key Laboratory of Tunable Laser Technology, Harbin Institute of Technology, China;* [4]*TEDA Applied Physics School, Nankai Univ., China.* We demonstrate stable self-trapping and self-induced transparency of light in nano-suspensions with negative polarizabilities. Comparing to colloidal systems with positive polarizabilities, a fivefold increase in transmission ratio is achieved.

QW3F • Laser Plasma Accelerators and Plasma in High Fields—Continued

QW3F.4 • 17:30
All-optical Betatron and Compton x-ray sources and application to phase contrast imaging, Sébastien Corde[1], Kim Ta Phuoc[1], Sylvain Fourmaux[2], Cédric Thaury[1], Philippe Lassonde[2], G. Lebrun[2], S. Payeur[2], F. Martin[2], R. Shah[3], Stéphane Sebban[1], Victor Malka[1], Jean Claude Kieffer[2], Antoine Rousse[1]; [1]*Laboratoire d'Optique Appliquée, ENSTA ParisTech, CNRS UMR7639, Ecole Polytechnique, France;* [2]*Institut National de la Recherche Scientifique - Energie, Matériaux et Télécommunications, Université du Québec, Canada;* [3]*Los Alamos National Laboratory, USA.* Bright x-ray beams, with energies up to hundreds of keV, have been produced from Betatron oscillations and Compton scattering in a laser-plasma accelerator. The potential of Betatron radiation for phase contrast imaging has been demonstrated.

QW3F.5 • 17:45
Control and Mapping of X-Ray Emission in a Laser-Plasma Accelerator, Cédric Thaury[1], Sébastien Corde[1], Kim Ta Phuoc[1], Agustin Lifschitz[1], Romuald Fitour[1], Jérôme Faure[1], Guillaume Lambert[1], Olle Lundh[1], Elsa Benveniste[2], Ahmed Ben-Ismail[2], Leonid Arantchouk[3], Alexandre Marciniak[1], Adrien Stordeur[1], P. Brijesh[1], Arnd Specka[2], Victor Malka[1], Antoine Rousse[1]; [1]*Laboratoire d'Optique Appliquée, ENSTA ParisTech, CNRS UMR7639, Ecole Polytechnique, France;* [2]*Laboratoire Leprince Ringuet, Ecole Polytechnique, CNRS-IN2P3 UMR7638, France;* [3]*Laboratoire de Physique des Plasmas, Ecole Polytechnique, CNRS UMR7648, France.* We show that the control and the mapping of the x-ray emission reveals unique features of the laser-plasma accelerator physics, including strong correlations between electron and x-ray beams, and density-dependence of electron injection position.

JOINT

JW3G • Nonlinear Microscopy—Continued

JW3G.4 • 17:30
Spatial overlap modulation nonlinear optical microscopy, Keisuke Isobe[1], Hiroyuki Kawano[2], Takanori Takeda[1,3], Akira Suda[3], Akiko Kumagai[2], Hideaki Mizuno[2], Atsushi Miyawaki[2], Katsumi Midorikawa[1]; [1]*RIKEN Advanced Science Institute, Japan;* [2]*RIKEN Brain Science Institute, Japan;* [3]*Tokyo University of Science, Japan.* We demonstrate nonlinear optical microscopy modulating the spatial overlap between two-color pulses, which provides the enhancement of the three-dimensional spatial resolution and the suppression of the out-of-focus signals in deep imaging.

JW3G.5 • 17:45
High-Speed Molecular Spectral Imaging by Stimulated Raman Scattering Microscopy Using Wavelength-Tunable Pulses, Wataru Umemura[1], Yasuyuki Ozeki[1,2], Kenta Fujita[1], Kazuhiko Sumimura[1], Norihiko Nishizawa[3], Kiichi Fukui[4], Kazuyoshi Itoh[1]; [1]*Department of Material and Life Science, Osaka University, Japan;* [2]*PRESTO, Japan Science and Technology Agency (JST), Japan;* [3]*Department of Electrical Engineering and Computer Science, Nagoya University, Japan;* [4]*Department of Biotechnology, Osaka University, Japan.* A 15-frame/s stimulated Raman microscope with frame-by-frame wavelength tunability has been developed. Fast spectral imaging of polymer beads in the CH stretching region with a bandwidth of 250 cm-1 is accomplished in 2.6 seconds.

Room A8

CLEO: QELS-Fundamental Science

QW3H • Nanofabrication and Plasmonic Detectors—Continued

QW3H.3 • 17:15
Applications of plasmonic hotspots on laser-treated AgOx thin film, Ming Lun Tseng[1,3], Yao-Wei Huang[1,2], Min-Kai Hsiao[4], Hsin Wei Huang[1,2], Yu-Hsuan Lin[5,6], Cheng Hung Chu[1,2], Nien-Nan Chu[5,6], You Je He[1,2], Chia Min Chang[7,2], Li Chung Kuo[2,1], Yu Lim Chen[2,1], Wei Chih Lin[1,2], Ding-Wei Huang[7], Hai-Pang Chiang[4], Din Ping Tsai[2,8]; *[1]Graduate Institute of Applied Physics, Taiwan University, Taiwan; [2]Physics, National Taiwan University, Taiwan; [3]Molecular Imaging Center, Taiwan University, Taiwan;[4]Institute of Optoelectronic Sciences, National Taiwan Ocean University, Taiwan; [5]Department of Electrophysics, National Chiao Tung University, Taiwan; [6]Instrument Technology Research Center, Taiwan; [7]Institute of Photonics and Optoelectronics, National Taiwan University, Taiwan; [8]Research Center for Applied Sciences, Academia Sinica, Taiwan.* Laser-treated AgOx thin film is used as the plasmon-active substrate for the SERS, molecule sensing, and photocatalyst. The presented technique is helpful for the solar cell, green energy, and biosensing with high efficiency and throughput.

QW3H.4 • 17:30
Metal Nitrides for Plasmonic Applications, Gururaj V. Naik[1], Jeremy L. Schroeder[2], Urcan Guler[1], Xingjie Ni[1], Alexander Kildishev[1], Timothy D. Sands[2], Alexandra Boltasseva[1,3], Alexandra Boltasseva[1,4]; *[1]Electrical & Computer Engineering, Purdue University, USA;[2]Materials Engineering, Purdue University, USA; [3]Photonics Engineering, Technical University of Denmark, Denmark; [4]Advanced optical technology, Universitat Erlangen-Nurnburg, Germany.* Metal nitrides as alternatives to metals such as gold could offer many advantages when used as plasmonic material. We show that transition metal nitrides can replace metals providing equally good optical performance for many plasmonic applications.

QW3H.5 • 17:45
Plasmon-enhanced Isotropic Structural Coloration of Metal Films with Homogenized Pinwheel Nanoparticle Arrays, Sylvanus Y. Lee[1,2], Carlo Forestiere[2], Alyssa Pasquale[2], Gary F. Walsh[2], Jacob Trevino[3], Marco Romagnoli[4], Luca Dal Negro[2,3]; *[1]Mechanical Engineering, Boston Univ, USA; [2]Electrical and Computer Engineering & Photonics Center, Boston University, USA; [3]Division of Materials Science and Engineering, Boston University, USA; [4]PhotonIC Corp., USA.* We design and demonstrate angle-insensitive structural color by engineering plasmon-enhanced light scattering from homogenized Pinwheel arrays of Au nanoparticles on Au substrate for plasmonic applications, like displays, tagging and solar cells.

Room B2 & B3

JOINT

JW3I • Symposium on Quantum Engineering and Architectures II: Optics and Atoms—Continued

JW3I.3 • 17:15
Quantum simulations with a two-dimensional Quantum Walk, Andreas Schreiber[1], Aurel Gabris[2], Peter P. Rohde[3,4], Kaisa Laiho[1], Martin Stefanak[2], Vaclav Potocek[2], Craig Hamilton[2], Igor Jex[2], Christine Silberhorn[1,4]; *[1]Max Planck Institute for the Science of Light, Germany; [2]Czech Technical University in Prague, Czech Republic; [3]Macquarie University, Australia; [4]University of Paderborn, Germany.* We present an experimental implementation of a quantum walk in two dimensions, employing an optical fiber network. We simulated entangling operations and nonlinear multi-particle interactions revealing phenomena such as bound states.

JW3I.4 • 17:30
Silicon Quantum Photonic Sources and Circuits, Erman Engin[1], Damien Bonneau[1], Josh Silverstone[1], Jianwei Wang[1], Kazuya Ohira[2], Nob Suzuki[2], Haruhiko Yoshida[2], Norio Iizuka[2], Mizunori Ezaki[2], Chandra M. Natarajan[3], Michael Tanner[3], Robert R. Hadfield[3], Sanders N. Dorenbos[4], V. Zwiller[4], Jeremy L. O'Brien[1], Mark G. Thompson[1]; *[1]Centre for quantum photonics, University of Bristol, United Kingdom; [2]Corporate Research & Development, Toshiba, Japan; [3]Scottish Universities Physics Alliance and School of Engineering and Physical Sciences, Heriot-Watt University, United Kingdom; [4]Kavli Institute of Nanoscience, TU Delft, Netherlands.* Elementary components required for photonics quantum information processing are realised in a silicon-on-insulator platform. Quantum interference, manipulation of entangled states and photon-pair generation in a ring resonator are demonstrated.

JW3I.5 • 17:45
Fault-tolerant quantum repeaters for long-distance quantum communication based on quantum dots, Nathan C. Jones[1], Kristiaan De Greve[1], Yoshihisa Yamamoto[1,2]; *[1]Stanford University, USA; [2]National Institute of Informatics, Japan.* We present a proposal for a quantum repeater which uses fault-tolerant quantum error correction to overcome decoherence limitations to creating long-distance entanglement between quantum dot spin qubits.

Room C1 & C2

CLEO: Applications & Technology

AW3J • Ultrafast Laser Applications—Continued

AW3J.2 • 17:30
Nondestructive Calibration of Chirped Fiber Bragg Grating Sensors using a Fiber-Based Ultrafast Laser, Richard L. Sandberg[1], Quinn McCulloch[1], Andrew M. Dattelbaum[1], Kyle W. Staggs[1], Rodriguez George[1]; *[1]MPA-CINT, Los Alamos National Laboratory, USA.* Chirped Fiber Bragg Gratings (CFBG) sensors are powerful high-speed strain detectors for applications like traffic monitoring or detonation measurement. Here we present a novel, non-destructive calibration for CFBGs using a femtosecond fiber laser.

AW3J.3 • 17:45
Field-Free Asymmetric Top Alignment and Rotational Revivals Using High Harmonic Generation, Limor Spector1,2, Song Wang1,2, Joe Farrell1,2, Brian McFarland2, Markus Guehr2, Phil Bucksbaum1,2, Maxim Artamonov3, Tamar Seideman3; 1Physics & Applied Physics, Stanford, USA; 2Photon Sciences Division, SLAC National Accelerator Laboratory, USA; 3Chemistry, Northwestern University, USA. Using high harmonic generation (HHG), we probe the nonadiabatic revival structure in the asymmetric top sulfur dioxide. We find that HHG is sensitive to molecular alignment about different axes as well as of partial revivals.

Room C3 & C4

CLEO: Science & Innovations

CW3K • Nonlinear Optics in Microcavities—Continued

CW3K.4 • 17:15
Wavelength Conversion via FWM in a Silicon Ring Resonator at 10 Gb/s for DPSK Signals, Fangxin Li[1], Mark Pelusi[1], Dan-Xia Xu[2], R. Ma[2], Siegfried Janz[2], Benjamin J. Eggleton[1], David J. Moss[1]; *[1]Physics, University of Sydney, Australia; [2]Institute for Microstructural Sciences, National Research Council of Canada, Canada.* We demonstrate all-optical wavelength conversion at 10 Gb/s for differential phase-shift keyed (DPSK) data in the C-band, in a silicon ring resonator. Error-free operation with a system penalty of ~ 4.1 dB is achieved.

CW3K.5 • 17:30 Invited
Observation of Brillouin Cooling, Gaurav Bahl[1], Metthew Tomes[1], Florian Marquardt[2], Tal Carmeon[1]; *[1]University of Michigan, USA; [2]Institut fur Theoretische Physik, Universitat Erlangen-Nurnberg, Germany.* We experimentally demonstrate the energy-reversed counterpart to Brillouin lasers, resulting in the cooling of Brownian surface-acoustic-wave whispering-gallery resonances by light in a silica microsphere resonator.

Wednesday, 9 May

Marriott San Jose
Salon I & II

Marriott San Jose
Salon III

Marriott San Jose
Salon IV

JOINT

CLEO: Science & Innovations

JW3L • Wide Bandgap Light-emitting Diodes—Continued

JW3L.4 • 17:15
High light extraction efficiency for light-emitting diodes grown on GaN and Sapphire substrates using vertical transparent packaging, Chih-Chien Pan[1]; *[1]Materials, UC-Santa Barbara, USA.* High light extraction efficiency (LEE) of 81% and 77% can be achieved for light-emitting diodes grown on free-standing GaN and sapphire substrates, respectively, using vertical geometry transparent package.

JW3L.5 • 17:30
260 nm Pseudomorphic Ultraviolet Light Emitting Diodes with Enhanced Photon Extraction Efficiency, Jianfeng Chen[1], Jamey Grandusky[1], Mark Mendrick[1], Shawn Gibb[1], Craig Moe[2], Michael Wraback[2], Yong-Sung Kim[3], Shawn-Yu Lin[3], Leo Schowalter[1]; *[1]Crystal IS, Inc., USA; [2]Army Research Laboratory, USA; [3]Rensselaer Polytechnic Institute, USA.* We designed and fabricated 260nm ultraviolet LEDs which demonstrated 20mW with greater than 1.5% WPE. Through surface roughening, substrate thinning and encapsulation, a 6× improvement in photon extraction efficiency has been achieved.

JW3L.6 • 17:45
Study of Optical Anisotropy of c-plane/m-plane Ultra-violet LED and Laser Diode by k.p Method, Chang-Pei Wang[1], Yuh-Renn Wu[1]; *[1]Institute of Photonic and Optoelectronics and Department of Electrical Engineering, National Taiwan University, Taiwan.* The optical anisotropic characteristics of AlGaN based quantum well of m-plane and c-plane UV LED are studied. Results shows that non-polar structures has a good X' polarized light source, which is good for LED or Laser applications.

CW3M • Optomechanical Systems II—Continued

CW3M.4 • 17:15
Phase noise of high Q silicon nitride nanomechanical resonators, King Yan Fong[1], Wolfram Pernice[1], Hong X. Tang[1]; *[1]Electrical Engineering, Yale University, USA.* We study noise characteristics of high Q silicon nitride nanomechanical resonators integrated in a nanophotonic circuit. Quality factor up to 2.2 million is measured and an intrinsic frequency noise spectrum with kT/f dependence is observed.

CW3M.5 • 17:30
A Cryogenic Cavity Optomechanics System for Membrane Microresonators, Thomas Purdy[1], Robert Peterson[1], Pen-Li Yu[1], Cindy Regal[1]; *[1]JILA, University of Colorado and National Institute of Standards and Technology, USA.* We have constructed a monolithic Fabry-Perot cavity optomechanical system. From cryogenic temperatures we significantly damp a Si3N4-membrane and achieve conditions suitable for cooling MHz mechanical resonators from [|#24#|]4K into the quantum regime.

CW3M.6 • 17:45
Non-Conservative Optical Forces on Single Particle in A Single-Mode Waveguide, Zheng Wang[1], Peter Rakich[2]; *[1]Electrical & Computer Engineering, The University of Texas at Austin, USA; [2]Sandia National Laboratories, USA.* Optical forces have been traditionally decomposed into gradient force and scattering force. We show the limit of this decomposition and the non-conservative nature of optical forces, even for single particle confined in a single-mode waveguide.

CW3N • VCSEL/N-Cavity Lasers—Continued

CW3N.3 • 17:15
Double Photonic Crystal VCSELs for CMOS integration, Corrado Sciancalepore[1,2], Badhise Ben Bakir[2], Xavier Letartre[1], Julie Harduin[2], Nicolas Olivier[2], Christian Seassal[1], Jean-Marc Fedeli[2], Pierre Viktorovitch[1]; *[1]Photonics and Photovoltaics, Institut des Nanotechnologies de Lyon (INL), UMR CNRS 5270 Ecole Centrale de Lyon, France; [2]Optronics, CEA-Leti, France.* CMOS-compatible 1.55-µm emitting VCSELs employing double photonic crystal mirrors (PCMs) are presented. Single-mode polarization-controlled continuous-wave laser operation up to 43°C is demonstrated under optical pumping excitation at low thresholds.

CW3N.4 • 17:30
Optical Spin-Injection of a 1300nm-VCSEL, Kevin R. Schires[1], Rihab Al Seyab[1], Antonio Hurtado[1], Ville-Markus Korpijärvi[2], Mircea Guina[2], Ian D. Henning[1], Michael J. Adams[1]; *[1]School of Computer Science and Electronic Engineering, University of Essex, United Kingdom; [2]Optoelectronics Research Centre (ORC), Tampere University of Technology, Finland.* We report the first room temperature optical spin-injection of a dilute nitride 1300 nm vertical-cavity surface-emitting laser under continuous wave pumping. Very good agreement is found with theoretical predictions obtained with the spin flip model.

CW3N.5 • 17:45
Transverse Mode Control of VCSELs with High Contrast Sub-Wavelength Grating Functioning as Angular Filter, Hayato Sano[1], Jyunichi Kashino[1], Adair Gerke[2], Akihiro Imamura[1], Fumio Koyama[1], Connie Chang-Hasnain[2]; *[1]Photonics Integration System Research Center, Tokyo Institute of Technology, Japan; [2]Department of Electrical Engineering and Computer Sciences, University of California, USA.* We present the design of HCG functioning as angularly selective filter for the transverse-mode-control of VCSELs. Highly angular dependent reflection characteristics can be obtained for avoiding high-order transverse modes in large-area VCSELs.

Room A1

Room A2

Room A3

Room A4

CLEO: Science & Innovations

JOINT

CLEO: Science & Innovations

CW3A • Applications of Laser Processing—Continued

CW3A.7 • 18:00 Invited

Intuitive Analysis of Space-time Focusing with Double-ABCD Calculation, Charles G. Durfee[1], Michael J. Greco[1], Erica Block[1], Dawn Vitek[1], Jeff A. Squier[1]; [1]*Dept of Physics, Colorado School of Mines, USA.* We analyze the structure of space-time focusing of spatially-chirped pulses using a technique where each frequency component of the beam follows its own Gaussian beamlet that in turn travels as a ray through the system.

CW3B • Trace Gas Sensing—Continued

CW3B.7 • 18:00

Explosive gas sensors with ultrahigh sensitivity in all-fiber configuration, Mi-Kyung Bae[1,2], Hee-Dok Choi[1], Jung Ah Lim[1], Sangsig Kim[2], Yong-Won Song[1]; [1]*Future Convergence Research Division, Korea Institute of Science and Technology, Republic of Korea;* [2]*School of Electrical Engineering, Korea university, Republic of Korea.* We realize a highly sensitive nitrobenzene sensor in all-fiber scheme employing fiber FPI with poly(4-Vinylpyridine) that provides volume expansion with gas absorption.Sensitivity level of 10ppm with >40nm spectral shift is successfully demonstrated.

CW3B.8 • 18:15

Long Term Stability of a Diode Laser-Based Sensor for High Precision Measurements of Ambient CO2 in Networks, David Sonnenfroh[1], K. R. Parameswaran[1]; [1]*Physical Sciences Inc., USA.* We have investigated the long term stability of a near-IR TDL sensor intended for long term deployment in monitoring networks. Performance under different operating modes will be discussed and evaluated.

JW3C • Symposium on Space Optical Systems: Opportunities and Challenges II—Continued

JW3C.5 • 18:00 Invited

Space-Based Lidar Systems, Xiaoli Sun[1]; [1]*Laser Remote Sensing Laboratory, NASA Goddard Space Flight Center, USA.* An overview of space-based lidar systems is presented, from the first laser altimeter on APOLLO 15 mission in 1971 to the Mercury Laser Altimeter on MESSENGER mission currently in orbit, and those currently under development.

CW3D • Pulse Shaping and Timing Control—Continued

CW3D.7 • 18:00

Electronic Dispersion Compensation in Fiber-link-based Timing Distribution System, Ming Xin[1], Franz X. Kaertner[1,2]; [1]*Center for Free-Electron Laser Science, Deutsches Elektronen-Synchrotron, Germany;* [2]*Department of Electrical Engineering and Computer Science and Research Laboratory of Electronics, Massachusetts Institute of Technology, USA.* An electronic dispersion compensation method based on coherent optical receiver and digital signal process is introduced in the fiber link timing distribution system. Then the timing error caused by dispersion can be significantly decreased.

CW3D.8 • 18:15

Generation of stabilized asynchronous pulse trains from a synchronously pumped optical parametric oscillator, Zhaowei Zhang[1], Tobias P. Lamour[1], Chenglin Gu[1,2], Jinghua Sun[1], Ching-yue Wang[2], Tom Gardiner[3], Derryck T. Reid[1]; [1]*Physics Department, Heriot-Watt University, United Kingdom;* [2]*School of Precision Instruments and Optoelectronics Engineering, Tianjin University, China;* [3]*National Physical Laboratory, United Kingdom.* Two asynchronous, broadband 3.3-µm pulse trains with a stabilized repetition-rate difference of up to 5 kHz were generated with an optical parametric oscillator. This system is potentially suitable for coherent dual-frequency-comb spectroscopy.

18:30–20:30 JW4A • Poster Session II & Conference Reception, *Concourse & Arcade Levels*

NOTES

Wednesday, 9 May

Room A5

Room A6

Room A7

CLEO: QELS-Fundamental Science

JOINT

QW3E • Optomechanics and Optofluidics—Continued

QW3E.6 • 18:00
Dynamics of a tethered silicon photonic crystal membrane due to optical gradient, photothermal and Casimir forces, Pui-Chuen Hui[1], David Woolf[1], Eiji Iwase[1], Irfan Bulu[1], Alejandro Rodriguez[2], Mughees Khan[3], Parag B. Deotare[1], Steven G. Johnson[2], Federico Capasso[1], Marko Loncar[1]; [1]*School of Engineering and Applied Sciences, Harvard University, USA;* [2]*Department of Mathematics, Massachusetts Institute of Technology, USA;* [3]*Wyss Institute for Biologically Inspired Engineering, Harvard University, USA.* We experimentally studied the effects of optical gradient and photothermal forces on the optomechanics of tethered silicon membranes. Novel engineering of support arms facilitates tunable optomechanical coupling and probing of Casimir interactions.

QW3E.7 • 18:15
Generating Phonon Pairs with Cavity Optomechanics, Chunhua Dong[1], Victor Fiore[1], Mark Kuzyk[1], Hailin Wang[1]; [1]*University of Oregon, USA.* We demonstrate the generation of classically correlated phonon pairs, for which two mechanical modes in a silica microsphere are coupled to an optical mode via optomechanical parametric amplification and state-transfer processes, respectively.

QW3F • Laser Plasma Accelerators and Plasma in High Fields—Continued

QW3F.6 • 18:00
In Situ Measurement of Cluster Mass Fraction in Supersonic Gas Jets by Frequency Domain Holography, Xiaohui Gao[1], Rick Korzekwa,[1], Xiaoming Wang[1], Bonggu Shim[1], Alexey V. Arefiev[1], Michael C. Downer[1]; [1]*University of Texas at Austin, USA.* We determine cluster mass fraction fc in supersonic gas jets by measuring femtosecond evolution of the jet's refractive index by single-shot frequency domain holography. Variations of fc with time, position and backing pressure are measured.

QW3F.7 • 18:15
Spatial properties of Doppler harmonics generated on plasma mirrors, Henri Vincenti[1], Fabien Quéré[1]; [1]*Service des Photons Atomes et Molécules, CEA, France.* We present the first analytical modeling of the spatial properties of Doppler harmonics generated on plasma mirrors, which understanding is crucial to get an exploitable light source for future attosecond pump-probe experiments.

JW3G • Nonlinear Microscopy—Continued

JW3G.6 • 18:00
Effect of the Nonresonant Background Medium in CARS and SRS Microscopy Image Formation, Konstantin Popov[1], Adrian Pegoraro[2,3], Albert Stolow[1,2], Lora Ramunno[1]; [1]*Department of Physics, University of Ottawa, Canada;* [2]*Steacie Institute for Molecular Sciences, National Research Council of Canada, Canada;* [3]*Department of Physics, Queen's University, Canada.* We examine the image formation in CARS, FM-CARS, AM-SRS and FM-SRS modalities. We find that in the presence of a nonresonant spatially-nonuniform background medium, only the FM-SRS modality can be considered both background and distortion free.

JW3G.7 • 18:15
Sensitivity Enhancement of Fiber-Laser-Based Stimulated Raman Scattering Microscopy by Intensity Noise Suppressor, Keisuke Nose[1], Yasuyuki Ozeki[1,2], Tatsuya Kishi[1], Kazuhiko Sumimura[1], Norihiko Nishizawa[3], Yasuo Kanematsu[1], Kazuyoshi Itoh[1]; [1]*Division of Advanced Science and Biotechnology, Osaka University, Japan;* [2]*PRESTO, Japan Science and Technology Agency, Japan;* [3]*Department of Electrical Engineering and Computer Science, Nagoya university, Japan.* Fiber laser pulses are split and combined with a delay to suppress the intensity noise by 23 dB, which is only 4-dB higher than the shot noise limit. Fiber-based stimulated Raman imaging is also demonstrated.

18:30–20:30 JW4A • Poster Session II & Conference Reception, *Concourse & Arcade Levels*

NOTES

Wednesday, 9 May

Room A8

CLEO: QELS-Fundamental Science

QW3H • Nanofabrication and Plasmonic Detectors—Continued

QW3H.6 • 18:00
Silicon-metal waveguide as a high efficiency Schottky detector for telecom wavelengths, Ilya Goykhman[1], Boris Desiatov[1], Jacob B. Khurgin[2], Joseph Shappir[1], Uriel Levy[1]; [1]*Applied Physics, Hebrew University, Israel;* [2]*Electrical Engineering, Jhons Hopkins University, USA.* We demonstrate an integrated on-chip compact and high efficiency Schottky detector for telecom wavelengths based on silicon metal waveguide. Detection is based on the internal photoemission process. Theory and experimental results are discussed.

QW3H.7 • 18:15
Leaky-mode effects in InAs quantum-dot infrared photodetectors coupled to metal photonic crystals, Seung-Chang Lee[1], Y. Sharma[1], S. Krishna[1], S. Brueck[1]; [1]*Center for High Technology Materials and Department of Electrical and Computer Engineering, University of New Mexico, USA.* A metal photonic crystals integrated on the n+-doped top contact layer of an InAs quantum-dot infrared photodetector is investigated. The contact layer thickness impacts the photoresponse by the leaky mode characteristics of this antiguide structure.

Room B2 & B3

JOINT

JW3I • Symposium on Quantum Engineering and Architectures II: Optics and Atoms—Continued

JW3I.6 • 18:00 Invited
Transport of Trapped-ion Qubits in a Scalable Architecture, R. Bradford Blakestad[1,2], Christian Ospelkaus[2], Aaron P. VanDevender[2], Janus H. Wesenberg[2], Michael J. Biercuk[2], Dietrich Leibfried[2], David J. Wineland[2]; [1]*Joint Quauntum Institute / NIST, USA;* [2]*NIST, USA.* Trapped-ion qubits can be transported through a two-dimensional trap array, while maintaining the ions near the motional ground-state. This helps demonstrate the viability of large-scale quantum processor architectures using trapped-ions.

Room C1 & C2

CLEO: Applications & Technology

AW3J • Ultrafast Laser Applications—Continued

AW3J.4 • 18:00 Invited
Applications of Ultrafast Lasers, Michael M. Mielke[1], Michael Greenberg[1], Carolyn Martinez[1], David M. Gaudiosi[1], Tim Booth[1]; [1]*Raydiance, Inc., USA.* We describe ultrafast laser material processing applications and differentiate these from conventional laser processing techniques. Ultrafast laser application examples show the unique, compelling benefits to high value microfabrication challenges.

Room C3 & C4

CLEO: Science & Innovations

CW3K • Nonlinear Optics in Microcavities—Continued

CW3K.6 • 18:00
Microcavity Brillouin Laser with High Coherence, Jiang Li[1], Hansuek Lee[1], Tong Chen[1], Oskar Painter[1], Kerry J. Vahala[1]; [1]*Caltech, USA.* The first chip-based stimulated Brillouin laser (SBL) is demonstrated. It has efficiency of 90% and exhibits record coherence for an on-chip device, featuring Schawlow-Townes frequency noise of 60 milliHz2/Hz. Low technical noise is also observed.

CW3K.7 • 18:15
Mode-hop-free tunable optical parametric oscillator utilizing a whispering gallery mode resonator, Michael J. Foertsch[1,2], Gerhard Schunk[1,2], Florian Sedlmeir[1,2], Josef Fuerst[1,2], Christoffer Wittmann[1,2], Dmitry Strekalov[1,3], Harald G. Schwefel[1,2], Christoph Marquardt[1,2], Gerd Leuchs[1,2]; [1]*Max Planck Insitute for the Science of Light, Germany;* [2]*Institut fuer Optik, Information und Photonik, Germany;* [3]*Jet Propulsion Laboratory, USA.* We report on a compact and stable optical parametric oscillator in a whispering gallery mode resonator, that combines very low pump thresholds with versatile tunability.

18:30–20:30 JW4A • Poster Session II & Conference Reception, *Concourse & Arcade Levels*

Exhibit Hall 3

JOINT

18:30–20:30
JW4A • Poster Session II

JW4A.1
Slow light over 1,000 fractional pulses based on ultrahigh-order guided modes in symmetrical metal-cladding optical waveguide, Yuanlin Zheng[1], Wen Yuan[1], Zhuangqi Cao[1], Xianfeng Chen[1]; [1]*Department of Physics, Shanghai Jiao Tong University, China.* We demonstrate $1,400$ fractional delay of sub-ps pulses based on ultra-high-order guided modes in symmetrical metal-cladding optical waveguide. DBP value of 10^4 is obtained by material dispersion independent and wide bandwidth operation.

JW4A.2
All Optical Flip Flop with two Coupled Travelling Waveguide SOA-XGM Switches, Christos Vagionas[1,2], Dimitrios Fitsios[1,2], George T. Kanellos[2], Nikos Pleros[1,2], Amalia Miliou[1]; [1]*Department of Informatics, Aristotle University of Thessaloniki, Greece;* [2]*Informatics and Telematics Institute, Center for Research and Technology Hellas, Greece.* We demonstrate a novel optical SR-flip flop with simple architecture, employing only two SOA XGM switches. Proof-of-principle operation is experimentally demonstrated at 8 Mb/s and numerically evaluated at 10 Gb/s.

JW4A.3
Experimental Test-bed For Studying Ultrawideband Wireless Multiple-Input Single-Output Time Reversal Using Optical Delay Lines, Amir Dezfooliyan[1], Andrew Weiner[1]; [1]*School of Elec. and Comp. Eng., Purdue University, USA.*, An experimental setup is designed to study Time-Reversal over ultrawideband multiple-input single-output configurations. Implementation is based on optical delay lines to apply appropriate time shifts to the output of an arbitrary waveform generator.

JW4A.4
CMOS Compatible Monolithic 1st and 2nd Order All-Optical Integrator, Marcello Ferrera[4], Yongwoo Park[2], Luca Razzari[5,2], Sai T. Chu[3], Brent Little[3], David J. Moss[1], Roberto Morandotti[2], José Azana[2]; [1]*Physics, University of Sydney, Australia;* [2]*EMT-INRS, INRS, Canada;* [3]*Infinera, USA;*[4]*Physics and Astronomy, University of St Andrews, United Kingdom;* [5]*3IIT, Istituto Italiano di Tecnologia,, Italy.* We demonstrate 1st and 2nd order all-optical ultra-high speed temporal integration of complex optical waveforms by using an integrated CMOS compatible four-port micro-ring resonator. The device offers an unprecedented processing speed > 400GHz.

JW4A.5
Compact Electrically Tunable Delay Generator on Silicon, Kambiz Jamshidi[1], Stefan Meister[2], Bulent Andreas Franke[2], Olga Dyatlova[2], Aws Al-saadi[2], Ulrike Woggon[2], Hans Joachim Eichler[2], Thomas Schneider[1]; [1]*High frequency technology, Deutsche Telekom university of applied sciences, Germany;* [2]*Technical University Berlin, Institut für Optik und Atomare Physik, Germany.* Feasibility of a tunable delay of optical data streams is proved by experimentally validating a hybrid fiber/integrated realization. Ultimate design can provide delays of more than 200 ps in an area of about 0.4 mm2.

JW4A.6
A Non-Hermitian Approach to Non-Linear Switching Dynamics in Coupled Cavity-Waveguide Systems, Mikkel Heuck[1], Philip Trøst Kristensen[1], Jesper Mørk[1]; [1]*DTU-Fotonik, Technical University of Denmark, Denmark.* We present a non-Hermitian perturbation theory employing quasi-normal modes to investigate non-linear all-optical switching dynamics in a photonic crystal coupled cavity-waveguide system and compare with finite-difference-time-domain simulations.

JW4A.7
Integrated all-optical 4-input NOR logic gate based on InP technology, Miguel Cabezon[1], Asier Villafranca[1], David Izquierdo[1], Juan J. Martinez[1], Ignacio Garcés[1]; [1]*Photonics Technology Group, I3A, Universidad de Zaragoza, Spain.* In this work we present an integrated all-optical 4-input NOR logic gate fabricated on InP technology and comprising a fabricated SOA operating at 25 Gb/s and a wavelength demultiplexer.

JW4A.8
SOI Modal Dispersion for On-Chip Mode-Division Multiplexing, Shih-Hsiang Hsu[1], Sheng-Chieh Tseng[1]; [1]*National Taiwan University of Science and Technology, Taiwan.* Recently the mode-division multiplexing is emerging to improve transmission capacity. An interferometry was utilized to demonstrate the intermodal group delay and intramodal dispersion on silicon-on-insulator waveguides for high-speed applications.

Marriott San Jose
Salon I & II

JOINT

JW3L • Wide Bandgap Light-emitting Diodes—Continued

JW3L.7 • 18:00
Enhancement of Light Extraction Efficiency for Deep Ultraviolet AlGaN Quantum Wells Light-emitting Diodes with III-nitride Microspheres, Peng Zhao[1], Di Sun[1], Hongping Zhao[1]; [1]*Department of Electrical Engineering and Computer Science, Case Western Reserve University, USA.* Deep ultraviolet AlGaN quantum wells light-emitting diodes with III-nitride microspheres on the p-type layer shows significant light extraction efficiency enhancement (>5.7 times) of the dominant transverse magnetic polarized spontaneous emission.

JW3L.8 • 18:15
Enhanced extraction efficiency of fluorescent SiC by surface nanostructuring, Yiyu Ou[1], Valdas Jokubavicius[2], Rositza Yakimova[2], Mikael Syväjärvi[2], Haiyan Ou[1]; [1]*Photonice Engineering, Technical University of Denmark, Denmark;* [2]*Department of Physics, Chemistry and Biology, Linköping University, Sweden.* Antireflective structures were fabricated on fluorescent 6H-SiC for white LEDs to enhance the extraction efficiency. Average surface reflectance decreased from 22.1% to 5.1% over a broad range, and luminescence intensity was enhanced by 41%.

Marriott San Jose
Salon III

CLEO: Science & Innovations

CW3M • Optomechanical Systems II—Continued

CW3M.7 • 18:00
A Slot-Suzuki-Phase Photonic Crystal for Optical Trapping via Guided Resonance Modes, Jing Ma[1], Luis Martínez[1], Michelle L. Povinelli[1]; [1]*Electrical Engineering, university of southern california, USA.* A novel photonic crystal design is proposed for optical trapping of particle arrays. The design introduces a slot in the unit cell of the Suzuki-Phase lattice to increase quality factor and trapping strength.

CW3M.8 • 18:15
Optical trapping of metal-dielectric nanoparticle clusters near photonic crystal microcavities, Camilo A. Mejia[1], Michelle Povinelli[1]; [1]*University of Southern California, USA.* We predict the formation of a stably trapped metal-dielectric nanoparticle cluster near a photonic crystal cavity. The cavity mode traps a gold particle, which provides a secondary trapping site for a pair of dielectric particles.

Marriott San Jose
Salon IV

CW3N • VCSEL/N-Cavity Lasers—Continued

CW3N.6 • 18:00
Coherent Optical Measurement of the Modulation Dynamics of Injection-Locked VCSELs, Sharad P. Bhooplapur[1], Nazanin Hoghooghi[1], Peter Delfyett[1]; [1]*College of Optics and Photonics, CREOL, University of Central Florida, USA.* We independently measure the optical phase and amplitude modulation characteristics of an injection-locked VCSEL for the first time at GHz rates, using a coherent optical demodulation scheme, giving us insight into different phase modulation regimes.

CW3N.7 • 18:15
High temperature continuous wave operation of Sb-based Monolithic EP-VCSEL with Selectively Etched Tunnel-Junction Apertures, Dorian Sanchez[1], Laurent Cerutti[1], Eric Tournie[1]; [1]*IES, France.,* We report on a monolithic Sb-based VCSEL operating at CW up to 70°C. The structure is made of two DBRs and a tunnel junction. By selectively under-etching this tunnel junction, we improve the VCSEL performances.

18:30–20:30 JW4A • Poster Session II & Conference Reception, *Concourse & Arcade Levels*

Exhibit Hall 3

JOINT

JW4A • Poster Session II—Continued

JW4A.9
Achieving continuously tunable slow and fast light by using an optically pumped tilted fiber Bragg grating, Jianping Yao[1], Hiva Shahoei[1]; [1]*EECS, University of Ottawa, Canada.* Continuously tunable slow and fast light is achieved by using a tilted fiber Bragg grating written in an erbium/ytterbium co-doped fiber. By pumping the grating, a tunable time-delay from -38 to 18 ps is achieved.

JW4A.10
High Coupling Efficiency Etched Facet Tapers in Silicon, Jaime Cardenas[1], Kevin Luke[1], Lian Wee Luo[1], Carl B. Poitras[1], Paul A. Morton[2], Michal Lipson[1,3]; [1]*Cornell University, USA;* [2]*Morton Photonics, USA;* [3]*Kavli Institute at Cornell, USA.* We demonstrate etched facet silicon inverse tapers with coupling loss as low as 0.7dB per facet. This taper can be fabricated on a wafer scale enabling mass-production of silicon photonic devices with broadband, high-efficiency couplers.

JW4A.11
MHz Bandwidth Electro-optical Modulator based on a Reconfigurable Photonic Metamaterial, Jun-Yu Ou[1], Eric Plum[1], Nikolay I. Zheludev[1]; [1]*Optoelectronics Research Centre, University of Southampton, United Kingdom.* We provide the first demonstration of megahertz-rate electro-optical modulation using a reconfigurable photonic metamaterial driven by electrostatic forces. The modulator can also be engaged in nonvolatile switching providing 90% switching contrast.

JW4A.12
Directed optical half-adder based on microring-resonator-based optical switches, Yonghui Tian[1]; [1]*State Key Laboratory on Integrated Optoelectronics and Optoelectronic System Laboratory, Institute of Semiconductors, Chinese Academy of Sciences, China.* We fabricate a directed optical logic circuit on silicon-on-insulator platform which can implement the addition of two bits. For proof of concept, a thermo-optic switch effect is employed with an operation speed of 10kbps.

JW4A.13
Design and Optimization of a Single-Shot Spectro-Polarimeter, Sebastian Knitter[1], Carsten Fallnich[1]; [1]*Inst. f. Angew. Physik, University of Munster, Germany.* We show an implementation of a spectrally resolving single-shot polarimeter, without any moving parts and few functional components. The functional principle and the setup as well as optimizations of the system will be presented.

JW4A.14
A universal method for constructing N-port non-blocking optical router based on microring resonators, Rui Min[1]; [1]*institute of semiconductor Chinese academe of sciences, China.* A universal method to constructing scalable non-blocking optical router for photonic NoC is proposed, which has fewer microring resonators, fewer waveguides and fewer crossings.

JW4A • Poster Session II—Continued

JW4A.15

On-a-chip QPSK and Optical CDMA Coders/Decoders Made with Digital Planar Holography, Konstantin Kravtsov[1], Igor Ivonin[1], Vladimir Yankov[1]; [1]*Nano-Optic Devices, USA.* We present novel on-a-chip spectral-phase devices that allow ultra-compact solutions for QPSK, QPSK over WDM, and optical CDMA. The used concept of digital planar holography is backed with simulations and experimental results.

JW4A.16

Competition of Resonant and Nonresonant Paths in Resonance-Enhanced Two-Photon Single Ionization of He by an Ultrashort Extreme-Ultraviolet Pulse, Kenichi L. Ishikawa[1], Kiyoshi Ueda[2]; [1]*Photon Science Center, Graduate School of Engineering, University of Tokyo, Japan;* [2]*Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, Japan.* The photoelectron angular distribution from the resonant two-photon ionization of He by femtosecond extreme-ultraviolet pulses dramatically varies with pulse width, due to changing competition between resonant and nonresonant ionization paths.

JW4A.17

A General Threshold for Laser-Driven Linear Particle Acceleration in Infinite Vacuum, Liang Jie Wong[1], Franz X. Kaertner[1,2]; [1]*Massachusetts Institute of Technology, USA;* [2]*Center for Free-Electron Laser Science, DESY, and Department of Physics, University of Hamburg, Germany.* We derive a threshold formula for unbounded vacuum acceleration by hypothesizing that this is possible only if the field perturbs the particle relativistically in its initial rest frame. Numerical simulations support our formula and hypothesis.

JW4A.18

Recombination Amplitude Calculation for Noble Gases beyond Strong Field Approximation in Length and Acceleration Gauge, Siddharth Bhardwaj[1], Sang-Kil Son[2], Robin Santra[2], Franz X. Kaertner[1,2]; [1]*Electrical Engineering and Computer Science, Massachusetts Institute of Technology, USA;* [2]*Center For Free Electron Lasers and Dept. of Physics, University of Hamburg, Germany.* Recombination is a critical step in tomographic orbital imaging and quantitative modeling of HHG. We calculate and compare recombination amplitudes in length and acceleration gauge, beyond Strong Field Approximation, for noble gases used in HHG.

JW4A.19

Sub-Doppler two-photon excitation spectra of atomic xenon: characterization of hyperfine structure and isotope shifts, Ken G. Baldwin[1], Mitsuhiko Kono[1], Yabai He[3,2], Brian J. Orr[2]; [1]*Research School of Physics and Engineering, Australian National University, Australia;* [2]*MQ Photonics Research Centre, Macquarie University, Australia;*[3]*National Measurement Institute, Australia.* Sub-Doppler two-photon excitation spectra are recorded for high-energy Rydberg levels of atomic xenon, using narrowband nanosecond pulses of coherent radiation at 206-210 nm. The diverse hyperfine and isotopic structure is assigned and analyzed.

JW4A.20

Highly Localized Plasma Formation in Air Using Space-time Focusing of mJ Ultrafast Pulses, Michael J. Greco[1], Amanda Meier[1], Erica Block[1], Marin Iliev[1], Dawn Vitek[1], Jeff A. Squier[1], Charles G. Durfee[1]; [1]*Dept of Physics, Colorado School of Mines, USA.* Space-time focusing of spatially-chirped Ti:Sapphire laser pulses is used to generate a plasma in air axially localized to 28x less than the confocal parameter, suppressing filamentation on the way to the focus.

JW4A.21

Intense Attosecond Pulse Trains from Relativistic Surface Plasmas, Christian Roedel[1,2], Jana Bierbach[1], Daniel an der Bruegge[3], Marc Yeung[4], Thomas Hahn[5], Brendan Dromey[4], Sven Herzer[1], Silvio Fuchs[1,2], Erich Eckner[1], Mirela Cerchez[5], Oliver Jäckel[1,2], Toma Toncian[5], Dirk Hemmers[5], Malte Kaluza[1,2], Georg Pretzler[5], Oswald Willi[5], Matthew Zepf[4], Gerhard Paulus[1,2]; [1]*Institute of Optics and Quantum Electronics, Friedrich-Schiller University Jena, Germany;* [2]*Helmholtz Institute Jena, Germany;* [3]*Institute of Theoretical Physics, Heinrich-Heine University Düsseldorf, Germany;* [4]*Centre of Plasma Physics, Queen's University Belfast, United Kingdom;* [5]*Institute for Laser- and Plasma Physics, Heinrich-Heine University Düsseldorf, Germany.* We report on the unequal spacing attosecond pulse trains from relativistic surface plasmas. The surface high harmonics efficiency is determined and could be enhanced using an optimized the plasma scale length and density.

JW4A.22

Divergence of high order harmonic emission from intense laser interactions with solid targets, James Easter[1,2], John A. Nees[2], Bixue Hou[2], Aghapi Mordovanakis[2], Gerard Mourou[2], Alexander Thomas[2], Karl Krushelnick[2]; [1]*Electrical Engineering and Computer Science, University of Michigan, USA;* [2]*Clark MXR, USA.* Laser plasma interaction reveals harmonic divergence <4 degrees and increasing with defocus. Circular polarization was found to cause a change in the angle of emission, which may be beneficial in efficient isolated attosecond pulse production.

JW4A.23

Broadband high harmonic generation from 400 nm sub-10 fs driving pulses, Yan Cheng[1,2], Sabih D. Khan[1], Baozhen Zhao[1], Kun Zhao[2], Michael Chini[2], Zenghu Chang[2,1]; [1]*Kansas State University, USA;* [2]*Physics, University of Central Florida, USA.* Broadband high harmonic generation produced from 400 nm sub-10 fs driving pulses is reported. The results indicate an efficient method of generating intense single attosecond pulses from 400 nm driving lasers.

JW4A.24

Low Noise Quantum-correlated Photon Pair Generation in Composite Tellurite/Phoshpate Microstructured Optical Fibers, Xin Yan[1], Meisong Liao[1], TongHoang Tuan[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Toyota technological institute, Japan.* We proposed a tellurite/phosphate composite microstructured optical fiber with small dispersion value and high nonlinear coefficient at telecommunication wavelengths to realize efficient and low noise quantum-correlated photon pair generation.

JW4A.25

Highly Efficient Coupling of Photons from Single CdSe/ZnS Nanocrystals into Single-Mode Optical Fibers, Masazumi Fujiwara[1,2], Kiyota Toubaru[1,2], Tetsuya Noda[1,2], Hong-Quan Zhao[1,2], Shigeki Takeuchi[1,2]; [1]*Research Institute for Electronic Science, Hokkaido University, Japan;* [2]*The Institute of Scientific and Industrial Research, Osaka University, Japan.* We report efficient coupling of nanoemitters and single-mode fibers. 7.4% of the total emitted photons from single CdSe/ZnS nanocrystals were directly coupled into 300-nm-diameter tapered fibers and were output from the single-mode fiber ends.

JW4A.26

Stochastic Spatiotemporal Dynamics of Stimulated Brillouin Scattering in an Optical Fiber, William N. Potter[1], John R. Thompson[1]; [1]*Department of Physics and Astronomy, Virginia Military Institute, USA.* We report transverse structure in the temporal dynamics of stimulated Brillouin scattering from single-mode pump pulses propagating through a two-mode fiber. Comparison of experiments and simulations clarify the roles of thermal and pump noise.

JW4A.27

Effective Methods of Simultaneous Control over Terahertz and High-Order Harmonic Generations, Sergey Y. Stremoukhov[1], Anatoly V. Andreev[1], Olga A. Shoutova[1]; [1]*physical department, M.V. Lomonosov Moscow State University, Russian Federation.* We present the results of theoretical study on the effective generation of both terahertz radiation and high-order harmonics in the process of a single atom interaction with a multicolor laser field. Numerical results are discussed.

JW4A.28

Nonlinear optical effects in N-type four-level atom-cavity systems, Jiteng Sheng[1], Min Xiao[1]; [1]*University of Arkansas, USA.* We experimentally study the nonlinear optical behaviors of N-type atom-cavity systems. These nonlinear effects include two-photon absorption, splitting of dark polariton, modified self-Kerr nonlinearity, Raman amplification, and white-light cavity.

JW4A.29

Fractional Second-harmonic Talbot Effect, Yong Zhang[1], Zhenhua Chen[1], Dongmei Liu[1], Jianming Wen[2,1], Xiaopeng Hu[1], Gang Zhao[1], Shining Zhu[1], Min Xiao[1,3]; [1]*National Laboratory of Solid State Microstructures, Nanjing University, China;* [2]*Institute for Quantum Information Science, University of Calgary, Canada;* [3]*Department of Physics, University of Arkansas, USA.* We report the fractional second-harmonic Talbot effect associating with the $\chi(2)$ in periodically-poled $LiTaO_3$ (PPLT) crystals. Our results show that the images are sensitive to the duty circle and the background of the array.

JW4A.30

Probing Limits on Spatial Resolution Using Nonlinear Optical Effects and Non-classical Light, Yongzhang Leng[1,2], Dong H. Park[1,2], Don C. Schmadel[3], Warren N. Herman[1], Julius Goldhar[1,2]; [1]*Laboratory for Physical Sciences, USA;* [2]*Department of Electrical and Computer Engineering, University of Maryland at College Park, USA;* [3]*Department of Physics, University of Maryland at College Park, USA.* Resolution of an optical system for grating detection was improved by a factor of two beyond the Abbe diffraction limit using nonlinear optics. Use of non-classical illumination did not provide any improvement.

JW4A.31

Defect induced EIT - like spectrum and tunable group delay in periodically poled LiNbO3, Xiao-shi Song[1], Hua-chao Hu[1], Fei Xu[1], Yan-qing Lu[1]; [1]*College of Engineering and Applied Sciences, Nanjing University, China.* Electromagnetically induced transparency - like spectrum with tunable group delay is observed in a periodically poled LiNbO3 with a central defect when an electric field is applied. A low voltage bulk phase shifter is obtained.

JW4A.32

Arbitrary complex phase-matching spectral grid designed by iterative domino method, Jui, Yu Lai[1]; [1]*National Tsing Hua University, Taiwan.* We designed complex phase-matching spectral grid by iterative domino algorithm, and analytically proved that it can achieve the maximum conversion efficiency. Experimentally measured conversion efficiencies agreed well with the numerical results.

JW4A.33

Extreme events in ultrafast lasers, Marcelo G. Kovalsky[1], Jorge Tredicce[2]; [1]*Centro de Investigaciones en láseres y aplicaciones, CITEDEF, Argentina;* [2]*Institute Non Lineaire de Nice, Universite de Nice, France.* We report experimental and theoretical evidence of the existence of extreme value events in the form of scarce and randomly emerging giant pulses in the femtosecond (self-pulsing or Kerr-lens mode-locked) Ti:sapphire laser.

JW4A.34

Concurrent slow-fast light pair with controllable X-type dispersion, Anil K. Patnaik[1,2], Sukesh Roy[3], James R. Gord[1]; [1]*Air Force Research Lab, USA;* [2]*Department of Physics, Wright State University, USA;* [3]*Spectral Energies, LLC, USA.* We demonstrate how simultaneous normal and anomalous (X-type) dispersion can be realized in a doubly driven double-ladder configuration and employed to obtain simultaneous slow-fast light.

JW4A.35

Destabilization of Solitons in PT-Symmetric Optical Lattices, Sean D. Nixon[1], Lijuan Ge[2,1], Jianke Yang[1]; [1]*Mathematics, University of Vermont, USA;* [2]*Shanghai University, China.* Stability of solitons in 1D and 2D parity-time (PT)-symmetric optical lattices is determined. We show that while stable solitons exist the addition of a PT-symmetric gain-loss profile has a destabilizing effect.

JOINT

JW4A • Poster Session II—Continued

JW4A.36
DAST- and BNA-DFG Terahertz-wave generation pumped by a dual-wavelength BBO optical parametric oscillator with independent wavelength-control, Takashi Notake[1], Kouji Nawata[1], Takeshi Matsukawa[1], Hiroaki Kawamata[1], Feng Qi[1], Hiroaki Minamide[1]; *[1]RIKEN, Japan.* We developed widely tunable collinear dual BBO-OPO to fully exploit organic nonlinear material's potential for DFG-THz source. Coherent THz radiations covering sub- to 50 THz can be achieved by using organic DAST and BNA crystals.

JW4A.37
Withdrawn

JW4A.38
Second and Third Harmonic Generation at ε-Near-Zero Crossing Point in Arrays of Plasmonic Nanoshells, Maria Antonietta Vincenti[1], Salvatore Campione[2], Domenico de Ceglia[1], Michael Scalora[3], Filippo Capolino[2]; *[1]Nanogenesis, AEgis Technologies Inc, USA; [2]Department of Electrical Engineering and Computer Science, University of California Irvine, USA; [3]Charles M. Bowden Research Center, RDECOM, US Army, USA.* We investigate harmonic generation at ε=0 crossing points where losses are compensated including active photonic materials in metallic nanoshells. This singularity-driven process lowers the thresholds for a plethora of nonlinear optical phenomena.

JW4A.39
Electroinduced Broadband Light Emission in Rare Earth Doped Lanthanum Lead Zirconate Titanate Ceramics, Jingwen W. Zhang[1], Long Xu[1], Xiudong Sun[1], Hua Zhao[1], Yingyin Zou[2], Kewen Li[2]; *[1]Physics, Harbin Institute of Technology, China; [2]Boston Applied Technologies, Inc., USA.* A continuum light emission was observed in a Tm3+/Ho3+ codoped PLZT ceramic slab upon exposing to a corona atmosphere. The origin of the broad light emission may be rooted in an electroinduced structural variation.

JW4A.40
One to Eight Multicasting of RZ-DPSK Based on Cascaded FOPA without Additional SBS Suppression, Zhiyu Chen[1], Lianshan Yan[1], Wei Pan[1], Bin Luo[1], Anlln Yi[1], Jia Ye[1], Hengyun Jiang[1], Ju Han Lee[2]; *[1]Southwest Jiaotong University, Center for Information Photonics & Communications, School of Information Science and Technology, China; [2]Department of Electrical and Computer Engineer, University of Seoul, Republic of Korea.* We experimentally demonstrate one-to-eight all-optical wavelength multicasting for RZ-DPSK based on FWM in a generally HNLF. No additional SBS suppression scheme is required in the experiment.

JW4A.41
All-optical Control of Transverse Patterns in Planar Semiconductor Microcavities, Nai-Hang Kwong[1,2], Ming Ho Luk[2], Yuen Chi Tse[2], Pui-Tang Leung[2], Stefan Schumacher[3], Rolf Binder[1]; *[1]Optical Sciences, University of Arizona, USA; [2]Physics, Chinese University of Hong Kong, China; [3]Physics, Paderborn University, Germany.* We analyze the selection/switching of instability-induced optical patterns in semiconductor microcavities. Besides realistic calculations, we use a population model and Catastrophe theory to organize our understanding of the patterns' dynamics.

JW4A.42
How can modulational instability generate solitons? Christoph Mahnke[1], Fedor Mitschke[1]; *[1]Institut fuer Physik, Universitaet Rostock, Germany.* Modulational instability converts cw light in a fiber into a train of pulses. We obtain its scattering eigenvalue spectrum and show that the pulses are not solitons. Raman shift can convert them to solitons, though.

JW4A.43
Third-Order Optical Nonlinearity in Bulk Nanoporous Silicon at Telecom Wavelengths, Ryan J. Suess[1,2], Thomas E. Murphy[1,2]; *[1]Electrical and Computer Engineering, University of Maryland, USA; [2]Laboratory for Physical Sciences, USA.* Nonlinear absorption and refraction coefficients of nanoporous silicon are reported and found to be enhanced compared to those of crystalline silicon. A pump-probe measurement showing the temporal character of the nonlinearity is also presented.

JW4A.44
Few-cycle self-compression via multimode nonlinear optics in gas filled waveguides, Patrick N. Anderson[1], Thomas J. Butcher[1], Peter Horak[1], Jeremy G. Frey[2], William S. Brocklesby[1]; *[1]Optoelectronics Research Centre, University of Southampton, United Kingdom; [2]School of Chemistry, University of Southampton, United Kingdom.* Multimode simulations predict dramatic ionization-induced self-compression of high energy ultrashort pulses within short gas filled capillaries. The mechanism observed allows for the temporal compression of 53 fs pulses into the few-cycle regime.

JW4A.45
Critical Boundary of Cascaded Quadratic Soliton Compression in PPLN, Hairun Guo[1], Xianglong Zeng[1], Binbin Zhou[1], Morten Bache[1]; *[1]DTU Fotonik, Department of Photonics Engineering, Technical University of Denmark, Denmark.* Cascaded quadratic soliton compression in PPLN is investigated and a general critical soliton number is found as the compression boundary. An optimal-parameter diagram for compression at 1550 nm is presented.

JW4A.46
Correlating one-photon, two-photon and excited state spectroscopy of CdSe quantum dots, Nikolay S. Makarov[1], Joe Perry[1], Pick Chung Lau[2], Robert Norwood[2], Nasser Peyghambarian[2]; *[1]School of Chemistry and Biochemistry, Georgia Institute of Technology, USA; [2]School of Optics, University of Arizona, USA.* We present two-photon absorption and excited-state absorption spectra of quantum dots. From the linear and transient spectra we determine transition dipole moments between the states and compare them with the two-photon cross-sections.

JW4A.47
Single-Shot Transient Pulse Dispersion Measurement, Shreya Nad[1], Nathan K. Butcher[1], Dmitry Pestov[2], Vadim V. Lozovoy[3], Marcos Dantus[3,1]; *[1]Physics and Astronomy, Michigan State University, USA; [2]Biophotonic Solutions Inc., USA; [3]Chemistry, Michigan State University, USA.* A method capable of measuring single-laser-pulse dispersion is described. It relies on acquiring a single SHG spectrum for a fixed reference phase mask and allows studying transient phase changes in optical media.

JW4A.48
Nonlinear optical study of oxygen-sulfur squaraines, Davorin Peceli[1], Honghua Hu[1], Scott Webster[1], Dmitry Fishman[1], Olga Przhonska[1,2], Vladimir V. Kurkyukow[3], Yurii L. Slominsky[3], Alexey D. Kachkovski[3], David Hagan[1], Eric Van Stryland[1]; *[1]CREOL, College of Optics and Photonics, University of Central Florida, USA; [2]Institute of Physics, National Academy of Science, Ukraine; [3]Institute of Organic Chemistry, National Academy of Science, Ukraine.* Replacing oxygen with sulfur in a squaraine bridge compound leads to a large increase in triplet yield (and triplet-state absorption) while maintaining the already enhanced two-photon absorption as well as the singlet excited-state absorption.

JW4A.49
Generation of Ultra-broadband Infrared Pulses through Difference Frequency Mixing, Baozhen Zhao[1,3], Sabih D. Khan[1], Yan Cheng[1], Yi Wu[2], Zenghu Chang[1,2]; *[1]Department of physics, Kansas state university, USA; [2]Department of physics and CREOL, University of Central Florida, USA; [3]Department of Physics and Astronomy, University of Nebraska, USA.* Ultra-broadband infrared pulses were generated through difference frequency mixing with BBO crystal. The spectra range of the generated infrared pulse was above one octave, with pulse duration 39fs and pulse energy of 15μJ.

JW4A.50
Dispersion of the Third-Order Nonlinear Optical Response of Organics Using a Few State Model, Joel Hales[1], Jochen Campo[1], Nikolay S. Makarov[1], Yanrong Shi[1], Stephen Barlow[1], Seth R. Marder[1], Joe Perry[1]; *[1]Georgia Institute of Technology, USA.* Dispersion of the third-order nonlinear optical response can be predicted using a perturbative few-state model approach with knowledge of the linear and two-photon absorption spectra. This approach has been applied toward polymethines and squarines.

JW4A.51
Biopolymer Random Laser Consisting of Rhodamine 6G and Silica Nanoparticles Incorporated to Bacterial Cellulose, Christian Tolentino[2], Molíria V. dos Santos[1], Sidney Ribeiro[1], Hernane Barud[1], Cid B. de Araujo[2], Anderson Gomes[2], Luciana de Melo[3]; *[1]Instituto de Química, Universidade Estadual Paulista, Brazil; [2]Física, Universidade Federal de Pernambuco, Brazil; [3]Laboratório de Óptica Biomédica e Imagem, Universidade Federal de Pernambuco, Brazil.* We demonstrate random lasing action in a biopolymer that has large potential for medical applications. The novel random laser consists of nanofibers of bacterial cellulose impregnated with silica nanoparticles and Rhodamine 6G.

JW4A.52
Nonlinear Optical Study of Ag Nanoparticles-Si Quantum Dots Plasmonic Nanostructured System, Alejandro Reyes-Esqueda[1], Lis Tamayo-Rivera[1], Luis Rodríguez-Fernández[1], Raúl Rangel-Rojo[2], Alicia Oliver[1]; *[1]Estado Solido, UNAM, Mexico; [2]Departamento de Optica, CICESE, Mexico.* We studied an integrated silver and silicon nanostructured system, which shows a nonlinear optical response changing its sign with wavelength, depending on its position with respect to the surface plasmon resonance of the nanocomposite.

JW4A • Poster Session II—Continued

JW4A.53

Efficient Distributed Feedback Dye Laser in Silk Fibroin Films, Robson R. da Silva[1], Christian Tolentino[2], Molíria V. dos Santos[1], Luciana de Melo[3], Sidney Ribeiro[4], Cid B. de Araujo[1], Anderson Gomes[2], Renato Barbosa-Silva[2]; *[1]Instituto de Química, Universidade Estadual Paulista, Brazil; [2]Física, Universidade Federal de Pernambudo, Brazil; [3]Laboratório de Óptica Biomédica e Imagem, Universidade Federal de Pernambuco, Brazil; [4]Programa de Pós-Graduação em Ciência de Materiais, Universidade Federal de Pernambudo, Brazil.* We observed longitudinal single-mode operation in a distributed feedback dye laser consisting of silk fibroin films doped with Rhodamine 6G dye and infiltrated with silica or silver nanoparticles.

JW4A.54

Random Laser Based on TiO2-Nanomembranes, Christian Tolentino[1], Denis Chaumont[2], Yvon Lacroute[2], Marco Sacilotti[1,2], Cid B. de Araujo[1], Anderson Gomes[1]; *[1]Física, Universidade Federal de Pernambudo, Brazil; [2]Nanoform Group, Université de Bourgogne, France.* We demonstrated directional random laser emission from a dye-doped polymer film in the presence of a scattering medium consisting of TiO2 nanomembranes. Evidence for coexistence of extended and localized modes are presented.

JW4A.55

Supercontinuum Generation in Short Soft Glass Microstructured Fibers Pumped by Quasi-CW Laser, Meisong Liao[1], Weiqing Gao[1], Xin Yan[1], Zhongchao Duan[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; *[1]Optical Functional Materials Lab., Toyota Technological Institute, Japan.* For the first time we investigate supercontinuum generation in highly nonlinear tellurite microstructured fibers with various core diameters pumped by quasi-CW laser. The fibers used are as short as several tens of centimeters.

JW4A.56

Generation of optical rogue waves by optical event horizons, Ayhan Demircan[1], Shalva Amiranashvili[2], Carsten Bree[2,4], Christoph Mahnke[3], Fedor Mitschke[3], Günter Steinmeyer[4]; *[1]Invalidenstr. 114, Germany; [2]Weierstrass Institute for Applied Analysis and Stochastics, Germany; [3]Institut für Physik, Universität Rostock, Germany; [4]Max-Born-Institut, Germany.* We demonstrate that optical event horizons arise naturally in the supercontinuum generation by soliton fission with the ability to generate rare solitons with extreme high peak powers.

JW4A.57

A Three-Primary-Color Continuous-Wave Laser Generated through Intracavity Raman-Resonant Four-Wave Mixing, Junpei Takabayashi[1], Shin-ichi Zaitsu[1], Totaro Imasaka[1,2]; *[1]Department of Applied Chemistry, Graduate School of Engineering, Kyushu University, Japan; [2]Division of Optoelectronics and Photonics, Center for Future Chemistry, Kyushu University, Japan.* A continuous-wave multicolor laser with wavelengths of 436, 532 and 683 nm is developed. These lines are generated through stimulated Raman scattering and Raman-resonant four-wave mixing in hydrogen molecules in a broadband optical cavity.

JW4A.58

Raman Amplification by Molecular Phase Modulation Induced for Vibrational Mode of Hydrogen, Osamu Shitamichi[1], Shin-ichi Zaitsu[1], Totaro Imasaka[1]; *[1]Graduate School of Engineering, Kyushu University, Japan.* A two-color pump beam (401 and 481 nm) was used for molecular phase modulation of hydrogen to enhance stimulated Raman scattering for efficient frequency conversion into the entire visible/ultraviolet region.

JW4A.59

High power UV laser with THz frequency modulation, Chia-Ying Wu[1], YenYin Lin[1], Yu-Chung Chiu[1], Yen-Chieh Huang[1]; *[1]Institute of Photonics Technologies Engineering, National Tsing-Hua University, Taiwan.* We report a UV laser at 390 nm with frequency modulation tunable between 0.25 and 1.5 THz. The laser generates 10 uJ/pulse in a ~300 ps width, corresponding to a peak power of 33 kW.

JW4A.60

Improving Soliton Compression Quality with Cascaded Nonlinearities by Engineered Multi-section Quasi-phase-matching Design, Xianglong Zeng[1,2], Hairun Guo[1], Binbin Zhou[1], Morten Bache[1]; *[1]Dept. of Photonics Engineering, Technical University of Denmark, Denmark; [2]Shanghai University, China.* In few-cycle soliton generation with large compression factors using cascaded nonlinearities the pulse quality can be improved by engineering quasi-phase-matching structures. The soliton-induced mid-IR optical Cherenkov wave is also enhanced.

JW4A.61

Spectral Compression of Intense Femtosecond Pulses by Self Phase Modulation in Silica Glass, Krzysztof Iwaszczuk[1], Binbin Zhou[1], Morten Bache[1], Peter U. Jepsen[1]; *[1]DTU Fotonik, Technical University of Denmark, Denmark.* We experimentally demonstrate spectral compression of mJ fs pulses by self phase modulation in silica glass. Spectral narrowing by factor 2.4 of near-transform-limited pulses is shown, with good agreement between experiment and numerical simulation.

JW4A.62

UV Continuum Generation in Ar-Filled Hollow-Core PCF, Wonkeun Chang[1], Philipp Hoelzer[1], John C. Travers[1], Johannes Nold[1], Nicolas Joly[2,1], Philip S. Russell[1,2]; *[1]Max Planck Institute for the Science of Light, Germany; [2]Department of Physics, University of Erlangen-Nuremberg, Germany.* We numerically model the generation, by continuous emission of dispersive waves in an Ar-filled hollow-core PCF with an axially increasing gas pressure distribution, of a UV continuum spanning 175-250 nm.

JW4A.63

Frequency Domain Aperture for Ultra-High Resolution Brillouin Based Spectroscopy, Andrzej Wiatrek[1], Stefan Preussler[1], Kambiz Jamshidi[1], Thomas Schneider[1]; *[1]Institut für Hochfrequenztechnik, Hochschule für Telekommunikation Leipzig, Germany.* The inhomogeneous saturation behavior in stimulated Brillouin scattering is exploited for increasing the resolution in Brillouin spectrometers. Based on a proof of concept experiment we report an optical resolution of 8MHz.

JW4A.64

All fiber based supercontinuum light source utilized for IR microscopy, Sune Dupont[1], Christian Petersen[2], Jan Thøgersen[2], Christian Agger[3], Ole Bang[3], Søren R. Keiding[2]; *[1]Department of Physics and Astronomy, Aarhus University, Denmark; [2]Department of Chemistry, Aarhus University, Denmark; [3]Department of Photonics Engineering, Tecnical University of Denmark, Denmark.* An all fiber based supercontinuum light source is demonstrated for infrared microscopy. The high brightness and spatial coherence of the source facilitate fast high resolution measurements.

JW4A.65

Spectral analysis of multi-beam pumped non collinear optical parametric amplifiers, Benoît Trophème[1], Gabriel Mennerat[2], Benoît Boulanger[3]; *[1]CEA/CESTA, France; [2]CEA/Saclay, France; [3]CNRS - Institut Néel, France.* From multi-beam pumped OPA experiments, we demonstrated the need for single-mode pumps to preserve a good spectral contrast and that these pumps can be mutually incoherent without decreasing the amplified signal spectral quality.

JW4A.66

Integrated cavity for a GaAs-based OPO, Marc Savanier[1], Alessio Andronico[1], Xavier Lafosse[2], Pascal Filloux[1], Ivan Favero[1], Sara Ducci[1], Giuseppe Leo[1]; *[1]Laboratoire Matériaux et Phénomènes Quantiques, Université Paris Diderot - CNRS, France; [2]Laboratoire de Photonique et de Nanostructures, CNRS, France.* We report on a GaAs/AlOx waveguide cavity designed to perform as an integrated OPO with degeneracy around 2μm. Parametric fluorescence is demonstrated in a nonlinear waveguide with integrated mirrors and propagation losses origins are investigated.

JW4A.67

Tunable Optical Delay Between Cascaded Stages of Four-Wave Mixing for DPSK Demodulation from 25 to 40 Gb/s, Yongheng Dai[1], Xuelei Fu[1], Gordon K. P. Lei[1], Chester Shu[1]; *[1]Department of Electronic Engineering, The Chinese University of Hong Kong, Hong Kong.* By exploiting tunable optical delay between cascaded stages of four-wave mixing in a highly nonlinear photonic crystal fiber, we demonstrate error-free tunable demodulation of RZ-DPSK signals from 25 to 40 Gbit/s.

JW4A.68

Electromagnetic field coupled to filaments in air for plasma characterization studies, Andreas Schmitt-Sody[1], Adrian Lucero[1], James O'Loughlin[1], William Roach[1], Gary Noojin[2], Clarance Cain[2]; *[1]RDLA, AFRL, USA; [2]711 HWP/RDHO, AFRL, USA.* We present new insights into laser filament coupling to a high AC electric field strength of 100kV/m.

JW4A.69

Non-degenerate Difference-Frequency Generation in Single-Stack Bragg Reflection Waveguides, Mandy Lungwitz[1], Payam Abolghasem[1], Amr S. Helmy[1]; *[1]University of Toronto, Canada.* We report non-degenerate type-II difference-frequency generation around 2.4μm in single-stack AlGaAs Bragg reflection waveguide using a pump around 945nm and a signal within the C-Band range. Idler wavelength tunability in excess of 76nm is measured.

JW4A.70

Optically Injection-locked Green-pumped Singly Resonant CW OPO based on Self-Guided Operation in a MgO:PPLN, In-ho Bae[1,2], Han Seb Moon[1], Seung Kwan Kim[2], Seung-Nam Park[2], Dong-Hoon Lee[2]; *[1]Department of Physics, Pusan National University (PNU), Republic of Korea; [2]Division of Physical Metrology, Korea Research Institute of Standards and Science (KRISS), Republic of Korea.* We report on the phase coherent operation of the singly resonant CW OPO based on self-guided operation in a MgO:PPLN crystal pumped at 532 nm via the optical injection-locking from the external cavity diode laser.

JW4A.71

Double crystal, dual synchronously pumped femtosecond optical parametric oscillator, Adolfo Esteban-Martin[1], Venkata Ramaiah-Badarla[1], Majid Ebrahim-Zadeh[1]; *[1]ICFO-Institut de Ciencies Fotoniques, Spain.* We report a femtosecond optical parametric oscillator based on two PPLN crystals pumped by Ti:sapphire laser with dual synchronization for intracavity signal amplification across the tuning range 1420-1580 nm.

JW4A.72

MAP-Fabricated Repositionable Micro-ring Resonators for In-line Side-polished Fiber(SPF) Devices, Sijia Qin[1,2], George Kumi[1,2], Donghun Park[2,1], Victor Yun[2,1], Yongzhang Leng[2,1], Julius Goldhar[2,1], Warren N. Herman[2,1], John T. Fourkas[1,2]; *[1]Chemistry&Biochemistry, University of Maryland- College Park, USA; [2]Laboratory for Physical Sciences, USA.* Micro-ring resonators with good performance were fabricated using multi-photon absorption polymerization (MAP) and directly pressed against SPF producing variable resonances in the optical output spectrum depending on positioning and pressure.

JW4A.73

Photonic Crystal Defect Cavity Q-Factor Optimization Using Slab Thickness, Jonathan R. Pugh[1], Ying-Lung Daniel Ho[1], Erman Engin[1], Geoff Nash[2,1], John Rarity[1], Martin Cryan[1]; *[1]Electrical and Electronic Engineering, University of Bristol, United Kingdom; [2]College of Engineering, Mathematics and Physical Sciences, University of Exeter, United Kingdom.* Three mechanisms are studied which give rise to a high-Q L3 cavity mode in a 2D photonic crystal slab where the in-plane photonic bandgap is closed due to increased slab thickness.

JW4A.74

Two-Tone Measurement of the Nonlinear Behavior of a Silicon-on-Insulator (SOI) Ring Resonator, Steven J. Spector[1], Siva Yegnanarayanan[1], Reuel Swint[1], Theodore M. Lyszczarz[1], Paul W. Juodawlkis[1]; *[1]MIT Lincoln Laboratory, USA.* The nonlinearity of a SOI ring resonator was measured using a two-tone method. At frequencies near 10 MHz, 1.5 mW causes significant signal degradation. At frequencies near 1 GHz, little signal degradation is seen.

JW4A • Poster Session II—Continued

JW4A.75
A Gallium Nitride Distributed Bragg Reflector Cavity for Integrated Photonics Applications, Nikolai A. Hueting[1], Erman Engin[1], Ahmad M. Zain[1], Andrei Sarua[2], Peter J. Heard[3], Martin Kuball[2], Tao Wang[4], Martin Cryan[1]; [1]*Photonics Research Group, Department of Electrical & Electronic Engineering, University of Bristol, United Kingdom;* [2]*School of Physics, University of Bristol, United Kingdom;* [3]*Interface Analysis Centre, University of Bristol, United Kingdom;* [4]*Dept of Electrical and Electronic Engineering, University of Sheffield, United Kingdom.* A deep etched 1D Distributed Bragg Reflector cavity in GaN-AlN-Sapphire has been analytically modeled and simulated using 2D FDTD. A structure fabricated using a hybrid Electron Beam- Focused Ion Beam method was assessed using microphotoluminescence.

JW4A.76
Asymmetric Fano Lineshapes in Integrated Silicon Bragg Reflectors, Chia-Ming Chang[1], Olav Solgaard[1]; [1]*E. L. Ginzton Lab, Stanford University, USA.* Asymmetric Fano resonances in monolithic silicon Bragg reflectors are demonstrated. Optimization of the lineshapes is achieved by controlling the phase of the reflected light from the Bragg reflectors.

JW4A.77
Compact SiGe HBT EO Modulator for Analog Applications, Pengfei Wu[1], Shengling Deng[1], Zhaoran Rena Huang[1]; [1]*Department of Electrical, Computer, and System Engineering, Rensselaer Polytechnic Institute, USA.* This paper proposed a compact linearized SiGe HBT EO modulator for applications in analog signal processing. The length of the modulator is only 15 µm. Simulation shows that it possesses a SFDR of 42 dB.

JW4A.78
Fabrication and optical characterization of high-Q guided mode resonances in a graphite-lattice photonic crystal slab, Luis J. Martinez Rodriguez[1], Eric Jaquay[1], Jing Ma[1], Michelle L. Povinelli[1]; [1]*Ming Hsieh Department of Electrical Engineering, USC, USA.* Photonic-crystal slabs based on the graphite lattice have been fabricated in silicon-on-insulator and optically characterized. Guided mode resonances were measured with quality factors up to 9800 in air and up to 8600 in water.

JW4A.79
Open Nanopatch Cavity with Annular Bragg Reflector and Bottom Metal Plane, Jong-Bum You[1], Wook-Jae Lee[1], Kyungmook Kwon[1], Kyoungsik Yu[1]; [1]*Electrical Engineering, KAIST, Republic of Korea.* We propose an open nanopatch cavity with radial Bragg reflectors and a bottom metal plane. Numerical simulations show that a high Q-factor of ~2800 and a small physical volume of ~0.86 cubic wavelength can be achieved.

JW4A.80
Anisotropic Photoluminescence from Er-TeO2 Thin Films Photonic Crystals for On-Chip NIR Light Source, Pao Lin[1], Michiel Vanhoutte[1], Juejun Hu[1], Neil Patel[1], V. Singh[1], Lionel Kimerling[1], A. Agarwal[1], Clara Dimas[2]; [1]*Massachusetts Institute of Technology, USA;* [2]*Masdar Institute of Science and Technology, United Arab Emirates.* Er3+-TeO2 thin film photonics crystals (PhCs) demonstrate anisotropic PL emission at near Infrared. By tuning the PhC structures, emission modes of surface extraction or waveguide propagation can be determined for on-chip light source.

JW4A.81
Scattering Loss in Thin, Shallow-Ridge Silicon-on-Insulator Waveguides, Thach G. Nguyen[1], Ravi S. Tummidi[2], Robert Pafchek[2], Thomas L. Koch[2], Arnan Mitchell[1]; [1]*Centre for Ultrahigh-bandwidth Devices for Optical Systems (CUDOS), School of Electrical and Computer Engineering, RMIT University, Australia;* [2]*Center for Optical Technologies, Lehigh University, USA.* Roughness induced scattering in thin, shallow-ridge silicon on insulator waveguides is analyzed by coupled mode theory and verified experimentally. Roughness in different waveguide regions causes different scattering natures of TM and TE modes.

JW4A.82
Characterization of Thermal Induced Nonlinear Effects in Silicon Microcylindrical Resonators, Natasha Vukovic[1], Noel Healy[1], Todd D. Day[2], Peter Horak[1], Pier J. Sazio[1], John V. Badding[2], Anna C. Peacock[1]; [1]*Optoelectronics Research Centre, University of Southampton, United Kingdom;* [2]*Department of Chemistry and Materials Research Institute, Pennsylvania State University, USA.* We explore the thermal nonlinearity in a-Si:H microcylindrical resonators fabricated from the silicon optical fiber platform. In particular, using a pump/probe technique, we determine the thermal response time and infer the material loss coefficient.

JW4A.83
Efficient Silicon-on-Insulator Polarization Rotator based on Mode Evolution, Justin C. Wirth[1], Jian Wang[1], Ben Niu[1], Yi Xuan[1], Li Fan[1], Leo Varghese[1], Dan E. Leaird[1], Andrew Weiner[1]; [1]*Electrical and Computer Engineering, Purdue University, USA.* A compact and high extinction SOI polarization rotator is fabricated and characterized. For TM to TE rotation, a device 37.5µm in length is demonstrated to have a polarization extinction ratio between 17.8-26dB from 1525nm to 1570nm.

JW4A.84
Thermo-Optic Switch based on Double-Slot Photonic Crystal Waveguide, Kaiyu Cui[1], Qiang Zhao[1], Xue Feng[1], Yidong Huang[1], Yongzhuo Li[1], Da Wang[1], Wei Zhang[1]; [1]*Electronic Engineering, Tsinghua University, China.* Thermo-optic switch based on double-slot photonic crystal waveguide is demonstrated, high extinction ratio of 17 dB has been experimentally achieved under a switching power as low as 9.2 mW while the device is only 16-µm-long.

JW4A.85
Parabolic Tapered Photonic Crystal Cavity in Silicon, Boris Desiatov[1], Ilya Goykhman[1], Uriel Levy[1]; [1]*Applied Physics, Hebrew University, Israel.* We demonstrate the design, fabrication, transmission and nearfield characterization of a parabolic tapered 1D photonic crystal cavity in silicon. The design allows repeatable device fabrication with a high quality factor and a small modal volume.

JW4A.86
Low insertion losses and high drop efficiency photonic crystal filter for advanced telecom modulation formats, Kevin Lengle[1], Laurent Bramerie[1], Mathilde Gay[1], Jean Claude Simon[1], Sylvain Combrié[2], Gaelle Lehoucq[2], Alfredo De Rossi[2], Stefania Malaguti[3], Stefano Trillo[3], Gaetano Bellanca[3]; [1]*CNRS FOTON UMR 6082, France;* [2]*Thales Research and Technology (TRT), France;* [3]*University of Ferrara (UniFe), Italy.* A 2D photonic crystal 3-ports filter with 6 dB bus insertion losses and drop efficiency of 47 % is reported. Error-free operation with low penalty (<0.5 dB) for OOK and DQPSK modulation formats is demonstrated.

JW4A.87
All optical control of optomechanical filters, Parag B. Deotare[1], Irfan Bulu[1], Ian Frank[1], Qimin Quan[1], Rob Ilic[2], Marko Loncar[1]; [1]*Harvard University-SEAS, USA;* [2]*Cornell University, USA.* We demonstrate optical reconfiguration of coupled photonic crystal nanobeam cavities by using optical gradient force. The on-chip temperature sensing along with pulsed operation allows us to estimate and isolated thermal and optomechanical effects.

JW4A.88
Maxwell Fisheye Lens as a Waveguide Crossing for Integrated Photonics, Joy C. Garnett[1], Jason G. Valentine[1]; [1]*Mechanical Engineering, Vanderbilt University, USA.* We demonstrate that the Maxwell Fisheye lens realized can serve as an ideal waveguide crossing hub for up to 8 waveguides with 0.1 dB loss (97.7% transmission) and crosstalk of -40 dB.

JW4A.89
Enhance the Efficiency of FWM-Based Wavelength Conversion with a Double-Ring Resonator, Ciyuan Qiu[1], Qianfan Xu[1]; [1]*ECE, Rice University, USA.* Wavelength conversion by the four-wave mixing process in a resonator faces a tradeoff between the bandwidth and the resonant enhancement. We show that a double-ring resonator can enhance the conversion efficiency without sacrifice the bandwidth.

JW4A.90
Thermally-induced nonlinearity and optical bistability in Si3N4 microring resonators, Amir Arbabi[1], Ping-Keng Lu[1], Benjamin G. Griffin[1], Lynford Goddard[1]; [1]*University of Illinois at Urbana-Champaign, USA.* We report on the nonlinear response and optical bistability in the transmitted and reflected signals of Si3N4 microrings. Micro-second temporal dynamics of the response suggest that the nonlinear behavior is due to the thermo-optic effect.

JW4A.91
Integrated Microring Add-Drop Filters with Contradirectional Couplers, Wei Shi[1], Xu Wang[1], Wen Zhang[1], Han Yun[1], Nicolas Jaeger[1], Lukas Chrostowski[1]; [1]*Electrical and Computer Engineering, University of British Columbia, Canada.* We demonstrate a novel silicon microring resonator using grating-assisted contradirecitonal couplers for wavelength-selective coupling control. A single resonant peak can be selected in a wide frequency window without impairing its quality factor.

JW4A • Poster Session II—Continued

JW4A.92
An Above-wavelength-Sized Bull's Eye and Its Application to High Throughput Photon Sorters, Hesam Edin Arabi Ardakani[1]; Hang-Eun Joe[2]; Tavakol Nazari[1]; Byun-Kwon Min[2]; Kyunghwan Oh[1]; [1]*Institute of physics and applied physics, Yonsei University, Republic of Korea;* [2]*Mechanical engineering, Yonsei University, Republic of Korea.* This study presents a micron-sized bull's eye aperture which plasmonically enhances optical transmission and dampens spectral noise. The experimental results show that the proposed aperture can have promising applications in photon sorters.

JW4A.93
Hybrid photonic molecules, Bo Peng[1], Sahin K. Ozdemir[1], Jiangang Zhu[1], Lan Yang[1]; [1]*Electrical and Systems Engineering, Washington University in St. Louis, USA.* We report spectral tuning of coupled whispering-gallery-mode microresonators formed with different geometries and materials. Thermal tuning is utilized to achieve spectral overlap and mode splitting is studied as a function of coupling distance.

JW4A.94
A Hollow-core Cavity in Three-layer Photonic Crystals, Jian Wang[1], Jing Ouyang[1], Leo Varghese[1], Li Fan[1], Minghao Qi[1]; [1]*ECE, Purdue University, USA.* We designed a hollow-core mode-gap cavity in three-layer photonic crystals with Q of 77,000 and 67% air energy concentration ratio. The 3D photonic confinement is achieved through in-plane PBG guiding and vertical total internal reflection.

JW4A.95
Photonic crystal waveguide coupling analysis using swept wavelength interferometry, James McMillan[1], Mingbin Yu[2], Dim-Lee Kwong[1], Chee Wei Wong[1]; [1]*Nanostructures Laboratory, Center for Integrated Science and Engineering, Solid-State Science and Engineering, and Mechanical Engineering, Columbia University, USA;* [2]*Institute of Microelectronics, Singapore.* Swept wavelength interferometry is used to analyze the group delay dependent coupling efficiency of photonic crystal waveguides. A direct comparison of slow-light coupling designs is made by measuring the transmission, group delay, and reflection.

JW4A.96
Towards Optical and Electrical optimization of an OLED heterostructure in a vertical microcavity, Anthony Coens[1], Mahmoud Chakaroun[1], Francois Gourdon[1], Nathalie Fabre[1], Min Lee[1], Jeanne Solard[2], Alexis Fischer[1], Azzedine Boudrioua[1]; [1]*Laboratoire de Physique des Lasers - LPL, UMR CNRS 7538, Université Paris 13, France;* [2]*Central de proximité,, Université Paris 13, France.* In the context of organic laser diode, we investigate theoretically and experimentally the electrical and optical optimization of OLEDs in a microcavity. We focus on two key parameters: the OLED heterostructures and the cathode thickness.

JW4A.97
Macroscopic Bell States and their Quantum Polarization Tomography, Bhaskar Kanseri[1], Timur Iskhakov[1], Maria Chekhova[1], Gerd Leuchs[1]; [1]*Max Planck Institute for the Science of Light, Germany.* Using three-dimensional quantum polarization tomography, the polarization properties of macroscopic Bell states are characterized. The reconstructed polarization quasi-probability distributions demonstrate squeezing in one or more Stokes parameters.

JW4A.98
HBT- Type Experiment with Optical Vortices, Ashok Kumar[1], J. Banerji[1], Ravindra P. Singh[1]; [1]*Theoretical Physics Division, Physical Research Laboratory, India.* The famous HBT experiments were performed with optical vortices. As observed, the intensity correlation functions for scattered vortices decay faster than that of the Gaussian laser beam and show additional peaks at larger time delay.

JW4A.99
A quantum random number generator based on photon number resolving detection of successive photon pulses, Yan Liang[1], Min Ren[1], E. Wu[1], Guang Wu[1], Heping Zeng[1]; [1]*State Key Laboratory of Precision Spectroscopy, East China Normal University, China.* We demonstrated a quantum random number generator based on the inherent randomness of photon number distributed in individual pulses, measured by using a silicon multi-pixel photon counter. The random bit generation efficiency reached over 40%.

JW4A.100
Quantum Mode Filtering for Robust Non-Gaussian States, Shuntaro Takeda[1], Hugo Benichi[1], Takahiro Mizuta[1], Jun-ichi Yoshikawa[1], Akira Furusawa[1]; [1]*The University of Tokyo, Japan.* We demonstrate an effective mode-filtering technique to obtain robust non-Gaussian states by removing their noisy low-frequency components. Mode-filtered states outperform conventional states in the robust implementation of quantum teleportation.

JW4A.101
Production of non-local optical phase space vortices, Stephen P. Walborn[1], Rafael M. Gomes[1], Alejo Salles[1], Fabricio Toscano[1], Paulo H. Souto Ribeiro[1]; [1]*Departamento de Física Matemática, Universidade Federal do Rio de Janeiro, Brazil.* We present novel optical vortices which appear in a non-local plane of the two-photon phase space, composed of a single degree of freedom of each photon of an entangled pair.

JW4A.102
Cluster State Generation with Quadrature Squeezed Cylindrically Polarized Modes, Christian Gabriel[1,2], Ioannes Rigas[1,2], Andrea Aiello[1,2], Stefan Berg-Johansen[1,2], Peter van Loock[1,2], Christoph Marquardt[1,2], Gerd Leuchs[1,2]; [1]*Max Planck Institute for the Science of Light, Germany;* [2]*Institute of Optics, Information and Photonics, University Erlangen-Nuremberg, Germany.* We present schemes which exploit the hybrid-entanglement in quadrature squeezed cylindrically polarized modes to generate cluster states. Such states are essential for one-way quantum computing.

JW4A.103
A High-Speed Secure Quantum Random Number Generator Based on Vacuum States, Christian Gabriel[1,2], Christoffer Wittmann[1,2], Bastian Hacker[1,2], Wolfgang Mauerer[3], Elanor Huntington[4,5], Metin Sabuncu[1,6], Christoph Marquardt[1,2], Gerd Leuchs[1,2]; [1]*Max Planck Institute for the Science of Light, Germany;* [2]*Institute of Optics, Information and Photonics, University Erlangen-Nuremberg, Germany;* [3]*Siemens AG, Corporate Technology, Germany;* [4]*Centre for Quantum Computation and Communication, Australian Research Council, Australia;* [5]*School of Engineering and Information Technology, The University of New South Wales, Australia;* [6]*Department of Electrical and Electronics Engineering, Dokuz Eylül University, Turkey.* A high-speed continuous-variable quantum random bit generator with an expected effective bit generation rate of up to 10 GBit/s is presented. The obtained bit sequences are truly random and unique, i.e. they cannot be known by an adversary.

JW4A.104
Classical Optical Simulation of Bi-Photon Generation in Quadratic Waveguide Arrays, Markus Gräfe[1], Alexander S. Solntsev[2], Robert Keil[1], Andreas Tuennermann[1], Stefan Nolte[1], Alexander Szameit[1], Andrey A. Sukhorukov[2], Yuri S. Kivshar[2]; [1]*Institute of Applied Physics, Friedrich-Schiller-University Jena, Germany;* [2]*Nonlinear Physics Centre, Research School of Physics and Engineering, Australian National University, Australia.* We suggest and demonstrate experimentally that evolution of classical light can simulate bi-photon generation through spontaneous parametric down-conversion and correlated quantum walks in waveguide arrays, including violation of Bell's inequality.

JW4A.105
Strenghtening Classical Symmetric Encryption with Continuous Variable Quantum Key Distribution., Thierry Debuisschert[1], Simon Fossier[1], Rosa Tualle-Brouri[2], Philippe Grangier[2], Eleni Diamanti[3], Anthony Leverrier[3], Romain Alléaume[3], Philippe Pache[4], Philippe Painchault[4], Paul Jouguet[5,3], Sébastien Kunz-Jacques[5]; [1]*Thales Research & Technology France, France;* [2]*Laboratoire Charles Fabry de l'Institut d'Optique, France;* [3]*Institut Télécom - Télécom ParisTech, France;* [4]*Thales Communications S.A, France;* [5]*SeQureNet SARL, France.* An improved security fast encryption prototype is implemented over field installed fibers. Continuous variable quantum key distribution produces 600 bit/sec secret keys allowing session keys renewal of classical symmetric algorithms each 10 seconds.

JW4A.106
Computation with quantum walks, Viv Kendon[1]; [1]*School of Physics and Astronomy, University of Leeds, United Kingdom.* Experimental implementations of quantum walks that perform useful computation need to access a Hilbert space larger than 236 to beat classical numerical simulation. This is likely to be useful only for multiple interacting walkers.

JW4A.107
Withdrawn

JW4A.108
How do they scale? - Classical and quantum nonlinear optical processes in integrated devices, Lukas G. Helt[1], Marco Liscidini[2], John E. Sipe[1]; [1]*Physics, University of Toronto, Canada;* [2]*Physics, University of Pavia, Italy.* We present simple expressions for the power generated via continuous-wave classical and quantum nonlinear optical processes in integrated devices, making it easy to benchmark quantum performance based on the results of classical experiments.

JW4A.109
Classical and quantum nonlinear photonics: Calculations made easy, Marco Liscidini[1], Lukas G. Helt[2], John E. Sipe[2]; [1]*Physics, University of Pavia, Italy;* [2]*Physics, University of Toronto, Canada.* We present a simple and flexible method for a rigorous description of nonlinear phenomena in photonic systems, well suited to model integrated and photonic crystal structures.

JW4A.110
Enhanced resolution of lossy interferometry by coherent amplification, Chiara Vitelli[1], Nicolò Spagnolo[1,2], Vito Giovanni Lucivero[1], Vittorio Giovannetti[3], Lorenzo Maccone[4], Fabio Sciarrino[1,5]; [1]*Physics, SAPIENZA, Italy;* [2]*Physics, Consorzio Nazionale Interuniversitario per le scienze fisiche della materia, Italy;* [3]*Scuola Normale Superiore and Istituto Nanoscienze-CNR, Italy;* [4]*Physics, INFN Sez. Pavia, Universit`a di Pavia, Italy;* [5]*Istituto Nazionale di Ottica, Consiglio Nazionale delle Ricerche (INO-CNR), Italy.* We present a strategy for phase estimation in presence of noisy detectors. This approach involves coherent and single photon states as input and phase-sensitive amplification after the interaction with the sample and before detection losses.

JW4A.111
Maximally Polarization Entangled Photons on a Chip, Sergei V. Zhukovsky[1,2], Lukas G. Helt[1], Payam Abolghasem[2], Dongpeng Kang[2], Amr S. Helmy[2], John E. Sipe[1]; [1]*Dept. of Physics, University of Toronto, Canada;* [2]*Dept. of Electrical and Computer Engineering, University of Toronto, Canada.* Spontaneous parametric downconversion in Bragg reflection waveguides is shown to produce maximally polarization-entangled photons by making the group velocities of TE-/TM-polarized downconverted photons, and thus their spectral properties, similar.

JW4A.112
Turning classical states quantum with linear optics and photon counting, Tim Bartley[1], Gaia Donati[1], Xian-Min Jin[1], Justin B. Spring[1], Marco Barbieri[1], Brian J. Smith[1], Animesh Datta[1], Lijian Zhang[1], Ian A. Walmsley[1]; [1]*Department of Physics, University of Oxford, United Kingdom.* We demonstrate a method to transmute classical light into a quantum state without invoking any nonlinear optical processes. Using a tunable beam splitter and photon number resolving measurement, we create a novel non-Gaussian state.

JW4A • Poster Session II—Continued

JW4A.113
Observation of spontaneous parametric down-conversion in LiNbO3 waveguide arrays, Alexander S. Solntsev[1], Frank Setzpfandt[2], Allen Wu[1], Dragomir N. Neshev[1], Andrey A. Sukhorukov[1], Yuri S. Kivshar[1], Thomas Pertsch[2]; *[1]Nonlinear Physics Centre, Australian National University, Australia; [2]Friedrich-Schiller-University Jena, Germany.* We study experimentally the process of bi-photon generation through spontaneous parametric down-conversion in waveguide arrays. We show the formation of a unique spatial-spectral photon pattern and its dependence on the phase-matching conditions.

JW4A.114
A laser diode for integrated photon pair generation at telecom wavelength, Adeline Orieux[1], Carlos Eduardo Rodrigues de Souza[1], Aristide Lemaître[2], Elisabeth Galopin[2], Christophe Manquest[1], Ivan Favero[1], Giuseppe Leo[1], Sara Ducci[1]; *[1]Laboratoire Matériaux et Phénomènes Quantiques, Université Paris Diderot, France; [2]Laboratoire de Photonique et de Nanostructures, CNRS, France.* We report on electrically pumped Bragg mode lasing at 775 nm at room temperature in an AlGaAs structure designed for type-II modal phase-matching showing a second harmonic generation efficiency of 35 %W-1cm-2.

JW4A.115
High-Speed Quantum Key Distribution Using Hyper-Entangled Photons, Bradley G. Christensen[1], Kevin T. McCusker[1], Daniel J. Gauthier[2], Paul G. Kwiat[1]; *[1]Physics, University of Illinois, USA; [2]Physics, Duke University, USA.* We discuss a quantum cryptography system using the timing and polarization degrees of freedom to produce a high bit rate for both technologically limited eavesdroppers and for any potential eavesdroppers.

JW4A.116
Feedback-Controlled Laser Fabrication of Micromirrors, Benjamin Petrak[1], Kumarasiri Konthasinghe[1], Sonia Perez[1], Andreas Muller[1]; *[1]Physics, University of South Florida, USA.* Micromirror templates of uniform size were created on silica chips and fibers by a feedback-controlled laser ablation process. The templates were coated with a high reflectivity dielectric coating and assembled into high-finesse microcavities.

JW4A.117
Quantum-state-preserving optical pulse reshaping and multiplexing by four-wave mixing in a fiber, Colin McKinstrie[1], Lasse Mejling[2], Michael G. Raymer[3], Karsten Rottwitt[2]; *[1]Alcatel-Lucent Bell Labs, USA; [2]Photonics, Technical University of Denmark, Denmark; [3]Physics, University of Oregon, USA.* Four-wave mixing driven by two pulsed pumps transfers the quantum state of an input signal pulse to an output idler pulse, which is a frequency-translated and reshaped version of the signal. This process is useful for quantum information networks.

JW4A.118
Detailed Performance Analysis of the Proposed QEYSSAT Quantum Receiver Satellite, Brendon L. Higgins[1], Jean-Philippe Bourgoin[1], Nikolay Gigov[1], Evan Meyer-Scott[1], Zhizhong Yan[1], Thomas Jennewein[1]; *[1]Institute for Quantum Computing, University of Waterloo, Canada.* Transmission losses limit quantum key distribution (QKD) to distances of only a few hundred kilometres. We investigate performance aspects of the QEYSSAT proposal to demonstrate global QKD using a microsatellite as a trusted quantum receiver.

JW4A.119
Plasmonic color filters for large area display devices fabricated by laser interference lithography, Yun Seon Do[1], Jung-Ho Park[2], Bo Yeon Hwang[2], Sung-Min Lee[1], Byeong-Kwon Ju[2], Kyung Cheol Choi[1]; *[1]Electrical Engineering, KAIST, Republic of Korea; [2]School of Electrical Engineering, Korea University, Republic of Korea.* We demonstrated a plasmonic color filter adopting laser interference lithography technology. Nano scaled hole arrays were obtained with a regular spatial period through the whole glass substrate area of 2.5 cm x 2.5 cm.

JW4A.120
Fabrication of Porous Ti Surface by Femtosecond Laser Sintering of Ti powder, Chien-Jung Huang[1]; *[1]ITRI South, Industrial Technology Research Institute, Taiwan.* This study prepares Ti porous structure on a Ti substrate by femtosecond laser sintering and controls the pore size of the thin layers by varying irradiation energy. The appearance of the induced nanostructures accompanies with oxidation.

JW4A.121
Fabrication of Graphene by Pulsed Laser Annealing from A Graphene Oxide Thin Film, Kun-Tso Chen[1], Yu-Hsuan Lin[1], Jeng-Rong Ho[1]; *[1]Mechanical Engineering, National Chung Cheng University, Taiwan.* A laser-based thin-film processing scheme for printing and annealing of graphene oxide is reported. The resulting graphene thin film is with good transmittance and its resistance is dramatically reduced from 200 MΩ to 80 kΩ.

JW4A.122
Numerical Dispersion Compensation for Optical Coherence Tomography on 3D Microstructure, Yu-Ta Wang[1], Meng-Ko Tsai[1], Chia-Kai Chang[1], Chien-Chung Tsai[1], Sheng-Lung Huang[1,2]; *[1]Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taiwan; [2]Department of Electrical Engineering, National Taiwan University, Taiwan.* A vertically aligned liquid crystal display panel was inspected with an optical coherence tomography system. The in-depth signal dispersion was numerically compensated so that high axial resolution can be maintained throughout the 3D microstructure.