7:30 a.m.–6:00 p.m. Registration Open, *San Jose McEnery Convention Center, Concourse Level*

8:00 a.m.–9:45 a.m. CThA • High Average Power Lasers

Francois Legare; INRS-EMT, Canada, Presider

CThA1 • 8:00 a.m. Invited

High-Energy Femtosecond Fiber Lasers Based on Dissipative Solitons, *Frank Wise;* *Cornell Univ., USA.* Short-pulse fiber lasers based on dissipative-soliton formation offer major performance and practical advantages over prior fiber lasers. Recent developments will be reviewed.

CThA2 • 8:30 a.m.

30-fs 1.6-mJ Pulses at a 1-kHz Repetition Rate from a Single-Stage DPSS Yb Amplifier, *Giedrius Andriukaitis*[1], *Daniil Kartashov*[1], *Audrius Pugžlys*[1], *Dušan Lorenc*[1], *Andrius Baltuška*[1], *Linas Giniūnas*[2], *Romualdas Danielius*[2], *Ömer F. Ilday*[3]; [1]*Photonics Inst., Vienna Univ. of Technology, Austria,* [2]*Light Conversion Ltd., Lithuania,* [3]*Dept. of Physics, Bilkent Univ., Turkey.* 200-fs 2.5-mJ pulses from a cw-diode-pumped Yb:CaF_2 MOPA are spectrally broadened in Ar and recompressed to 30 fs at 980 nm using a prism pair. Multi-millijoule 12-fs pulses are feasible upon higher-order spectral phase correction.

CThA3 • 8:45 a.m.

Temporal Reciprocity of Chirped Volume Bragg Grating Pulse Compressors, *Matthew Rever*[1], *Guoqing Chang*[1], *Vadim Smirnov*[2], *Eugene Rotari*[2], *Ion Cohanoshi*[2], *Sergiy Mokhov*[3], *Leonid Glebov*[3], *Almantas Galvanauskas*[1]; [1]*Univ. of Michigan at Ann Arbor, USA,* [2]*OptiGrate, USA,* [3]*CREOL, College of Optics and Photonics, Univ. of Central Florida, USA.* The temporal reciprocity of chirped-volume-Bragg-grating stretchers and compressors is shown to depend on the bandwidth, length, and index-modulation. Transform-limited pulses can be achieved readily for femtosecond pulses, and also for picosecond pulses using long-length gratings.

8:00 a.m.–9:30 a.m. CThB • Photonic Crystal Fiber Devices and Dispersion

Benjamin G. Lee; IBM Res., USA, Presider

CThB1 • 8:00 a.m.

Monolithic Silicon Photonic Crystal Fiber Tip Sensor for Refractive Index and Temperature Sensing, *Bryan S. Park*[1], *Il Woong Jung*[2], *J. Provine*[3], *Roger T. Howe*[3], *Olav Solgaard*[1]; [1]*E. L. Ginzton Lab, Dept. of Electrical Engineering, Stanford Univ., USA,* [2]*Ctr. for Nanoscale Materials, Argonne Natl. Lab, USA,* [3]*Integrated Circuits Lab, Dept. of Electrical Engineering, Stanford Univ., USA.* We demonstrate that monolithic 2-dimensional silicon photonic crystals confined to the facet of single-mode optical fibers are capable of determining refractive index and temperature of a sample simultaneously from reflectivity measured at two different wavelengths.

CThB2 • 8:15 a.m.

Selectively Filled Photonic Crystal Fibers, *Marius Vieweg,* *Timo Gissibl, Harald Giessen; 4th Physics Inst., Univ. of Stuttgart, Germany.* We present a new technique to fill arbitrary patterns of a photonic crystal fiber selectively with high nonlinear liquids. Thus we can create waveguides and waveguide arrays with tailored dispersion, nonlinearity, and spatial arrangement.

CThB3 • 8:30 a.m.

Ultra-High Reflectivity Hollow Core PCF Microcell Using a Tapered Micro-Mirror, *Natalie V. Wheeler,* *Michael D. W. Grogan, Thomas D. Bradley, Francois Couny, Timothy A. Birks, Fetah Benabid; Univ. of Bath, UK.* Ultra-high reflectivity is achieved at the end-face of a hollow-core PCF via the insertion and fusion of a metal-coated tapered single-mode-fiber to the core of the hollow fiber. Saturable absorption is demonstrated using this device.

CThB4 • 8:45 a.m.

Supermode Dispersion of Strongly Coupled Silicon-on-Insulator Waveguides, *Charles E. de Nobriga*[1], *William J. Wadsworth*[1], *Andrey V. Gorbach*[1], *Dmitry V. Skryabin*[1], *Jonathan C. Knight*[1], *Antonio Samarelli*[2], *Marc Sorel*[2], *Richard M. De La Rue*[2]; [1]*Univ. of Bath, UK,* [2]*Univ. of Glasgow, UK.* We report measurement of the group index dispersion of the supermodes of a three channel array of strongly coupled silicon-on-insulator waveguides, and compare results with numerical simulations. We observe strong coupling-induced dispersion.

8:00 a.m.–9:45 a.m. CThC • Advanced Modulation Formats

Curtis Menyuk; Univ. of Maryland, Baltimore County, USA, Presider

CThC1 • 8:00 a.m.

16-Level Optical Quadrature Amplitude Modulation Using Monolithic Quad-Parallel Mach-Zehnder Optical Modulator and Signal Transmission over 75-km Single-Mode Fiber, *Akito Chiba*[1], *Takahide Sakamoto*[1], *Tetsuya Kawanishi*[1], *Kauru Higuma*[2], *Masaaki Sudou*[2], *Junichiro Ichikawa*[2]; [1]*NICT, Japan,* [2]*New Technology Res. Labs, Sumitomo Osaka Cement Co., Ltd., Japan.* We demonstrated the transmission of a 10-GBaud, 16-level optical quadrature amplitude modulation signal over a 75-km single mode fiber. The signal was generated by a quad-parallel Mach-Zehnder optical modulator monolithically integrated on a $LiNbO_3$ substrate.

CThC2 • 8:15 a.m.

Polarization Dependent Formalism of Interferometric Structures Describing DPSK and DQPSK Receivers, *Yannick Keith Lize*[1], ***Jean-Christophe Richard***[1], *Payman Samadi*[2], *Lawrence Chen*[2]; [1]*Opnext, Inc., USA,* [2]*McGill Univ., Canada.* We describe a polarization dependent formalism for DPSK and DQPSK receivers and show that the combined effect of PDL and PDFS cannot be decoupled making the birefringence axes non-orthogonal and independent of PDL axes.

CThC3 • 8:30 a.m.

Performance Evaluation and Comparison of DPSK CoWDM Systems Based on Odd/Even and Array Configurations, *Selwan Ibrahim,* *Fatima Gunning, Andrew Ellis; Tyndall Natl. Inst., Ireland.* A practical implementation of a 31.99Gbit/s DPSK CoWDM system using a 3-modulator array is compared to a 2-modulator odd/even configuration in terms of receiver sensitivity and phase influence on the crosstalk between the sub-carriers.

CThC4 • 8:45 a.m.

1500-km Transmission of 100-Gb/s Coherent PM-QPSK with 10 Cascaded 50-GHz Wavelength Selective Switches, *Bo Zhang*[1], *Christian Malouin*[1], *Guangxun Liao*[2], *Samuel Liu*[1], *Ping Wang*[2], *Hudson Washburn*[2], *Jim Yuan*[2], *Theodore J. Schmidt*[1]; [1]*Opnext, Inc., USA,* [2]*CoAdna Photonics, USA.* We demonstrate experimentally penalty-free transmission of 127-Gb/s coherent PM-QPSK signals through 10 cascaded 50-GHz commercial WSS over 1500-km SMF. Simulation results show that more than 40 cascades of such 50-GHz liquid-crystal based WSS is feasible.

8:00 a.m.–9:45 a.m. CThD • Microscopy: Applications

Siavash Yazdanfar; GE Global Res., USA, Presider

CThD1 • 8:00 a.m.

Quantitative Imaging of Molecular Order in Lipid Membranes Using Two-Photon Fluorescence Polarimetry, *Alicja Gasecka,* *Tsai-Jung Han, Cyril Favard, Sophie Brasselet; Inst. Fresnel - MOSAIC group, France.* Complex molecular orders in heterogeneous Giant Unilamellar Vesicle as well as cell membranes are investigated using polarization resolved two-photon fluorescence microscopy. This method provides local structural information that cannot be achievable using traditional anisotropy measurements.

CThD2 • 8:15 a.m.

Three-Photon/Two-Photon Resonance Enhancement of Third Harmonic Generation in Human Oxyhemoglobin and Deoxyhemoglobin, *Chiehfeng Chang*[1], *Che-Hang Yu*[1], *Chi-Kuang Sun*[1,2]; [1]*Natl. Taiwan Univ., Taiwan,* [2]*Academia Sinica, Taiwan.*** We demonstrated that the spectroscopic enhancement of third harmonic generation (THG) of human oxyhemoglobin and deoxyhemoglobin in the 1200-1300 nm region agreed with the absorption spectra and was dominated by three-photon/two-photon resonance.

CThD3 • 8:30 a.m.

Location of Subcellular Calcium Store by Femtosecond Laser, *Hao He,* *Siu Kai Kong, Kam Tai Chan; Chinese Univ. of Hong Kong, Hong Kong.* Calcium is an important messenger in cells, but its store location inside cells remains unclear. We induced subcellular Ca^{2+} release by femtosecond laser exposure and observed its propagation and successfully identified its store location.

CThD4 • 8:45 a.m.

High-Throughput Microfluidics and Ultrafast Optics for *in vivo* Compound/Genetic Discoveries, *Chris Rohde, Cody Gilleland, Chrysanthi Samara,* ***Mehmet F. Yanik;*** *MIT, USA.* We developed microfluidic and ultrafast optical technologies that enable high-throughput whole-animal neural regeneration studies. These technologies allow automated and rapid manipulation and non-invasive immobilization of C. elegans for sub-cellular resolution two-photon imaging and femtosecond-laser nanosurgery.

7:30 a.m.–6:00 p.m. Registration Open, *San Jose McEnery Convention Center, Concourse Level*

8:00 a.m.–9:45 a.m. QThA • Distributed Quantum Information

Ray Beausoleil; Hewlett-Packard Labs, USA, Presider

QThA1 • 8:00 a.m. Tutorial

Quantum Teleportation and Quantum Information Processing, *Akira Furusawa;* *Univ. of Tokyo, Japan.* Teleportation-based quantum information processing is reviewed.

Akira Furusawa is a professor in the Department of Applied Physics, University of Tokyo. He received his B.S. degree from the University of Tokyo, and his M.S. and Ph.D. degrees also from the University of Tokyo in 1984, 1986 and 1991, respectively, B.S. and M.S. in applied physics and Ph.D. in physical chemistry. Furusawa's research interest has been in the area of nonlinear optics, quantum optics and quantum information science. He has authored more than 50 papers in leading technical journals and conferences, which includes the first realization of continuous-variable quantum teleportation. He received the Ryogo Kubo Memorial Award in 2006, JSPS prize and Japan Academy Medal in 2007, International Quantum Communication Award in 2008. He is a member of the Physical Society of Japan, the Japanese Society of Applied Physics, and the Optical Society of America.

8:00 a.m.–9:45 a.m. CThE • Quantum Cascade Lasers

Daniel Wasserman; Univ. of Massachusetts at Lowell, USA, Presider

CThE1 • 8:00 a.m.

Single-Mode Quantum Cascade Lasers with a Folded Fabry-Perot Resonator Waveguide, *Peter Q. Liu*[1], *Xiaojun Wang*[2], *Jen-Yu Fan*[2], *Claire F. Gmachl*[1]; [1]*Princeton Univ., USA,* [2]*AdTech Optics, USA.* We demonstrate single mode operation of Quantum Cascade lasers employing a folded Fabry-Perot resonator waveguide design. Single mode emission is achieved with ~20dB side mode suppression up to ~400mA above threshold current in pulsed operation.

CThE2 • 8:15 a.m.

Reduced Threshold and High Temperature Operation in Single-Mode Ring Cavity Surface Emitting Quantum Cascade Lasers, *Elvis Mujagic*[1], *Clemens Schwarzer*[1], *Michele Nobile*[1], *Hermann Detz*[1], *Sangil Ahn*[1], *Werner Schrenk*[1], *Jianxin Chen*[2], *Claire Gmachl*[2], *Gottfried Strasser*[1]; [1]*Inst. for Solid State Electronics, Vienna Univ. of Technology, Austria,* [2]*Dept. of Electrical Engineering, Princeton Univ., USA.* Reduced threshold currents and high temperature operation in surface emitting quantum cascade lasers are demonstrated by using ring-based cavities. The devices exhibit robust and tunable single-mode operation as well as low divergence symmetric beams.

CThE3 • 8:30 a.m.

A Compact Semiconductor Device for Surface Plasmon Generation and Launching, *Adel Bousseksou*[1], *Arthur Babuty*[2], *Jean Philippe Tetienne*[1], *Ioana Moldovan-Doyen*[2], *Gregoire Beaudoin*[3], *Carlo Sirtori*[4], *Isabelle Sagnes*[3], *Yannick De Wilde*[2], *Raffaele Colombelli*[1]; [1]*Inst. d'Electronique Fondamentale, Univ. Paris-Sud, France,* [2]*Inst. Langevin, Lab d'Optique Physique, CNRS, France,* [3]*Lab de Photonique et de Nanostructures, CNRS, France,* [4]*Lab MPQ, Univ. Paris Diderot, France.* We report an experimental demonstration of a compact mid-infrared semiconductor quantum cascade laser device for the generation and the launching of surface plasmon in a passive waveguide at room temperature.

CThE4 • 8:45 a.m.

Gain Competition in Multicolor Quantum Cascade Lasers, *Christian Pflügl*[1], *Markus Geiser*[1], *Alexey Belyanin*[2], *Qi Jie Wang*[1], *Nanfang Yu*[1], *Tadataka Edamura*[3], *Masamichi Yamanishi*[3], *Hirofumi Kan*[3], *Milan Fischer*[4], *Andreas Wittmann*[4], *Jerome Faist*[4], *Federico Capasso*[1]; [1]*Harvard Univ., USA,* [2]*Texas A&M Univ., USA,* [3]*Central Res. Labs, Hamamatsu Photonics, Japan,* [4]*ETH Zürich, Switzerland.* We studied the performance of multicolor quantum cascade lasers and found that their performance strongly depends on mutual gain depletion. We developed a model to understand the underlying physics necessary to improve device performance.

8:00 a.m.–9:45 a.m. QThB • Fundamentals of Metamaterials

Martin Wegener; Karlsruhe Inst. of Technology, Univ. of Karlsruhe, Germany, Presider

QThB1 • 8:00 a.m. Tutorial

Transforming Light with Tunable and Active Metamaterials, *Vladimir M. Shalaev;* *Purdue Univ., USA.* Loss-free and active metamaterials can enable a new powerful paradigm of engineering space for light with transformation optics, leading to a family of new applications ranging from a planar hyperlens to optical black hole.

Vladimir (Vlad) M. Shalaev, the Robert and Anne Burnett Professor of Electrical and Computer Engineering at Purdue University, specializes in nanophotonics, plasmonics, and optical metamaterials. Vlad Shalaev received several awards for his research in the field of nanophotonics and metamaterials, including the Willis E. Lamb Award for Laser Science and Quantum Optics. He is a Fellow of the IEEE, APS, SPIE, and OSA. Prof. Shalaev authored three books, twenty one invited book chapters and over 300 research publications, in total.

7:30 a.m.–6:00 p.m. Registration Open, *San Jose McEnery Convention Center, Concourse Level*

8:00 a.m.–9:45 a.m. QThC • Low Dimensional Quantum Systems

Shun Lien Chuang; Univ. of Illinois, USA, Presider

QThC1 • 8:00 a.m.
High-Amplitude THz and GHz Strain Waves, Generated by Ultrafast Screening of Piezoelectric Fields in InGaN/GaN Multiple Quantum Wells, ***Henrik P. Porte***[1]*, Peter J. S. van Capel*[2]*, Dmitry Turchinovich*[1]*, Jaap I. Dijkhuis*[2]*;* [1]*DTU Fotonik, Technical Univ. of Denmark, Denmark,* [2]*Debye Inst. for Nanomaterials Science, Utrecht Univ., Netherlands.* Screening of large built-in piezoelectric fields in InGaN/GaN quantum wells leads to high-amplitude acoustic emission. We will compare acoustic emission by quantum wells with different thicknesses with photoluminescence; indicating screening.

QThC2 • 8:15 a.m.
Photoluminescence Quenching Due to Relocation of Electrons in GaN/AlN Asymmetric-Coupled Quantum Wells, ***Guan Sun***[1]*, Suvranta K. Tripathy*[1]*, Yujie J. Ding*[1]*, Guangyu Liu*[1]*, Hongping Zhao*[1]*, G. S. Huang*[1]*, Nelson Tansu*[1]*, Jacob B. Khurgin*[2]*;* [1]*Lehigh Univ., USA,* [2]*Johns Hopkins Univ., USA.* We have observed dramatic photoluminescence quenching caused by relocation of photogenerated electrons under large internal electric fields, inherent in GaN/AlN asymmetric-coupled quantum wells.

QThC3 • 8:30 a.m.
Ultrafast Measurements of Thermal Transport in Graphene, ***Haining Wang****, Jared H. Strait, Shriram Shivaraman , Justin D. Besant, Virgil B. Shield, Michael G. Spencer, Farhan Rana; Cornell Univ., USA.* We present results from measurements of ultrafast thermal transport in Graphene. We find that carriers, instead of phonons, dominate thermal energy transport. The energy transport is found to be diffusive over 5-20 micron length scales.

QThC4 • 8:45 a.m.
Ultrafast Mid-Infrared Intra-Excitonic Response of Individualized Single-Walled Carbon Nanotubes, ***Jigang Wang***[1]*, Matt W. Graham*[2]*, Yingzhong Ma*[2]*, Graham R. Fleming*[2]*, Robert A. Kaindl*[3]*;* [1]*Ames Lab, Iowa State Univ., USA,* [2]*Dept. of Chemistry, Physical Biosciences Div., Lawrence Berkeley Natl. Lab, Univ. of California at Berkeley, USA,* [3]*Materials Sciences Div., Lawrence Berkeley Natl. Lab, USA.* We report ultrafast mid-infrared studies of individualized semiconducting carbon nanotubes. Transient spectra of (6,5) and (7,5) nanotubes evidence photoinduced absorption around 200 meV, associated with intra excitonic transitions that reflect quasi-1-D exciton correlations and dynamics.

8:00 a.m.–9:45 a.m. QThD • Photodetection in Quantum Communication

Brian J. Smith; Univ. of Oxford, UK, Presider

QThD1 • 8:00 a.m. Invited
Complete Characterization of Weak-Homodyne Photon-Number-Resolving Detectors: Applications to Non-Classical Photonic State Reconstructions, ***Hendrik B. Coldenstrodt-Ronge***[1]*, Graciana Puentes*[1]*, Offir Cohen*[1]*, Florencia Noriega*[1]*, Xiaodan Yang*[1]*, Jeff S. Lundeen*[2]*, Animesh Datta*[3]*, Lijian Zhang*[1]*, Brian J. Smith*[1,4]*, Martin B. Plenio*[5]*, Ian A. Walmsley*[1]*;* [1]*Univ. of Oxford, UK,* [2]*Inst. for Natl. Measurement Standards, Canada,* [3]*Imperial College, UK,* [4]*NUS Ctr. for Quantum Technologies, Natl. Univ. of Singapore, Singapore,* [5]*Ulm Univ., Germany.* A novel detector combining phase sensitivity and photon-number resolution is experimentally characterized by measuring its positive-operator-value measurement set. Direct application to tomographic reconstruction of heralded single-photon states is presented.

QThD2 • 8:30 a.m.
Displacement Controlled Photon Number Resolving Detector for Coherent State Discrimination, ***Christoffer Wittmann***[1,2]*, Ulrik L. Andersen*[1,2,3]*, Masahiro Takeoka*[4]*, Denis Sych*[1,2]*, Gerd Leuchs*[1,2]*;* [1]*Max-Planck-Inst. for the Science of Light, Germany,* [2]*Inst. for Optics, Information and Photonics, Univ. Erlangen-Nuremberg, Germany,* [3]*Technical Univ. of Denmark, Denmark,* [4]*NICT, Japan.* The presented probabilistic scheme for discrimination of optical coherent states consists of an optimized displacement followed by postselection of a photon number resolving measurement. The scheme outperforms the homodyne receiver in theory and experiment.

QThD3 • 8:45 a.m.
Multi-Gigahertz Photon Counting Using InGaAs APDs, ***Zhiliang Yuan****, Andrew W. Sharpe, James F. Dynes, Alex R. Dixon, Andrew J. Shields; Toshiba Res. Europe Ltd., UK.* We demonstrate multi-gigahertz photon-counting at 1550nm using self-differencing InGaAs APDs. The quantum efficiency is characterized as 23.5% at an afterpulse probability of 4.84%. The device will further increase the bit-rate for fiber quantum key distribution.

8:00 a.m.–9:45 a.m. CThF • Microwave Photonics

Tetsuya Kawanishi; NICT, Japan, Presider

CThF1 • 8:00 a.m. Tutorial
Microwave Photonics, ***Alwyn J. Seeds****, Chin-Pang Liu, Tabassam Ismail, Martyn J. Fice, Francesca Pozzi, Robert J. Steed, Efthymios Rouvalis, Cyril C. Renaud; Univ. College London, UK.* Microwave photonics is the use of photonic techniques for the generation, transmission, processing and reception of signals having spectral components at microwave frequencies. This tutorial reviews the technologies used and gives applications examples.

Alwyn Seeds holds Ph.D. and D.Sc. degrees from the University of London. He was a Staff Member at Lincoln Laboratory, Massachusetts Institute of Technology, and joined University College London in 1986, where he is now Professor of Opto-electronics and Head of the Department of Electronic and Electrical Engineering. He is a Fellow of the Royal Academy of Engineering (UK), an IEEE Fellow (USA) and Vice-President for Technical Affairs of the IEEE Photonics Society (USA). He has served on the programme committees for many international conferences. He is a co-founder of Zinwave, a manufacturer of wireless over fibre systems.

8:00 a.m.–9:45 a.m. CThG • CLEO Symposium on Laser Beam Combining I: Coherent Beam Combining: Techniques and Applications

Richard Berdine; AFRL, USA, Presider

CThG1 • 8:00 a.m. Tutorial
Laser Beam Combining: Theory and Methods, ***James R. Leger****; Univ. of Minnesota, USA.* This tutorial explores the fundamental underpinnings of laser beam combining theory, as well as several incoherent and coherent beam combining methods. A modal approach is used to explain complex resonator behavior.

James Leger is the Cymer Professor of Electrical and Computer Engineering at the University of Minnesota. His previous work at MIT Lincoln Lab and current research concerns diffractive and microoptics applied to lasers, metrology and imaging systems. Leger is a Fellow of the OSA, IEEE and SPIE, and winner of the 1998 OSA Fraunhofer Award. He is a former topical editor for *Optics Express* and *Applied Optics*, and is a past member of the Board of Directors of OSA.

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

Thursday, May 20

7:30 a.m.–6:00 p.m. Registration Open, *San Jose McEnery Convention Center, Concourse Level*

8:00 a.m.–9:45 a.m. JThA • Attosecond Science

Henry C. Kapteyn; Univ. of Colorado at Boulder, USA, Presider

JThA1 • 8:00 a.m.
Isolated Attosecond Pulses Generated Directly from Femtosecond Chirped Pulse Amplifier, ***Yi Wu****, Steve Gilbertson, Sabih Khan, Michael Chini, Kun Zhao, Ximao Feng, Zenghu Chang; Kansas State Univ., USA.* Using a generalized version of double optical gating, we produced single isolated attosecond pulses with 2 mJ, 25 fs driving lasers. Through attosecond streaking, we characterized isolated 160 attosecond pulses with 170 pJ pulse energy.

JThA2 • 8:15 a.m.
Time Gating of High Order Harmonics for the Generation of Continuous XUV Spectra with Multi-Cycle Driving Pulses, *Carlo Altucci[1], Raffaele Velotta[1], Valer Tosa[2], Fabio Frassetto[3], Luca Poletto[3], Paolo Villoresi[3], Caterina Vozzi[4], Matteo Negro[4], Francesca Calegari[4], Sandro De Silvestri[4],* ***Salvatore Stagira[4]****; [1]CNISM - Dept. di Scienze Fisiche, Univ. di Napoli Federico II, Italy, [2]Natl. Inst. for R&D Isotopic and Molecular Technologies, Romania, [3]LUXOR, CNR-INFM and DEI, Univ. di Padova, Italy, [4]ULTRAS, CNR-INFM and Dept. di Fisica, Politecnico di Milano, Italy.* A continuous XUV spectrum was obtained by high-order harmonic generation driven by a multi-cycle, 15-fs driving pulse. The gating technique for XUV emission is based on a polarization tailoring of the driving electric field.

JThA3 • 8:30 a.m.
Optimization of Continuum Harmonic Generation by Using Multi-Cycle Two-Color Fields, ***Eiji J. Takahashi****[1], Pengfei Lan[1], Oliver D. Muecke[1,2], Yasuo Nabekawa[1], Katsumi Midorikawa[1]; [1]RIKEN, Japan, [2]Vienna Univ. of Technology, Australia.* By mixing two infrared laser pulses of different wavelengths, we generate the continuum harmonic around a cut-off region. Our obtained harmonic spectra clearly show the possibility of generating isolated attosecond pulses from many-cylse laser pulse.

JThA4 • 8:45 a.m.
Direct Measurement of Laser-Induced Electron Tunneling, ***Ladan Arissian[1,2]****, Chris Smeenk[1], Fraser Turner[1,3], Carlos Trallero[1], Alexei Sokolov[2], Andre Staudte[1], David Villeneuve[1], Paul Corkum[1]; [1]Joint Lab of Attosecond Science, Univ. of Ottawa and Natl. Res. Council, Canada, [2]Texas A&M Univ., USA, [3]Univ. of Waterloo, Canada.* We measure momentum distribution of tunneled electrons in femtosecond circular polarized light. We find that the electron momentum distribution perpendicular to the laser field depends on the field strength and is independent of the wavelength.

8:00 a.m.–9:45 a.m. CThH • Mid-IR Parametric Sources

Andrew Schober; Lockheed Martin Coherent Technologies, USA, Presider

CThH1 • 8:00 a.m.
Singly Resonant CW Mid-IR Optical Parametric Oscillator Pumped by a Tunable C-Band Source for Free Space Coherent Optical Communications, ***Katerina Ioakeimidi****, Judith R. Schwesyg, Chris R. Phillips, Konstantin L. Vodopyanov, Martin M. Fejer; Stanford Univ., USA.* We demonstrate the first CW PPLN OPO pumped with a C-Band tunable laser with a ~3800nm idler output suitable for free space coherent communications. The threshold is 6-7W and idler power up to 1.7W.

CThH2 • 8:15 a.m.
A Compact, Tunable, and Highly-Efficient Continuous-Wave Intracavity Optical-Parametric Oscillator by Use of Periodically Poled MgO-Doped $LiNbO_3$ Oscillating at 4.7μm, ***Ichiro Shoji****[1], Hajime Sannomiya[2], Keiji Miura[2], Koichi Matsukawa[2]; [1]Chuo Univ., Japan, [2]Nippon Signal Co., Ltd., Japan.* We have developed a continuous-wave intracavity optical-parametric oscillator consisting of tandem diode-pumped Nd:YVO_4 and periodically poled MgO-doped $LiNbO_3$. An idler output of 40mW has been obtained with the wavelengths tunable from 4.50 to 4.77μm.

CThH3 • 8:30 a.m.
Sub-Nanosecond, 1-kHz, Temperature-Tuned, Non-Critical Mid-IR OPO Based on $CdSiP_2$ Crystal Pumped at 1064 nm, ***Valentin Petrov****[1], Georgi Marchev[1], Peter G. Schunemann[2], Aleksey Tyazhev[1], Kevin T. Zawilski[2], Thomas M. Pollak[2]; [1]Max-Born-Inst. for Nonlinear Optics and Ultrafast Spectroscopy, Germany, [2]BAE Systems, Inc., USA.* Temperature tuning (6.117-6.554-μm for the idler) and sub-nanosecond durations are demonstrated with a non-critical, 1064-nm pumped $CdSiP_2$-OPO. At 1 kHz, the output idler energy of 24 μJ corresponds to an average power of 24 mW.

CThH4 • 8:45 a.m.
Mid-Infrared Picosecond Laser Source with High Average Output Power Exceeding 1 W at 4.5 μm, ***Felix Ruebel****[1], Gregor Anstett[2], Johannes A. L'huillier[1]; [1]Photonik-Zentrum Kaiserslautern e.V., Germany, [2]Fraunhofer-FOM, Germany.* The generation of tunable mid-infrared picosecond laser radiation in the spectral range from 3-5μm by nonlinear frequency conversion in PPLN is reported. More than 3W output power at 3μm and 1.1W at 4.5μm were achieved.

8:00 a.m.–9:45 a.m. JThB • *In situ* Laser-Based Sensing

Douglas J. Bamford; Physical Sciences Inc., USA, Presider

JThB1 • 8:00 a.m.
Fourier Transform Spectrometers Utilizing Mid-Infrared Quantum Cascade Lasers, ***Laurent Diehl****[1], Christian Pflugl[1], Mark F. Witinski[1], Peng Wang[2], Tom J. Jr Tague[2], Federico Capasso[1]; [1]Harvard Univ., USA, [2]Bruker Optics, USA.* Fabry-Perot Quantum Cascade Lasers can be used with FTIR spectrometers to perform spectroscopic experiments that require orders of magnitude more photons than what is achievable with a thermal source. Three proof-of-concept experiments will be discussed.

JThB2 • 8:15 a.m.
Simultaneous Measurements of H_2O and CO_2 Isotope Ratios Using 2.73 μm Laser Spectrometer, *Tao Wu[1,2],* ***Weidong Chen****[1], Erik Kerstel[3], Eric Fertein[1], Xiaoming Gao[2], Johannes Koeth[4], Karl Roebner[4], Daniela Brueckner[4], Dominique Duclerc[5]; [1]Univ. du Littoral, France, [2]Anhui Inst. of Optics and Fine Mechanics, Chinese Acad. of Sciences, China, [3]Univ. of Groningen, Netherlands, [4]Nanoplus Nanosystems and Technologies GmbH, Germany, [5]Total, France.* Simultaneous measurements of water and CO_2 isotopologue ratios were performed using laser absorption spectroscopy in combination with Kalman filtering at 2.73 μm. The isotopic compositions of eH_2O and eCO_2 in breath gas were analyzed.

JThB3 • 8:30 a.m.
VCSEL-Based CO_2 and H_2O Sensor with Inherent Self Calibration, ***Andreas Hangauer****[1,2], Jia Chen[1,2], Kay Seemann[1], Philip Karge[1], Rainer Strzoda[1], Markus C. Amann[2]; [1]Siemens AG, Germany, [2]Walter-Schottky-Inst., Technical Univ. of Munich, Germany.* A compact CO_2 and H_2O laser spectroscopy sensor based on cost-efficient vertical-cavity surface-emitting lasers for safety and air-quality applications is presented. It implements inherent wavelength calibration to achieve self-monitored and calibration-free operation during sensor lifetime.

JThB4 • 8:45 a.m.
Low-Power Portable Laser Spectroscopic Sensor for Atmospheric CO_2 Monitoring, ***Clinton J. Smith****, Stephen So, Gerard Wysocki; Princeton Univ., USA.* We demonstrate a wireless, portable CO_2 sensor based on laser absorption spectroscopy. Allan variance for long run tests yielded Gaussian noise limited operation up to 100 seconds with ultimate minimum detection limit of 5.1x10-7.

CLEO

CThA • High Average Power Lasers—Continued

CThA4 • 9:00 a.m.
120 W Average Power from a Mode-Locked Yb:Lu_2O_3 Thin Disk Laser, ***Clara J. Saraceno***[1], *Cyrill R. E. Baer*[1], *Christian Kränkel*[1], *Oliver H. Heckl*[1], *Matthias Golling*[1], *Thomas Südmeyer*[1], *Ursula Keller*[1], *Rigo Peters*[2], *Klaus Petermann*[2], *Guenter Huber*[2]; [1]*ETH Zürich, Switzerland,* [2]*Univ. of Hamburg, Germany.* We present a mode-locked Yb:Lu_2O_3 thin disk laser with an average power of 120 W setting a new record for mode-locked laser oscillators. The laser generates 796-fs pulses with an energy of 2.1 µJ.

CThA5 • 9:15 a.m.
Power Scaling of an Yb:YCOB Thin Disk Laser to 101 W cw and Initial Modelocking Experiments, ***Oliver H. Heckl***[1], *Christian Kränkel*[1], *Cyrill R. E. Baer*[1], *Clara J. Saraceno*[1], *Thomas Südmeyer*[1], *Klaus Petermann*[2], *Günter Huber*[2], *Ursula Keller*[1]; [1]*ETH Zürich, Switzerland,* [2]*Inst. of Laser-Physics, Univ. of Hamburg, Germany.* The >25-nm broad emission bandwidth of Yb:YCOB is highly attractive for femtosecond lasers. We confirm its suitability for high-power thin disk operation by cw-multimode power scaling to 100 W and present intial low-power modelocking results.

CThA6 • 9:30 a.m.
Power Scaling of a 78 MHz-Repetition Rate Femtosecond Enhancement Cavity, ***Ioachim Pupeza***[1,2], *Tino Eidam*[3], *Birgitta Bernhardt*[1], *Akira Ozawa*[1], *Jens Rauschenberger*[1,2], *Ernst Fill*[1], *Alexander Apolonski*[2], *Thomas Udem*[1], *Jens Limpert*[3], *Zeyad A. Alahmed*[4], *Abdallah M. Azzeer*[4], *Theodor W. Hänsch*[1], *Andreas Tünnermann*[3], *Ferenc Krausz*[1,2]; [1]*Max-Planck-Inst. for Quantum Optics, Germany,* [2]*Ludwig-Maximilians-Univ. München, Germany,* [3]*Inst. of Applied Physics, Friedrich-Schiller-Univ. Jena, Germany,* [4]*King Saud Univ., Saudi Arabia.* We report on the cavity enhancement of a 78MHz, 200fs ytterbium-fiber laser system. Constant enhancement up to a record intra-cavity average power of 18kW has been observed. Beyond the linear regime, 40kW have been achieved.

CThB • Photonic Crystal Fiber Devices and Dispersion—Continued

CThB5 • 9:00 a.m.
Chromatic Dispersion in Tightly Curved Silicon Waveguides and Ring Resonators, ***Lin Zhang***[1], *Yang Yue*[1], *Yinying Xiao-Li*[1], *Raymond G. Beausoleil*[2], *Alan E. Willner*[1]; [1]*Univ. of Southern California, USA,* [2]*HP Labs, USA.* We numerically analyze chromatic dispersion in tightly curved strip and slot waveguides with high index contrast. Zero-dispersion-wavelength may have a shift over 220 nm when bending radius is reduced to a few microns.

CThB6 • 9:15 a.m.
Optical Trapping with Real-Time Feedback Using Planar Silicon Micro-Ring Resonators, ***Shiyun Lin****, Kenneth B. Crozier; Harvard Univ., USA.* We experimentally demonstrate optical trapping with micro-ring resonators. Tuning the incident wavelength enables controlled trapping and release of particles. The resonance frequency red-shift upon trapping enables monitoring of the particle physical properties.

CThC • Advanced Modulation Formats—Continued

CThC5 • 9:00 a.m.
Carrierless Amplitude and Phase Modulation for Low-Cost, High-Spectral-Efficiency Optical Datacommunication Links, ***Jonathan D. Ingham***[1], *Richard V. Penty*[1], *Ian H. White*[1], *David G. Cunningham*[2]; [1]*Univ. of Cambridge, UK,* [2]*Avago Technologies, UK.* Carrierless amplitude and phase modulation for next-generation datacommunication links is considered for the first time. Low-cost implementation of a high-spectral-efficiency 10 Gb/s channel is demonstrated as a route to links at 40 Gb/s and beyond.

CThC6 • 9:15 a.m.
Dispersion-Compensation-Free, Long-Reach OCDMA-PON System with Passive Remote Node at Arbitrary Position Using Single Multi-Port Encoder/Decoder, ***Nobuyuki Kataoka***[1], *Naoya Wada*[1], *Gabriella Cincotti*[2], *Ken-ichi Kitayama*[3]; [1]*NICT, Japan,* [2]*Univ. Roma Tre, Italy,* [3]*Osaka Univ., Japan.* We propose flexible, long-reach OCDMA-PON system, which deploys a remote node with single multi-port E/D. 10Gbps, 4-user, OCDMA transmission both up- and down-link are experimentally demonstrated over 59km SSMF without inline dispersion compensation.

CThC7 • 9:30 a.m.
2.5Gbps Two-User OCDMA System Based on Time Domain Spectral Phase Encoding and Variable-Bandwidth Spectrum Shaper Decoding, *Zhensen Gao*[1], ***Xu Wang***[1], *Nobuyuki Kataoka*[2], *Naoya Wada*[2]; [1]*Heriot-Watt Univ., UK,* [2]*NICT, Japan.* A 2.5Gbps two-user OCDMA transmission over 34km fiber with 8-chip, 20GHz/chip optical code pattern based on time domain spectral phase encoding (SPE) and Variable-Bandwidth Spectrum Shaper (VBS) has been experimentally demonstrated with BER<10^{-9}.

CThD • Microscopy: Applications—Continued

CThD5 • 9:00 a.m.
Asymmetric Growth of Cancer Cell Filopodia under Electric Field Stimulation Measured by Structured Illumination Nano-Profilometry, ***Chun-Chieh Wang***[1], *Yu-Chiu Kao*[2], *Jiunn-Yuan Lin*[2], *Ji-Yen Cheng*[1], *Chau-Hwang Lee*[1]; [1]*Res. Ctr. for Applied Sciences, Academia Sinica, Taiwan,* [2]*Dept. of Physics, Natl. Chung-Cheng Univ., Taiwan.* We use structured-illumination nano-profilometry with sub-diffraction-limit lateral resolution to measure the filopodium dynamics of lung cancer cells under stimulation of DC electric fields. The cathode growth bias and enhanced expression of filopodia are observed.

CThD6 • 9:15 a.m.
Controlling Fluorescence Resonance Energy Transfer (FRET) by Optical Confinement in a λ/2-Microresonator, ***Raphael Gutbrod****, Frank Schleifenbaum, Sebastian Bär, Sébastien Peter, Kirstin Elgass, Alfred J. Meixner; Univ. of Tuebingen, Germany.* FRET plays an important role in light-induced processes in life sciences, e.g. energy transfer in light harvesting complexes. We present a method to tune the energy transfer from donor to acceptor in an optical microresonator.

CThD7 • 9:30 a.m.
Digital Optical Phase Conjugation, ***Meng Cui****, Changhuei Yang; Caltech, USA.* We present a novel optical phase conjugation method that combines phase-shifting holography with spatial phase shaping. We discuss its design, implementation, and application for compensating the wave-front distortion caused by a random scattering medium.

10:00 a.m.–10:30 a.m. Coffee Break, *San Jose McEnery Convention Center, Exhibit Halls 1 and 2*

10:00 a.m.–3:00 p.m. Exhibit Open, *San Jose McEnery Convention Center, Exhibit Halls 1, 2 and 3*

NOTES

Room A5	Room A6	Room A7
QELS	CLEO	QELS

QThA • Distributed Quantum Information—Continued

QThA2 • 9:00 a.m.
Implementation of Atom-Photon Interfaces for Quantum Networking, *Lukas Brandt*, *Cecilia Muldoon, Tobias Thiele, Jerome Dilley, Peter Nisbet, Gunnar Langfahl-Klabes, Axel Kuhn; Univ. of Oxford, UK.* We present two schemes for interfacing and manipulating individual atoms: one involves an array of dipole-traps using a spatial light modulator. The other implements cavity-based single photon generation combined with photon storage.

QThA3 • 9:15 a.m.
Tailored State Preparation for Solid-State Quantum Memory, *Elizabeth A. Goldschmidt*[1,2], *Sergey V. Polyakov[1,2], Sarah E. Beavan[1,3], Jingyun Fan[1,2], Alan L. Migdall[1,2]; [1]NIST, USA, [2]Joint Quantum Inst., USA, [3]Laser Physics Ctr., RSPhysSE, Australia.* We report progress in implementing a quantum memory scheme in Pr^{3+}:Y_2SiO_5, including experimental and theoretical results using spectral hole-burning to generate narrow absorbing features and implement narrow spectral filtering.

QThA4 • 9:30 a.m.
Spin Squeezing via Quantum Non-Demolition Measurements in Cold 87Rb Atomic Ensemble, *Marco Koschorreck*, *Mario Napolitano, Brice Dubost, Naeimeh Behbood, Robert Sewell, Morgan W. Mitchell; ICFO, Spain.* We demonstrate spin squeezing of a magnetically sensitive coherent spin-state in an ensemble of 0.65 million cold 87Rb atoms. Quantum non-demolition measurements achieved a spin-noise reduction by 2.9dB compared to the initial projection noise level.

CThE • Quantum Cascade Lasers—Continued

CThE5 • 9:00 a.m.
Light-Induced Tuning of Quantum Cascade Lasers, *Bernhard Basnar*[1], *Elvis Mujagic[1], Aaron Maxwell Andrews[1], Tomas Roch[2], Werner Schrenk[1], Gottfried Strasser[1,3]; [1]Ctr. for Micro- and Nanostructures, Vienna Univ. of Technology, Austria, [2]Inst. of Experimental Physics, Comenius Univ., Slovakia, [3]SUNY Buffalo, USA.* We present a novel method for the light-induced tuning of a grating-free mid-IR QCL utilizing the absorbance changes of a photochromic cladding. This photosensitization allowed for reversible shifts in the emission wavelength of 5 cm^{-1}

CThE6 • 9:15 a.m.
Thermoelectric Effect in Quantum Cascade Lasers, *Matthew D. Escarra*[1], *Alexander Benz[2], Anjali M. Bhatt[3], Anthony J. Hoffman[1], Xiaojun Wang[4], Jen-Yu Fan[4], Claire F. Gmachl[1]; [1]Princeton Univ., USA, [2]Vienna Univ. of Technology, Austria, [3]Harvard Univ., USA, [4]Adtech Optics, Inc., USA.* A thermoelectric effect is observed in quantum cascade lasers and validated through thermal/electrical transport modeling. Choosing the proper polarity leads to an active core heat reduction of 9 K for a 7.5 kW/cm^2 thermal load.

CThE7 • 9:30 a.m.
Mid-Infrared Emission of Quantum-Dash-Based Quantum Cascade Laser Structures, *Valeria Liverini*, *Alfredo Bismuto, Laurent Nevou, Mattias Beck, Jerome Faist; ETH Zürich, Switzerland.* We developed two mid-infrared quantum cascade laser structures based on InAs quantum dashes embedded either in AlInGaAs lattice-matched to InP or in tensile-strained AlInAs. Both devices emit between 7 and 11 μm.

QThB • Fundamentals of Metamaterials—Continued

QThB2 • 9:00 a.m.
Electromagnetic Field Enhancement in Realistic Transition Metamaterials, *Irene Mozjerin*[1], *Tolanya Gibson[1], Edward P. Furlani[2], Ildar R. Gabitov[3], Natalia M. Litchinitser[1]; [1]SUNY Buffalo, USA, [2]Inst. for Lasers, Photonics and Biophotonics, SUNY Buffalo, USA, [3]Univ. of Arizona, USA.* We investigate the effect of anomalous field enhancement in lossy optical transition metamaterials and provide guidelines for optimizing the profile of the transition layer for maximum enhancement in these structures.

QThB3 • 9:15 a.m.
Electro-Modulation of Plasmonic and Photonic-Metamaterial Structures, *Stefan Linden*, *Matthias Ruther, Lihua Shao, Jörg Weißmüller, Martin Wegener; Karlsruhe Inst. of Technology, Germany.* By applying voltages of about 1V to usual metal nanostructures via an aqueous electrolyte, we demonstrate reversible modulation of plasmonic resonances by as much as 14 THz. Gold split-ring resonators serve as an example.

QThB4 • 9:30 a.m.
Analogue of Electromagnetically Induced Transparency in a Terahertz Metamaterial, *Sher-Yi Chiam*[1], *Ranjan Singh[2], Carsten Rockstuhl[3], Falk Lederer[3], Weili Zhang[2], Andrew A. Bettiol[1]; [1]Dept. of Physics, Natl. Univ. of Singapore, Singapore, [2]School of Electrical and Computer Engineering, Oklahoma State Univ., USA, [3]Inst. of Condensed Matter Theory and Solid State Optics, Friedrich-Schiller-Univ. Jena, Germany.* We experimentally demonstrate a metamaterial that mimics electromagnetically induced transparency at terahertz frequencies. This is achieved by independently exciting two resonances in which their coupling to the radiation field, and thus their linewidth, differs strongly.

10:00 a.m.–10:30 a.m. Coffee Break, *San Jose McEnery Convention Center, Exhibit Halls 1 and 2*

10:00 a.m.–3:00 p.m. Exhibit Open, *San Jose McEnery Convention Center, Exhibit Halls 1, 2 and 3*

NOTES

QThC • Low Dimensional Quantum Systems—Continued

QThC5 • 9:00 a.m.
Reaction, Diffusion and Dissociation of Excitons on Carbon Nanotubes, *Jeremy Allam*[1], *Richard Sutton*[1], *Muhammad T. Sajjad*[1], *Konstantin Litvinenko*[1], *Zhongyang Wang*[1,2], *Sofia Siddique*[1], *Quan-Hong Yang*[2,3], *Tom Brown*[3], *Wei Loh*[3]; [1]*Univ. of Surrey, UK,* [2]*Tianjin Univ., China,* [3]*Univ. of Southampton, UK.* We study exciton reactions on carbon nanotubes in the regime of many, few and one exciton per nanotube, and demonstrate classic 1-D reaction-diffusion behaviour. Dissociation occurs when exciton spacing is less than the exciton length.

QThC6 • 9:15 a.m.
Ultrafast Electron Dynamics in a Pb/Cu(111) Quantum-Well System, *Stefan Mathias*[1], *Andreas Ruffing*[2], *Frederik Deicke*[2], *Martin Wiesenmayer*[3], *Martin Aeschlimann*[2], *Michael Bauer*[3]; [1]*JILA, NIST, Univ. of Colorado, USA,* [2] *Res. Ctr. OPTIMAS, Univ. of Kaiserslautern, Germany,* [3]*Inst. für Experimentelle und Angewandte Physik, Univ. Kiel, Germany.* Time- and angle-resolved two-photon photoemission has been used to investigate hot-electron lifetimes in Pb/Cu(111). Our findings suggest that the peculiar electronic structure of quantum-well systems can be used to tune ultrafast dynamical properties in metals.

QThC7 • 9:30 a.m.
Ultrafast Optical Response and Transient Population Inversion of Photoexcited Ge/SiGe Quantum Wells, *Sangam Chatterjee*[1], *Christoph Lange*[1], *Niko S. Köster*[1], *Martin Schäfer*[1], *Mackillo Kira*[1], *Stephan W. Koch*[1], *Daniel Chrastina*[2], *Giovanni Isella*[2], *Hans von Känel*[2], *Hans Sigg*[3]; [1]*Faculty of Physics and Material Sciences Ctr., Philipps-Univ. Marburg, Germany,* [2]*CNISM and L-NESS, Dept. di Fisica, Politecnico di Milano, Italy,* [3]*Paul Scherrer Inst., Switzerland.* The ultrafast carrier dynamics of Ge/SiGe quantum wells on Si substrate are investigated by pump-probe spectroscopy. Pronounced nonequilibrium effects in the relaxation dynamics and transient gain are observed and analyzed using a microscopic many-body theory.

QThD • Photodetection in Quantum Communication—Continued

QThD4 • 9:00 a.m.
Photon-Number-Counting with an InGaAs/InP Avalanche Photodiode by Optical Self-Balancing, *Yi Jian, E. WU, Guang Wu, Heping Zeng; East China Normal Univ., China.* Infrared photon-number-resolving detection was achieved with an InGaAs/InP avalanche avalanche photodiode by using optical self-balancing technique to cancel the spike noise. A photon-number-resolving detection was achieved with the detection efficiency as high as 36%.

QThD5 • 9:15 a.m.
Mid-Infrared Single-Photon Detection Using Superconducting Nanowires Integrated with Nano-Antennae, *Xiaolong Hu, Francesco Marsili, Faraz Najafi, Karl K. Berggren; MIT, USA.* We present some major challenges of mid-infrared superconducting nanowire single-photon detector technology and our device design with nano-antenna integration to address these challenges.

QThD6 • 9:30 a.m.
Experimental Characterization of Optical Detectors for Single Photon Subtraction, *Virginia D'Auria*[1], *Noriyuki Lee*[2], *Taoufik Amri*[1], *Julien Laurat*[1], *Claude Fabre*[1]; [1]*Lab Kastler Brossel, Univ. Pierre et Marie Curie, France,* [2]*Dept. of Applied Physics, School of Engineering, Univ. of Tokyo, Japan.* Quantum detector tomography enables to reconstruct POVMs associated to a measurement apparatus. For two detectors, an APD and a TMD, we study the evolution of projectivity under the effect of background noise and quantum efficiencies.

CThF • Microwave Photonics—Continued

CThF2 • 9:00 a.m.
All- Optical Microwave Up- Conversion Using an Optical Broadband Source and a Mach-Zehnder Interferometer, *Mora Jose, Capmany José, Ortega Beatriz, Grassi Fulvio; Inst. de Telecomunicaciones y Aplicaciones Multimedia, Univ. Politécnica de Valencia, Spain.* A technique to perform all optical microwave up-conversion is proposed for a RoF system based on the employment of an optical broadband source. The Mach-Zehnder interferometer is the fundamental device for rejecting undesired frequency components.

CThF3 • 9:15 a.m.
Demonstration of Photonically Assisted RF Waveform Generation with 1-Nanosecond Update Time, *Christopher M. Long, Daniel E. Leaird, Andrew M. Weiner; Purdue Univ., USA.* Photonically assisted RF arbitrary waveform generation with 1-ns update time is demonstrated utilizing a commercial tunable DBR laser to affect frequency modulation of the optical frequency comb carrier in conjunction with line-by-line pulse shaping.

CThF4 • 9:30 a.m.
Broadband Photonic Arbitrary Waveform Generation Using a Frequency Agile Laser at 1.5µm, *Vianney Damon*[1], *Vincent Crozatier*[2], *Thierry Chanelière*[1], *Jean-Louis Le Gouët*[1], *Ivan Lorgeré*[1]; [1]*CNRS, France,* [2]*Fastlite, France.* We use a pulse-compression chirp-transform algorithm to generate broadband photonic arbitrary waveforms. A phase-locked loop frequency agile laser provides the needed broadband frequency scans. The experiment operates at the telecom wavelength of 1.5µm.

CThG • CLEO Symposium on Laser Beam Combining I: Coherent Beam Combining: Techniques and Applications—Continued

CThG2 • 9:00 a.m. Invited
Coherent Beam Combining of Fiber Amplifiers and Solid-State Lasers Including the Use of Diffractive Optical Elements, *Michael Wickham; Northrop Grumman Corp., USA.* Two coherent combining solid state laser systems are described. One approach uses a fiber optic amplifier array and the other 7 tiled slab amplifier chains which achieved a world record 105.5 kW of power CW.

CThG3 • 9:30 a.m.
Two-Dimensional Electronic Beam Steering in Coherently-Coupled Vertical-Cavity Surface-Emitting Laser Arrays, *Dominic F. Siriani, Joshua D. Sulkin, Kent D. Choquette; Univ. of Illinois at Urbana-Champaign, USA.* We demonstrate two-dimensional electronic beam steering using only the in-phase mode of a vertical-cavity surface-emitting laser (VCSEL) array. The steering is highly-controllable, and the interference visibility is typically very high.

10:00 a.m.–10:30 a.m. Coffee Break, *San Jose McEnery Convention Center, Exhibit Halls 1 and 2*

10:00 a.m.–3:00 p.m. Exhibit Open, *San Jose McEnery Convention Center, Exhibit Halls 1, 2 and 3*

NOTES

JThA • Attosecond Science—Continued

JThA5 • 9:00 a.m.
Control of Electron Dynamics of Doubly Excited States from Isolated Attosecond Pulses, ***Steve Gilbertson****, Michael Chini, Sabih Khan, Yi Wu, Ximao Feng, Zenghu Chang; Kansas State Univ., USA.* The lifetime of the 2s2p autoionization state in helium was measured with attosecond pulses by modifying the doubly excited state with an infrared laser. Control of the electron dynamics was also demonstrated.

JThA6 • 9:15 a.m.
Intracycle Interference in above-Threshold Ionization, ***Kenichi L. Ishikawa****[1], Diego G. Arbó[2,3], Klaus Schiessl[4], Emil Persson[4], Joachim Burgdörfer[4]; [1]Univ. of Tokyo, Japan, [2]IAFE, Argentina, [3]Univ. of Buenos Aires, Argentina, [4]Vienna Univ. of Technology, Austria.* Above-threshold ionization spectra consist of intra- and intercycle interferences of electron trajectories. The former is imprinted as a modulation envelope of discrete peaks formed by the latter. This modulation is clearly seen in the wavelength-dependence.

JThA7 • 9:30 a.m.
HOMO Signature in High Order Harmonics Driven in N_2O and CO_2 by a Few-Cycle 1.5-micron Parametric Source, *Caterina Vozzi[1], Matteo Negro[1], Francesca Calegari[1], Fabio Frassetto[2], Mauro Nisoli[1], Luca Poletto[2], Giuseppe Sansone[1], Paolo Villoresi[2], Sandro De Silvestri[1],* ***Salvatore Stagira****[1]; [1]ULTRAS, CNR-INFM and Dept. di Fisica, Politecnico di Milano, Italy, [2]LUXOR, CNR-INFM and DEI, Univ. di Padova, Italy.* High order harmonics driven by an ultrafast IR parametric source were generated in aligned N_2O and CO_2; the experimental results are numerically reproduced taking into account the HOMO structure.

CThH • Mid-IR Parametric Sources—Continued

CThH5 • 9:00 a.m.
More than 1000-nm-Wide Mid-IR Frequency Comb Based on Divide-by-2 Optical Parametric Oscillator, ***Konstantin Vodopyanov****[1], Nick Leindecker[1], Robert Byer[1], Vladimir Pervak[2]; [1]Stanford Univ., USA, [2]Dept. für Physik, Ludwig-Maximilians-Univ., Germany.* We implement a new approach for creating broadband mid-infrared frequency combs via degenerate divide-by-2 optical parametric oscillator. It was pumped by a 1560-nm femtosecond Er-fiber laser and produced > 1000-nm-wide frequency comb centered at 3.1μm.

CThH6 • 9:15 a.m.
High-Power, Broadband, Continuous-Wave, Mid-Infrared Optical Parametric Oscillator Based on MgO:PPLN, ***S. Chaitanya Kumar****[1], Ritwick Das[1], Goutam Kumar Samanta[1], Majid Ebrahim-Zadeh[1,2]; [1]ICFO, Spain, [2]ICREA, Spain.* We present a broadband, high-power, fiber-laser-pumped, continuous-wave optical parametric oscillator for mid-infrared by exploiting extended phase-matching properties of MgO:PPLN. Total powers of 11.3W, with 5.3W broadband mid-infrared idler in excellent beam quality are generated.

CThH7 • 9:30 a.m.
Wavelength-Tunable Mid-Infrared 3-μm-Waveband Light Source with 805/1064-nm Differential Frequency Generation in Effective Intracavity System, ***Naokatsu Yamamoto****[1], Ryo Naito[2], Kouichi Akahane[1], Tetsuya Kawanishi[1], Hideyuki Sotobayashi[2]; [1]NICT, Japan, [2]Aoyama Gakuin Univ., Japan.* A wavelength-tunable mid-infrared 3-μm-waveband light source with an effective intracavity system is successfully demonstrated. Its advantages include wide wavelength-tunable range (> 85 nm), high emission intensity, simple controllability, and small footprint.

JThB • *In situ* Laser-Based Sensing—Continued

JThB5 • 9:00 a.m.
Highly-Sensitive Measurements of Changes in Density and Refractive Index of Air Using Fiber Laser Polarization Mode Beating Techniques, ***Andrea Rosales-García****[1], Theodore F. Morse[1], Juan Hernández-Cordero[2]; [1]Boston Univ., USA, [2]Inst. de Investigaciones en Materiales, Univ. Nacional Autónoma de México, Mexico.* We demonstrate a highly-sensitive fiber optic sensor for measuring changes in the refractive index of air. This technique provides an accurate method for monitoring refractive index, density and pressure of gases in an intra-cavity vessel.

JThB6 • 9:15 a.m.
Gas Sensing with a Sub-Micron Tapered Fibre Embedded in Hydrophobic Aerogel , ***Limin Xiao****, Michael Grogan, Richard England, William Wadsworth, Tim Birks; Univ. of Bath, UK.* Tapered fibres with waist diameters down to 0.7 μm embedded in hydrophobic aerogel are demonstrated as evanescent-field gas sensors. The porous aerogel is permeable to gases but protects the sub-micron fibre from contamination and damage.

JThB7 • 9:30 a.m.
Directly Coupled VCSELs and Suspended-Core PCFs for Robust Near-Infrared Gas Sensing, ***Jia Chen****[1,2], Andreas Hangauer[1,2], Rainer Strzoda[1], Tijmen Euser[3], Jocelyn Chen[3], Michael Scharrer[3], Philip Russell[3], Markus Amann[2]; [1]Siemens, Germany, [2]Walter-Schottky-Inst., Technical Univ. of Munich, Germany, [3]Max-Planck-Inst. for the Science of Light, Germany.* We demonstrate direct-coupling of vertical-cavity surface-emitting lasers to suspended-core PCFs and present characterization of this gas sensor. The spectral background and power-overlap from 763 to 2004 nm are measured to determine the quantitative detection sensitivity.

10:00 a.m.–10:30 a.m. Coffee Break, *San Jose McEnery Convention Center, Exhibit Halls 1 and 2*

10:00 a.m.–3:00 p.m. Exhibit Open, *San Jose McEnery Convention Center, Exhibit Halls 1, 2 and 3*

NOTES

10:30 a.m.–12:15 p.m.
CThI • Saturable Absorber Mode-Locked Sources
Fiorenzo Omenetto; Tufts Univ., USA, Presider

CThI1 • 10:30 a.m.
First SESAM-Modelocked Yb:KGW Femtosecond Oscillator Operating at 1 GHz Repetition Rate, ***Selina Pekarek***[1]*, Christian Fiebig*[2]*, Max C. Stumpf*[1]*, Andreas E. H. Oehler*[1]*, Katrin Paschke*[2]*, Götz Erbert*[2]*, Thomas Südmeyer*[1]*, Ursula Keller*[1]*;* [1]*ETH Zürich, Switzerland,* [2]*Ferdinand-Braun-Inst. für Höchstfrequenztechnik, Germany.* We present the first femtosecond SESAM-modelocked Yb:KGW laser operating at 1 GHz repetition rate. We generated 120 mW output power in 317-fs pulses at 1.7-W pump power from a high-brightness single-frequency DBR tapered diode laser.

CThI2 • 10:45 a.m.
Quantum Well Saturable Absorber Mirror with Electrical Control of Modulation Depth, ***Xiaomin Liu***[1]*, Edik U. Rafailov*[2]*, Daniil Livshits*[3]*, Dmitry Turchinovich*[1]*;* [1]*DTU Fotonik, Technical Univ. of Denmark, Denmark,* [2]*Photonics and Nanoscience, Univ. of Dundee, UK,* [3]*Innolume GmbH, Germany.* A saturable absorber mirror comprizing InGaAs/GaAs quantum wells incorporated into a *p-i-n* structure is demonstrated. Its modulation depth can be reduced from 4.25% to 1.63% by applying reverse bias voltage in the range 0-1 V.

CThI3 • 11:00 a.m.
Widely-Tunable Femtosecond Operation of Cr:LiSAF Lasers Using Broadband Saturable Bragg Reflectors, ***Umit Demirbas****, Gale S. Petrich, Sheila Nabanja, Jonathan R. Birge, Leslie A. Kolodziejski, Franz X. Kärtner, James G. Fujimoto; MIT, USA.* We describe a low-cost diode-pumped Cr:LiSAF laser, mode-locked using a broadband saturable Bragg reflector. The laser produces continuously tunable sub-200-fs duration pulses from 800 nm to 905 nm.

CThI4 • 11:15 a.m.
Noise and Stability in Giant-Chirp Oscillators Mode-Locked with a Nanotube-Based Saturable Absorber, ***E. J. R. Kelleher***[1]*, J. C. Travers*[1]*, Z. Sun*[2]*, A. C. Ferrari*[2]*, S. V. Popov*[1]*, J. R. Taylor*[1]*;* [1]*Imperial College London, UK,* [2]*Univ. of Cambridge, UK.* We compare experimental results showing stable dissipative-soliton solutions exist in mode-locked lasers with ultra-large normal dispersion (as large as 21.5 ps^2), with both the analytic framework provided by Haus' master-equation and full numerical simulations.

10:30 a.m.–12:15 p.m.
CThJ • Silicon Modulators and Switches
Michael Watts; Sandia Natl. Labs, USA, Presider

CThJ1 • 10:30 a.m. Invited
Broadband Silicon Photonic Switch Integrated with CMOS Drive Electronics, ***Benjamin G. Lee****, Joris Van Campenhout, Alexander V. Rylyakov, Clint L. Schow, William M. J. Green, Solomon Assefa, Min Yang, Fuad E. Doany, Christopher V. Jahnes, Richard A. John, Jeffrey A. Kash, Yurii A. Vlas; IBM Res., USA.* A CMOS driver and broadband silicon photonic switch are co-designed and wire-bond packaged. The integrated switch demonstrates less than 2.1-ns transition times, better than 15-dB extinction, and 5.9-mW total power consumption.

CThJ2 • 11:00 a.m.
Microwave Photonic Phase Shifter Based on Tunable Silicon-on-Insulator Microring Resonator, ***Minhao Pu***[1]*, Liu Liu*[1]*, Weiqi Xue*[1]*, Lars Hagedorn Fradsen*[2]*, Haiyan Ou*[1]*, Kresten Yvind*[1]*, Jørn Märcher Hvam*[1]*;* [1]*Technical Univ. of Denmark, Denmark,* [2]*NKT Photonics, Denmark.* We demonstrate a microwave photonic phase shifter based on an electrically tunable silicon-on-insulator microring resonator. A continuously tunable phase shift of up to 315° at a microwave frequency of 15GHz is obtained.

CThJ3 • 11:15 a.m.
Silicon Microring Modulator with Integrated Heater and Temperature Sensor for Thermal Control, ***Christopher T. DeRose****, Michael R. Watts, Douglas C. Trotter, David L. Luck, Gregory N. Nielson, Ralph W. Young; Sandia Natl. Labs, USA.* The first demonstration of a silicon microring modulator with both an integrated resistive heater and diode-based temperature sensor is shown. The temperature-sensor exhibits a linear response for more than an 85 °C external temperature range.

10:30 a.m.–12:15 p.m.
CThK • Access Networks
Chang-Hee Lee; KAIST, Republic of Korea, Presider

CThK1 • 10:30 a.m.
Plastic Optical Fiber with VCSEL Sources: A Statistical Evaluation, ***Patrick J. Decker****, Stephen E. Ralph; Georgia Tech, USA.* We report the first statistical evaluation of the calculated effective modal bandwidth and 10Gb/s ISI penalty of graded-index perfluorinated plastic optical fiber under VCSEL illumination, utilizing high temporal-resolution differential modal delay measurements.

CThK2 • 10:45 a.m.
Robustness of VCSEL-Based WDM-PON Using Orthogonally Polarized Injection, ***Devang Parekh****, Julian Treu, Weijian Yang, Werner Hofmann, Connie J. Chang-Hasnain; Univ. of California at Berkeley, USA.* We demonstrate a wavelength division multiplexed passive optical network scheme utilizing long wavelength VCSELs under orthogonally polarized optical injection. Robustness to optical feedback for both upstream and downstream data is shown.

CThK3 • 11:00 a.m.
Suppression of Harmonic and Intermodulation Distortion for SCM-WDM RoF Systems based on the Spectral Slicing of Optical Broadband Sources, ***Mora Jose****, Capmany Jose, Ortega Beatriz, Grassi Fulvio; Inst. de Telecomunicaciones y Aplicaciones Multimedia, Univ. Politécnica de Valencia, Spain.* This paper presents the experimental evaluation of harmonic and intermodulation distortions in a SCM-WDM RoF scheme based on spectral slicing of an optical broadband source. The insertion of a Mach-Zehnder interferometer suppresses significantly nonlinear terms.

CThK4 • 11:15 a.m.
Optical Double-to-Single Sideband Modulation Converter for Radio-over-Fiber Systems Based on Injection-Locked Fabry-Peròt Lasers, *Giulio Cossu,* ***Marco Presi****, Ernesto Ciaramella; Scuola Superiore Sant'Anna, Italy.* We experimentally demonstrate a double-to-single sideband converter based on an injection-locked semiconductor laser. By this technique a 64-QAM 54Mb/s-OFDM signal at 6 GHz is transmitted successfully over 80 km SMF avoiding penalties associated to fading.

10:30 a.m.–12:15 p.m.
CThL • Quantum Wires and Dots
Fumio Koyama; Tokyo Inst. of Technology, Japan, Presider

CThL1 • 10:30 a.m. Invited
Novel Growth and Device Concepts for High-Efficiency InGaN Quantum Wells Light-Emitting Diodes, *Hongping Zhao, Guangyu Liu, Xiao-Hang Li, Yik-Khoon Ee, Hua Tong, Jing Zhang, G. S. Huang,* ***Nelson Tansu****; Lehigh Univ., USA.* The growths and characteristics of staggered InGaN quantum wells (QWs) and type-II InGaN-GaNAs QWs are presented for high-efficiency green-emitting light-emitting diodes (LEDs). Approaches for enhancing internal-quantum-efficiency, light-extraction-efficiency, and efficiency-droop in nitride LEDs are discussed.

CThL2 • 11:00 a.m.
Holographic Patterning of Semiconductor CdSe Quantum Dots in Polymer for Constructing Photonic Lattice Structures, *Xiangming Liu*[1]*,* ***Yasuo Tomita***[1]*, Juro Oshima*[2]*, Katsumi Chikama*[2]*, Takuya Nakashima*[3]*, Tsuyoshi Kawai*[3]*;* [1]*Univ. of Electro-Communications, Japan,* [2]*Nissan Chemical Industries, Ltd., Japan,* [3]*Nara Inst. of Science and Technology, Japan.* We demonstrate holographic patterning of semiconductor CdSe quantum dots in photo-polymerizable monomer films for constructing cm-size transmission volume Bragg grating structures. The diffraction efficiency near 100% from the grating structure was observed in the green.

CThL3 • 11:15 a.m.
Parametric Results of the AlGaInAs Quantum-Well Saturable Absorber for Use as a Passive Q-Switch, ***Daniel A. Bender****, Jeffrey G. Cederberg, Gregory A. Hebner; Sandia Natl. Lab, USA.* We have successfully designed, built and operated a microlaser based on a AlGaInAs multiple quantum well (MQW) semiconductor saturable absorber (SESA). Optical characterization of the semiconductor absorber, as well as, the microlaser output is presented.

Room A5

JOINT

10:30 a.m.–12:15 p.m.
JThC • Joint CLEO/QELS Symposium on Quantum Control I
Debabrata Goswami; Indian Inst. of Technology, Kanpur, India, Presider

JThC1 • 10:30 a.m. Invited
Preserving Quantum Coherence Using Optimized Open-Loop Control Techniques, ***Michael J. Biercuk****, Hermann Uys, Aaron P. VanDevender, Nobuyasu Shiga, Wayne M. Itano, John J. Bollinger; NIST, USA.* We describe experimental and theoretical optimizations of open-loop quantum control techniques known as dynamical decoupling (DD) for the suppression of decoherence-induced errors in quantum systems.

JThC2 • 11:00 a.m.
Quantum Process Tomography by Direct Characterization of Quantum Dynamics Using Hyperentangled Photons, ***Trent M. Graham***[1]*, Paul G. Kwiat*[1]*, Julio Barreiro*[2]*;* [1]*Univ. of Illinois, USA,* [2]*Univ. Innsbruck, Austria.* We present the first experimental results using photons entangled in multiple degrees of freedom to efficiently characterize various preserving single-photon processes by Direct Characterization of Quantum Dynamics (DCQD), with the fewest possible number of measurements.

JThC3 • 11:15 a.m.
Ultrafast Coherent Control of Spin Waves with Intense Terahertz Magnetic Transients, ***Alexander Sell***[1]*, Tobias Kampfrath*[2]*, Gregor Klatt*[1]*, Sebastian Mährlein*[1]*, Alexej Pashkin*[1]*, Manfred Fiebig*[3]*, Thomas Dekorsy*[1]*, Martin Wolf*[4]*, Rupert Huber*[1]*, Alfred Leitenstorfer*[1]*;* [1]*Univ. of Konstanz, Germany,* [2]*FOM Inst. for Atomic and Molecular Physics (AMOLF), Netherlands,* [3]*Helmholtz-Inst. für Strahlen- und Kernphysik, Germany,* [4]*Fritz-Haber-Inst. der Max-Planck-Gesellschaft, Germany.* Intense terahertz transients coherently control magnon oscillations in antiferromagnetic NiO. The magnetic component of the light field directly couples to the spins via Zeeman interaction. 8-fs probe pulses sample the ultrafast dynamics via Faraday rotation.

Room A6

CLEO

10:30 a.m.–12:15 p.m.
CThM • High Power/Broadly Tunable QCLS
Mikhail Belkin; Univ. of Texas at Austin, USA, Presider

CThM1 • 10:30 a.m. Tutorial
Technology, Manufacturing and Applications Associated with the Commercialization of Systems Based on Quantum Cascade Gain Media and Lasers, ***Tim Day****; Daylight Solutions, USA.* Extraordinary progress has been made to advance the performance and manufacturability of quantum cascade materials. In this talk, we will describe some of the key technology and manufacturing issues for commercializing quantum cascade laser products.

Dr. Timothy Day is a cofounder of Daylight Solutions and serves as the CEO and CTO for the company. Dr. Day has over 20 years' experience in both technical and business management in the photonics industry. He started his career as a cofounder of New Focus, where he served from 1990 through 2004. Dr. Day has extensive technical knowledge and experience and is considered an expert in the field of photonics. He holds both a B.S. and an M.S. in Physics from San Diego State University and a Ph.D. in Electrical Engineering from Stanford University.

Room A7

QELS

10:30 a.m.–12:15 p.m.
QThE • Plasmonic Metamaterials
Henri Lezec; NIST, USA, Presider

QThE1 • 10:30 a.m.
Negative Refraction in Indefinite Permittivity Medium, ***Dmitriy V. Korobkin***[1]*, Burton Neuner III*[1]*, Chris Fietz*[1]*, Gennady Shvets*[1]*, Davy Carole*[2]*, Gabriel Ferro*[2]*;* [1]*Univ. of Texas at Austin, USA,* [2]*Univ. Claude Bernand Lyon 1, France.* We present theoretical calculations and experimental results demonstrating the negative refraction in indefinite permittivity medium based on SiO_2-SiC- SiO_2 multi-layer structure. Also the enhancement of higher order Fourier harmonics has been experimentally shown.

QThE2 • 10:45 a.m.
Experimental Realization of a Perfect Infrared Absorber, *Hossein Mousavi, Alexander Khanikaev, Burton Neuner III, Dmitry Korobkin,* ***Gennady Shvets****; Univ. of Texas at Austin, USA.* Low-absorbing materials can be made strongly absorbing by utilizing plasmonic metamaterials. We propose and experimentally validate the concept of a plasmonic MetaMirror which improves energy absorption efficiency by an order of magnitude.

QThE3 • 11:00 a.m.
Extraordinary Low Transmission of a Metamaterial for Application in Lithography , ***Sabine Dobmann***[1,2,3]*, Daniel Ploss*[1,2]*, David Reibold*[2]*, Andreas Erdmann*[4]*, Ulf Peschel*[2,5]*;* [1]*Max-Planck-Inst. for the Science of Light, Germany,* [2]*Univ. of Erlangen-Nuremberg, Germany,* [3]*Erlangen Graduate School in Advanced Optical Technologies (SAOT), Germany,* [4]*Fraunhofer Inst. of Integrated Systems and Device Technology, Germany,* [5]*Cluster of Excellence, Engineering of Advanced Materials, Germany.* We present experiments on a metamaterial made from an ultrathin (<40 nm) metal film. It exhibits extraordinary low transmission due to an antenna resonance and may form building blocks of future lithographic masks.

QThE4 • 11:15 a.m.
Ultra-Thin Ultra-Smooth and Low-Loss Silver and Silver-Silica Composite Films for Superlensing Applications, ***Weiqiang Chen****, Mark D. Thoreson, Alexander V. Kildishev, Vladimir M. Shalaev; Purdue Univ., USA.* We demonstrate a method to fabricate ultra-thin ultra-smooth and low-loss silver and silver-silica composite films using a germanium wetting layer and a rapid post-annealing treatment. Such achievement satisfies both the demands for superlenses and hyperlenses.

10:30 a.m.–12:15 p.m. QThF • Collective Excitation and Losing in Semiconductors

Alexey Belyanin; Texas A&M Univ., USA, Presider

QThF1 • 10:30 a.m.

Formation of Coherent Longitudinal Optical Phonon and Plasmon Coupling Modes in Semiconductors, *Yu-Ming Chang;* *Ctr. for Condensed Matter Sciences, Taiwan.* Coherent LO phonon and plasmon coupling dynamics in GaAs (100) is investigated with TRSHG. Quantum interference near zero time delay is identified and ascribed to Fano resonance between coherent LO phonon and photoexcited plasma continuum.

QThF2 • 10:45 a.m.

Terahertz Studies of Collective Excitations and Microscopic Physics in a Semiconductor Magneto-plasma, *Alexey Belyanin*[1], *Xiangfeng Wang*[2], *Scott A. Crooker*[3], *Daniel M. Mittleman*[2], *Junichiro Kono*[2]; [1]*Dept. of Physics, Texas A&M Univ., USA,* [2]*Dept. of Electrical and Computer Engineering, Rice Univ., USA,* [3]*Natl. High Magnetic Field Lab, USA.* Using coherent THz time-domain spectroscopy, we observe and successfully model a rich variety of interference phenomena related to long-lived magneto-plasmon excitations in InSb magneto-plasmas. New effects of tunable thermally and magnetically induced transparency are observed.

QThF3 • 11:00 a.m.

The Guided-Mode Phonon-Polariton in Suspended Waveguides, *Scott A. Holmstrom*[1], *Todd H. Stievater*[2], *Marcel W. Pruessner*[2], *Doewon Park*[2], *William S. Rabinovich*[2], *Subramaniam Kanakaraju*[3], *Christopher J. K. Richardson*[3], *Jacob B. Khurgin*[4]; [1]*Univ. of Tulsa, USA,* [2]*NRL, USA,* [3]*Lab for Physical Sciences, USA,* [4]*Johns Hopkins Univ., USA.* Using Raman scattering measurements in suspended semiconductor waveguides coupled with finite-element analysis, we elucidate the properties of the guided-mode phonon-polariton, which plays a critical role in many current terahertz generation approaches.

QThF4 • 11:15 a.m.

Theory of Stimulated Optical Emission Dynamics in Conjugated Polymers, *Stefan Schumacher*[1], *Ian Galbraith*[1], *Arvydas Ruseckas*[2], *Graham A. Turnbull*[2], *Ifor D. W. Samuel*[2]; [1]*Heriot-Watt Univ., UK,* [2]*Univ. of St. Andrews, UK.* We present a microscopic many-particle theory of intense ultrafast optical pulse propagation in conjugated polymers. For a polyfluorene film rich amplified spontaneous emission dynamics and significant pulse reshaping is found.

10:30 a.m.–12:15 p.m. QThG • Single Photon Technology and Applications

Jian-Wei Pan; Univ. Heidelberg, Germany, Presider

QThG1 • 10:30 a.m. Invited

Advances in Photonic Quantum Information Science, *Alberto Politi*[1], *Jonathan C. F. Matthews*[1], *Anthony Laing*[1], *Alberto Peruzzo*[1], *Pruet Kalaswan*[1], *Xiao-Qi Zhou*[1], *Maria Rodas Verde*[1], *Martin J. Cryan*[1], *John G. Rarity*[1], *Andre Stefanov*[2], *Timothy C. Ralph*[3], *Siyuan Yu*[1], *Mark G. Thompson*[1], *Jeremy L. O'Brien*[1]; [1]*Univ. of Bristol, UK,* [2]*Federal Office of Metrology METAS, Switzerland,* [3]*Univ. of Queensland, Australia.* Quantum technologies based on photons will likely require integrated optics architectures for improved performance, miniaturization and scalability. We demonstrate high-fidelity silica-on-silicon integrated optical realizations of key quantum photonic circuits and the first integrated quantum algorithm.

QThG2 • 11:00 a.m.

Phase-Controlled Photonic Quantum Circuits in Laser Written Integrated Optics, *Nicholas L. Thomas-Peter*[1], *Brian J. Smith*[1,2], *Dmytro Kundys*[3], *Peter G. R. Smith*[3], *Ian A. Walmsley*[1]; [1]*Dept. of Physics, Oxford Univ., UK,* [2]*Ctr. for Quantum Technologies, Natl. Univ. of Singapore, Singapore,* [3]*Optoelectronics Res. Ctr., Univ. of Southamption, UK.* We present a direct UV written integrated photonic circuit with on-chip phase control through a thermo-optic phase shifter. An arbitrary beam splitter and a two-photon N00N state are demonstrated with high visibility interference.

QThG3 • 11:15 a.m.

Triggered Single Photons from a Diamond Nanowire Antenna, *Thomas M. Babinec*[1], *Birgit Hausmann*[1], *Mughees Khan*[1], *Yinan Zhang*[1], *Philip Hemmer*[2], *Marko Loncar*[1]; [1]*Harvard Univ., USA,* [2]*Texas A&M Univ., USA.* We describe room temperature CW and pulsed spectroscopic studies of a high-flux source of single photons based on the fluorescence of an individual Nitrogen-Vacancy color center in a diamond nanowire antenna.

10:30 a.m.–12:15 p.m. CThN • Waveguide Applications

David C. Hutchings; Univ. of Glasgow, UK, Presider

CThN1 • 10:30 a.m.

Experimental and Theoretical Demonstration of Wavelength Conversion of 10 Gb/s RZ-OOK in a Si nanowire via XPM, *Jeffrey B. Driscoll*[1], *W. Astar*[2,3], *Xiaoping Liu*[1], *Richard R. Grote*[1], *Jerry I. Dadap*[1], *William M. J. Green*[4], *Yurri A. Vlasov*[4], *Gary M. Carter*[2,3,5], *Richard M. Osgood, Jr.*[1]; [1]*Columbia Univ., USA,* [2]*Lab for Physical Sciences, USA,* [3]*Ctr. for Advanced Studies in Photonics Res., USA,* [4]*IBM T. J. Watson Res. Ctr., USA,* [5]*Univ. of Maryland, Baltimore County, USA.* We present all-optical wavelength conversion (WC) of 10 Gb/s RZ-OOK data in a Si nanowire waveguide via cross-phase-modulation (XPM). The WC mechanism is analytically modeled and shown to be scalable to 40 Gb/s RZ-OOK data.

CThN2 • 10:45 a.m.

All Optical Wavelength Conversion in an Integrated Ring Resonator, *Alessia Pasquazi*[1], *Raja Ahmad*[2], *Martin Rochette*[2], *Michael Lamont*[3], *Roberto Morandotti*[1], *Brent E. Little*[4], *Sai T. Chu*[4], *David Moss*[3]; [1]*Ultrafast Optical Processing Group INRS-EMT, Canada,* [2]*McGill Univ., Canada,* [3]*CUDOS, School of Physics, Univ. of Sydney, Australia,* [4]*Infinera Corp., USA.* We present the first system penalty measurements for all-optical wavelength conversion via four wave mixing in an integrated, CMOS compatible, ring resonator, obtaining < 0.3 dB system penalty at 2.5Gb/s for ~22dBm average pump power.

CThN3 • 11:00 a.m.

10 Gb/s Operation of Monolithic All-Optical Set-Reset Flip-Flop Based on Semiconductor Ring Laser, *Andrea Trita*[1], *Gabor Mezosi*[2], *Maria Jose Latorre Vidal*[1], *Marco Zanola*[1], *Ilaria Cristiani*[1], *Marc Sorel*[2], *Paolo Ghelfi*[3], *Antonella Bogoni*[3], *Guido Giuliani*[1]; [1]*Electronic Dept., Univ. of Pavia, Italy,* [2]*Dept. of Electronics and Electrical Engineering, Univ. of Glasgow, UK,* [3]*CNIT-Photonic Networks Natl. Lab, Italy.* A monolithic semiconductor ring laser is operated as an all-optical Flip-Flop triggered by 4ps optical pulses. Bit-Error-Rate measurements of Set-Reset switchings under the injection of a Pseudo-Random-Bit-Sequence at 5 and 10 Gb/s have been performed.

CThN4 • 11:15 a.m.

Nonlinear Distortions Induced by Non-Idealities of Integrated Silicon Waveguides in Analog Optical Links, *Lin Zhang*[1], *Jian Wang*[1], *Muping Song*[2], *Yang Yue*[1], *Yinying Xiao-Li*[1], *Raymond G. Beausoleil*[3], *Alan E. Willner*[1]; [1]*Univ. of Southern California, USA,* [2]*Zhejiang Univ., China,* [3]*HP Labs, USA.* We analyze nonlinear distortions caused by integrated silicon strip waveguides for analog applications. Performance degradations due to interactions of nonlinear Kerr effects, chromatic dispersion and carrier dynamics are discussed.

10:30 a.m.–12:15 p.m. CThO • CLEO Symposium on Laser Beam Combining II: Beam-Combined Fiber Lasers and Amplifiers

Daniel J. Ripin; MIT Lincoln Lab, USA, Presider

CThO1 • 10:30 a.m. Invited

Beam Combining in Multi-Core, Holey Fiber Lasers, *Terence Shepherd,* *Laurent Michaille, Charlotte R. Bennett, David M. Taylor; QinetiQ Ltd., UK.* Multiple-core fibers offer the possibility of creating fiber lasers with enlarged effective core diameter, while simultaneously controlling mode shape and quality. A review is presented of the basic theory used for design, and examples presented of such lasers operating in Q-switched mode. Examples of active, non-interacting, and passive multiple-core fibers are also presented.

CThO2 • 11:00 a.m.

All-Fiber Phase-Locked Multi-Core Photonic Crystal Fiber Laser with Fill-Factor Enhancement and High Efficiency, *Akira Shirakawa,* *Tetsuya Kobayashi, Michio Matsumoto, Ken-ichi Ueda; Inst. for Laser Science, Univ. of Electro-Communications, Japan.* We report large-mode-area Yb-doped 6-core photonic crystal fiber laser in in-phase supermode operation. A monolithic Talbot device, enhancing the fill-factor in fiber and central-lobe fraction in the far-field profile, was demonstrated with 84% slope efficiency.

CThO3 • 11:15 a.m. Invited

Coherent Fiber Combining by Digital Holography, *Cindy Bellanger*[1], *M. Paurisse*[2], *A. Brignon*[1], *J. Colineau*[1], *J. P. Huignard*[1], *M. Hanna*[2], *F. Druon*[2], *P. Georges*[2]; [1]*Thales Res. and Technology, France,* [2]*Lab Charles Fabry de l'Inst. d'Optique, Univ. Paris-Sud, France.* We present and demonstrate a technique for coherent beam combining of fibre amplifiers using phase conjugation by digital holography. The method is also applied to realize beam correction on multimode and multicore fibers.

Thursday, May 20

San Jose Salon III (San Jose Marriott)

JOINT

10:30 a.m.–12:15 p.m.
JThD • Ultrafast and Short Wavelength Technology

John Crane; Lawrence Livermore Natl. Lab, USA, Presider

JThD1 • 10:30 a.m.
High Energy 13.9 nm Table-Top Soft X-Ray Laser Operating at 2.5 Hz Repetition Rate, ***David A. Alessi****, Dale H. Martz, Brad M. Luther, Yong Wang, Mark A. Berrill, David J. Kemp, Dinesh Patel, Carmen S. Menoni, Jorge J. Rocca; Colorado State Univ., USA.* We have demonstrated table-top generation of λ = 13.9 nm laser pulses with 7μJ energy at 2.5Hz from nickel-like ions in a laser-created plasma that will enable new applications of coherent soft X-ray light on a table-top.

JThD2 • 10:45 a.m.
High-Energy, Picosecond, Cryogenic Yb:YAG Chirped-Pulse Amplifier at kHz Repetition Rates for OPCPA Pumping, ***Kyung-Han Hong***[1]*, Juliet Gopinath*[2]*, Darren Rand*[2]*, Aleem Siddiqui*[1]*, Shu-Wei Huang*[1]*, Enbang Li*[3]*, Benjamin Eggleton*[3]*, John Hybl*[2]*, Tso Yee Fan*[2]*, Franz X. Kärtner*[1]*; [1]MIT, USA, [2]MIT Lincoln Lab, USA, [3]CUDOS, School of Physics, Univ. of Sydney, Australia.* We report on the development of a 50-mJ-class ~10-ps chirped-pulse amplifier at kHz repetition rates using cryogenic Yb:YAG regenerative and multi-pass amplifiers. The system is well suited as pump laser for kHz high-average-power ultra-broadband OPCPAs.

JThD3 • 11:00 a.m.
Production of 3ps Multi-Terawatt Pulses in a CO_2 Laser System, ***D. Haberberger****, S. Tochitsky, C. Joshi; Univ. of California at Los Angeles, USA.* 15TW picosecond 10μm laser pulses are obtained at the UCLA Neptune Laboratory achieving record CO_2 laser power. This peak power opens unique opportunities for applications in high-field experiments in the mid-IR range.

JThD4 • 11:15 a.m.
CEP-Locked Three-Color Parametric System for "Perfect Wave" Synthesis, *Tadas Balčiūnas*[1]*, Giedrius Andriukaitis*[1]*,* ***Oliver D. Mücke***[1]*, Aart J. Verhoef*[1]*, Audrius Pugžlys*[1]*, Andrius Baltuška*[1]*, Darius Mikalauskas*[2]*, Linas Giniūnas*[2]*, Romualdas Danielius*[2]*, Ronald Holzwarth*[3]*; [1]Vienna Univ. of Technology, Austria, [2]Light Conversion Ltd., Lithuania, [3]Menlo Systems GmbH, Germany.* The relative and absolute phases of femtosecond 1.03-μm pump, 1.55-μm signal and 3.09-μm idler pulses are stabilized paving the way for the generation of optimized driver waveforms for higher-order-harmonic generation and electron impulsive momentum transfer.

San Jose Salon I & II (San Jose Marriott)

CLEO

10:30 a.m.–12:15 p.m.
CThP • Optical Parametric Oscillators I

Darrell Armstrong; Sandia Natl. Labs, USA, Presider

CThP1 • 10:30 a.m. Invited
Optical Parametric Oscillators: A New Generation, ***Majid Ebrahim-Zadeh****; ICFO, Spain.* Progress in continuous-wave and ultrafast femtosecond optical parametric oscillators, covering spectral regions from 250 nm in the ultraviolet to 5 μm in the infrared, using novel design concepts and advanced laser pump sources is reviewed.

CThP2 • 11:00 a.m.
Efficient, High-Power, 16-GHz, Picosecond Optical Parametric Oscillator Pumped by an 81-MHz Fiber Laser, ***Omid Kokabee***[1]*, Adolfo Esteban-Martin*[1]*, Majid Ebrahim-Zadeh*[1,2]*; [1]ICFO, Spain, [2]ICREA, Spain.* We report the generation of 16-GHz repetition-rate picosecond pulses in an optical parametric oscillator synchronously pumped by an 81-MHz Yb fiber laser, providing 650 mW of average power tunable over 1.45-1.75 μm.

CThP3 • 11:15 a.m.
Management of Thermal Effects in High Average Power Pulsed Optical Parametric Oscillators, ***Antoine Godard***[1]*, Myriam Raybaut*[1]*, Thomas Schmid*[1]*, Michel Lefebvre*[1]*, Anne-Marie Michel*[2]*, Michel Péalat*[2]*; [1]ONERA - the French Aerospace Lab, France, [2]SAGEM, Groupe SAFRAN, France.* We report on experimental investigation and modelling of thermal effects in high-power pulsed OPOs. A significant improvement of the conversion efficiency is demonstrated when a proper temperature gradient is applied to the nonlinear crystal.

Room B2-B3

CLEO: Applications

10:30 a.m.–12:15 p.m.
AThA • Laser Fusion

Timothy Carrig; Lockheed Martin, USA; Presider

AThA1 • 10:30 a.m. Tutorial
Laser Fusion for Laser Jocks: Basic Principles of a Laser Application Meeting a Grand Challenge, ***Jonathan D. Zuegel****; Lab for Laser Energetics, Univ. of Rochester, USA.* Controlled nuclear fusion has long been sought as a global energy source and ignition of a laser fusion target will soon be realized. Fundamentals and requirements for this ultimate laser application will be presented.

Jonathan Zuegel received the B.S. and the M.Eng. degrees in electrical engineering from Cornell University in 1983 and 1984, respectively, and the Ph.D. degree in optics from The Institute of Optics at the University of Rochester in 1996 after serving in the U.S. Navy. He joined the Laboratory for Laser Energetics in 1996. He has led the Laser Technology Development Group since 2001 and was promoted to Senior Scientist in 2005. His research interests include the solid-state lasers, electro-optics and laser diagnostics. Dr. Zuegel chaired the Advanced Solid State Photonics topical meeting and is currently the OSA Technical Group Chair for Laser Systems.

AThA2 • 11:15 a.m. Tutorial
Fusion Energy: Laser Systems Required to Harness the Power of the Sun, ***Andy J. Bayramian****, R. J. Deri, C. A. Ebbers, A..C. Erlandson, W. A. Molander, S. B. Sutton, S. Telford, J. A. Caird; Lawrence Livermore Natl. Lab, USA.* Laser systems deployed in Inertial Fusion Energy power plants will usher in space qualified laser engineering and materials on a massive scale. Understanding subsystem efficiencies and component Mean Time Between Failure (MTBF) are critical for success.

CThI • Saturable Absorber Mode-Locked Sources—Continued

CThI5 • 11:30 a.m.
High Contrast Grating Based Saturable Absorber for Mode-Locked Lasers, *Weijian Yang*[1], *Forrest Sedgwick*[1], *Zhigang Zhang*[2], *Connie J. Chang-Hasnain*[1]; [1]*Dept. of Electrical Engineering and Computer Sciences, Univ. of California at Berkeley, USA,* [2]*State Key Lab of Advanced Optical Communication Systems and Networks, School of Electronics Engineering and Computer Science, Peking Univ., China.* A novel semiconductor saturable absorber based on high contrast grating is investigated for the first time. The extremely broad reflection band, low saturation fluence, and large design flexibility make it useful in mode-locked femtosecond lasers.

CThI6 • 11:45 a.m.
420 fs Pulses from an Ultrafast Laser Inscribed Waveguide Laser Utilizing a Carbon Nanotube Saturable Absorber, *Stephen J. Beecher*[1], *Robert R. Thomson*[1], *Nicholas D. Psaila*[1], *Ajoy K. Kar*[1], *Zhipei Sun*[2], *Tawfique Hasan*[2], *Alex Rozhin*[2], *Andrea C. Ferrari*[2]; [1]*Heriot-Watt Univ., UK,* [2]*Univ. of Cambridge, UK.* We report the generation of 420 fs pulses of 1.56 µm light from a mode-locked ultrafast laser inscribed Er-doped waveguide laser. Passive mode-locking was achieved using a carbon nanotube saturable absorber.

CThI7 • 12:00 p.m.
Mode Locking with Minimum Nonlinearity Using Inverse-Gain Output Couplers, *Li-Jin Chen*, *Michelle Y. Sander, Franz X. Kärtner; MIT, USA.* Broadband laser mode-locking is demonstrated at greatly reduced modelocking strength with an output coupler that compensates for gain filtering. The concept is demonstrated with a <8fs Ti:sapphire laser showing dramatically improved stability and beam quality.

CThJ • Silicon Modulators and Switches—Continued

CThJ4 • 11:30 a.m.
Low-Power High-Speed Silicon Microdisk Modulators, *William A. Zortman*, *Michael R. Watts, Douglas C. Trotter, Ralph W. Young, Anthony L. Lentine; Sandia Natl. Labs, USA.* A novel silicon microdisk modulator with "error-free" ~3 femtojoule/bit modulation at 12.5Gbs has been demonstrated. Modulation with a 1 volt swing allows for compatibility with current and future digital logic CMOS electronics.

CThJ5 • 11:45 a.m.
Tunable High Speed Silicon Microring Modulator, *Po Dong*[1], *Shirong Liao*[1], *Dazeng Feng*[1], *Hong Liang*[1], *Roshanak Shafiiha*[1], *Ning-Ning Feng*[1], *Guoliang Li*[2], *Xuezhe Zheng*[2], *Ashok V. Krishnamoorthy*[2], *Mehdi Asghari*[1]; [1]*Kotura Inc., USA,* [2]*Sun Microsystems, USA.* We present a 12.5 Gbps silicon micro-ring modulator achieved by carrier depletion in a lateral pn diode. Tunability of the resonant wavelength is accomplished by means of a micro-heater, with an efficiency of 2.36 mW/nm.

CThJ6 • 12:00 p.m.
Ultra Low Power Electro-Optic Modulator on Silicon: Towards Direct Logic Driven Silicon Modulators, *Sasikanth Manipatruni*, *Long Chen, Kyle Preston, Michal Lipson; Cornell Univ., USA.* We demonstrate ultra-low switching energy (9.4 fJ/bit), ultra-low swing voltage (150 mV peak-peak) electro-optic modulation in a 2.5 µm radius silicon ring modulator. These results can enable direct logic driven, driverless silicon modulators.

CThK • Access Networks—Continued

CThK5 • 11:30 a.m.
Single-Sideband Modulation of Vector Signals Based on an Injection-Locked DFB Laser in 60-GHz RoF Systems, *Cheng Zhang*, *Cheng Hong, Peng Guo, Jun Duan, Weiwei Hu, Zhangyuan Chen; Peking Univ., China.* We experimentally demonstrate vector signals transmission over 60-GHz RoF systems using single-sideband modulation based on an injection-locked DFB laser. Both 1-Gb/s QPSK and 1.2-Gb/s 16QAM transmission over 50-km SSMF are realized successfully.

CThK6 • 11:45 a.m.
Radio over Free Space Optical Link Using a Directly Modulated Two-Electrode High Power Tapered Laser, *Michael J. Crisp*[1], *C. H. Kwok*[1], *Mo Xia*[1], *Richard V. Penty*[1], *Ian H. White*[1], *Nicolas Michel*[2], *Michel Krakowski*[2], *M. Calligaro*[2], *M. Lecomte*[2], *O. Parillaud*[2]; [1]*Cambridge Univ., UK,* [2]*Alcatel-Thales III-V Lab, UK.* The analog modulation performance of a high-power two-electrode tapered laser is investigated. A 25dB dynamic range for 2.4GHz 802.11g signals is achieved with a 26dB loss budget, showing a >1km free space range is possible.

CThK7 • 12:00 p.m.
Quasi-Passive and Reconfigurable Node for Optical Access Network, *She-Hwa Yen*[1], *Mihir Tendulkar*[1], *John Jameson*[1], *Shinji Yamashita*[2], *Yoshio Nishi*[1], *Olav Solgaard*[1], *Leonid Kazovsky*[1]; [1]*Stanford Univ., USA,* [2]*Fujitsu Labs, Japan.* We propose a quasi-passive reconfigurable power/wavelength distribution device for optical access network. It can adapt to deployment condition and optimize the energy consumption. Novel tri-state non-volatile optical switches are designed to preserve the semi-passive operation.

CThL • Quantum Wires and Dots—Continued

CThL4 • 11:30 a.m.
Very Low Threshold of Amplified Spontaneous Emission in II-VI Colloidal Quantum Dots at Low Exciton Number, *Cuong H. Dang*, *Arto V. Nurmikko; Brown Univ., USA.* We demonstrate amplified spontaneous emission from close-packed, II-VI QD thin-films at record low threshold excitation energy corresponding to ~1.2 effective exciton per QD. Photon statistics from single QDs illustrates excitonic interactions at lasing threshold excitation.

CThL5 • 11:45 a.m.
Femtosecond Dispersion Measurements of 1.3 µm Quantum Dot Semiconductor Optical Amplifier, *Marcus Bagnell*, *Josue Davila-Rodriguez, Abhijeet Ardey, Peter J. Delfyett; CREOL, College of Optics and Photonics, Univ. of Central Florida, USA.* Spectral interferometry is used to measure the dispersion of a quantum dot semiconductor optical amplifier under various injection current values in the wavelength range of 1200 to 1340 nm, spanning ground and first excited state.

CThL6 • 12:00 p.m.
Photoluminescence Emission in Deep Ultraviolet Region from GaN/AlN Asymmetric-Coupled Quantum Wells, *Guan Sun*[1], *Suvranta K. Tripathy*[1], *Yujie J. Ding*[1], *Guangyu Liu*[1], *G. S. Huang*[1], *Hongping Zhao*[1], *Nelson Tansu*[1], *Jacob B. Khurgin*[2]; [1]*Lehigh Univ., USA,* [2]*Johns Hopkins Univ., USA.* Deep ultraviolet photoluminescence peaks up to 5.1 eV with dramatically improved intensities are observed in GaN/AlN asymmetric-coupled quantum wells, due to recombination of electrons in AlN coupling barriers with heavy holes in GaN quantum wells.

10:30 a.m.–12:30 p.m. Market Focus: Biophotonics, *San Jose McEnery Convention Center, Exhibit Hall 2*

12:15 p.m.–1:00 p.m. Lunch Break *(concessions available on exhibit floor)*

NOTES

Thursday, May 20

Room A5

JOINT

JThC • Joint CLEO/QELS Symposium on Quantum Control I—Continued

JThC4 • 11:30 a.m. Invited

Optical Arbitrary Waveform Generation, ***E. Ippen****, A. Benedick, J. Birge, H. Byun, L.-J. Chen, G. Chang, D. Chao, J. Morse, A. Motamedi, M. Sander, G. Petrich, L. Kolodziejski, F. Kärtner; MIT, USA.* Advances in technology for optical arbitrary waveform generation will be described. Combs spanning two octaves, from 500nm to 2μm, based on GHz modelocked Ti:sapphire and erbium- fiber lasers, have been carrier-envelope stabilized and frequency referenced.

JThC5 • 12:00 p.m.

Temperature Dependent Study of Coherently Controlled Photocurrents Generation in Epitaxial Graphene, ***Dong Sun****[1], Charles Divin[1], Momchil Mihnev[1], Clair Berger[2], Walt de Heer[2], Phillip First[2], Julien Rioux[3], John Sipe[3], Theodore Norris[1]; [1]Univ. of Michigan, USA, [2]Georgia Tech, USA, [3]Univ. of Toronto, Canada.* We study the electron-temperature dependence of optically injected coherently controlled ballistic currents in epitaxial graphene by near field THz detection in cryostat and optical pre-pulse excitation of background hot carriers.

Room A6

CLEO

CThM • High Power/Broadly Tunable QCLS—Continued

CThM2 • 11:30 a.m.

High-Power Thermoelectrically-Cooled and Uncooled Mid-Wave Infrared Quantum Cascade Lasers, ***Richard Maulini****[1], Arkadiy Lyakh[1], Alexei Tsekoun[1], Christian Pflugl[2], Laurent Diehl[2], Federico Capasso[2], Kumar Patel[1,3]; [1]Pranalytica, Inc., USA, [2]School of Engineering and Applied Sciences, Harvard Univ., USA, [3]Dept. of Physics and Astronomy, Univ. of California at Los Angeles, USA.* We present high performance thermoelectrically-cooled and uncooled mid-wave infrared (λ=4.6 μm) quantum cascade lasers with continuous-wave output power of 2.9 W and 1 W at room temperature, respectively.

CThM3 • 11:45 a.m.

Broadband Gain from a "Continuum-to-Bound" Quantum Cascade Laser Design, ***Yu Yao****[1], Tracy Tsai[1], William O. Charles[1], Jianxin Chen[2], Gerard Wysocki[1], Claire F. Gmachl[1]; [1]Princeton Univ., USA, [2]Chinese Acad. of Sciences, China.* A Quantum Cascade laser design based on "continuum-to-bound" transitions with several strongly coupled upper laser states is demonstrated, which enables external cavity tuning over 190 cm^{-1} in pulsed mode operation at 0°C.

CThM4 • 12:00 p.m.

Widely Tunable External Cavity Interband Cascade Laser for Spectroscopic Applications, ***Tracy R. Tsai****[1], Igor Trofimov[2], Charles W. Heaps[1], Mikhail Maiorov[2], Vladimir Zeidel[2], Chul Soo Kim[3], Mijin Kim[3], Chadwick L. Canedy[3], William W. Bewley[3], J. Ryan Lindle[3], Igor Vurgaftman[3], Jerry Meyer[3], Gerard Wysocki[1]; [1]Princeton Univ., USA, [2]AKELA Laser Corp., USA, [3]NRL, USA.* We performed spectroscopy of methane using a broadly tunable external cavity interband cascade laser (EC-ICL). A miniaturized EC-ICL design for field applications, with improved anti-reflection and high-reflection coatings and new EC tuning mechanism, is presented.

Room A7

QELS

QThE • Plasmonic Metamaterials—Continued

QThE5 • 11:30 a.m.

Giant Optical Birefringence Induced by Plasmonic Nano-Gratings, ***Yu-Ju Hung****[1], Ehren Hwang[2], Tsung-Hsien Lin[1], Christopher C. Davis[2]; [1]Natl. Sun Yat-sen Univ., Taiwan, [2]Univ. of Maryland, USA.* A giant birefringence effect has been observed with PMMA surface gratings on a gold film substrate.Surface Plasmon polaritons excited on these nanostructured periodic surfaces are highly anisotropic. This makes very thin waveplates (~150nm) feasible.

QThE6 • 11:45 a.m.

Form-Birefringent Metal and Its Plasmonic Anisotropy, ***Liang Feng****, Zhaowei Liu, Vitaliy Lomakin, Yeshaiahu Fainman; Univ. of California at San Diego, USA.* We constructed a form-birefringent metal exhibiting different polarizabilities along different optical axes and its supported optical anisotropy of surface plasmon waves. The generated plasmonic index ellipsoid existing in reciprocal lattice space has been directly mapped.

QThE7 • 12:00 p.m.

Slow Light without Electromagnetically-Induced Transparency: The Double-Fano Resonance Approach, ***Gennady Shvets****, Chih-Hui Wu, Alexander Khanikaev; Univ. of Texas at Austin, USA.* A new approach to slowing light in plasmonic structures is proposed. We utilize the phenomenon of double-Fano resonance. Specific implementations of such structures based on plasmonic antennas are presented, applications outlined.

10:30 a.m.–12:30 p.m. Market Focus: Biophotonics, *San Jose McEnery Convention Center, Exhibit Hall 2*

12:15 p.m.–1:00 p.m. Lunch Break *(concessions available on exhibit floor)*

NOTES

QThF • Collective Excitation and Losing in Semiconductors—Continued

QThF5 • 11:30 a.m. Invited

Quantum Kinetics of Transport and Gain in Quantum Cascade Lasers: Looking for the Essential Principles of Design, ***Andreas Wacker****; Lund Univ., Sweden.* The complex interplay by tunneling and scattering in quantum cascade lasers is analyzed with nonequilibrium Green's functions. It is argued that a QCL design needs at least three levels per period.

QThF6 • 12:00 p.m.

Time-Domain Observation of Rabi Flopping in a Laser, ***Hyunyong Choi****[1,2], Vasileios-Marios Gkortsas[3], Laurent Diehl[4], David Bour[5], Scott Corzine[5], Jintian Zhu[5], Gloria Höfler[5], Federico Capasso[4], Franz X. Kärtner[3], Theodore B. Norris[2]; [1]Lawrence Berkeley Natl. Lab, USA, [2]Univ. of Michigan, USA, [3]MIT, USA, [4]Harvard Univ., USA, [5]Agilent Labs, USA.* We report direct time-domain observation of Rabi flopping in an operating semiconductor quantum cascade laser.

QThG • Single Photon Technology and Applications—Continued

QThG4 • 11:30 a.m.

Generation of Time-Bin Entangled Photon Pairs Using Cascaded Second Order Nonlinearity in Single Periodically-Poled Lithium Niobate Waveguide, *Myrtille Hunault[1],* ***Hiroki Takesue****[1], Osamu Tadanaga[2], Yoshiki Nishida[2], Masaki Asobe[2]; [1]NTT Basic Res. Labs, Japan, [2]NTT Photonics Labs, Japan.* We report a simple scheme to generate time-bin entangled photon pairs based on cascaded second-order nonlinear processes in a single periodically-poled lithium niobate waveguide. We successfully observed two-photon interference fringes up to 97% visibilities.

QThG5 • 11:45 a.m.

Towards Interfacing Dissimilar Quantum Systems, ***Sergey V. Polyakov****[1], Andreas Muller[1], Alexander Ling[1], Edward B. Flagg[1], Natalia Rutter[1,2], Edward Van Keuren[2], Alan L. Migdall[1], Glenn S. Solomon[1]; [1]Joint Quantum Inst., NIST and Univ. of Maryland, USA, [2]Physics Dept., Georgetown Univ., USA.* We report on an experimental implementation of an interface between quantum dots (QD) and parametric downconversion (PDC). We present a PDC source compatible with QD emission and our efforts to demonstrate such compatibility.

QThG6 • 12:00 p.m.

Telecom-Band Single Photon Switch, ***Matthew A. Hall****, Joseph B. Altepeter, Prem Kumar; Northwestern Univ., USA.* We present a high-speed all-optical switch for use in quantum information processing. The demonstrated implementation is capable of operating on 1310-nm single photons. Its performance is characterized using polarization-entangled photon pairs.

CThN • Waveguide Applications—Continued

CThN5 • 11:30 a.m.

Time-Lens for Sub-Picosecond Optical Pulse Measurement on a Chip, ***Alessia Pasquazi****[1], Yongwoo Park[1], Jose Azaña[1], François Légaré[2], Roberto Morandotti[1], Brent Little[3], Sai T. Chu[3], David Moss[4]; [1]Ultrafast Optical Processing Group INRS-EMT, Canada, [2]INRS-EMT, Canada, [3]Infinera Corp., USA, [4]CUDOS, School of Physics, Univ. of Sydney, Australia.* We demonstrate temporal imaging of optical signals with sub-picosecond time features based on four wave mixing temporal-to-frequency domain conversion in a CMOS compatible, high index glass waveguide.

CThN6 • 11:45 a.m.

Error-Free All-Optical Demultiplexing at 160Gb/s via FWM in a Silicon Nanowire, *Fangxin Li[1], Mark Pelusi[1], Benjamin J. Eggleton[1], Adam Densmore[2], Rubin Ma[2], Siegfried Janz[2], DanXia Xu[2],* ***David J. Moss****[1]; [1]Univ. of Sydney, Australia, [2]Inst. for Microstructural Sciences, Natl. Res. Council, Canada.* We demonstrate all-optical time division demultiplexing from 160Gb/s to 10Gb/s in the C-band, based on four-wave mixing in a silicon nanowire. We achieve error-free operation with a system penalty of ~ 3.9dB at 10-9 BER.

CThN7 • 12:00 p.m.

All-Optical Quantization Using a Chalcogenide Waveguide: Towards on-Chip Ultrahigh-Bandwidth Analog-to-Digital Conversion, ***Ravi Pant****[1], Chunle Xiong[1], Steve Madden[2], Barry L. Davies[2], Benjamin J. Eggleton[1,2]; [1]Univ. of Sydney, Australia, [2]Australian Natl. Univ., Australia.* We investigate 8-level all-optical quantization by broadening the pulse spectrum in a chalcogenide (As_2S_3) waveguide, for 8 different power levels, and subsequently slicing the measured spectrum using an array of filters.

CThO • CLEO Symposium on Laser Beam Combining II: Beam-Combined Fiber Lasers and Amplifiers—Continued

CThO4 • 11:45 a.m.

Wavefront Control by Digital Holography in an Yb-Doped Multi-Core Fiber Amplifier, ***Mathieu Paurisse****, Marc Hanna, Frédéric Druon, Patrick Georges; Lab Charles Fabry de l'Inst. d'Optique, Univ. Paris-Sud, France.* We demonstrate wavefront control of an Yb-doped multi-core fiber amplifier using phase conjugation by digital holography. A gain of 23 dB is demonstrated with a pulsed laser at 1064 nm.

CThO5 • 12:00 p.m.

Phase Locking an Array of Fiber Amplifiers onto a Remote Object, ***Benjamin Pulford****[1], Thomas Shay[1], Jeff Baker[2], Angel Flores[1], Craig Robin[1], Chris Vergien[1], Clint Zeringue[1], David Gallant[2], Anthony D. Sanchez[1], Chunte Lu[1], Art Lucero[1]; [1]AFRL, USA, [2]Boeing LTS Inc., USA.* Experiments demonstrating a novel technique that coherently combines an array of beams and automatically corrects for turbulence in the beam path are presented. This technique is insensitive to near field backscattering from aerosols and particulates.

10:30 a.m.–12:30 p.m. Market Focus: Biophotonics, *San Jose McEnery Convention Center, Exhibit Hall 2*

12:15 p.m.–1:00 p.m. Lunch Break *(concessions available on exhibit floor)*

San Jose Salon III (San Jose Marriott)

JOINT

JThD • Ultrafast and Short Wavelength Technology—Continued

JThD5 • 11:30 a.m.
**Plasma-Mirror-Cleaned High-Contrast Few-Cycle Relativistic-Intensity Light Pulses, *Julia M. Mikhailova*[1,2,3], *Laszlo Veisz*[1], *Antonin Borot*[4], *Karl Schmid*[1], *Christopher M. S. Sears*[1], *Daniel Herrmann*[5], *Raphael Tautz*[6], *Alexander Buck*[1], *Rainer Hoerlein*[7], *Patrick Heissler*[1], *George Tsakiris*[3], *Ferenc Krausz*[1,7]; [1]*Max-Planck-Inst. für Quantenoptik, Germany,* [2]*Intl. Laser Ctr., M. V. Lomonosov Moscow State Univ., Russian Federation,* [3]*General Physics Inst., Russian Acad. of Sciences, Russian Federation,* [4]*Lab d'Optique Appliquée, École Polytechnique, France,* [5]*Lehrstuhl für BioMolekulare Optik, Ludwig-Maximilians-Univ., Germany,* [6]*Ctr. for Nanoscience, Ludwig-Maximilians-Univ., Germany,* [7]*Ludwig-Maximilians-Univ., Germany.* A plasma mirror is shown to enhance the intensity contrast of 8fs multiterawatt light pulses by 2.5 orders of magnitude, while keeping the pulse duration unchanged. High reflectivity and improved near-field beam quality are demonstrated.

JThD6 • 11:45 a.m.
**Double Self-Compression of Femtosecond Pulses in Filaments, *Carsten Bree*[1,2], *Jens Bethge*[2], *Stefan Skupin*[3,4], *Luc Bergé*[5], *Ayhan Demircan*[1], *Günter Steinmeyer*[2]; [1]*Weierstraß-Inst. für Angewandte Analysis und Stochastik, Germany,* [2]*Max-Born-Inst., Germany,* [3]*Max-Planck-Inst. für Physik Komplexer Systeme, Germany,* [4]*Inst. für Festkörpertheorie und -Optik, Friedrich-Schiller-Univ., Germany,* [5]*CEA-DAM, DIF, France.* We discuss pulse-splitting-isolation cycles as the origin of pulse self-compression in filaments. These cycles can be cascaded in a single gas-filled cell, giving rise to tenfold compression. XFROG spectrograms provide experimental evidence for double self-compression.

JThD7 • 12:00 p.m.
Generation of CPA Seed Pulses by Direct Phase Modulation, *Ran Xin,* *Jonathan D. Zuegel; Univ. of Rochester, USA.* A 10.5-kHz train of 2.5-ns optical pulses with 1.15-nm bandwidth centered at 1053-nm suitable for seeding chirped-pulse amplification is produced in a programmable, all-fiber system through direct phase modulation.

San Jose Salon I & II (San Jose Marriott)

CLEO

CThP • Optical Parametric Oscillators I—Continued

CThP4 • 11:30 a.m.
**Tunable Intracavity up-Converted Optical Parameteric Oscillator by Cascaded Adiadbatic Sum Frequency Generation, *Gil Porat*[1], *Haim Suchowski*[2], *Yaron Silberberg*[2], *Ady Arie*[1]; [1]*Tel Aviv Univ., Israel,* [2]*Weizmann Inst. of Science, Israel.* We experimentally demonstrate efficient tunable up-conversion by cascading optical oscillation and wide-band adiabatic sum frequency generation in a single nonlinear crystal, yielding red light tunable over a 6.2nm wavelength band.

CThP5 • 11:45 a.m.
**Optical Parametric Oscillation in a High-Index Doped Silica Glass Micro-Ring Resonator, *Luca Razzari*[1,2], *David Duchesne*[1], *Marcello Ferrera*[1], *Roberto Morandotti*[1], *Sai Chu*[3], *Brent Little*[3], *David Moss*[4]; [1]*INRS-EMT, Canada,* [2]*Dept. di Elettronica, Univ. di Pavia, Italy,* [3]*Infinera Corp., USA,* [4]*CUDOS, School of Physics, Univ. of Sydney, Australia.* We demonstrate a CMOS-compatible, integrated optical parametric oscillator in a high-index doped silica glass ring resonator. We obtain lasing with wavelength spacings from 200 GHz to > 6THz, with a threshold as low as 54mW.

CThP6 • 12:00 p.m.
**Stable, 17.5 W, Optimally-Output-Coupled, Yb-Fiber-Pumped Mid-Infrared Optical Parametric Oscillator, *S. Chaitanya Kumar*[1], *Ritwick Das*[1], *Goutam Kumar Samanta*[1], *Majid Ebrahim-Zadeh*[1,2]; [1]*ICFO, Spain,* [2]*ICREA, Spain.* We report stable, continuous-wave, mid-infrared optical-parametric-oscillator based on MgO:PPLN, pumped by Yb-fiber-laser, generating total power of 17.5W at 61% extraction efficiency, in TEM_{00}(M^2_{Idler}<1.24,M^2_{Signal}<1.24) spatial mode with peak-peak idler power stability of 5% over 14 hours.

Room B2-B3

CLEO: Applications

AThA • Laser Fusion—Continued

Andy Bayramian received his bachelors from Montana State University, Bozeman, in 1995, and his Ph.D. in Applied Science at Lawrence Livermore National Laboratory from University of California, Davis in 2000. Following school, Andy immediately accepted a position as the lead scientist on the Mercury laser project at Lawrence Livermore National Laboratory (LLNL), a high average power diode pumped solid state laser testbed for fusion driver technology. He is currently working on several aspects of the Laser Inertial Fusion Energy (LIFE) project at LLNL. Andy's interests include applied research in laser optical materials, diode pumped solid state lasers, and LIFE research and technologies. Dr. Andy Bayramian can be reached at bayramian1@llnl.gov. A listing of current projects of interest can be found at https://lasers.llnl.gov/.

AThA3 • 12:00 p.m.
**Feasibility Study of Cryogenic Yb:YAG Zig-Zag Active-Mirror Laser for Ten-Kilowatts, *Hiroaki Furuse*[1], *Junji Kawanaka*[2], *Noriaki Miyanaga*[2], *Taku Saiki*[1], *Kazuo Imasaki*[1], *Masayuki Fujita*[1], *Kenji Takeshita*[3], *Shinya Ishii*[3], *Yasukazu Izawa*[1]; [1]*Inst. for Laser Technology, Japan;* [2]*Inst. of Laser Engineering, Osaka Univ., Japan;* [3]*Mitsubishi Heavy Industries, Japan.* We report a new compact high power laser system using zig-zag optical path based on the cryogenic Yb:YAG total-reflection active-mirror laser for ten-kilowatts. The thermal analyses of the laser have also been discussed.

10:30 a.m.–12:30 p.m. Market Focus: Biophotonics, *San Jose McEnery Convention Center, Exhibit Hall 2*

12:15 p.m.–1:00 p.m. Lunch Break *(concessions available on exhibit floor)*

1:00 p.m.–2:30 p.m.
JThE • Joint CLEO/QELS Poster Session III

QELS 06. Nano-Optics and Plasmonics

JThE1
What Can Be Observed from Surface Plasmon Spectral Interference? *Qiaoqiang Gan*[1], *Yongkang Gao*[1], *Lin Zhu*[2], *Filbert Bartoli*[1]; [1]*Lehigh Univ., USA,* [2]*Clemson Univ., USA.* A far-field experiment was presented to observe the SPP spectral interference and reveal the SPP contribution in the interaction between the nano-objects, and directly address the key issue of a debate raised in *Nature Physics*.

JThE2
Radiative Decay Engineering of Direct Bandgap Emission in Silver Ion-Implanted Polarized Silicon Quantum Dots, *Akhilesh Singh*[1], *Karol Gryczynski*[1], ***Arup Neogi***[1], *Moon Kim*[2]; [1]*Univ. of North Texas, USA,* [2]*Univ. of Texas at Dallas, USA.* Emission from low energy Silver ion implanted crystalline silicon quantum dots can be enhanced due to enhanced radiative recombination induced by polarization of the dots and metal induced local field effects.

JThE3
Guided Subwavelength Slow-Light Mode Supported by a Periodic Plasmonic Waveguide, *Liu Yang, Changjun Min,* ***Georgios Veronis****; Louisiana State Univ., USA.* We introduce periodic plasmonic waveguides which support a guided subwavelength slow-light mode over a very broad range of frequencies. The structure consists of a metal-dielectric-metal waveguide side-coupled to a periodic array of metal-dielectric-metal stub resonators.

JThE4
Silicon-Based Plasmonic Waveguides Interfaced to Silicon Photonic Platform, *Shawn M. B. Sederberg**, Vien Van, Abdul Y. Elezzabi; Univ. of Alberta, Canada.* A silicon-based plasmonic waveguide is designed, fabricated and characterized. A propagation distance of 2.00μm at λ=1550nm was measured and the coupling efficiency to the silicon-on-insulator platform was 38.0%. Scans of telecommunication wavelengths are presented.

JThE5
Subwavelength Silicon Hybrid Plasmonic Waveguides and Components, *Marcelo Wu,* *Vien Van; Univ. of Alberta, Canada.* Subwavelength hybrid plasmonic waveguides, s-bends and power splitters are demonstrated on a SOI platform. A long plasmonic waveguide propagation length of 40μm and highly efficient coupling to Si photonic waveguides were achieved using simple tapers.

JThE6
Extraordinary Transmission in the UV Range from Sub-Wavelength Slits on Semiconductors, *Maria Antonietta Vincenti*[1], *Domenico de Ceglia*[1], *Milan C. Buncick*[1], *Neset Akozbek*[2], *Mark J. Bloemer*[2], *Michael Scalora*[2]; [1]*AEgis Technologies Group Inc., USA,* [2]*Charles M. Bowden Res. Ctr., USA.* Accessing the part of the spectrum where semiconductors behave like metals leads to extraordinary transmission in the UV regime and enhanced nonlinear plasmonic phenomena in the UV and soft X-ray wavelengths.

JThE7
Validation of the Parallel Three-Dimensional Solver for Analysis of Optical Plasmonic Bi-Periodic Multilayer Nanostructures, *Xingjie Ni*[1], *Zhengtong Liu*[1], *Alexandra Boltasseva*[1,2], *Alexander V. Kildishev*[1]; [1]*Purdue Univ., USA,* [2]*Technical Univ. of Denmark, Denmark.* Fundamentals of the three-dimensional spatial harmonic analysis (SHA) approach are reviewed, and the advantages of a fast-converging formulation versus the initial formulation are emphasized with examples using periodic plasmonic nanostructures.

JThE8
Control of Nano-Scale Plasmon in Time and Space Using Pulse Shaped Femtosecond Laser, *Takuya Harada*[1], *Keiichiro Matsuishi*[1], *Naoko Sugiura*[1], *Yu Oishi*[1], *Keisuke Isobe*[2], *Akira Suda*[2], *Hideaki Mizuno*[3], *Atsushi Miyawaki*[3], *Katsumi Midorikawa*[2], *Fumihiko Kannari*[1]; [1]*Dept. of Electronics and Electrical Engineering, Keio Univ., Japan,* [2]*Laser Technology Lab, RIKEN, Japan,* [3]*Lab for Cell Functon Dynamics, RIKEN, Japan.* We demonstrate spatio-temporal control of local plasmon on Au nano-rods with different aspect ratios irradiated by pulse shaped femtosecond laser. This technique could form a novel nano-scale reaction field.

JThE9
Broadband Waveguide QED System on a Chip, *Qimin Quan**, Irfan Bulu, Jennifer T. Choy, Marko Loncar; Harvard Univ., USA.* We demonstrate a slot waveguide provides a broad-band, loss-free platform suitable for applications in quantum optics. The strong coupling between light quanta and quantum emitter can be achieved with Purcell factor larger than 200.

JThE10
Twisted Chains of Resonant Nanoparticles: Polarization Control, Waveguidance and Radiation, *Derek A. Van Orden**, Yeshaiahu Fainman, Vitaliy Lomakin; Univ. of California at San Diego, USA.* Linear arrays of resonant nanoparticles that are sequentially rotated about the array axis display interesting polarization sensitive optical properties. Such "twisted" arrays support two transverse modes with distinct waveguidance and radiation properties.

JThE11
Ultrafast Hot Electron Relaxation in a Metal Nanostructure Detected by Femtosecond-SNOM, *Zhi Li**, Song Yue, Jianjun Chen, Qihuang Gong; Peking Univ., China.* Ultrahigh spatiotemporal resolved pump-probe signal on a metal nanostructure is detected by femtosecond-SNOM. By using two-color pump-probe configuration, ultrafast hot electron transportation is clearly observed on a time scale of a few hundred femtoseconds.

JThE12
Ab initio* Theory of the Whispering Gallery Mode Carousel Phenomenon,** *Joel T. Rubin,* ***Lev I. Deych*; Dept. of Physics, Queens College CUNY, USA.* A model of the optomechanical interaction of a nanoparticle and a spherical Whispering Gallery Mode microresonator is derived. The theory furnishes exact equations of motion and describes the observed circular orbits of the particle.

JThE13
Light Tunneling in Multi-Layered Photonic-Plasmonic Nanostructures, *Alp Artar**, Ahmet Yanik, Hatice Altug; Boston Univ., USA.* Photonic and plasmonic interactions in multi-layered plasmonic crystals, formed by coupling nanohole-nanoparticle arrays, are investigated. The hybrid structure exhibits extraordinary optical transmission as in single layer nanohole arrays and supports Fabry-Perot mode with improved sensitivity.

JThE14
Controlling the Anti-Crossing between Localized Surface Plasmons and Surface Plasmon Polaritons, *Yizhuo Chu**, Kenneth B. Crozier; Harvard Univ., USA.* We study a structure consisting of a gold disk array, an SiO_2 spacer and a gold film. We study the effect of spacer thickness on the anti-crossing between localized plasmons and surface plasmon polaritons.

JThE15
Surface Enhanced Raman Study of the Interaction of PEDOT:PSS with Silver and Gold Nanoparticles, *Anne M. Kelley**, Marina Stavytska-Barba; Univ. of California at Merced, USA.* Surface enhanced Raman spectroscopy is used to characterize the interaction of PEDOT:PSS, a polymer blend widely used as a hole-transporting electrode coating in organic polymer photovoltaic cells, with plasmonically active metal nanoparticles.

JThE16
Multi-Photon Excited UV Luminescence of ZnO Nanorods after Irradiation with Few-nJ Femtosecond Laser Pulses, *Susanta K. Das*[1], *Daragh Byrne*[2], *Enda McGlynn*[2], *Martin Bock*[1], *Ruediger Grunwald*[1]; [1]*Max-Born-Inst. for Nonlinear Optics and Short-Pulse Spectroscopy, Germany,* [2]*School of Physical Sciences, Dublin City Univ., Ireland.* Highly efficient two-photon-absorption induced defect-level-emission-free UV luminescence of ZnO nanorods grown by vapor phase transport was demonstrated with sub-20 fs, few-nJ pulses extracted from a Ti:sapphire laser oscillator. Potential applications in phototherapy are discussed.

JThE17
Grating Coupling with Hybrid Plasmonic/Dielectric Structure Efficiently Converts Light to Surface Plasmons, *Philip D. Flammer*[1], *Thomas E. Furtak*[1], *Charles G. Durfee*[1], *Reuben T. Collins*[1], *Russell E. Hollingsworth*[2]; [1]*Colorado School of Mines, USA,* [2]*ITN Energy Systems, Inc., USA.* We present simulation and experimental results of a hybrid plasmonic/dielectric waveguide with a grating, which efficiently converts radiation to surface plasmons. Resonant cavities yield energy density enhancements of 225 times the incident energy density.

JThE18
Efficient and Robust Energy Transfer Network in Quantum Dot Mixtures via Optical Near-Fields Interactions, *Makoto Naruse*[1,2], *Tadashi Kawazoe*[2], *Motoichi Ohtsu*[2]; [1]*NICT, Japan,* [2]*Univ. of Tokyo, Japan.* We theoretically and experimentally investigate an optimal mixture of different-sized quantum dots so that energy transfers via near-field interactions are efficiently induced. We also demonstrate the near-field interaction network provides robustness to tolerate system errors.

JThE19
A New Insight on Laser Threshold in Devices Operating at Nanoscale, *Isabelle Robert-Philip**, Alexios Beveratos, Rémy Braive, Xavier Hachair, Isabelle Sagnes, Richard Hostein, Grégoire Beaudoin, Luc Le Gratiet, Anne Talneau; CNRS - Lab de Photonique et de Nanostructures, France.* We will present a further understanding of the threshold transition in lasers operating at nanoscale, by measuring the threshold transition from a quantum, statistical and dynamical points of view at room temperature and telecommunication wavelengths.

JThE20
Surface Plasmon Enhanced Fluorescence Emission inside Metal Nanoshells, *Xiaoyu Miao*[1], *Ting-Shan Luk*[1], *Igal Brener*[1], *Carlee Ashley*[2], *Shisheng Xiong*[2], *David Peabody*[2], *Jeffrey Brinker*[1]; [1]*Sandia Natl. Labs, USA,* [2]*Univ. of New Mexico, USA.* We study the surface plasmon enhanced fluorescence where an emitter is embedded in a metal nanoshell. Both simulation and experimental results are presented.

JThE21
Plasmonic Aerogel Doped with Gold Nanoparticles, *Michael D. W. Grogan*[1], *Matthew D. Rollings*[1], *Limin Xiao*[1], *William J. Wadsworth*[1], *Richard England*[2], *Stefan A. Maier*[3], *Timothy A. Birks*[1]; [1]*Dept. of Physics, Univ. of Bath, UK,* [2]*Dept. of Chemical Engineering, Univ. of Bath, UK,* [3]*Dept. of Physics, Imperial College London, UK.* We have developed a new technique to incorporate gold nanoparticles into silica aerogel without aggregation. Such a doped "plasmonic" aerogel can be used for nonlinear optical experiments and plasmonic sensing.

JThE22
Goos-Hänchen Effect Enhancement by Surface Electromagnetic Waves in Photonic Crystals, *Irina V. Soboleva*[1,2], *Valentina V. Moskalenko*[1], *Andrey A. Fedyanin*[1]; [1]*Faculty of Physics, M.V.Lomonosov Moscow State Univ., Russian Federation,* [2]*A. N. Frumkin Inst. of Physical Chemistry and Electrochemistry, Russian Acad. of Sciences, Russian Federation.* The Goos-Hänchen effect enhancement caused by surface electromagnetic waves excited in one-dimensional photonic crystals is directly observed using angular spectroscopy in Kretschmann-Raether configuration and far-field optical microscopy visualization.

JThE23
Direct Observations of UV Extraordinary Optical Transmission and Localized Field Enhancement through Nanoslits, *Qiaoqiang Gan**, Liangcheng Zhou, Volkmar Dierolf, Filbert Bartoli; Lehigh Univ., USA.* The UV extraordinary optical transmission through nanoslit structures in the far-field and localized field enhancement in the near-field are both directly observed. Numerical modeling results are also presented, showing good agreement with the experiment results.

Thursday, May 20

QELS 02. Quantum Science, Engineering and Technology

JThE24
Demonstration of Unconditional One-Way Quantum Computations, *Ryuji Ukai*[1], *Noriaki Iwata[1], Yuji Shimokawa[1], Seiji Charles Armstrong[1,2], Alberto Politi[1,3], Jun-ichi Yoshikawa[1], Peter van Loock[4], Akira Furusawa[1]; [1]Univ. of Tokyo, Japan, [2]Australian Natl. Univ., Australia, [3]Univ. of Bristol, UK, [4]Univ. Erlangen-Nuernberg, Germany.* We demonstrate unconditional one-way quantum computation experiments using a linear cluster state of four entangled optical modes. Our results provide a first demonstration of the fundamental components for one-way quantum computation with continuous variables.

JThE25
Continuous-Variable Quantum Erasure Correcting Code, *Mikael Lassen*[1], *Metin Sabuncu[1,2], Alexander Huck[1], Julian Niset[3,4], Nicolas Cerf[3], Gerd Leuchs[2,5], Ulrik Andersen[1]; [1]Technical Univ. of Denmark, Denmark, [2]Max-Planck-Inst. for the Science of Light, Germany, [3]Quantum Information and Communication, École Polytechnique, Univ. Libre de Bruxelles, Belgium, [4]Dept. of Physics, Hunter College of CUNY, USA, [5]Univ. Erlangen-Nürnberg, Germany.* We experimentally demonstrate a continuous variable quantum erasure-correcting code, which protects coherent states of light against complete erasure. The scheme encodes two coherent states into a bi-party entangled state.

JThE26
Demonstration of Unconditional Quantum Erasing for Continuous Variables, *Yoshichika Miwa*[1], *Ryuji Ukai[1], Jun-ichi Yoshikawa[1], Radim Filip[2], Peter van Loock[3], Akira Furusawa[1]; [1]Univ. of Tokyo, Japan, [2]Palacky Univ., Czech Republic, [3]Univ. Erlangen-Nuernberg, Germany.* We demonstrate "undoing" quantum non-demolition gates by quantum erasing. In one-way quantum computation, these operations remove unwanted nodes from cluster states. Experimentally one mode was removed from two-mode and four-mode cluster state, respectively.

JThE27
High Speed True Random Number Generation Using Chaotic Light, *Wei Wei*, *Wenzhuo Tang, Hong Guo; School of Electronics Engineering and Computer Science, Peking Univ., China.* Using chaotic light, we propose a new method for true random number generation, which is promising, high speed, convenient and low cost. A prototype has been built up with a generation rate of 192Mbits/s.

JThE28
Multi-Channel Superconducting Nanowire Single Photon Detector System with High Detection Efficiency, *Taro Yamashita*[1], *Shigehito Miki[1], Mikio Fujiwara[2], Masahide Sasaki[2], Zhen Wang[1]; [1]Kansai Advanced Res. Ctr., NICT, Japan, [2]NICT, Japan.* We report a development of a multi-channel superconducting nanowire single photon detector system, which showed the high detection efficiency over 10% at 100 Hz dark count rate and the wavelength of 1550 nm.

JThE29
Experimental Implementation of Optimum Unambiguous and Maximum-Confidence Discrimination of Two Single Photon Mixed States, *Oliver Benson,* ***Gesine Steudle****, Sebastian Knauer, Ulrike Herzog; Humboldt Univ. Berlin, Germany.* We introduce experimental implementations of optimum unambiguous and maximum-confidence discrimination of two mixed states. Linear optics and polarization states of single photons from a true single-photon source based on a semiconductor quantum dot are utilized.

CLEO 16. Micro- and Nano-Photonics Devices

JThE30
Efficient Planar Single-Mode Fiber-to-Chip Coupler Based on Two-Stage Adiabatic Evolution, *Anatol Khilo*, *Franz X. Kärtner; MIT, USA.* A novel planar two-stage adiabatic single-mode fiber-to-chip coupler design is presented. The combination of rib and inverse tapers allows to make it 2-2.5 times shorter than state-of-the art inverse taper-based couplers with similar conversion efficiency.

JThE31
Finite Difference Time Domain Studies of Plasmonic Nanostructures Across Wide Frequency Ranges, *Alexander S. McLeod*; *Lawrence Berkeley Natl. Lab, USA.* We present analytic models describing the optical properties of the noble metals at frequencies from .5-7eV. With a single finite difference time domain calculation, these models enable a complete spectral description of plasmonic nano-structure properties.

JThE32
3-D AFM Characterization of the Edge Roughness of High Q Silicon Resonators, *Patrick Schiavone*[1,2], *Mickaël Martin[2], Payam Alipour[3], Ali Eftekhar[3], Siva Yegnanarayanan[3], Ali Adibi[3]; [1]CNRS, USA, [2]Lab des Technologies de la Microélectronique, CNRS, France, [3]Georgia Tech, USA.* Nanophotonic resonators are very sensitive to surface roughness. We investigate in detail the surface roughness, correlation length and fractal roughness exponent for high Q silicon resonators using a 3-D AFM and correlate to optical response.

JThE33
Hollow-Core High-Q Micro-Cavities in Three-Dimensional Photonic Crystals, *Jing Ouyang*, *Jian Wang, Yi Xuan, Minghao Qi; Purdue Univ., USA.* Hollow-core micro-cavities with quality factors up to 70,000 are designed in a 3-D photonic crystal with only nine structural layers. A six-layer structure with hollow cavities in the 4th layer has been fabricated.

JThE34
Design of Ultrahigh-Q Photoinduced Cavities in Defect-Free Photonic Crystal Slabs, *Snjezana Tomljenovic-Hanic,* ***Snjezana Tomljenovic-Hanic****, C. Martijn de Sterke; CUDOS, School of Physics, Univ. of Sydney, Australia.* We demonstrate that cavities with $Q \sim 10^7$ can be designed in defect-free photonic crystals made of photosensitive material (chalcogenide). Since the high-Q mode can originate from an air-band, these cavities are ideal candidates for sensing applications.

JThE35
Fiber Taper Collection of Photoluminescence at 1.54 µm from Erbium Doped Silicon Nitride Photonic Crystal Cavities, *Gary Shambat*[1], *Yiyang Gong[1], Jesse Lu[1], Selcuk Yerci[2], Rui Li[2], Luca Dal Negro[2], Jelena Vuckovic[1]; [1]Stanford Univ., USA, [2]Boston Univ., USA.* Photoluminescence at 1.54 µm from Er-doped silicon nitride in silicon photonic crystal cavities was extracted with 2.5x greater efficiency compared to free space, with loaded Q values of up to 98% of the intrinsic Q.

JThE36
Uniformity of Concentration Factor and Back Focal Length in Molded Polymer Microlens Arrays, *Silvano Donati*[1], *Enrico Randone[1], Mohammad Fathi[1], Jiun-Haw Lee[2], Edoardo Charbon[3], Giuseppe Martini[1]; [1]Univ. of Pavia, Italy, [2]Natl. Taiwan Univ., Taiwan, [3]Univ. of Delft, Netherlands.* An array of 32x32 polymer microlenses, 50-µm pitch, is used in connection to an array of 6-µm SPAD, recovering a factor C=35 in sensitivity. Repeatability of concentration factor and back focal length are reported.

JThE37
All-Optical Swicthing by Optical Kerr Effect in AlGaAs Photonic Crystal Slab Waveguide, *Hisaya Oda*[1], *Akio Yamanaka[1], Naoki Ikeda[2], Yoshimasa Sugimoto[2], Kiyoshi Asakawa[2]; [1]Chitose Inst. of Science and Technology, Japan, [2]Natl. Inst. for Material Science, Japan.* We have succeeded all-optical Mach-Zehnder type switch by optical Kerr effect around 1550nm in AlGaAs photonic crystal slab waveguide. We also studied nonlinear refractive index n'_2 in this waveguide.

JThE38
Theory of Mechanical Displacement Measurement Using a Multiple Cavity Mode Transducer, *Jens M. Dobrindt*, *Tobias J. Kippenberg; Max-Planck-Inst. of Quantum Optics, Germany.* We present an optomechanical displacement transducer that features three cavity modes coupled to a mechanical oscillator. Matching the modes' frequency spacing to the mechanical resonance frequency reduces the input power necessary to reach the SQL.

JThE39
Plasmonic Waves to Electrical Current Conversion for Integrated Plasmonic-Electronic Circuits, *Mingxia Gu*, *Ping Bai, Hong Son Chu, Er-Ping Li; Inst. of High Performance Computing, Singapore.* A novel ultra-compact THz-bandwidth plasmon-to-electron converter is reported for hybrid plasmon-electron integrated circuits. 20% of the optical power from plasmonic waveguide can be converted to photocurrent via a nanoscale active volume of 50×50×130nm3.

JThE40
Narrow Beam Radiation from a CMOS Compatible Leaky Wave Optical Antenna, *Qi Song*, *Ozdal Boyraz, Filippo Capolino; Univ. of California at Irvine, USA.* CMOS compatible leaky wave optical antennas are proposed and analyzed for electronically controlled radiation pattern generation. Very directive far field radiation pattern (>15dB) is generated from a Si_3N_4 leaky wave antenna with silicon periodic perturbations.

JThE • Joint CLEO/QELS Poster Session III—Continued

JThE41
Modeling of a 10GHz SiGe HBT EO Modulator, *Shengling Deng*, *Tuhin Guha Neogi, Joseph Novak, John McDonald, Z. Rena Huang; Rensselaer Polytechnic Inst., USA.* The modeling of an EO modulator based on SiGe Heterojunction Bipolar Transistor is presented. The device exhibits 10GHz speed with a Pi-phase shift length of 74 microns. The total propagation loss is less than 4dB.

JThE42
Low Chromatic Dispersion of ±16 ps(nm·km) over a 550-nm Wavelength Range Using a Strip/Slot Hybrid Silicon Waveguide, *Lin Zhang*[1], *Yang Yue*[1], *Yinying Xiao-Li*[1], *Raymond G. Beausoleil*[2], *Alan E. Willner*[1]; [1]*Univ. of Southern California, USA,* [2]*HP Labs, USA.* We propose a dispersion-flattened silicon waveguide that exhibits a flat and near-zero dispersion within ±16 ps/nm/km over a 550-nm wavelength range. Averaged dispersion can be shifted from negative to positive with almost the same flatness.

JThE43
Solving Dielectric and Plasmonic Dispersion Equations on a Pocket Calculator, *Rohan D. Kekatpure*, *Aaron C. Hryciw, Edward S. Barnard, Mark L. Brongersma; Geballe Lab of Advanced Materials, Stanford Univ., USA.* We present an accurate analytical technique for rapid and automated design of multilayer-waveguide-based nano-optical devices. The method allows arbitrary-precision mode-index calculations for dielectric and plasmonic waveguides, and can be implemented on a pocket calculator.

JThE44
Titania-Clad Microresonators on SOI With Athermal Performance, *Payam Alipour*, *Amir Hossein Atabaki, Ali Asghar Eftekhar, Ali Adibi; Georgia Tech, USA.* We propose the use of titanium dioxide as cladding material to reduce the temperature sensitivity of silicon-based microresonators. The advantages of using titanium dioxide over the conventional alternatives are discussed, and experimental results are presented.

JThE45
The Evolution of Photoinduced Photonic Crystal Cavities during Writing, *Michael W. Lee*[1], *Christian Grillet*[1], *Snjezana Tomljenovic-Hanic*[1], *David J. Moss*[1], *Benjamin J. Eggleton*[1], *Xin Gai*[2], *Steve Madden*[2], *Duk-Yong Choi*[2], *Douglas Bulla*[2], *Barry Luther-Davies*[2]; [1]*CUDOS, School of Physics, Univ. of Sydney, Australia,* [2]*CUDOS, Laser Physics Ctr., Australian Natl. Univ., Australia.* We present results showing the formation and evolution of a photonic crystal cavity during writing by selective optical exposure in a photosensitive chalcogenide photonic crystal. Q-factors of up to 125,000 were obtained in these cavities.

JThE46
Contra-Directional Coupling between TE and TM Modes in Asymmetric Photonic Crystal Waveguides, *Juraj Topolancik*[1], ***Zao Liu***[1], *Rob B. Ilic*[2]; [1]*Northeastern Univ., USA,* [2]*Cornell Nanoscale Facility, Cornell Univ., USA.* Coupling between the fundamental TE- and TM-like modes in a photonic crystal waveguide is investigated. Coupling is achieved by introducing transverse and vertical asymmetries into the periodic guiding layer. Polarization-insensitive narrow-band filtering behavior is demonstrated.

JThE47
Novel Nanowire Cavity Using Cut-off Mode Reflector, *Thai-Truong Tran*[1], *Connie J. Chang-Hasnain*[2]; [1]*Applied Science and Technology Group, Univ. of California at Berkeley, USA,* [2]*EECS Dept., Univ. of California at Berkeley, USA.* Free-standing nanowire-cavities, having a low index contrast with their substrate, typically have low Q-factors because of the lack of reflective bottom mirrors. A novel method facilitating a high-reflection bottom mirror using cut-off mode is presented.

JThE48
Waveguide Integrated Plasmonic Devices, *Irfan Bulu*, *Qimin Quan, Fatih Degirmenci, Mughees Khan, Federico Capasso, Marko Loncar; School of Engineering and Applied Sciences, Harvard Univ., USA.* We theoretically study waveguide-integrated plasmonic nano-antennas. The device consists of a nano-antenna coupled to a slot-waveguide. We show that spontaneous emission rate is enhanced by three orders of magnitude and nano-antenna efficiently couples to waveguide.

JThE49
Evanescent Excitation of Plasmonic Nanodisks Using Hybrid Guided Wave Silicon Nitride Structures, *Maysamreza Chamanzar*, *Ehsan Shah Hosseini, Sivay Yegnanarayanan, Ali Adibi; Georgia Tech, USA.* We propose a hybrid scheme in which light is coupled into gold nanodisks from a silicon nitride waveguide or travelling wave resonator. Large field enhancements in the vicinity of the nanodisk resonator can be achieved.

CLEO 12. Lightwave Communications and Optical Networks

Monitoring

JThE50
PMD and OSNR Insensitive 40-Gb/s OOK/DPSK Chromatic Dispersion Monitoring Using a Delay-Line Interferometer and a <10-GHz Photodetector, *Jeng-Yuan Yang*, *Mohammad R. Chitgarha, Lin Zhang, Alan E. Willner; Dept. of Electrical Engineering, Univ. of Southern California, USA.* We experimentally demonstrate a CD monitoring technique utilizing a delay-line interferometer and <10-GHz photodetector for 40-Gb/s OOK/DPSK. Spectral shift of RF dip changing with up to 560-ps/nm-CD is measured insensitive to 23-ps-DGD and <15-dB-OSNR.

JThE51
Signed Chromatic Dispersion Monitoring for DPSK Signal Based on Delay-Tap Sampling, *Jian Zhao*[1], *Alan Lau*[2], *Zhaohui Li*[1], *Chao Lu*[1], *H. Tam*[2]; [1]*Photonics Res. Ctr., Dept. of Electronic and Information Engineering, Hong Kong Polytechnic Univ., Hong Kong,* [2]*Photonics Res. Ctr., Dept. of Electrical Engineering, Hong Kong Polytechnic Univ., Hong Kong.* We demonstrated a signed chromatic dispersion (CD) monitoring method for NRZ-DPSK signals based on delay-tap sampling technique. The monitoring range can reach from -425ps/nm to 425ps/nm and the monitoring sensitivity is ±8ps/nm.

JThE52
Chromatic Dispersion Monitoring of 40-Gb/s OOK Data Using Optical VSB Filtering at High Frequency, *Jeng-Yuan Yang*, *Mohammad R. Chitgarha, Lin Zhang, Alan E. Willner; Dept. of Electrical Engineering, Univ. of Southern California, USA.* We experimentally demonstrate a CD monitoring technique for a 40-Gb/s OOK data by measuring the pulse pattern after optical VSB filtering centered at high frequency. A 142.2-ps delay of the pattern changes with 0~400-ps/nm dispersion.

JThE53
Simultaneously Transmitter Chirp and Chromatic Dispersion Monitoring of OOK Data Using First and Second Optical Harmonics of the Data Clock Tones, *Mohammadreza Chitgarha*, *Jeng-Yuan Yang, Alan Willner; Univ. of Southern California, USA.* We experimentally demonstrate a simultaneously transmitter chirp and chromatic dispersion monitoring technique utilizing the first and second optical harmonics of a RZ-OOK data. Monitored results of modulator typical chirp dispersion of 0~400-ps/nm are obtained.

Advanced Formats

JThE54
Gaussian Minimum Shift Keying for Spectrally Efficient and Dispersion Tolerant Optical Communications, *Bishara Shamee*, *Louis Christen, Scott Nuccio, Jeng-Yuan Yang, Alan Willner; Univ. of Southern California, USA.* Gaussian Minimum Shift Keying (GMSK) is a spectrally efficient phase modulation based on the gaussian shaping of the transmitted phase. We simulate GMSK dispersion tolerance at 40 Gbps and measure back-to-back BER at 2.5 Gbps.

Wavelength Converters

JThE55
System Design Guidelines When Utilizing Chirp-Inducing Wavelength Converters in a Fiber Transmission System, *Salman Khaleghi*[1], *Irfan M. Fazal*[1], *Lin Zhang*[1], *Janet Jackel*[2], *Anjali Agarwal*[2], *Ronald C. Menendez*[2], *Alan E. Willner*[1]; [1]*Univ. Of Southern California, USA,* [2]*Telcordia Technologies, USA.* We simulate an arbitrary-chirp-waveform -generator to explore the fiber-transmission-performance of chirp-inducing-devices output. If the chirp is symmetric around the center, the signal is ~3dB more-robust-to-dispersion. Chirp peak on edges results in ~2dB improvement at high-power.

JThE56
Broadband Multi-Wavelength Light Source Generation Using a Single Phase Modulator in a Loop, *Jing Yang*[1], *Changyuan Yu*[1,2]; [1]*Natl. Univ. of Singapore, Singapore,* [2]*RF and Optical Dept., A*STAR Inst. for Infocomm Res., Singapore.* We propose a scheme on broadband multi-wavelength light source generation based on phase modulation in a ring. 125-channel light source with channel spacing of 10-GHz is demonstrated using a single phase modulator in a loop.

JThE57
Simultaneous Two-Channel Wavelength Conversion of 40-Gbit/s DPSK WDM Signals without Additional Pumps, *Xiaoxia Wu*, *Hao Huang, Jian Wang, Xue Wang, Omer F. Yilmaz, Scott R. Nuccio, Alan Willner; Univ. of Southern California, USA.* We experimentally demonstrate simultaneous two-channel wavelength conversion of 40-Gbit/s RZ-DPSK signals using four-wave mixing in highly nonlinear fiber without additional pumps, with power penalty of <1 dB as channel spacing varies from 200GHz to 1THz.

JThE58
Optimizing RZ 40-Gbit/s Fiber Transmission System Performance when Utilizing SOA-Based DXPM Wavelength Converters, *Irfan M. Fazal*[1], *Salman Khaleghi*[1], *Omer F. Yilmaz*[1], *Jeng-Y Yang*[1], *Lin Zhang*[1], *Anajali Agarwal*[2], *Ron Menendez*[2], *Janet Jackel*[2], *Alan E. Willner*[1]; [1]*Univ. of Southern California, USA,* [2]*Telcordia Technologies, USA.* We experimentally demonstrate the effect of negative chirp produced by SOA-MZI DXPM-based wavelength convertor at 40-Gb/s 33%-RZ in a 80-km dispersion-compensated SMF link. >2-dB performance improvement is achieved by adding positive residual dispersion of +30ps/nm.

Regeneration

JThE59
Nonlinear Phase-Shift Compensation by a Nonlinear Amplifying Loop Mirror, *Klaus Sponsel*[1,2], *Christian Stephan*[1,2,3], ***Georgy Onishchukov***[1,3], *Bernhard Schmauss*[3,4], *Gerd Leuchs*[1,2,3]; [1]*Max-Planck-Inst. for the Science of Light, Germany,* [2]*Inst. of Optics, Information and Photonics, Univ. Erlangen-Nuremberg, Germany,* [3]*Erlangen Graduate School of Advanced Optical Technologies, Germany,* [4]*Inst. of Microwave Technology, Univ. Erlangen-Nuremberg, Germany.* The nonlinear amplifying loop mirror as a nonlinear phase-shift compensator for multilevel phase-encoded optical signals is considered. Simulations of a 20 Gb/s DQPSK transmission system showed a significant BER improvement for post-compensation.

JThE60
Paper Withdrawn.

Digital Systems

JThE61
Single AWG Based Clock Extraction from WDM NRZ-DPSK Signals with Mixed Bit-Rates, *Yu Yu*[1,2], *Xinliang Zhang*[1], *Fei Wang*[1], *Dexiu Huang*[1]; [1]*Wuhan Natl. Lab for Optoelectronics and School of Optoelectronic Science and Engineering, Huazhong Univ. of Science and Technology, China,* [2]*Ctr. for Photonic Systems, Engineering Dept., Univ. of Cambridge, UK.* A simple and flexible simultaneous clock extraction for WDM NRZ-DPSK signals with mixed bit-rates from 10-to-40Gb/s is proposed and demonstrated using a single commercial AWG. Clock recovery can be easily achieved from the pre-processed signals.

JThE • Joint CLEO/QELS Poster Session III—Continued

JThE62
DPSK Receiver with Feedforward Control to Mitigate in-Band Crosstalk and ASE Noise, ***Hiroki Kawahara***[1,2]*, Naoya Kunigita*[1,2]*, Kyo Inoue*[1,2,3]*;* [1]*Osaka Univ., Japan,* [2]*JST, CREST, Japan,* [3]*NTT Basic Res. Labs, Japan.* We propose and demonstrate a scheme that suppresses degradation induced by in-band crosstalk and amplified spontaneous emission noise in DPSK signal, using feedforward control.

JThE63
12.5Gbps PSK Signal Detection Using 200MHz Detector with Dual Heterodyne Mixing Method, ***Tatsutoshi Shioda****, Toshiaki Yamazaki, Hiroshi Ono; Nagaoka Univ. of Technology, Japan.* Novel method for relative phase measurement between optical longitudinal modes has been proposed and named as "dual heterodyne mixing method". It was applied for 12.5GBps BPSK signal sensing by 200MHz low-speed receiver.

JThE64
Local Oscillator Linewidth Limitation on 16 QAM Coherent Optical Transmission System, ***Kailu Gao***[1]*, Junyi Wang*[1]*, Lu Yang*[1]*, Xuan He*[1]*, Daniel Peterson*[2]*, Zhongqi Pan*[1]*;* [1]*Univ. of Louisiana at Lafayette, USA,* [2]*Verizon Business, USA.* We studied the LO linewidth limitation for a 16-QAM WDM coherent system. The simulation shows that the linewidth should be less than 500 KHz for ≥ 100 Gb/s over 300 km dispersion managed fiber link.

JThE65
Paper Withdrawn

JThE66
Low Speed Sampling in Heterodyne Optical OFDM System, ***Lin Cheng****, He Wen, Xiaoping Zheng, Hanyi Zhang, Yili Guo, Bingkun Zhou; Tsinghua Univ., China.* We experimentally demonstrate a receiving method in heterodyne OOFDM system. With multiple channels with delay lines, the speed requirement for electrical devices is reduced when directly receiving the intermediate-frequency signal. No essential deterioration is induced.

Access

JThE67
Sextuple Frequency Millimeter Signal Generation for Radio-over-Fiber (RoF) Using Dual Drive Mach-Zehnder Modulator (DDMZM) and SOA, ***Mingtao Liu****, Min Zhang, Wei Yang, Peida Ye; Key Lab of Information Photonics and Optical Communications, Ministry of Education, Beijing Univ. of Posts and Telecommunications, China.* A sextuple frequency millimeter wave signal generation for RoF using a DDMZM and an SOA has been proposed and demonstrated via simulation. A study on the effect of SOA parameters on RoF is presented.

JThE68
Bidirectional CATV/FTTH Transport Systems Based on a RSOA, ***Cheng-Ling Ying***[1]*, Ching-Hung Chang*[2]*, Ya-Ling Houng*[1]*, Hai-Han Lu*[2]*, Wen-Shing Tsai*[3]*, Heng-Sheng Su*[2]*;* [1]*Jinwen Univ. of Science and Technology, Taiwan,* [2]*Natl. Taipei Univ. of Technology, Taiwan,* [3]*Mingchi Univ. of Technology, Taiwan.* A bidirectional down-link CATV/fiber-to-the-home (FTTH) and up-link FTTH transport system is proposed. By employing -1 side-mode injection-locked and optoelectronic feedback techniques in our system, brilliant performances are experimentally observed in both downstream and upstream transmissions.

JThE69
Full-Duplex CATV/ROF Transport System with Colorless Remodulation Scheme, *Ching-Hung Chang,* ***Wen-Yi Lin****, Ching-Hsiu Huang, Peng-Chun Peng, Hai-Han Lu; Natl. Taipei Univ. of Technology, Taiwan.*A full-duplex CATV/Radio-over-fiber (ROF) transport system employing a phase modulator as wavelength reuse and remodulation schemes is proposed and demonstrated. Good performances were achieved for downstream and upstream over a 20-km transmission.

CLEO 09. Components, Integration, Interconnects and Signal Processing

JThE70
Field Perturbations Due to Strong Coupling and Modal Confinement in SOI Arrayed Waveguides, ***Michael L. Cooper****, Shayan Mookherjea; Univ. of California at San Diego, USA.* We present a method of rescaling the basis set used in coupled mode theory for constructing the mode profiles of silicon-on-insulator strongly coupled arrayed waveguides to account for the fanout of the supermode decay constant.

JThE71
Integrated Optical Input Interface for Single-Flux-Quantum Circuit Buffer Memory, ***Satoshi Shinada****, Hirotaka Terai, Zhen Wang, Naoya Wada; NICT, Japan.* We have developed an optical input module for single-flux-quantum (SFQ) circuit to achieve high-speed buffer memory in the optical packet switch. We succeeded in demonstrating SFQ pulse generation by optical pulse input with 100-ps width.

JThE72
Spatial Spectral Interferometer for Frequency Resolved Angle of Arrival Estimation, ***Zeb W. Barber****, Calvin Harrington, Wm. Randall Babbitt, R. Krishna Mohan; Montana State Univ., USA.* Spatial-spectral materials are utilized to record the phase and power spectra of microwave signals. Spectral phase mapping via readout of a fiber interferometer enables precise frequency resolved time delay and angle of arrival estimation.

JThE73
High-Speed and Low Driving Voltage $LiNbO_3$ Optical Switch Composed of New Structure, ***Yasuhiro Kuratani****, Michio Kadota; Murata Manufacturing Co., Ltd., Japan.* Authors realized the optical switch satisfying high-speed response (<10 nsec), polarization independent operation and low driving voltage of 3 volt by constructing a new structure on $LiNbO_3$ substrate for the first time in the world.

JThE74
Integrated Polarization Converters for Mid-Infrared Applications, *Xin Xia,* ***Christi Madsen****; Texas A&M Univ., USA.* Two types of integrated polarization converters for mid-infrared operation were designed and fabricated, utilizing Ti-diffused $LiNbO_3$ waveguides. Narrowband and broadband converters with maximum conversion efficiencies of 79% and 92% were obtained at 2 microns, respectively.

JThE75
Effect of Gain-Dependent Phase Shift for All-Optical Tunable Mach-Zehnder Interferometers, ***Nan-Kuang Chen***[1,2]*, Zhi-Zheng Feng*[1]*, Kuan-Yi Lu*[1]*;* [1]*Dept. of Electro-Optical Engineering, Natl. United Univ., Taiwan,* [2]*Optoelectronics Res. Ctr., Natl. United Univ., Taiwan.* A differential gain-dependent phase shift between the core- and cladding-mode can be efficiently and all-optically tuned by a cw 975nm pump light for Mach-Zehnder interferometers using successive abrupt fiber tapers on a 1.2-cm-long Er/Yb-codoped fiber.

JThE76
A Photonic Method for Overcoming the Mode Partition Noise Contribution in the AM Noise Spectra of Periodic Electrical Signals, ***Dimitrios Mandridis****, Ibrahim Ozdur, Mehmetcan Akbulut, Peter J. Delfyett; CREOL, College of Optics and Photonics, Univ. of Central Florida, USA.* We measure the AM Noise of periodic electrical signals in the frequency domain. Mode partition noise is found to be detrimental and dependent on the signal's duration. A photonic technique is presented alleviating this ambiguity.

JThE77
A Surface Plasmon Polariton Absorption Modulator, ***Argishti Melikyan***[1]*, Thomas Vallaitis*[1]*, Nicole Lindenmann*[2]*, Thomas Schimmel*[3]*, Wolfgang Freude*[2]*, Juerg Leuthold*[2]*;* [1] *Inst. of Photonics and Quantum Electronics, Karlsruhe Inst. of Technology, Germany,* [2] *Inst. of Photonics and Quantum Electronics, Karlsruhe Inst. of Technology, Germany,* [3] *Inst. of Applied Physics, Karlsruhe Inst. of Technology, Germany.* A new compact electrically controlled surface plasmon polariton (SPP) absorption modulator operating at communication wavelengths is introduced. The modulator is controlled by changing the free carrier density and thereby the propagation loss of the SPP.

JThE • Joint CLEO/QELS Poster Session III—Continued

CLEO 08. Ultrafast Optics, Optoelectronics and Applications

JThE78
Single-Prism/Grating Pulse Compressor, ***Vikrant K. Chauhan****, Pamela Bowlan, Jacob Cohen, Rick Trebino; Georgia Tech, USA.* We introduce an ultrashort-laser-pulse compressor that uses a single prism and a single grating. It is compact and automatically aligned for distortion-free output, and it compensates for significant material dispersion up to third order.

JThE79
High Gain Broadband Amplification of Ultraviolet Pulses Using Optical Parametric Chirped Pulse Amplifier, ***Pawel Wnuk****[1], Yuriy Stepanenko[2], Czeslaw Radzewicz[1,2]; [1]Warsaw Univ., Poland, [2]Inst. of Physical Chemistry, Polish Acad. of Sciences, Poland.* We report on a high gain amplification of broadband ultraviolet femtosecond pulses in an optical parametric chirped pulse amplifier. Amplification of 0.5·106 was achieved, with the pulse energy of 30μJ and duration of 24fs.

JThE80
Single-Shot Complex-Field Characterization of Ultrafast Optical Waveforms with MHz Measurement Update Rates, ***Mohammad Hossein Asghari****, Yongwoo Park, José Azaña; INRS, Canada.* Balanced spectral interferometry is combined with dispersion-induced frequency-to-time mapping to achieve single-shot full (amplitude and phase) characterization of dynamical THz-bandwidth optical signals over sub-nanosecond time windows at unprecedented measurement update rates of nearly 20 MHz.

JThE81
Characterization and Optimization of a Femtosecond Laser by Self-Referenced Spectral Interferometry, ***Antoine Moulet****, Nicolas Forget, Richard Herzog, Sebastien Coudreau, Thomas Oksenhendler; Ctr. Scientifique d'Orsay, Fastlite, France.* We present an extended version of the self-referenced spectral interferometry technique allowing for both spectral phase and intensity retrieval from a single-shot interferogramm. Feedback to an AOPDF was performed to demonstrate the measurement accuracy.

JThE82
Ultra-Stable 18mJ Ti:Sa Amplifier System with Tunable Central Wavelength, Bandwidth and Pulse Duration, ***Alexandre Trisorio****[1], Clemens Ruchert[1], Fabien Plé[2], Pierre-Marie Paul[2], Christoph P. Hauri[1]; [1]Paul Scherrer Inst., Switzerland, [2]Amplitude Technologies, France.* We demonstrate an ultrastable high-power laser system providing transform-limited 20-to-100 fs pulses at a tunable central wavelength. Subsequent frequency-conversion provides wavelength-tunable second and third harmonic radiation with up to 3.7 mJ.

JThE83
Time-Frequency Real-Time Imaging of Ultrashort Laser Pulses with a Single Echelon Mirror, *Hiroyuki Sakaibara, Ikufumi Katayama,* ***Jun Takeda****; Yokohama Natl. Univ., Japan.* Time-frequency two-dimensional imaging of ultrashort laser pulses from 0.15 to 6 ps pulse duration has been successfully demonstrated in real-time, using a new autocorrelation scheme with a single echelon mirror.

JThE84
Strain Field Manipulation in Ultrafast Laser Inscribed Nonlinear BiB_3O_6 Optical Waveguides, ***Stephen J. Beecher****[1], Robert R. Thomson[1], Nicholas D. Psaila[1], Derryck T. Reid[1], Ajoy K. Kar[1], Majid Ebrahim-Zadeh[2]; [1]Heriot-Watt Univ., UK, [2]ICFO, Spain.* Type I phase matching is demonstrated in an ultrafast laser inscribed BiB_3O_6 optical waveguide. A novel technique was implemented to achieve good spatial overlap of the horizontally and vertically polarized modes in "strain-field" type waveguides.

JThE85
Phase-Contrast CARS Spectroscopy with Rapid Phase Modulation, ***Takayuki Suzuki****, Kazuhiko Misawa; Tokyo Univ. of Agriculture and Technology, Japan.* We demonstrate a novel method of phase-contrast CARS spectroscopy by using an optical bandpass filter and a mechanical modulator instead of a 4f pulse shaper used in previous studies.

JThE86
Monolayer Graphene Saturable Absorber for Bulk Laser Mode-Locking, *Won Bae Cho[1], Hwang Woon Lee[1], Sun Young Choi[1], Jun Wan Kim[1], Dong-Il Yeom[1],* ***Fabian Rotermund****[1], Jinho Kim[2], Byung Hee Hong[2]; [1]Ajou Univ., Republic of Korea, [2]Sungkyunkwan Univ., Republic of Korea.* Monolayer graphene was synthesized and used to develop novel saturable absorbers for bulk solid-state laser mode-locking. The graphene mode-locked Cr:forsterite laser delivers stable 130-fs pulses at 1.25 μm with output powers up to 230 mW.

JThE87
Multiple Channel on-Chip Spectral Shaper for Programmable Radio Frequency Arbitrary Waveform Generator, ***Hao Shen****, Li Fan, Leo Tom Varghese, Daniel E. Leaird, Andrew M. Weiner, Minghao Qi; Purdue Univ., USA.* We present a tunable multiple-channel microring resonator spectral shaper for radiofrequency arbitrary waveform generation (RFAWG). Sixteen resonators are cascaded to create various RF waveforms.

JThE88
Tunable Infrared Laser Femtosecond Source and Novel Pulse Clean Technique, ***Chunmei Zhang****, Yansui Huang, Yuxin Leng, Ruxin Li, Zhizhan Xu; Shanghai Inst. of Optics and Fine Mechanics, Chinese Acad. of Sciences, China.* A novel tunable phase-stabilized infrared femtosecond source was developed with CEP stabilization and >1mJ pulse energy. Based on the laser source, a novel pulse clean technique is developed, and the 10^{11} contrast ratio is demonstrated.

JThE89
Generation of Energetic Femtosecond Green Pulses Based on an OPCPA - SFG Scheme, ***Mark Mero****[1], Gabor Kurdi[1], Aron Sipos[2], Karoly Osvay[2]; [1]HAS Res. Group on Laser Physics, Hungarian Acad. of Sciences, Hungary, [2] Dept. of Optics and Quantum Electronics, Univ. of Szeged, Hungary.* By applying the techniques of achromatic phase matching and chirp assisted group velocity matching, we demonstrate a broadband, high-contrast sum-frequency generation scheme between the signal and idler output of a high-power optical chirped pulse amplifier.

JThE90
Measurement of Gamma in Photonic Crystal Fibers by the Induced Grating Autocorrelation Technique, ***Robinson Kuis****[1,2], Anthony Johnson[1,2,3], Sudhir Trivedi[4]; [1]Ctr. for Advanced Studies in Photonics Res., Univ. of Maryland, Baltimore County, USA, [2]Physics Dept., Univ. of Maryland, Baltimore County, USA, [3]CSEE, Univ. of Maryland, Baltimore County, USA, [4]Brimrose Corp., USA.* The induced grating autocorrelation technique was used to measure gamma in short lengths of solid-core photonic crystal fibers (SC-PCFs): a 35-cm highly nonlinear PCF and two large mode area PCFs of lengths 4.5-m and 4.9-m.

JThE91
Observation of Very Large THz Electro-Optic Response in (Cd,Mn)Te Single Crystals, ***Allen S. Cross****[1], Dominika Kochanowska[2], Marta Witkowska-Baran[2], Andrzej Mycielski[2], Martin Mikulics[3], Detlev Grützmacher[3], Roman Sobolewski[1]; [1]Univ. of Rochester, USA, [2]Inst. of Physics, Polish Acad. of Sciences, Poland, [3]Inst. of Bio- and Nanosystems: Res. Ctr. Jülich, Germany.* Large electro-optic Pockels effect is observed in (Cd,Mn)Te single crystals in response to THz pulses, presenting voltage sensitivity ten times greater than at MHz frequencies. We demonstrate that the discrepancy is due to free-carrier screening.

JThE92
High-Bit-Rate Pump-Probe Experiments on Bundled Single-Walled Carbon Nanotubes for 1.55μm Telecom Signal Regeneration, ***Hanond Nong****[1], Maud Gicquel[1], Laurent Bramerie[1], Fréderic Grillot[1], Mathieu Perrin[1], Baolai Liang[2], Diana Huffaker[2], Slimane Loualiche[1]; [1]FOTON, Univ. Européenne de Bretagne, France, [2]Electrical Engineering Dept., Univ. of California at Los Angeles, USA.* Single-walled carbon nanotubes (SWNT) based saturable absorber (SA) are investigated by pump-probe experiments at 10GHz repetition rate within the telecom wavelength range 1.51-1.55μm. Results show that SWNT exhibit a great potential for high-bit-rate optical regeneration.

JThE93
Spatio-Temporal Analysis of Ultrashort Pulses by Statistical Signatures of Frequency Converted Needle Beams, ***Martin Bock****, Jan T. Preusse, Ruediger Grunwald; Max-Born-Inst. for Nonlinear Optics and Short Pulse Spectroscopy, Germany.* A technique for temporally diagnosing extremely short pulses based on key statistical signatures of shape functions of nondiffracting needle beams after nonlinear conversion is proposed theoretically. With arrays of separated subbeams, spatial resolution is achievable.

JThE94
Towards High Energy 10 fs Laser Pulse via Regenerative Pulse Shaping, ***Pierre-Mary E. Paul****; Amplitude Technologies, France.* We demonstrated the use of regenerative pulse shaping approach to obtain ultrashort pulses with at the output of titanium: sapphire laser system. This scheme can be scaled to higher output energy and sub 10fs pulses.

JThE95
Automated Supercontinuum Pulse Compression from Ultrafast Fiber Lasers Using MIIPS, ***Haowen Li****[1], Igor Pastirk[1], Bingwei Xu[1], Tissa C. Gunaratne[1], Marcos Dantus[1,2]; [1]BioPhotonic Solutions Inc., USA, [2]Michigan State Univ., USA.* We report precise characterization and compensation of high-order phase distortions of a supercontinuum generated by ultrafast fiber lasers. By using MIIPS, the pulses are compressed to 12.8 fs automatically in less than thirty seconds.

JThE96
Calibration of a High Harmonic Spectrometer by Laser Induced Plasma Emission, ***Limor S. Spector****[1,2], J. P. Farrell[1,2], B. K. McFarland[1,2], P. H. Bucksbaum[1,2], M. Gühr[1,2]; [1]SLAC Natl. Accelerator Lab, USA, [2]Stanford Univ., USA.* We present a method that allows for a convenient switching between high harmonic generation and accurate calibration of the vacuum ultraviolet spectrometer used to analyze the harmonic spectrum.

JThE97
Mode-Locking of a Cr^{2+}: ZnSe Laser Using a PPLN Nonlinear Mirror: Theoretical Modelling and Cavity Design, ***Jean-Baptiste Dherbecourt****, Jean-Michel Melkonian, Myriam Raybaut, Antoine Godard, Michel Lefebvre, Juliet Ryan, Emmanuel Rosencher; ONERA, France.* We numerically investigate the use of a PPLN nonlinear mirror to achieve pulsed operation of a Cr2+:ZnSe laser. We discuss the effect of various parameters on the laser dynamics (CW, Q-switched and/or mode-locked operation).

JThE98
Compact Ultrafast Laser Enabled by Distortion Free Pulse Stretching and Compression by Chirped Volume Holographic Gratings, ***Christophe Moser****, Frank Havermeyer; Ondax, Inc., USA.* We demonstrate a method to correct the spatial distortion resulting from temporally stretching/compressing optical pulses with a chirped volume holographic grating that enables the practical realization of ultra-compact and efficient chirped pulse amplification laser systems.

JThE99
Tunable Nonlinear Time Response of Nanocomposites by Doping CdTeS Quantum Dots, ***Gong Qihuang****, Xiaoyong Hu, Jianxiang Zhang, Hong Yang; Peking Univ., China.* Tunable nonlinear time response of nano-Ag:polymer nanocomposite is realized by doping CdTeS quantum dots. Response time is quickened through doping. An ultrafast response time of 14.5 ps is achieved at a doping concentration of 27%.

JThE • Joint CLEO/QELS Poster Session III—Continued

QELS 04. Optical Interactions with Condensed Matter and Ultrafast Phenomena

JThE100
Second-Order Nonlinear Optical Effects of Spin Currents, *Ren-Bao Liu*[1], *Jing Wang*[1,2], *Bang-Fen Zhu*[2,3]; [1]*Dept. of Physics, Chinese Univ. of Hong Kong, Hong Kong,* [2]*Dept. of Physics, Tsinghua Univ., China,* [3]*Inst. of Advanced Study, Tsinghua Univ., China.* We show by symmetry analysis and microscopic calculation that a pure spin current has sizable second-order nonlinear optical effects. Thus spin currents can be studied by standard nonlinear optical spectroscopy.

JThE101
Electron Thermalization in Gold on the 10-fs Timescale, *Daniele Brida, Giulio Cerullo; Dept. di Fisica, Politecnico di Milano, Italy.* Using 5-fs visible probe pulses we study the electron distribution dynamics in thin gold films triggered by sub-15-fs near-IR pump pulses. We observe in real-time the build-up and decay of the thermal electron distribution.

JThE102
Anomalous Temperature Dependence of Exciton Absorption in a Mixed-Type GaAs Quantum Well , *Carey E. Phelps*[1], *Hailin Wang*[1], *John Prineas*[2]; [1]*Dept. of Physics, Univ. of Oregon,* [2]*Dept. of Physics and Astronomy, Univ. of Iowa, USA.* Experimental studies of excitons in mixed-type quantum wells reveal surprisingly that in the presence of relatively low densities of trions and two-dimensional electron gases, the exciton absorption can increase significantly with increasing temperature.

JThE103
Berry Curvature Effects in the THz Response of Holes, *Kuljit S. Virk, John E. Sipe; Univ. of Toronto, Canada.* A scheme is suggested to reveal and study the Berry curvature of energy bands in a quantum well using the THz radiation of holes.

JThE104
Proposal for an on-Demand Source of Indistinguishable Single Photons from a Single Quantum Dot - Cavity System, *Pradyumna K. Pathak, Stephen Hughes; Queens Univ., Canada.* We present a new scheme for the on-demand-generation of indistinguishable single-photons using adiabatic Raman passage through the Autler-Townes doublet, generated from a resonant field applied between the biexciton and exciton states in a quantum dot.

JThE105
Near-Band-Edge Resonant Excitation of Coherent Phonons in Carbon Nanotubes, *Y. S. Lim*[1], *H. S. Han*[1], *T. Joo*[2], *K. J. Yee*[3], *E. H. Haroz*[4], *L. G. Booshehri*[4], *J. Kono*[4]; [1]*Dept. of Applied Physics, Konkuk Univ., Republic of Korea,* [2]*Dept. of Chemistry, Pohang Univ. of Science and Technology, Republic of Korea,* [3]*Dept. of Physics, Chungnam Natl. Univ., Republic of Korea,* [4]*Dept. of Electrical and Computer Engineering, Rice Univ., USA.* In contrast to the previously-studied coherent phonons excited through high-energy (E_{22}) transitions, the redial breathing modes show comparable intensities between v = +1 and -1 nanotubes.

JThE106
Probing Ultrafast Carrier-Carrier Scattering Dynamics in Epitaxial Graphene, *Tze Chien Sum*[1], *Guichuan Xing*[1], *Cheng Hon Alfred Huan*[1], *Hongchen Guo*[2], *Xinhai Zhang*[2]; [1]*Nanyang Technological Univ., Singapore,* [2]*Inst. of Materials Res. and Engineering, A* STAR, Singapore.* Saturable absorption of graphene was experimentally and theoretically investigated in femtosecond time regime with the z-scan technique. Our results strongly suggest that graphene is an excellent atomic layer saturable absorber.

JThE107
Observation of Coherent Magnons in an Antiferromagnet Nickel Oxide, *Toshiro Kohmoto, Hokyun Jinn, Suguru Wakabayashi, Takahiro Yamauchi, Takeshi Moriyasu; Kobe Univ., Japan.* Optically induced magnetization, whose relaxation time is of the order of a hundred picoseconds, and coherent oscillations of magnons in terahertz region were observed in an antiferromagnet NiO by polarization spectroscopy with the pump-probe technique.

JThE108
Recovery of Polaritonic Stop-Band in Pressed Polycrystalline CaF_2 Powder, *Yi Jiang, Yujie J. Ding; Lehigh Univ., USA.* We have demonstrated recovery of polaritonic stop-band in pressed polycrystalline CaF_2 powder. Due to small sizes of CaF_2 particles, we have observed evidence of severe damping of polaritonic waves at particle surfaces.

JThE109
Observation of Coherent G-Mode Phonon Oscillations in Few-Layer Epitaxial Graphene Films, *Ji-Hee Kim*[1], *Ki-Ju Yee*[1], *Keun Soo Kim*[2], *Byung Hee Hong*[2]; [1]*Chungnam Natl. Univ., Republic of Korea,* [2]*Sungkyunkwan Univ., Republic of Korea.* Coherent G-mode phonon oscillations in few-layer graphene films were generated using ultrafast pump-probe spectroscopy. The frequency and the decay time were different depending on the thickness of the graphene layers.

JThE110
Quantum-Mechanical Inelastic Collisions of Wannier-Mott Excitons, *Kosuke Yoshioka, Takuro Ideguchi, Makoto Kuwata-Gonokami; Dept. of Applied Physics, Univ. of Tokyo, and SORST-CREST, JST, Japan.* Systematic measurements of the temperature dependence of the two-body collision-induced loss of dark paraexcitons in Cu_2O show a diverging cross section at low temperatures. Scattering problems between excitons in general require quantum-mechanical treatments.

JThE111
Observation of Polariton Dispersions for ZnO Microcavities in Strong Couple Regime, *Jun-Rong Chen*[1], *Tien-Chang Lu*[1], *Yung-Chi Wu*[1], *Shiang-Chi Lin*[1], *Wei-Rein Liu*[1], *Wen-Feng Hsieh*[1], *Chien-Cheng Kuo*[2], *Cheng-Chung Lee*[2], *Hao-Chung Kuo*[1], *Shing-Chung Wang*[1]; [1]*Dept. of Photonics, Inst. of Electro-Optical Engineering Natl. Chiao-Tung Univ., Taiwan,* [2]*Thin Film Technology Ctr., Natl. Central Univ., Taiwan.* Characteristics of ZnO-based MCs with vacuum Rabi splitting of 72 meV are demonstrated. It is found that only the LPBs can be observed in ZnO MCs since the Rabi splitting pushes UPBs into scattering absorption.

CLEO/QELS 07. Joint Subcommittee on High-Field Physics and High-Intensity Lasers

JThE112
Super-Uniform Target Illmination for Direct Drive as a Self-Organizing System, *Murakami Masakatsu; Inst. of Laser Engineering, Osaka Univ., Japan.* We propose a new algorithm to give an optimum direct-drive beam configuration for super-uniform illumination. It is obtained as a self-organizing system by solving N-body charged particle simulation, applicable for an arbitrary number of beams.

JThE113
Improved on-Shot Focal Spot Diagnosis on the OMEGA EP Short-Pulse Laser System, *B. E. Kruschwitz, S.-W. Bahk, J. Bromage, D. Irwin, M. D. Moore, L. J. Waxer, J. D. Zuegel, J. H. Kelly; Lab for Laser Energetics, Univ. of Rochester, USA.* Diagnosis of the on-target focal spot using the current OMEGA EP diagnostics is challenging due to differential piston uncertainty and calibration errors. Performance was improved by retrieving phase information from far-field images using numerical optimization.

JThE114
Paper Withdrawn.

JThE115
Ultra-Broadband Spectral-Shifted Pulse Pair Generation by Amplitude Modulation for Single Attosecond Pulse Characterization Using the SPIDER Method, *Jiangfeng Zhu, Takashi Tanigawa, Tao Chen, Shaobo Fang, Keisaku Yamane, Mikio Yamashita; Dept. of Applied Physics, Hokkaido Univ., Japan.* Ultra-broadband amplitude modulation for spectral-shifted pulse pair generation is realized by a liquid-crystal spatial light modulator. The results indicate that it's a promising way for single attosecond pulse characterization by the conventional SPIDER method.

JThE • Joint CLEO/QELS Poster Session III—Continued

JThE116
In situ* Grating-Damage Detection and Analysis for the 1.5 m Grating Compressor of the OMEGA EP Kilojoule, Petawatt-Class Short-Pulse Laser System, *Jie Qiao, *Leon J. Waxer, Thanh Nguyen, Joachim Bunkenburg, Colin Kingsley, John Kelly, Ansgar Schmid, David Weiner; Lab for Laser Energetics, Univ. of Rochester, USA.* A grating-inspection system and damage-analysis method have been developed to measure in-situ laser-induced damage of a 1.5-m grating in the OMEGA EP pulse compressor during a 2.2-kJ energy ramp.

JThE117
Contrast Measurements of Kilojoule Laser Pulses at the Omega EP Laser Facility, *Christophe Dorrer*, *David Irwin, Albert Consentino, Jie Qiao; Lab for Laser Energetics, Univ. of Rochester, USA.* The OMEGA EP intensity contrast has been measured to be approximately 6 decades for kilojoule 10-ps pulses. The OPCPA front end is the primary source of the measured incoherent pedestal.

JThE118
Isolated Sub-50-as Pulse Generation by Direct Optimization of Two-Color Laser Fields Using the Genetic Algorithm, *Kenichi L. Ishikawa*[1], *Shao Fang*[2], *Takashi Tanigawa*[2], *Naoki Karasawa*[3], *Mikio Yamashita*[2]; *[1]Univ. of Tokyo, Japan, [2]Hokkaido Univ. and CREST, JST, Japan, [3]Chitose Inst. of Science and Technology, Japan.* By optimizing two-color laser fields using genetic algorithm where the duration of the generated high-harmonic pulse is directly taken as a target function, we show that an isolated 40 attosecond pulse is created.

JThE119
Spatiotemporal Dynamics of Ionizing Filaments in Air, *Daniel E. Adams*[1], *Thomas A. Planchon*[2], *Jeff A. Squier*[1], *Charles G. Durfee*[1]; *[1]Colorado School of Mines, USA, [2]Howard Hughes Medical Inst., USA.* We use time-domain Spatially and Spectrally Resolved Interferometry (SSRI) to measure the intensity and phase of filaments. The optical power of self-focusing pulses is shown to be consistent with defocusing due to ionization.

JThE120
Attosecond Pulse Generation in Noble Gases in the Presence of Extreme High Intensity THz Pulses, *Katalin Varju*[1], *Jozsef Andras Fulop*[2], *Peter Dombi*[3], *Gyozo Farkas*[3], *Janos Hebling*[2]; *[1]Univ. of Szeged, Hungary, [2]Univ. of Pecs, Hungary, [3]Res. Inst. for Solid-State Physics and Optics, Hungary.* High harmonic generation by a strong laser pulse in the presence of a THz pulse is simulated. Consequent spectral extension for different laser wavelengths, and the temporal chirp of the synthesized attosecond pulses are studied.

JThE121
Frequency Modulation of High-Order Harmonics Depending on the Delay between Two-Color Laser Fields, *Abdolreza Amani Eilanlou*[1], *Yasuo Nabekawa*[1], *Kenichi L. Ishikawa*[2], *Hiroyuki Takahashi*[2], *Eiji J. Takahashi*[1], *Katsumi Midorikawa*[1]; *[1]RIKEN, Japan, [2]Univ. of Tokyo, Japan.* We have observed periodical frequency modulation of high-order harmonics by changing the delay between the driving two-color laser fields, for the first time. The amplitude of the modulation has been up to ~0.4 eV.

JThE122
Spatio-Temporal Characterization of Single-Order High Harmonic Pulses Separated by Pulse-Front-Tilt Compensator, *Taro Sekikawa*, *Motohiko Ito, Yoshimasa Kataoka, Tatsuya Okamoto, Mikio Yamashita; Hokkaido Univ., Japan.* Extreme ultraviolet single-order harmonic pulses, separated by a pulse-front-tilt compensator, were spatially and temporally characterized to have a spot size of 58 μm at focus and a pulse duration of 47 fs.

JThE123
Chirp Effects in High-Order Harmonics Generated from Solid Surface, *Crina A. Popovici*[1], *Rashid A. Ganeev*[2], *Xavier Lavocat-Dubuis*[1], *François Vidal*[1], *Tsuneyuki Ozaki*[1]; *[1]INRS-EMT, Canada, [2]Scientific Association Akadempribor, Uzbekistan.* We study the effect of pump laser chirp to increase the efficiency of high-order harmonic generation from solid surfaces. We find that HHG is critically dependent on the frequency component of the pump laser.

JThE124
Generation of 5-fs, 5-mJ Pulse Using Hollow-Fiber Pulse Compression at 1 kHz, *Samuel Bohman*[1,2], ***Akira Suda***[1], *Tsuneto Kanai*[1], *Shigeru Yamaguchi*[2], *Katsumi Midorikawa*[1]; *[1]RIKEN Advanced Science Inst., Japan, [2]Dept. of Physics, Tokai Univ., Japan.* We have demonstrated the generation of 5 fs, 5 mJ pulses at 1kHz repetition rate using a pulse compression technique in a hollow fiber with a pressure gradient.

JThE125
Scaling Law of High Harmonics Generated in the Two-Color Infrared Laser Field, *Pengfei Lan*, *Eiji Takahashi, Katsumi Midorikawa; RIKEN Advanced Science Inst., Japan.* We theoretically investigate and demonstrate a two-color scheme mixed by an infrared and fundamental (800 nm) laser pulses to enhance the harmonic yield and soften the wavelength dependence.

1:30 p.m.–2:30 p.m. Market Focus Technology Transfer Session, *San Jose McEnery Convention Center, Exhibit Hall 2*

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

NOTES

2:30 p.m.–4:15 p.m.
CThQ • High Harmonic Generation
Sterling Backus; Kapteyn-Murnane Labs, USA, Presider

CThQ1 • 2:30 p.m. Invited

High-Harmonic Generation by Resonant Plasmon Field Enhancement, ***Seung-Woo Kim****, Seungchul Kim, In-Yong Park, Joonhee Choi; KAIST, Republic of Korea.* We explain how to produce coherent XUV radiation at high repetition rate by means of high harmonic generation using locally enhanced femtosecond laser pulses by surface plasmon.

CThQ2 • 3:00 p.m.

High Power Femtosecond Laser System for Intracavity High Harmonic Generation, *Jane Lee, Justin Paul,* ***Jason Jones****; Univ. of Arizona, USA.* We report on a high power (>6.5 Watts) Ti:sapphire based frequency comb producing ~25 μJ pulses at 50MHz inside a fs enhancement cavity. The system is used to generate intracavity high harmonics below 62 nm.

CThQ3 • 3:15 p.m. Invited

Demonstration of Fully Spatially Coherent Soft X-Ray High Harmonic Beams in the Water Window, ***Paul C. Arpin****[1], Ming-Chang Chen[1], Tenio Popmintchev[1], Michael Gerrity[1], Matt Seaberg[1], Bosheng Zhang[1], Eric Gullikson[2], Farhad Salmassi[2], Yanwei Liu[2], Alon Bahabad[1], Henry C. Kapteyn[1], Margaret M. Murnane[1]; [1]JILA, Univ. of Colorado at Boulder, USA, [2]Ctr. for X-Ray Optics, Lawrence Berkeley Natl. Lab, USA.* We generate fully spatially coherent soft X-ray beams in the water window region of the spectrum using phase matched high harmonic upconversion of a 2 μm driving laser.

2:30 p.m.–4:15 p.m.
CThR • Nonlinear Silicon Photonics
Carl B. Poitras; Cornell Univ., USA, Presider

CThR1 • 2:30 p.m. Invited

Ultrafast Silicon-Organic Hybrid (SOH) Photonics, ***Wolfgang Freude****[1], Thomas Vallaitis[1], Christian Koos[2], Jan-Michael Brosi[3], Luca Alloatti[1], Pieter Dumon[4], Roel Baets[4], Michelle L. Scimeca[5], Ivan Biaggio[5], Benjamin Breiten[6], François Diederich[6], Juerg Leuthold[1]; [1] Inst. of Photonics and Quantum Electronics, Karlsruhe Inst. of Technology, Germany, [2]Carl Zeiss AG, Germany, [3]Robert Bosch GmbH, Power Tools Div., Germany, [4] Photonics Res. Group, Ghent Univ., IMEC, Belgium, [5] Dept. of Physics, Lehigh Univ., USA, [6] Lab of Organic Chemistry, ETH Zürich, Switzerland.* We demonstrate ultrafast optical signal processing up to bitrates of 170Gbit/s. We use silicon waveguides with organic nonlinear cladding that is not impaired by TPA. Our waveguide design then greatly reduces the influence of TPA.

CThR2 • 3:00 p.m.

Silicon Nanophotonic Mid-Infrared Optical Parametric Amplifier with 25 dB Gain, ***Xiaoping Liu****[1], Richard M. Osgood, Jr.[1], Yurii A. Vlasov[2], William M. J. Green[2]; [1]Columbia Univ., USA, [2]IBM T.J. Watson Res. Ctr., USA.* We demonstrate a broadband silicon mid-infrared optical parametric amplifier operating near λ = 2200 nm. The amplifier exhibits a maximum gain as large as 25 dB, and net off-chip gain greater than 13 dB.

CThR3 • 3:15 p.m.

Demonstration of Frequency-Detuning Compensation in a Traveling-Wave Resonator for Efficient Four-Wave-Mixing, ***Amir Hossein Atabaki****, Qing Li, Siva Yegnanarayanan, Ali Adibi; Georgia Tech, USA.* A resonator-based device is proposed and experimentally demonstrated in silicon-on-insulator platform in which frequency-detuning of its traveling-wave modes is dynamically tuned using integrated micro-heaters. Zero frequency-detuing for efficient four-wave-mixing is achieved using <1mW.

2:30 p.m.–4:15 p.m.
CThS • Photonic Crystal Devices
Yasuo Tomita; Univ. of Electro-Communications, Japan, Presider

CThS1 • 2:30 p.m.

Woodpile Photonic Crystals with a Complete Bandgap Reaching Telecom Wavelengths, ***Isabelle Staude****[1], Michael Thiel[1], Sabine Essig[2], Christian Wolff[2], Kurt Busch[2], Georg von Freymann[1,3], Martin Wegener[1,3]; [1]Inst. für Angewandte Physik and DFG-Ctr. for Functional Nanostructures, Karlsruhe Inst. of Technology, Germany, [2]Inst. für Theoretische Festkörperphysik and DFG-Ctr. for Functional Nanostructures, Karlsruhe Inst. of Technology, Germany, [3]Inst. für Nanotechnologie, Karlsruhe Inst. of Technology, Germany.* By using direct laser writing into a novel commercially available photoresist, silicon-double-inversion, and tempering of the resulting structures, we realize woodpile photonic crystals with a complete bandgap near 1.55 μm wavelength.

CThS2 • 2:45 p.m.

Experimental Observation of Photonic Bandgaps in Hyperuniform Disordered Materials, ***Weining Man****[1], Marian Florescu[2], Kazue Matsuyama[1], Polin Yadak[1], Salvatore Torquato[2], Paul J. Steinhardt[2], Paul Chaikin[3]; [1]San Francisco State Univ., USA, [2]Princeton Univ., USA, [3]New York Univ., USA.* We report the first experimental demonstration of photonic bandgaps (PBGs) in 2-D hyperuniform disordered materials and show that is possible to obtain isotropic, disordered, photonic materials of arbitrary size with complete PBGs.

CThS3 • 3:00 p.m.

Enhanced Transduction of Polymer Photonic Crystal Band-Edge Lasers via Additional Layer Deposition, ***Cameron L. C. Smith****, Mads B. Christiansen, Thomas Buß, Anders Kristensen, Claus H. Nielsen, Niels B. Larsen; DTU Nanotech, Technical Univ. of Denmark, Denmark.* We present the concept of enhanced transduction for polymer photonic crystal lasers by deposition of an additional polymer layer with selective gas response. We report a significant increase in sensitivity to changes in gas concentration.

CThS4 • 3:15 p.m.

Improved Emission Properties of Polymer Photonic Crystal Lasers by Introducing a Phase-shift, ***Mads B. Christiansen****, Thomas Buss, Cameron L. C. Smith, Anders Kristensen; Technical Univ. of Denmark, DTU Nanotech, Denmark.* Introducing a phase-shift in nanoimprinted polymer dye lasers is shown to increase the probability of single mode lasing from 19% to 99%. Low-index lasers with only one longitudinal mode are thus superior to band-edge lasers.

2:30 p.m.–4:15 p.m.
CThT • Microscopy: Technology Development
Brian Applegate; Texas A&M Univ., USA, Presider

CThT1 • 2:30 p.m.

CARS Microscopy Using the Amplified Soliton Self-Frequency Shift Output of a Nonlinear Fiber, ***Petra Gross****, Sebastian Beer, Lisa Kleinschmidt, Carsten Cleff, Carsten Fallnich; Univ. of Münster, Germany.* A light source based on a single femtosecond laser oscillator and using soliton self-frequency shift in a nonlinear fiber followed by amplification in ytterbium-doped fiber is presented. CARS microscopy is successfully demonstrated.

CThT2 • 2:45 p.m.

Fluorescence Background Suppression in Raman Spectroscopy, ***Michael Mazilu****, Anna Chiara De Luca, Andrews Riches, Simon Herrington, Kishan Dholakia; Univ. of St. Andrews, UK.* Raman spectroscopy provides a non-invasive method to study biological samples. We demonstrate the powerful capabilities of our novel Raman modulation technique to detect weak Raman signals hidden by a strong fluorescent background.

CThT3 • 3:00 p.m.

Ultrahigh Resolution Optical Coherence Tomography via Ce^{3+}:YAG Double-Clad Crystal Fiber Source, ***Chien-Chung Tsai****[1], Yen-Sheng Lin[1], Ting-Hao Chen[1], Yu-Ta Wang[1], Wei Chang[1], Po-Kai Hsu[1], Yung-Hsin Chang[1], Edmund Sun[2], Sheng-Lung Huang[1]; [1]Inst. of Photonics and Optoelectronics, Natl. Taiwan Univ., Taiwan, [2]Res. Ctr. for Information Technology Innovation, Academia Sinica, Taiwan.* A novel light source, emitted from 10-μm-core Ce^{3+}:YAG double-clad crystal fiber, was applied on optical coherence tomography with 1.5-μm axial resolution in air. The 3-dimensional stroma of fish cornea was mapped as an *in vivo* demonstration.

CThT4 • 3:15 p.m.

1.7 μm Wavelength Tunable Supercontinuum Source for Optical Coherence Tomography, ***Shutaro Ishida****, Norihiko Nishizawa, Takefumi Ohta, Kazuyoshi Itoh; Osaka Univ., Japan.* High resolution and high penetration depth OCT is demonstrated with Gaussian shaped, center wavelength tunable, 230 nm wide bandwidth, high power supercontinuum at 1.65-1.73 μm wavelengths region using ultrashort pulse fiber laser based system.

Room A5

JOINT

2:30 p.m.–4:15 p.m.
JThF • Joint CLEO/QELS Symposium on Quantum Control II
Michael Biercuk; NIST, USA, Presider

JThF1 • 2:30 p.m. Invited
Femtosecond Spatiotemporal Control with Multiple Knobs, *Debabrata Goswami;* *Indian Inst. of Technology, Kanpur, India.* For controlling non-resonant molecular fragmentation process, simultaneous effect of chirp and polarization of a femtosecond pulse is mutually independent. For multiphoton fluorescence microscopy and optical tweezers with high-repetition-rate lasers, interpulse separation and polarization is important.

JThF2 • 3:00 p.m. Invited
From Order to Chaos with a Spin and a Twist, *Poul S. Jessen*[1], *I. H. Deutsch*[2], *S. Ghose*[3]; [1]*Univ. of Arizona, USA,* [2]*Univ. of New Mexico, USA,* [3]*Wilfrid Laurier Univ., Canada.* Ultracold atoms are an excellent platform for testing new ideas in quantum control and measurement. I will review our recent work, including an experiment that has observed novel quantum signatures of chaos in unprecedented detail.

Room A6

CLEO

2:30 p.m.–4:15 p.m.
CThU • THz QCLS
William Charles; Princeton Univ., USA, Presider

CThU1 • 2:30 p.m. Invited
Operation of a 1.8-THz Quantum-Cascade Laser Above 160 K, *Sushil Kumar*[1], *Chun W. I. Chan*[1], *Qing Hu*[1], *John L. Reno*[2]; [1]*MIT, USA,* [2]*Sandia Natl. Labs, USA.* The maximum operating temperature of terahertz quantum-cascade lasers (QCLs) has empirically been limited to hbar.omega/kB. We report a new design to achieve 163K operation for a 1.8THz QCL, which is 1.9 times larger than hbar.omega/kB.

CThU2 • 3:00 p.m.
Development of Tunable Terahertz Wire Lasers, *Qi Qin*[1], *Benjamin Williams*[1,2], *Sushil Kumar*[1], *Qing Hu*[1], *John L. Reno*[3]; [1]*Dept. of Electrical Engineering and Computer Science and Res. Lab of Electronics, MIT, USA,* [2]*Dept. of Electrical Engineering, Univ. of California at Los Angeles, USA,* [3] *Ctr. of Integrated Nanotechnologies, Sandia Natl. Labs, USA.* We report a novel tuning mechanism based on a "wire-laser" with subwavelength transverse dimensions(w<<lambda). By manipulating the waveguided mode propagating outside the cavity, frequency tuning of ~137GHz(3.6%) is demonstrated from a single-laser device at ~3.8THz.

CThU3 • 3:15 p.m.
Terahertz Time Domain Spectroscopy of Phonon-Depopulation Based Quantum Cascade Lasers, *Sukhdeep S. Dhillon*[1], *Nathan Jukam*[1], *Dimitri Oustinov*[1], *Julien Madeo*[1], *Raffaele Colombelli*[2], *Paul Dean*[3], *Mohammed Salih*[3], *Suraj P. Khanna*[3], *Edmund H. Linfield*[3], *Giles Davies*[3], *Jerome Tignon*[1]; [1]*Lab Pierre Aigrain, Univ. Paris, France,* [2]*Inst. d'Electronique Fondamentale, Univ. Paris Sud, France,* [3]*School of Electronic and Electrical Engineering, Univ. of Leeds, UK.* A 3.1THz phonon depopulation-based quantum-cascade-laser is investigated using terahertz time domain spectroscopy. A gain of 25/cm and absorption features due to the lower laser level being populated from a parasitic electronic channel are highlighted.

Room A7

QELS

2:30 p.m.–4:15 p.m.
QThH • Nanoplasmonics
Gennady Shvets; Univ. of Texas at Austin, USA, Presider

QThH1 • 2:30 p.m.
Local Capacitor Model for Plasmonic Electric Field Enhancement, *Ji-Hun Kang*[1], *Min-Ah Seo*[2], *Dai-Sik Kim*[2], *Q-Han Park*[1]; [1]*Dept. of Physics, Korea Univ., Republic of Korea,* [2]*Ctr. for Subwavelength Optics and Dept. of Physics, Seoul Natl. Univ., Republic of Korea.* We present the local capacitor model that enables a simple, yet accurate description of lightning rod effect in nanoplasmonics. The λ-zone capacitance is proposed and applied to predict strongly induced electric field near metal edges.

QThH2 • 2:45 p.m.
Nano-Coupling and Enhancement in Plasmonic Conical Needle , *Alex Normatov*[1], *Nikolai Berkovitch*[1], *Pavel Ginzburg*[1], *Gilad M. Lerman*[2], *Avner Yanai*[2], *Uriel Levy*[2], *Meir Orenstein*[1]; [1]*Technion – Isreal Inst. of Technology, Israel,* [2]*Hebrew Univ. of Jerusalem, Israel.* Efficient coupling and power concentration of radially-polarized light in conical plasmonic needle is presented. Needle length dependent resonances are calculated. Radial plasmonic DBR with needle as defect was fabricated for NSOM and nonlinear conversion experiments.

QThH3 • 3:00 p.m. Invited
A Pointed Look at Light at the Nanoscale, *L. (Kobus) Kuipers;* *FOM Inst. for Atomic and Molecular Physics, Netherlands.* The subwavelength structure of light fields can be controlled with nanostructures. We map these fields, observe polarization singularities in the electric fieldis and, for the first time, visualize the magnetic component of light.

2:30 p.m.–4:15 p.m.
CThV • Fabrication of Photonic Structures
Nelson Tansu; Lehigh Univ., USA, Presider

CThV1 • 2:30 p.m.
Single Crystalline GaAs Nanoneedles Grown on 46% Lattice-Mismatched Sapphire with Bright Luminescence, *Linus C. Chuang*, *Kar Wei Ng, Thai-Truong D. Tran, Wai Son Ko, Michael Moewe, Shanna Crankshaw, Roger Chen, Connie Chang-Hasnain; Dept. of Electrical Engineering and Computer Sciences, Univ. of California at Berkeley, USA.* Catalyst-free GaAs nanoneedles are grown on a c-plane sapphire substrate at 400C using MOCVD. Despite of an extremely large lattice mismatch of 46%, the nanoneedles show single wurtzite-phase and bright room-temperature photoluminescence with narrow linewidths.

CThV2 • 2:45 p.m.
Growths of Ultra High Density InGaN-Based Quantum Dots on Self-Assembled Diblock Copolymer Nanopatterns, *Guangyu Liu*[1], *Hongping Zhao[1], Joo-Hyung Park[2], Luke J. Mawst[2], Nelson Tansu[1]; [1]Lehigh Univ., USA, [2]Univ. of Wisconsin at Madison, USA.* Selective area growths of highly-uniform InGaN quantum dots (QDs) on dielectric nanopatterns defined by self-assembled diblock copolymer were demonstrated with ultra-high QDs density of $8x10^{10}cm^{-2}$, which represents the highest QDs density reported for nitride-based QDs.

CThV3 • 3:00 p.m.
Laser Scanning Holographic Fabrication of Large Area Photonic Crystal Templates, *Liang (Leon) Yuan*, *Peter R. Herman; Univ. of Toronto, Canada.* Laser scanning of diffractive optics is introduced for flexible holographic fabrication of three-dimensional photonic crystal templates that facilitate seamless stitching of large-area crystals with spectral bandgap tuning, chirping, apodization and novel integration approaches for optofluidics.

CThV4 • 3:15 p.m.
Fabrication of Photonic Crystals with Sub-100 nm Features Using Multiphoton Lithography with Pre-Swollen Resins, *Vincent W. Chen*, *Nathan D. Jarnagin, Joseph W. Perry; Georgia Tech, USA.* Pre-swelling of resins has allowed the fabrication of photonic crystals with linewidths below 100 nm using multiphoton lithography at 730 nm. The resulting polymer photonic crystals show stop-band reflectivities over 70% at ~1.8 micron.

2:30 p.m.–4:15 p.m.
QThI • Quantum Communication
Norbert Lütkenhaus; Univ. of Waterloo, Canada, Presider

QThI1 • 2:30 p.m.
Actively Stabilised Quantum Key Distribution Operating Continuously at 1 Mbit/s, *Alex R. Dixon, **Zhiliang L. Yuan**, James F. Dynes, Andrew W. Sharpe, Andrew J. Shields; Toshiba Res. Europe Ltd., UK.* We report the continuous operation of an actively stabilised gigahertz clocked quantum key distribution system, with an average secure key rate of 1 Mbit/s over a distance of 50 km.

QThI2 • 2:45 p.m.
High-Rate Quantum Key Distribution with Superconducting Nanowire Single Photon Detectors, *Eric A. Dauler*[1], *Neal W. Spellmeyer[1], Andrew J. Kerman[1], Richard J. Molnar[1], Karl K. Berggren[2], John D. Moores[1], Scott A. Hamilton[1]; [1] MIT Lincoln Lab, MIT, USA, [2]MIT, USA.* We demonstrate the potential for 1.85 Mbit/s secure key rates over 101 km of fiber, >100 times faster than previously demonstrated, using the differential phase shift quantum key distribution protocol and superconducting nanowire single-photon detectors.

QThI3 • 3:00 p.m.
Macroscopic DPS-QKD Using an Optically Amplified Receiver, *Kyo Inoue*, *Tatsuya Kukita, Hiroshi Takada; Dept. of Electric and Electronic Information Engineering, Osaka Univ., Japan.* A QKD scheme using macroscopic coherent light with phases of $\pm\delta$ and optically pre-amplified direct differential detection is described. Its setup is basically the same as classical DPSK and is favorable for practicality.

QThI4 • 3:15 p.m.
Witnessing Effective Entanglement over 2km of Optical Fiber, *Christoffer Wittmann*[1,2], *Josef Fürst[1,2], Carlos Wiechers[1,2,3], Dominique Elser[1,2], Hauke Häseler[2,4], Norbert Lütkenhaus[1,2,4], Gerd Leuchs[1,2]; [1]Max-Planck-Inst. for the Science of Light, Germany, [2]Inst. for Optics, Information and Photonics, Univ. Erlangen-Nuremberg, Germany, [3]Dept. de Física, Univ. de Guanajuato, Mexico, [4]Inst. for Quantum Computing, Univ. of Waterloo, Canada.* We present a continuous-variable QKD system using heterodyne detection. We experimentally determine channel characteristics and compare them to bounds of our entanglement criterion. For the first time, the local oscillator is considered in this verification.

2:30 p.m.–4:15 p.m.
CThW • Novel Waveguides
Ian Young; Intel Corp., USA, Presider

CThW1 • 2:30 p.m.
Enhanced Guided-to-Radiation Mode Conversion in Electro-Optic Annealed Proton-Exchanged PPLN Waveguides, *Yen-Hung Chen*, *Jui-Wen Chang, Chia-Sheng Hsieh, Quan-Hsiang Tseng, Po-Chih Chuang, Wei-Kun Chang, Hsueh-Tsung Lyu; Dept. of Optics and Photonics, Natl. Central Univ., Taiwan.* We report a TM-guided to TE-radiation mode converter in electro-optic (EO) annealed proton-exchanged, 23.6-μm-period PPLN waveguides at 1550-nm band. Over 80%/cm mode-conversion efficiency was obtained with this device at 28°C with ~8 V/μm EO field.

CThW2 • 2:45 p.m.
The Effect of the Longitudinal Electric Field and Tensor Susceptibility on the Effective Nonlinear Parameter for Silicon Nanowire Waveguides, *Jeffrey B. Driscoll*[1], *Ron Lidar[1], Xiaoping Liu[1], Richard R. Grote[1], Jerry I. Dadap[1], Nicolae C. Panoiu[2], Richard M. Osgood, Jr.[1]; [1]Columbia Univ., USA, [2]Univ. College London, UK.* We show the significant impact of the longitudinal electric field component and full tensor susceptibility on the effective nonlinear parameter in subwavelength silicon nanowire waveguides. Inclusion of these effects is necessary for satisfactory wire modeling.

CThW3 • 3:00 p.m.
Octave Spanning 50:50 Beam Splitting via Interrupted STIRAP, *Felix Dreisow*[1], *Marco Ornigotti[2], Alexander Szameit[3], Matthias Heinrich[1], Robert Keil[1], Stefan Nolte[1], Andreas Tünnermann[1], Stefano Longhi[2]; [1]Friedrich-Schiller-Univ. Jena, Germany, [2]Dept. di Fisica and Inst. di Fotonica e Nanotecnologie del CNR, Italy, [3]Dept. of Physics and Solid State Inst., Technion – Israel Inst. of Technology, Israel.* We report on octave spanning 50:50 beam splitting via an interrupted stimulated Raman adiabatic passage in femtosecond laser written waveguides. The device is spatially and spectrally characterized by utilizing color center fluorescence at several wavelengths.

CThW4 • 3:15 p.m.
Photonic Devices in Low-Temperature Laser-Crystallized Deposited Silicon, *Kyle Preston*, *Carl B. Poitras, Michael O. Thompson, Michal Lipson; Cornell Univ., USA.* We demonstrate integrated optical devices in deposited silicon crystallized at room temperature for 3-D photonic integration. These devices can enable electro-optic switching and modulation on low-temperature substrates such as glass, plastic, and post-back-end CMOS wafers.

2:30 p.m.–4:15 p.m.
CThX • CLEO Symposium on Laser Beam Combining III: Beam Combining and Locking of High-Power Diode Lasers
James R. Leger; Univ. of Minnesota, USA, Presider

CThX1 • 2:30 p.m. Invited
Volume Bragg Gratings for Spectral Beam Combining, *Leonid B. Glebov*[1,2], *[1]CREOL, College of Optics and Photonics, Univ. of Central Florida, USA, [2]OptiGrate Corp., USA.* Basics and last results in spectral beam combining by volume Bragg gratings recorded in photo-thermo-refractive glass based on their high efficiency, narrow spectral selectivity and high tolerance to high power laser radiation are presented.

CThX2 • 3:00 p.m. Invited
Beam Reformatting and Combining of High-Power Laser Diode Stacks, *Howard J. Baker*[1], *N. Trela[1], D. R. Hall[1], R. McBride[2], J. J. Wendland[2]; [1]Heriot-Watt Univ., UK, [2]PowerPhotonic Ltd., UK.* Custom beam correction phase-plates developed for conserving brightness for diode laser bars in beam shaping/combining now provide multiple optical functions in one component, for new approaches to spatial, wavelength and coherent combining of arrays.

Thursday, May 20

San Jose Salon III (San Jose Marriott)

JOINT

2:30 p.m.–4:15 p.m.
JThG • Extreme Light
Jonathan Zuegel; Univ. of Rochester, USA, Presider

JThG1 • 2:30 p.m. Invited
The National Ignition Campaign on NIF, *Brian MacGowan*; *Lawrence Livermore Natl. Lab, USA.* This talk will describe progress in the experiments campaign on the National Ignition Facility(NIF) that has the goal of igniting and burning DT fuel through Inertial Confinement Fusion utilizing the world's largest laser.

JThG2 • 3:00 p.m.
Extreme Light Infrastructure (ELI): Physics and Lasers at the Ultra-Intense Frontier, *Georg Korn*[1], *Sergei V. Bulanov*[2], *Jean-Paul Chambaret*[3], *Dimitrios Charambilidis*[4], *John Collier*[5], *Mike Dunne*[5], *Klaus Ertel*[5], *Joachim Hein*[6], *Stefan Karsch*[1], *Ferenc Krausz*[1,7], *Gerard Mourou*[3], *Peter Nickles*[8], *Karoly Osvay*[3], *Bedrich Rus*[9], *Wolfgang Sandner*[8], *Georg Tsakiris*[1], *Toshiki Tajima*[7]; [1]*Max-Planck-Inst. for Quantum Optics, Germany,* [2]*Advanced Photon Res. Ctr. JAEA, Japan,* [3]*ILE, France,* [4]*FORTH-Hellas Inst. of Electronic Structure and Laser, Greece,* [5]*CLF Rutherford Appleton Lab, UK,* [6]*Inst. for Optics and Quantum Electronics, Germany,* [7]*Ludwig-Maximilians-Univ., Germany,* [8]*Max-Born-Inst., Germany,* [9]*PALS Res. Ctr. Inst. of Physics, Czech Republic.* We report on the Pan-European ELI-Infrastructure dedicated to develop, build and explore high-intensity lasers which will enter the ultra-relativistic interaction regime (I> 10 24 W/cm2). The main scientific pillars, applications and timelines are reviewed.

JThG3 • 3:15 p.m.
Development of 0.1-Hz 1-PW Ti:sapphire Laser, *Jae Hee Sung*, *Seong Ku Lee, Tae Jun Yu, Tae Moon Jeong, Jongmin Lee; Advanced Photonics Res. Inst., Gwangju Inst.of Science and Technology, Republic of Korea.* We have developed an 1-PW 30-fs Ti:sapphire laser with 0.1-Hz repetition rate. From its final booster amplifier pumped with 96-J energy, IR laser pulses with 47-J energy and flat-top spatial intensity profile have been obtained.

San Jose Salon I & II (San Jose Marriott)

CLEO

2:30 p.m.–4:15 p.m.
CThY • Optical Parametric Oscillators II
Darrell Armstrong; Sandia Natl. Labs, USA, Presider

CThY1 • 2:30 p.m.
High-Power, Fiber-Laser-Pumped Picosecond Optical Parametric Oscillator for the Near- to Mid-Infrared, *Omid Kokabee*[1], *Adolfo Esteban-Martin*[1], *Majid Ebrahim-Zadeh*[1,2]; [1]*ICFO, Spain,* [2]*ICREA, Spain.* We report a high-power picosecond optical parametric oscillator synchronously pumped by a Yb fiber laser. The oscillator provides a total average power of 9.58 W at 60% extraction efficiency in a TEM_{00} spatial beam profile.

CThY2 • 2:45 p.m.
Proportional-Integral Control for Wavelength Stabilization of a Synchronously-Pumped Optical Parametric Oscillator, *Tobias P. Lamour*, *Jinghua H. Sun, Derryck T. Reid; Heriot-Watt Univ., UK.* We present a rigorous method for the wavelength stabilization of a synchronously-pumped optical parametric oscillator using proportional-integral control. With wavelength stabilization active, the relative intensity noise is limited only by that of the pump laser.

CThY3 • 3:00 p.m.
Parametric Gain Shaping in Doubly Resonant OPOs: Theory, Experiment and Future Applications, *Bertrand G. M. Hardy, Myriam Raybaut,* ***Antoine Godard****, Michel Lefebvre; Onera - the French Aerospace Lab, France.* We investigate spectral shaping of the parametric gain in a double-pass doubly resonant OPO. The experimental demonstration is made possible by our specific OPO design that enables the precise control of the backward relative phase.

CThY4 • 3:15 p.m.
A Pump-Resonant Signal-Resonant Optical Parametric Oscillator for Spectroscopic Breath Analysis, *Jean-Jacques Zondy*, *Abdallah Rihan, Emeline Andrieux, Thomas Zanon-Willette, Stephan Briaudeau, Marc Himbert; Inst. Natl. de Métrologie, Conservatoire Natl. des Arts et Métiers, France.* We report on an idler octave-spanning (1.6 - 3.5μm) cw titanium-sapphire pump-resonant signal-resonant optical parametric oscillator delivering 10 to 50 mW, for multi-species trace gas sensing based on cavity ring down spectroscopy.

Room B2-B3

JOINT

2:30 p.m.–4:00 p.m.
JThH • High Energy Lasers for Defense Applications
Bryce Schumm; AFRL, USA, Presider

JThH1 • 2:30 p.m. Tutorial
Challenges to Making High-Power Solid-State Lasers, *John M. Slater*; *Schafer Corp., USA.* This is a tutorial exploring some of the key engineering issues that have been and must be addressed to construct solid state lasers in the 100 kW, CW class with good beam quality.

Dr. Slater joined Schafer Corporation in 2002 and presently leads the Schafer team supporting the High Energy Laser Joint Technology Office (HEL-JTO). He has been closely connected with the JTO's 100 kW solid state laser program, including the Government-sponsored independent testing of high power lasers. He received his Ph.D. in atomic physics from the University of Colorado and has worked previously at STI Optronics, with emphasis on free electron lasers, and with the physics group at the Idaho National Laboratory. He is a Fellow of the Directed Energy Professional Society.

CThQ • High Harmonic Generation—Continued

CThQ4 • 3:45 p.m.
Observation of Quasi-Ballistic Heat Transport at Nano-Interfaces Using Coherent Soft X-Ray Beams, ***Qing Li***[1], *Mark E. Siemens*[1], *Ronggui Yang*[1], *Margaret M. Murnane*[1], *Henry C. Kapteyn*[1], *Erik H. Anderson*[2], *Keith A. Nelson*[3]; [1]*JILA, Univ. of Colorado, USA,* [2] *Ctr. for X-Ray Optics, Lawrence Berkeley Natl. Lab, USA,* [3]*Dept. of Chemistry, MIT, USA.* We make the first observation and quantitative measurement of quasi-ballistic thermal transport from a nanoscale heat source, finding a significant decrease in energy transport away from the hotspot compared with diffusive thermal transport predictions.

CThQ5 • 4:00 p.m.
High Harmonic Transient Grating Spectroscopy, ***Joseph P. Farrell****, Limor S. Spector, Brian K. McFarland, Phil H. Bucksbaum, Markus Guehr; Stanford Univ., USA.* We demonstrate a unique pump-probe scheme for high harmonic spectroscopy, which is sensitive to weak excitations and provides spectral information without the need for a VUV spectrometer.

CThR • Nonlinear Silicon Photonics—Continued

CThR4 • 3:30 p.m.
Suppression of Free Carrier Absorption in Multi-Slot Silicon Light Emission Devices, ***Yijing Fu***[1], *Karl Ni*[2], *Philippe M. Fauchet*[2]; [1]*Inst. of Optics, Univ. of Rochester, USA,* [2]*Dept. of Electrical and Computer Engineering, Univ. of Rochester, USA.* Free carrier absorption is the major obstacle towards achieving optical gain in Er-doped nc-Si. We experimentally demonstrated the suppression of free carrier absorption by multi-slot waveguide. The experimental results agree well with our theoretical calculations.

CThR5 • 3:45 p.m.
Dispersion Tailoring in Dual Slot Waveguide, ***Yinying Xiao-Li***[1], *Lin Zhang*[1], *Yang Yue*[1], *Jian Wang*[1], *Raymond G. Beausoleil*[2], *Alan E. Willner*[1]; [1]*Univ. of Southern California, USA,* [2]*HP Labs, USA.* Dual slot waveguides incorporate a sub-core in the slot, so that the guided beam is confined two-dimensionally. The modification enlarges the room for tailoring dispersive properties and birefringence. Both zero-dispersion and constant-dispersion points are demonstrated.

CThR6 • 4:00 p.m.
>25× Reduction in the Effective Nonlinear Coefficient over a 100-nm Wavelength Range Using Vertically-Slotted Silicon Waveguide, ***Yang Yue***[1], *Lin Zhang*[1], *Jian Wang*[1], *Yinying Xiao-Li*[1], *Raymond Beausoleil*[2], *Alan Willner*[1]; [1]*Univ. of Southern California, USA,* [2]*HP Labs, USA.* Vertically-slotted waveguides are used to achieve low nonlinearity. Compared with strip waveguide, it demonstrates a >25× reduction in the nonlinear coefficient for a 100-nm wavelength range.

CThS • Photonic Crystal Devices—Continued

CThS5 • 3:30 p.m.
Shear Ordering in Polymer Photonic Crystals, ***David R. E. Snoswell***[1], *Andreas Kontogeorgos*[1], *Jeremy J. Baumberg*[1], *Tim D. Lord*[1], *Malcolm R. Mackley*[1], *Peter Spahn*[2], *Goetz P. Hellmann*[2]; [1]*Cambridge Univ., UK,* [2]*Duetsches Kunststoff-Inst., Germany.* Time-resolved scattering spectra of flowing polymer-based colloidal opals are presented. Broadband spectra reflecting dynamic structural changes during a shear-ordering process reveal four distinct regimes of crystal growth and decay identified under different flow conditions.

CThS6 • 3:45 p.m.
Reversible Tuning of Photonic Crystal Cavities Using Photochromic Films, ***Deepak Sridharan***[1], *Edo Waks*[1], *John T. Fourkas*[1], *Glenn Solomon*[2]; [1]*Univ. of Maryland, USA,* [2]*NIST, USA.* We demonstrate reversible tuning of photonic-crystal cavity resonance by 2.7nm using a photochromic film of spiropyran. Exposure of spiropyran to ultraviolet light redshifts the cavity resonance that can be reversed by exposure to visible light.

CThS7 • 4:00 p.m.
Internal Field Measurements of Finite Length 1-D Form-Birefringent Periodic Structures, *Shawn P. Rigdon*[1], *Mitchell Pate*[1], ***Weiguo Yang***[1], *John D. Graham*[1], *Michael Clare*[1], *Mesfin Woldeyohannes*[1], *John O. Schenk*[2], *Robert P. Ingel*[2], *Michael A. Fiddy*[2]; [1]*Western Carolina Univ., USA,* [2]*Univ. of North Carolina at Charlotte, USA.* We report measurements of internal field intensity distribution over 1-D form-birefringent periodic structures of finite length. Field distributions and field enhancement are verified but at significantly reduced strength attributed to small but finite material loss.

CThT • Microscopy: Technology Development—Continued

CThT5 • 3:30 p.m.
High Speed Axial Scanning in a Temporal Focusing Setup with Piezo Bimorph Mirror Dispersion Tuning, ***Adam A. Straub****, Michael E. Durst, Chris Xu; Cornell Univ., USA.* Remote axial scans of mouse tissue are taken at high speed in a temporal focusing setup. A piezo bimorph mirror is used for tunable dispersion, capable of $\pm 2.5 \times 10^5$ fs^2 of GDD and 100 Hz modulation.

CThT6 • 3:45 p.m.
Liquid Lens Approaches For Simultaneous Standard and Extended Depth of Field Imaging, ***Nicolas Olivier***[1,2], *William T. Mozet*[2], *Alexander Mermillod-Blondin*[2], *Emmanuel Beaurepaire*[1], *Craig B. Arnold*[2]; [1]*École Polytechnique, France,* [2]*Princeton Univ., USA.* A tunable acoustic gradient lens is shown to provide depth-of-field switching at kilohertz rates in a nonlinear microscope. We demonstrate two modulation strategies; fast varifocus scanning during each pixel and pseudo-Bessel beam excitation.

CThT7 • 4:00 p.m.
Performance of Serial Time-Encoded Amplified Microscopy, *Kevin K. Tsia*[1], ***Keisuke Goda***[2], *Dale Capewell*[2], *Bahram Jalali*[2]; [1]*Univ. of Hong Kong, Hong Kong,* [2]*Univ. of California at Los Angeles, USA.* Serial time-encoded amplified microscopy (STEAM) is a new high-sensitivity ultrafast real-time imaging modality. Here we describe an analysis of its spatial resolution, frame rate, and detection sensitivity.

4:15 p.m.–4:45 p.m. Coffee Break, *San Jose McEnery Convention Center, Concourse 1*

NOTES

JThF • Joint CLEO/QELS Symposium on Quantum Control II—Continued

JThF3 • 3:30 p.m.
Concentration of Phase-Information, *Christian R. Müller*[1], *Mario Usuga*[2], *Christoffer Wittmann*[1], *Petr Marek*[3], *Radim Filip*[3], *Christoph Marquardt*[1], *Ulrik L. Andersen*[2], *Gerd Leuchs*[1]; [1]*Max-Planck-Inst. for the Science of Light, Germany,* [2]*Technical Univ. of Denmark, Denmark,* [3]*Dept. of Optics, Palacký Univ., Czech Republic.* We demonstrate a probabilistic scheme capable of increasing the phase information of weak coherent states by addition of thermal noise and subsequent photon-counting based postselection. We present experimental and theoretical results.

JThF4 • 3:45 p.m.
Adaptive Optical Phase Estimation, *D. Nakane*[1], *T. A. Wheatley*[1,2,3], *D. W. Berry*[4], *H. Yonezawa*[1], *H. Arao*[1], *D. T. Pope*[5], *T. C. Ralph*[2,6], *H. M. Wiseman*[2,7], *E. H. Huntington*[2,3], *A. Furusawa*[1]; [1]*Dept. of Applied Physics and Quantum-Phase Electronics Ctr., School of Engineering, Univ. of Tokyo, Japan,* [2]*Ctr. for Quantum Computer Technology, Australian Res. Council, Australia,* [3]*School of Engineering and Information Technology, Univ. College, Univ. of New South Wales, Australia,* [4]*Inst. for Quantum Computing, Univ. of Waterloo, Canada,* [5]*Perimeter Inst., Canada,* [6]*Dept. of Physics, Univ. of Queensland, Australia,* [7]*Ctr. for Quantum Dynamics, Griffith Univ., Australia.* We experimentally performed adaptive phase estimation using time-symmetric quantum smoothing for a stochastically varying phase on continuous wave coherent beam. We demonstrate better accuracy than conventional methods.

JThF5 • 4:00 p.m.
Coherent-Feedback Formulation of Continuous Quantum Error Correction Protocols, *Joseph Kerckhoff*[3], *Hendra I. Nurdin*[1,2], *Dmitri S. Pavlichin*[1], *Hideo Mabuchi*[1]; [1]*Edward L. Ginzton Lab, Stanford Univ., USA,* [2]*Dept. of Information Engineering, Australian Natl. Univ., Australia.* We propose an approach to continuous-time quantum error correction based on the coherent feedback of optical probes that naturally utilizes photonic device physics to implement a stationary and 'on-chip' protected quantum memory.

CThU • THz QCLS—Continued

CThU4 • 3:30 p.m.
Non-Equilibrium LO and TO Phonon Generation by Electron Transport in Terahertz Quantum Cascade Lasers , *Miriam S. Vitiello*[1], *Gaetano Scamarcio*[1], *Rita C. Iotti*[2], *Fausto Rossi*[2], *Lukas Mahler*[3], *Alessandro Tredicucci*[3]; [1]*CNR-INFM LIT3, Italy,* [2]*Politecnico di Torino, Italy,* [3]*CNR-INFM NEST and Scuola Normale Superiore, Italy.* We report on the experimental observation of non-equilibrium longitudinal and transverse optical phonons populations associated with electron transport in resonant-phonon THz quantum-cascade lasers and compare the results with the outcome of Monte Carlo simulations.

CThU5 • 3:45 p.m.
Terahertz Amplifier Based on Gain Switching in a Quantum Cascade Laser, *Nathan Jukam*[1], *Sukhdeep S. Dhillon*[1], *Dimitri Oustinov*[1], *Julien Madeo*[1], *Stefano Barbieri*[2], *Christophe Manquest*[2], *Carlo Sirtori*[2], *Suraj P. Khanna*[3], *Edmund H. Linfield*[3], *Giles Davies*[3], *Jerome Tignon*[1]; [1]*Lab Pierre Aigrain, Univ. Paris, France,* [2]*Matériaux et Phénomènes Quantiques, Univ. Denis Diderot, France,* [3]*School of Electronic and Electrical Engineering, Univ. of Leeds, UK.* A terahertz quantum cascade laser and an integrated Auston-switch are coupled to perform ultrafast gain switching. The resulting non-equilibrium gain is not clamped above laser threshold and large amplification of input terahertz pulses is demonstrated.

CThU6 • 4:00 p.m.
Integrated Terahertz Pulse Generation and Amplification in Quantum Cascade Lasers, *Sukhdeep S. Dhillon*[1], *Simon Sawallich*[1], *Nathan Jukam*[1], *Dimitri Oustinov*[1], *Julien Madeo*[1], *Stefano Barbieri*[2], *Pascal Filloux*[2], *Carlo Sirtori*[2], *Xavier Marcadet*[3], *Jerome Tignon*[1]; [1]*Lab Pierre Aigrain, France,* [2]*Matériaux et Phénomènes Quantiques, Univ. Denis Diderot, France,* [3]*Alcatel-Thales III-V lab, France.* Terahertz pulse generation is demonstrated by a resonant femtosecond interband excitation of the miniband of a quantum-cascade-laser. The laser gain is subsequently used to amplify the terahertz pulse generated as it propagates through the cavity.

QThH • Nanoplasmonics—Continued

QThH4 • 3:30 p.m.
Phase Front Design with Metallic Pillar Arrays, *Lieven Verslegers*, *Peter B. Catrysse, Zongfu Yu, Wonseok Shin, Zhichao Ruan, Shanhui Fan; Stanford Univ., USA.* We demonstrate numerically the ability to design a phase front using an array of metallic pillars. We show that in such structures, the local phase delay upon transmission can be tuned by local geometry.

QThH5 • 3:45 p.m.
Nonlinear Plasmonics: From Second-Harmonic Generation to Spatial Solitons, *Artur R. Davoyan, Ilya V. Shadrivov, Yuri S. Kivshar; Australian Natl. Univ., Australia.* We study two major nonlinear effects in plasmonic structures: second-harmonic generation in metal-insulator-metal waveguides and self-focusing of plasmons propagating along an interface between metal and Kerr-type nonlinear dielectric with the formation of spatial plasmon-polariton solitons.

QThH6 • 4:00 p.m.
Electrostatic Field Control of Exciton-Surface-Plasmon Coupling in Individual Carbon Nanotubes, *Igor Bondarev*[1], *Lilia Woods*[2], *Kevin Tatur*[2]; [1]*North Carolina Central Univ., USA,* [2]*Univ. of South Florida, USA.* We show that the perpendicular electrostatic field allows one to control the exciton-plasmon coupling and photoluminescence of individual carbon nanotubes. The effect may be used for the development of nanotube based tunable optoelectronic device applications.

4:15 p.m.–4:45 p.m. Coffee Break, *San Jose McEnery Convention Center, Concourse 1*

NOTES

Room A8	Room C1&2	Room C3&4	San Jose Ballroom IV (San Jose Marriott)
CLEO	QELS	CLEO	

CThV • Fabrication of Photonic Structures—Continued

CThV5 • 3:30 p.m.
Single-Defect Photonic Crystal Cavity Laser Fabricated by a Combined Lithography of Laser Holography and Focused Ion Beam, *Sungmo Ahn, Sihan Kim,* ***Heonsu Jeon****; Seoul Natl. Univ., Republic of Korea.* InP-based square-lattice photonic crystal laser with a single air-hole defect was fabricated by a combined lithography of laser holography and focused ion beam, which enables the large scale and high throughput fabrication of PC-based devices.

CThV6 • 3:45 p.m.
Non-Lithographic Patterning and Metal-Assisted Chemical Etching for Manufacturing of Tunable Light-Emitting Silicon Nanowire Arrays, ***Xiuling Li****; Univ. of Illinois, USA.* We report a top-down fabrication method that involves the combination of superionic-solid-state-stamping (*S4*) patterning with metal-assisted-chemical-etching (*MacEtch*), to produce silicon nanowire arrays with defined geometry and optical properties in a manufacturable fashion.

CThV7 • 4:00 p.m.
Rare Earth Doped Optical Fiber Fabrication Using Novel Gas Phase Deposition Technique, ***Alexander J. Boyland****, Andrew S. Webb, Mridu P. Kalita, Seongwoo Yoo, Christophe A. Codemard, Robert J. Standish, Johan Nilsson, Jayanta K. Sahu; Univ. of Southampton, UK.* We report a highly versatile gas phase technique for making ytterbium doped silica fibers. Initial results generated 200W output power with a slope efficiency of 72%.

QThI • Quantum Communication—Continued

QThI5 • 3:30 p.m.
Relay-Assisted Free-Space Quantum-Key Distribution with Partial Phase Compensation, ***Majid Safari****, Murat Uysal; Univ. of Waterloo, Canada.* We study the effect of partial phase compensation on a free-space relay-assisted quantum-key distribution system. Our analytical results demonstrate that the relay-assisted system outperforms the direct transmission even with partial phase compensation.

QThI6 • 3:45 p.m.
Quantum Interference Measurement for Realizing a Polarization-Based Quantum Relay at 1550 nm, ***Yinghong Xue****[1,2], Akio Yoshizawa[1,2], Hidemi Tsuchida[1,2]; [1]AIST, Japan, [2] JST, Japan.* We observed quantum interference using two polarization-entangled photon pairs at 1550 nm, created in two periodically poled lithium niobate waveguides. Using four-fold coincidences, a visibility of 75% was observed without subtracting accidental coincidences.

QThI7 • 4:00 p.m.
Quantum Spread Spectrum Communication, ***Travis S. Humble****; Oak Ridge Natl. Lab, USA.* We demonstrate that spectral teleportation can coherently dilate the spectral probability amplitude of a single photon. In preserving the encoded quantum information, this variant of teleportation subsequently enables a form of quantum spread spectrum communication.

CThW • Novel Waveguides—Continued

CThW5 • 3:30 p.m.
Zero-Dispersion Slow Light in Hollow Waveguide with High-Contrast Grating, ***Ayumi Fuchida****[1], Bala Pesala[2], Vadim Karagodsky[2], Forrest G. Sedgwick[2], Fumio Koyama[1], Connie J. Chang-Hasnain[2]; [1]Tokyo Inst. of Technology, Japan, [2]Univ. of California at Berkeley, USA.* Zero-dispersion slow light can be seen in a hollow waveguide using high-contrast grating in wide spectral range. A zero-dispersion group index of 7 can be obtained with propagation loss of below 1dB/mm and 15nm-optical bandwidth.

CThW6 • 3:45 p.m.
Nanoporous Polymer Liquid Core Waveguides, ***Nimi Gopalakrishnan****[1], Kaushal S. Sagar[2], Mads B. Christiansen[1], Sokol Ndoni[1], Martin E. Vigild[2], Anders Kristensen[1]; [1]DTU Nanotech, Technical Univ. of Denmark, Denmark, [2]DTU Chemical and Biochemical Engineering, Technical Univ. of Denmark, Denmark.* We demonstrate liquid core waveguides defined by UV to enable selective water infiltration in nanoporous polymers, creating an effective refractive index shift Δn=0.13. The mode confinement and propagation loss in these waveguides are presented.

CThW7 • 4:00 p.m.
Chalcogenide Nanowire Waveguides with a Nonlinear Parameter 150,000 W-1km-1, ***Barry Luther-Davies****, Xin Gai, Steven Madden, Duk-yong Choi, Douglas Bulla; CUDOS, Laser Physics Ctr., Res. School of Physics and Engineering, Australian Natl. Univ., Australia.* We report dispersion-engineered nanowire waveguides fabricated in Ge11.5As24Se54.5 chalcogenide glass with a nonlinear parameter γ>150,000W-1km-1 - the highest reported for a glass waveguide.

CThX • CLEO Symposium on Laser Beam Combining III: Beam Combining and Locking of High-Power Diode Lasers—Continued

CThX3 • 3:30 p.m.
Wavelength-Locking of an Ultra-Collimated 49 Element Single-Mode Diode Laser Array by a Distant VHG, ***Natalia Trela****, Howard J. Baker, Denis R. Hall; Heriot-Watt Univ., UK.* VHG-locking of a 49 single mode emitter bar, combined with dual-axis correction/collimation for smile elimination and beam pointing improvement, gives 100% wavelength locking to 48 mm VHG-bar separation and an extended temperature range.

CThX4 • 3:45 p.m.
Advanced Packaging of High-Power Slab-Coupled Optical Waveguide Laser and Amplifier Arrays for Coherent Beam Combining, ***Leo J. Missaggia****[1], Shawn M. Redmond[1], Michael A. Brattain[1], Michael K. Connors[1], Kevin J. Creedon[1], Robin K. Huang[2], Bien Chann[2], Janice M. Caissie[1], Antonio Sanchez-Rubio[1], George W. Turner[1]; [1]MIT Lincoln Lab, USA, [2]Teradiode, USA.* Individually addressable GaAs-based 9XX-nm Slab-Coupled Optical Waveguide (SCOW) laser and amplifier arrays have been demonstrated in a modular 2-D stacked architecture. Approximately 20 W of coherently-combined power was obtained from two optically stacked amplifier modules.

CThX5 • 4:00 p.m.
Wavelength-Beam-Combined Quantum-Cascade-Laser Array for Remote Spectroscopy, ***Anish K. Goyal****[1], Melissa Spencer[1], Oleg Shatrovoy[1], Antonio Sanchez[1], Benjamin G. Lee[2], Laurent Diehl[2], Christian Pflugl[2], Federico Capasso[2]; [1]MIT Lincoln Lab, USA, [2]Harvard Univ., USA.* We demonstrate transmission spectroscopy between a monostatic transceiver based on a wavelength-beam-combined quantum-cascade-laser array and a retroreflector placed at 35 meters.

4:15 p.m.–4:45 p.m. Coffee Break, *San Jose McEnery Convention Center, Concourse 1*

NOTES

Thursday, May 20

San Jose Salon III (San Jose Marriott)

JOINT

JThG • Extreme Light—Continued

JThG4 • 3:30 p.m.
Compression of Ultra-High Power Laser Pulses, *Vladimir Chvykov*[1], *Christophe Radier*[2], *Gilles Chériaux*[2], *Galina Kalinchenko*[1], *Victor Yanovsky*[1], *Gerard Mourou*[2]; [1]*Univ. of Michigan, USA,* [2]*Lab d'Optique Appliquée, ENSTA, École Polytechnique, France.* We present easy-scalable pulse recompression method based on spectral broadening due to self phase modulation in bulk medium. Our experiment demonstrates a possibility of compression of high-energy pulses above 1J from 30 to 14 fs.

JThG5 • 3:45 p.m.
Design of the 10 PW OPCPA Facility for the Vulcan Laser, *Ian O. Musgrave*[1], *Oleg Chekhlov*[1], *John Collier*[1], *R. Clarke*[1], *A. Dunne*[1], *S. Hancock*[1], *R. Heathcote*[1], *C. Hernandez-Gomez*[1], *M. Galimberti*[1], *A. Lyachev*[1], *P. Matousek*[1], *D. Neely*[1], *P. Norreys*[1], *I. Ross*[1], *Y. Tang*[1], *T. Winstone*[1], *G. New*[2]; [1]*Central Laser Facility, CCLRC Rutherford Appleton Lab, UK,* [2]*Imperial College London, UK.* We present the progress made in developing 10PW OPCPA facility for the Vulcan laser to produce pulses with focused intensities $>10^{23}$ Wcm^{-2}. This power level will be delivered by generating pulses with >300J in 30fs.

JThG6 • 4:00 p.m.
Demonstration of aTemporally and Spatially High Quality Petawatt-Class Laser System, *Hiromitsu Kiriyama*[1], *Michiaki Mori*[1], *Yoshiki Nakai*[1], *Takuya Shimomura*[1], *Hajime Sasao*[1], *Momoko Tanaka*[1], *Yoshihiro Ochi*[1], *Manabu Tanoue*[1], *Hajime Okada*[1], *Shuhei Kanazawa*[1], *Akito Sagisaka*[1], *Izuru Daito*[1], *Daisuke Wakai*[1], *Fumitaka Sasao*[1], *Masayuki Suzuki*[1], *Kiminori Kondo*[1], *Akira Sugiyama*[1], *Sergei Bulanov*[1], *Paul R. Bolton*[1], *Hiroyuki Daido*[1], *Atsushi Yokoyama*[1], *Shunichi Kawanishi*[1], *Toshiki Tajima*[1,2]; [1]*JAEA, Japan,* [2]*Ludwig-Maximilians-Univ., Germany.* We report the demonstration of over 30-J of uncompressed broadband energy, indicating the potential peak power in excess of 500-TW with high temporal-contrast around 10^{11} and a flat-toped spatial-profile with an ~80% filling factor.

San Jose Salon I & II (San Jose Marriott)

CLEO

CThY • Optical Parametric Oscillators II—Continued

CThY5 • 3:30 p.m.
Highly Stable Diode-Laser Pumped, Idler Resonant CW OPO Based on MgO:PPLN, *Andreas Lenhard*[1], *Sebastian Zaske*[1], *Johannes A. L'huillier*[2], *Christoph Becher*[1]; [1]*Univ. des Saarlandes, Germany,* [2]*Technische Univ. Kaiserslautern, Germany.* We report on a diode laser pumped continuous wave, pump enhanced idler-resonant optical parametric oscillator. Cavity stabilization by a Pound-Drever-Hall scheme using direct modulation of the diode laser enables long-time frequency and amplitude stable output.

CThY6 • 3:45 p.m.
Narrow-Band Degenerate Optical Parametric Oscillator in Periodically Poled MgO:$LiNbO_3$ with a Volume Bragg Grating Output Coupler, *Peter Koch*[1], *Felix Ruebel*[1], *Martin Nittmann*[2], *Thorsten Bauer*[2], *Juergen Bartschke*[2], *Johannes A. L'huillier*[1]; [1]*Photonik-Zentrum Kaiserslautern e. V., Germany,* [2]*Xiton Photonics GmbH, Germany.* We report on a narrow-band (<0.7nm) optical parametric oscillator operating at degeneracy. By using a volume Bragg grating a signal power of 1.7W with a slope efficiency of 31.8% and good beam quality was achieved.

CThY7 • 4:00 p.m.
High-Power, CW Optical Parametric Oscillator Pumped by an Optically-Pumped-Semiconductor-Laser at 532 nm, *Goutam K. Samanta*[1], *Majid Ebrahim-Zadeh*[1,2]; [1]*ICFO, Spain,* [2]*ICREA, Spain*. We report the first continuous-wave optical-parametric-oscillator pumped externally by an optically-pumped-semiconductor-laser. The device provides >2W of frequency-stable output (>60 MHz over 60 seconds) at 48.7% extraction efficiency in TEM_{00} spatial beam tunable over 873-1360 nm.

Room B2-B3

JOINT

JThH • High Energy Lasers for Defense Applications—Continued

JThH2 • 3:30 p.m. Invited
Textron's J-HPSSL 100 kW ThinZag® Laser Program, *Alex Mandl*, *Daniel E. Klimek; Textron Defense Systems, USA.* In this presentation, we describe recent work performed at Textron Defense Systems in the development of a 100 kW ThinZag® laser as part of the Joint High Power Solid State Laser program.

4:15 p.m.–4:45 p.m. Coffee Break, *San Jose McEnery Convention Center, Concourse 1*

NOTES

4:45 p.m.–6:30 p.m.
CThZ • Parametric Generation
Catherine Le Blanc; École Polytechnique, France, Presider

CThZ1 • 4:45 p.m.
Generation of Sub 7-fs Pulses at 800 nm from a Degenerate Optical Parametric Amplifier, *Aleem M. Siddiqui*[1], *Giovanni Cirmi*[1,2], *Daniele Brida*[2], *Giulio Cerullo*[2], *Franz X. Kärtner*[1]; [1]*MIT, USA,* [2]*Politecnico di Milano, Italy.* We generate 800-nm, sub-7-fs pulses from a degenerate Optical Parametric Amplifier pumped by the second harmonic of a Ti:sapphire system and seeded by supercontinuum generated by a near IR OPA pumped by the same source.

CThZ2 • 5:00 p.m.
Picosecond Synchronously Pumped $ZnGeP_2$ Optical Parametric Oscillator, *Jean-Baptiste Dherbecourt*, *Antoine Godard, Myriam Raybaut, Michel Lefebvre; DMPH Onera, The French Aerospace Lab, France.* We report the continuous modelocked operation of a picosecond, singly-resonant, synchronously-pumped optical parametric oscillator (SPOPO) based on ZGP. The ZGP SPOPO emits in the 4-6 μm range with signal power higher than 800 mW.

CThZ3 • 5:15 p.m.
Multi-Octave-Spanning Laser Harmonics for Ultrafast Waveform Synthesis, *Wei-Chun Hsu*[1], *Ying-Yao Lai*[2], *Chien-Jen Lai*[3], *Lung-Han Peng*[3], *Ci-Ling Pan*[4], *Andy Kung*[1,4]; [1]*Academia Sinica, Taiwan,* [2]*Natl. Taiwan Univ., Taiwan,* [3]*MIT, USA,* [4]*Natl. Tsing Hua Univ., Taiwan.* The second to the fifth harmonics of a fundamental frequency are generated in a lithium tantalate crystal by cascaded quasi-phase-matched frequency mixing. These harmonics can be used to synthesize a train of periodic sub-femtosecond pulses.

CThZ4 • 5:30 p.m.
15-fs Multicolor Laser Pulses Generation Using Cascaded Four-Wave Mixing with Chirped Pulses Incidence, *Takayoshi Kobayashi*[1,2,3,4], *Jun Liu*[1,2]; [1]*JST, ICORP, Ultrashort Pulse Laser Project, Japan,* [2]*Univ. of Electro-Communications, Japan,* [3]*Natl. Chiao Tung Univ., Taiwan,* [4]*Osaka Univ., Japan.* With the use of negatively chirped and positively chirped incident pulses, as short as 15 fs multicolor pulses were obtained in a fused silica glass using cascaded four-wave mixing technique.

4:45 p.m.–6:30 p.m.
CThAA • Silicon Photonics
Joyce Poon; Univ. of Toronto, Canada, Presider

CThAA1 • 4:45 p.m.
Characterization of SOI Microrings Using IR Imaging , *Michael L. Cooper*[1], *Greeshma Gupta*[1], *Jung S. Park*[1], *Mark A. Schneider*[1], *Ivan B. Divliansky*[2], *Shayan Mookherjea*[1]; [1]*Univ. of California at San Diego, USA,* [2]*Univ. of Central Florida, USA.* We demonstrate a non-invasive diagnostic method of quantitative infrared (IR) imaging, applied here to a series cascade of SOI microrings. The images contain information on inaccessible through-ports and resonators themselves, providing coupling and intensity-enhancement parameters.

CThAA2 • 5:00 p.m.
Adiabatic Couplers in SOI Waveguides, *Liang Cao*, *Ali Elshaari, Abdelsalam Aboketaf, Stefan Preble; Rochester Inst. of Technology, USA.* Adiabatic 3-dB couplers based on highly confined silicon waveguides are studied and experimentally demonstrated. The couplers are inherently broadband and insensitive to fabrication imperfections, which enables reliable photonic circuits.

CThAA3 • 5:15 p.m.
Silicon RF MEMS Based Optical Modulator, *Suresh Sridaran*, *Sunil A. Bhave; School of Electrical and Computer Engineering, Cornell Univ., USA.* We report on co-fabrication of photonic microdisk resonators and RF-MEMS radial-contour mode resonators on the same SOI substrate. By mechanically coupling the two resonators, we demonstrate an optical modulator for 1560nm light operating at 288MHz.

CThAA4 • 5:30 p.m.
Optical Micromechanical Amplification and Damping in a Waveguide Microcavity, *Marcel W. Pruessner*, *Todd H. Stievater, William S. Rabinovich; NRL, USA.* We demonstrate resonant amplification and damping in an integrated micromechanical resonator coupled to a waveguide Fabry-Perot microcavity. By varying the laser power and wavelength, the effective mechanical Q-factor (Q0=25,000) is varied from 9,800 to 490,000.

4:45 p.m.–6:30 p.m.
CThBB • Tunable Networks and Regeneration
Natasha Litchinitser; SUNY Buffalo, USA, Presider

CThBB1 • 4:45 p.m.
Optical Carrier Regeneration for Wavelength Reusable Multicarrier Distributed OADM Network, *Motoharu Matsuura*, *Eiji Oki; Univ. of Electro-Communications, Japan.* We demonstrate optical carrier regeneration for wavelength reuse in a multicarrier distributed OADM network. It is possible to achieve a high-quality regenerated signal even though the employed data signal for wavelength reuse is drastically degraded.

CThBB2 • 5:00 p.m.
Performances of All-Optical Wavelength Conversion by Means of Nonlinear Polarization Rotation in an SOA for WLAN Systems Using RoF Technologies, *Motoharu Matsuura*, *Nanang Krisdianto, Naoto Kishi; Univ. of Electro-Communications, Japan.* We report an all-optical wavelength conversion for WLAN systems using radio-over-fiber technologies. We investigate the performances and successfully achieve high conversion performances in the operating wavelength range of 60 nm.

CThBB3 • 5:15 p.m.
Improvement of NOLM-Based Phase-Preserving Amplitude Limiters by Fiber Optimizations, *Christian Stephan*[1,2,3], *Klaus Sponsel*[1,2], *Georgy Onishchukov*[1,3], *Bernhard Schmauss*[3,4], *Gerd Leuchs*[1,2,3]; [1]*Max-Planck-Inst. for the Science of Light, Germany,* [2]*Inst. of Optics, Information and Photonic, Univ. of Erlangen-Nuremberg, Germany,* [3]*Erlangen Graduate School in Advanced Optical Technologies, Germany,* [4]*Chair for Microwave Engineering, Univ. of Erlangen-Nuremberg, Germany.* The noise limits of phase-preserving NOLM-based regenerators from Rayleigh backscattering and possible improvements are investigated. Applying optimizations a four fold increase in the number of cascaded regenerators was achieved for a DPSK transmission system.

CThBB4 • 5:30 p.m.
8-Channel 20 Gb/s Non-Return-to-Zero Signal Regeneration, *Yu Yu*, *Adrian Wonfor, Jose B. Rosas–Fernández, Jonathan D. Ingham, Richard V. Penty, Ian H. White; Ctr. for Photonic Systems, Electrical Engineering Div., Engineering Dept., Univ. of Cambridge, UK.* We demonstrate multi-channel NRZ signal regeneration with NRZ-RZ-NRZ regenerative format conversion, using a phase-modulator and two fiber MZIs. Q improvements for eight 20Gb/s channels and BER for two representative channels demonstrate regeneration is achieved simultaneously.

4:45 p.m.–6:30 p.m.
CThCC • Superresolution Imaging
Brian Applegate; Texas A&M Univ., USA, Presider

CThCC1 • 4:45 p.m. **Tutorial**
Single-Molecule Approaches for Superresolution Imaging, Trapping, and Nanophotonics, *W. E. Moerner*; *Stanford Univ., USA.* Single fluorescent molecules provide useful nanometer-sized absorbers and sources of light, which enable superresolution imaging, trapping, and nanometer-scale probing of optical fields in nanophotonic structures. Fundamentals of these effects will be described.

W. E. (William E.) Moerner obtained his M.S. (1978) and Ph.D. (1982) in Physics from Cornell University. He spent thirteen years as a Research Staff Member, Project Leader, and Manager at the IBM Almaden Research Center in San Jose, California. After an appointment as Visiting Guest Professor of Physical Chemistry at ETH-Zuerich (1993-1994), he assumed the Distinguished Chair in Physical Chemistry in the Department of Chemistry and Biochemistry at the University of California, San Diego in 1995. His research group moved to Stanford University in 1998 where he became Professor of Chemistry (1998), Harry S. Mosher Professor (2003), and Professor, by courtesy, of Applied Physics (2005). He received the Earle K. Plyler Prize for Molecular Spectroscopy in 2001, the Wolf Prize in Chemistry in 2008, and the Irving Langmuir Prize in Chemical Physics in 2009, and was elected to the National Academy of Sciences in 2007.

QELS

4:45 p.m.–6:30 p.m.
QThJ • Quantum Coherence and Entanglement

Roman Schnabel; Leibnitz Univ. Hannover, Germany, Presider

QThJ1 • 4:45 p.m. Invited

Suppression of Collisional Decoherence in Optically Trapped Atomic Ensemble by Bang-Bang Dynamical Decoupling, ***Yoav Sagi****, Ido Almog, Nir Davidson; Weizmann Inst. of Science, Israel.* We employ dynamical decoupling techniques to suppress the decoherence induced by elastic collisions in optically trapped Rb atoms. Coherence times exceeding 3 sec in a dense ensemble are demonstrated for an arbitrary initial state.

QThJ2 • 5:15 p.m.

Paper Withdrawn.

QThJ3 • 5:30 p.m.

Experimental Demonstration of Computer Reconfigurable Multimode Entanglement, ***Jean-Francois Morizur***[1,2]*, Lachlan Nicholls*[1]*, Pu Jian*[1,2]*, Seiji Armstrong*[1]*, Kate Wagner*[1]*, Magnus Hsu*[3]*, Warwick P. Bowen*[3]*, Nicolas Treps*[2]*, Jiri Janousek*[1]*, Hans Bachor*[1]*;* [1]*Australian Ctr. for Quantum Atom Optics, Australian Natl. Univ., Australia,* [2]*Lab Kastler Brossel, Univ. Pierre et Marie Curie, France,* [3]*Univ. of Queensland, Australia.* Quantum protocols require multiple entangled modes. We demonstrate a set of tools that generate, manipulate and detect multimode entanglement within a single beam of light. This new method is flexible and computer controlled.

4:45 p.m.–6:30 p.m.
QThK • Single Emitters and Photons

Charles Santori; Hewlett-Packard Labs, USA, Presider

QThK1 • 4:45 p.m.

Optical Properties of Nitrogen-Vacancy Centers Created near a Diamond Surface, ***Kai-Mei C. Fu****, Charles Santori, Paul E. Barclay, Raymond G. Beausoleil; Hewlett-Packard Labs, USA.* We study the optical properties of nitrogen-vacancy centers created near the diamond surface by nitrogen implantation and annealing and present a method to convert neutral NV centers to the desired negatively charged state.

QThK2 • 5:00 p.m.

Cavity QED of Nitrogen Vacancy Centers in Diamond with Nanopillar and Deformed Silica Microsphere, ***Russell J. Barbour****, Khodadad Nima Dinyari, Hailin Wang; Univ. of Oregon, USA.* Deformed silica microspheres are used to greatly enhance evanescent coupling between whispering gallery modes and nitrogen vacancy centers in a diamond nanopillar, overcoming the difficulty of short evanescent decay length of the composite cavity-QED system.

QThK3 • 5:15 p.m.

Using Laser Spectroscopy to Study Non-Maxwellian Behavior of Trapped Ions, ***Ralph DeVoe****; Stanford Univ., USA.* Trapped ions cooled by a buffer gas can form an extended diffuse cloud dominated by power-law tails, rather than the Gaussian expected by Maxwell-Boltzmann statistics, as described in PRL 102, 063001 (2009).

QThK4 • 5:30 p.m.

Pumping of Nuclear Spins by Optical Excitation of Spin-Forbidden Transitions in a Quantum Dot, *Evgeny A. Chekhovich*[1,2]*,* ***Maxim N. Makhonin***[1]*, Kirill V. Kavokin*[3]*, Andrey B. Krysa*[1]*, Maurice S. Skolnick*[1]*, Alexander I. Tartakovskii*[1]*;* [1]*Univ. of Sheffield, UK,* [2]*Inst. of Solid State Physics, Russian Federation,* [3]*A. F. Ioffe Physico-Technical Inst., Russian Federation.* We demonstrate optical pumping of nuclear spins in semiconductor quantum dots by resonant pumping of optically forbidden transitions. Employing this process, nuclear polarization of 65% is achieved, markedly higher than from pumping the allowed transition.

4:45 p.m.–6:30 p.m.
QThL • Plasmonic and Nanophotonic Emission Control

Martin Wegener; Karlsruhe Inst. of Technology, Univ. of Karlsruhe, Germany, Presider

QThL1 • 4:45 p.m.

Impact of High-Order Surface Plasmon Modes of Metal Nanoparticles on Emission Enhancement, ***Greg Sun***[1]*, Jacob B. Khurgin*[2]*;* [1]*Univ. of Massachusetts at Boston, USA,* [2]*Johns Hopkins Univ., USA.* High-order surface plasmon modes of the metal nanoparticles are modelled analytically to treat on the efficiency enhancement of optical emission, the effect of the luminescence quenching and to optimize luminescence enhancement factor.

QThL2 • 5:00 p.m.

Plasmonic Dicke Effect, ***Tigran V. Shahbazyan****, Vitaliy N. Pustovit; Jackson State Univ., USA.* A plasmon-mediated mechanism of cooperative emission by an ensemble of dipoles near a metal nanoparticle is studied. The radiation is dominated by plasmonic super-radiant states which survive dipole-dipole interactions and non-radiative losses in the metal.

QThL3 • 5:15 p.m.

Resonance Fluorescence of Single Molecules Assisted by Plasmonic Structure, ***Ying Gu***[1]*, Lina Huang*[2]*, Qihuang Gong*[1]*, Olivier J. F. Martin*[2]*;* [1]*Inst. of Optics, School of Physics, Peking Univ., China,* [2]*INanophotonics and Metrology Lab, Swiss Federal Inst. of Technology Lausanne, École Polytechnique Fédérale de Lausanne, Switzerland.* When molecules are resonantly excited by enhanced near field of silver nanostrips, through a balance between field enhancement and decay modification, Mollow triplet of fluorescence and antibunching of emission photons are found.

QThL4 • 5:30 p.m.

Surface-Enhanced Raman Scattering of Semiconducting Quantum Dots on Nanostructured Plasmonic Surfaces, ***James T. Hugall****, Jeremy J. Baumberg, Sumeet Mahajan; NanoPhotonics Ctr., Cavendish Lab, Univ. of Cambridge, UK.* Nanostructured gold surfaces with localized surface plasmon resonances are shown to produce surface-enhanced Raman scattering (SERS) of sub-monolayers of semiconducting quantum dots. These results pave the way for quantum dots use as markers.

Room A8 | Room C1&2

QELS

4:45 p.m.–6:30 p.m.
QThM • Semiconductor Photonic Structures
Alfred Leitenstorfer; Univ. Konstanz, Germany, Presider

QThM1 • 4:45 p.m. Tutorial

Quantum Optics with Semiconductor Quantum Dots in Microcavities, *C. Gies, S. Ritter, M. Florian, P. Gartner,* ***Frank Jahnke****; Inst. for Theoretical Physics, Univ. of Bremen, Germany.* For quantum-dot-based microcavity lasers with large spontaneous emission coupling we compare results of a microscopic theory with recent experiments. Coherence properties and photon correlations are discussed and the single-emitter limited is studied.

Frank Jahnke received his Ph.D. in Physics from the University of Rostock (Germany) in 1990. He was postdoctoral research associate at the Forschungszentrum Jülich (Germany) and at the Optical Sciences Center, University of Arizona. He obtained his Habilitation at the University of Marburg (Germany) in 1997 and subsequently became Heisenberg Fellow of the German Science Foundation (DFG). In 2000 he joined the University of Bremen (Germany) as a full professor for Theoretical Physics. Frank Jahnke's research activities involve quantum optical effects and many-body interactions in semiconductor nanostructures. He contributed to the development of microscopic models that successfully covered various applications ranging from quantum-dot lasers to non-classical semiconductor light sources.

4:45 p.m.–6:30 p.m.
QThN • Quantum Imaging and Sensing
Prem Kumar; Northwestern Univ., USA, Presider

QThN1 • 4:45 p.m.

Enhancing Contrast of Point Images Using Coherent States and Photon-Number-Resolving Detectors, ***Alexander Ling****, Aaron Pearlman, Elizabeth Goldschmidt, Jingyun Fan, Alan Migdall; Joint Quantum Inst., NIST and Univ. of Maryland, USA.* We map the transverse profile of light beams using photon-number-resolving detectors, and observe compression of beam profiles for higher detected photon-number, enabling contrast enhancement between two Airy disk beams at the Rayleigh limit.

QThN2 • 5:00 p.m.

Sub-Rayleigh Imaging via N-Photon Detection, ***Fabrizio Guerrieri****[1], Lorenzo Maccone[2], Franco N. C. Wong[2], Jeffrey H. Shapiro[2], Simone Tisa[3], Franco Zappa[1]; [1]Politecnico di Milano, Italy, [2]MIT, USA, [3]Micro Photon Devices srl, Italy.* We demonstrate resolution enhancement beyond the Rayleigh diffraction limit using an N-photon detection strategy that is implemented with a single-photon imager. Experimental results are in good agreement with theory proposed by Giovannetti et al.

QThN3 • 5:15 p.m.

Spatial Resolution below the Diffraction Limit, ***Lee A. Rozema****[1], Lynden K. Shalm[1], Aephraim M. Steinberg[1], Malcolm N. O'Sullivan[2], Robert W. Boyd[2]; [1]Ctr. for Quantum Information and Quantum Control and Inst. for Optical Sciences, Univ. of Tornto, Canada, [2]Inst. of Optics, Univ. of Rochester, USA.* Entanglement can lead to sub-Rayleigh resolution. We demonstrate this spatial super-resolution in a manner compatible with lithography and diffraction based biosensors. We characterize sensitivity to spatial shifts and discuss when there is a quantum advantage.

QThN4 • 5:30 p.m.

Dispersion Cancellation with Phase-Sensitive Gaussian-State Light, ***Jeffrey H. Shapiro****; MIT, USA.* Gaussian-state phase-sensitive light is used to explain Franson's nonlocal dispersion cancellation [Phys. Rev. A 45, 3126 (1982)]. It is shown that entanglement is only needed to achieve high contrast.

San Jose Ballroom IV (San Jose Marriott)

CLEO

4:45 p.m.–6:30 p.m.
CThDD • FEC and Signal Processing
Rene-Jean Essiambre; Bell Labs, Alcatel-Lucent, USA, Presider

CThDD1 • 4:45 p.m. Tutorial

Forward Error Correction (FEC) in Optical Communication, ***Frank Kschischang****, Benjamin P. Smith; Univ. of Toronto, Canada.* Error-control coding is becoming increasingly important, in combination with advanced modulation methods, for improving the spectral efficiency of optical communication systems. This tutorial reviews fundamental limits on and promising practical architectures for modern FEC methods.

Frank R. Kschischang is a Professor of Electrical and Computer Engineering and Canada Research Chair in Communication Algorithms at the University of Toronto,where he has been a faculty member since 1991. During 1997-98, he was a visiting scientist at MIT, Cambridge, MA and in 2005 he was a visiting professor at the ETH, Zürich. His research interests are focused on information theory and channel coding techniques applied to various practical channels. Dr. Kschischang is a Fellow of IEEE and of the Engineering Institute of Canada, and he serves as the 2010 President of the IEEE Information Theory Society.

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

Thursday, May 20

San Jose Salon III (San Jose Marriott)

JOINT

4:45 p.m.–6:30 p.m.
JThI • High Harmonic Generation
David Villeneuve; Natl. Res. Council Canada, Canada, Presider

JThI1 • 4:45 p.m.
Spectral Wavefront Optical Reconstruction by Diffraction, *Eugene Frumker*[1,2], *Gerhard G. Paulus*[2,3], *Hiromichi Niikura*[4,5], *David M. Villeneuve*[1], *Paul B. Corkum*[1]; [1]*Joint Laboratory for Attosecond Science, Natl. Res. Council Canada and Univ. of Ottawa, Canada,* [2]*Texas A&M Univ., USA,* [3]*Inst. of Optics and Quantum Electronics, Germany,* [4]*Natl. Res. Council, Canada,* [5]*PRESTO, JST, Japan.* We demonstrate a new concept of spectrally-resolved wavefront characterization, particular useful for high-harmonic and soft X-ray radiation. It is based on an analysis of radiation diffracted from a slit scanned in front of flat-field spectrometer.

JThI2 • 5:00 p.m.
Observation of Nonlinear Wavelength Conversion Processes of High Order Harmonics, *Tsuneto Kanai*, *Akira Suda, Katsumi Midorikawa; RIKEN, Japan.* We observe nonlinear wavelength conversion processes of high harmonics for the first time. The energies of the generated photons are up-converted and momenta of them are narrowly-distributed.

JThI3 • 5:15 p.m. Invited
Full Phase Matching of Ultrafast Coherent High Harmonic X-Rays at 0.5 keV, *Ming-Chang Chen*, *Paul Arpin, Tenio Popmintchev, Michael Ryan Gerrity, Matt Seaberg, Bosheng Zhang, Margaret Murnane, Henry Kapteyn; JILA, NIST, Univ. of Colorado at Boulder, USA.* By focusing a 2 μm driving laser into a multi-atmosphere pressure, gas-filled waveguide, we demonstrate full phase matching of high harmonic x-rays throughout the water window for the first time, at energies > 0.5 keV.

San Jose Salon I & II (San Jose Marriott)

CLEO

4:45 p.m.–6:30 p.m.
CThEE • Quasi-Phasematching Devices
Narasimha S. Prasad; NASA Langley Res. Ctr., USA, Presider

CThEE1 • 4:45 p.m.
Self-Guided Operation of Green-Pumped Singly Resonant CW OPO Based on Bulk MgO:PPLN, *In-Ho Bae*[1], *Han Seb Moon*[1], *Sebastian Zaske*[2], *Christoph Becher*[2], *Seung Kwan Kim*[3], *Seung Nam Park*[3], *Dong-Hoon Lee*[3]; [1]*Pusan Natl. Univ., Republic of Korea,* [2]*Univ. des Saarlandes, Germany,* [3]*Korea Res. Inst. of Standards and Science, Republic of Korea.* We report on the self-guided operation of a singly resonant, thermally loaded CW OPO and its improved characteristics of mode quality and stability in the case of a MgO:PPLN crystal pumped at 532 nm.

CThEE2 • 5:00 p.m.
Frequency Upconversion in Periodically Poled $LiNbO_3$ Capable of Achieving Single-Photon Sensitivities for Detections at 1.27 μm and 1.57 μm, *Yi Jiang*[1], *Yujie J. Ding*[1], *Ioulia B. Zotova*[2], *Narasimha S. Prasad*[3]; [1]*Lehigh Univ., USA,* [2]*ArkLight, USA,* [3]*NASA Langley Res. Ctr., USA.* We have demonstrated that frequency upconversion in periodically-poled $LiNbO_3$ is capable of reaching single-photon sensitivities for detections at 1.27 μm and 1.57 μm at room temperature.

CThEE3 • 5:15 p.m.
Efficient Second Harmonic Generation in Orientation Patterned GaAs Waveguides, *M. B. Oron*, *P. Blau, S. Pearl, S. Shusterman; Soreq NRC, Israel.* High SHG efficiency of $21\%W^{-1}$ was demonstrated in OPGaAs waveguides for the first time. The high efficiency is attributed to record low loss values of 1.5db/cm obtained in these waveguides.

CThEE4 • 5:30 p.m.
Difference Frequency Generation in Domain-Disordered Quasi-Phase Matching Semiconductor Waveguides, *Sean J. Wagner*[1], *Iliya Sigal*[1], *Amr S. Helmy*[1], *J. Stewart Aitchison*[1], *Usman Younis*[2], *Barry M. Holmes*[2], *David C. Hutchings*[2]; [1]*Univ. of Toronto, Canada,* [2]*Univ. of Glasgow, UK.* Idler wavelengths in the L- and U-bands were produced from a C-band signal and short-wave infrared pump by three-wave mixing in quasi-phase-matched semiconductor superlattice waveguides. Development of superlattice lasers demonstrates compatibility for monolithic integration.

Room B2-B3

JOINT

4:45 p.m.–6:30 p.m.
JThJ • Standoff Laser Sensing
Joseph Buck; Lockheed Martin, USA, Presider

JThJ1 • 4:45 p.m. Invited
Automatic Recognition of Diverse 3-D Objects and Analysis of Large Urban Scenes Using Ground and Aerial LIDAR Sensors, *Yuri Owechko*, *Swarup Medasani, Thommen Korah; HRL Labs, LLC, USA.* We describe a learning-based 3-D object recognition pipeline developed under the DARPA URGENT program for analyzing a large LIDAR dataset collected by both airborne and ground platforms for an extended urban area.

JThJ2 • 5:15 p.m. Invited
High Pulse-Energy Atmospheric Aerosol Lidar at 1.5-Microns Wavelength: Opportunities for Innovation from a Meteorologist's Perspective, *Shane D. Mayor*; *California State Univ. at Chico, USA.* Laser and optical engineering challenges and recent progress in the area of high pulse-energy direct-detection atmospheric lidar near 1.5 microns wavelength are described.

CThZ • Parametric Generation—Continued

CThZ5 • 5:45 p.m.
Eliminating Spatiotemporal Distortions from Angular Dispersion in Noncollinear Optical Parametric Amplifiers, ***Jake Bromage****, Christophe Dorrer, Jonathan D. Zuegel; Univ. of Rochester, USA.* Spatiotemporal aberrations from megahertz-repetition-rate noncollinear optical parametric amplifiers are characterized using spatially resolved spectral interferometry. Pulse-front tilt is eliminated by optimizing the signal's angular gain spectrum, increasing the intensity at focus.

CThZ6 • 6:00 p.m.
0.4 µJ, Sub-10-fs Pulses from a MHz-NOPA, ***Moritz Emons****[1], Andy Steinmann[1,2], Thomas Binhammer[3], Guido Palmer[1], Marcel Schultze[1], Uwe Morgner[1,4]; [1]Inst. of Quantum Optics, Leibniz Univ. Hannover, Germany, [2]4th Physics Inst., Univ. of Stuttgart, Germany, [3]VENTEON Laser Technologies GmbH, Germany, [4]Laser Zentrum Hannover, Germany.* We present a non-collinear optical parametric amplifier (NOPA) delivering sub-10-fs pulses with 420 nJ of pulse energy. The system is driven by pulse trains at 1-MHz repetition rate from an amplified Yb:KYW oscillator with cavity-dumping.

CThZ7 • 6:15 p.m.
A Picosecond Optical Parametric Oscillator Synchronously Pumped by an Amplified Gain-Switched Laser Diode, ***Florian Kienle****[1], Kang K. Cheng[1], Shaif-ul Alam[1], Corin B. E. Gawith[2], Jacob I. Mackenzie[1], David C. Hanna[1], David J. Richardson[1], David P. Shepherd[1]; [1]Univ. of Southampton, UK, [2]Covesion Ltd., UK.* We demonstrate a picosecond optical parametric oscillator synchronously pumped by a fiber-amplified gain-switched laser diode. Up to 7.3W at 1.54µm and 3.1W at 3.4µm is obtained at pulse repetition rates between 114.8 and 918.4MHz.

CThAA • Silicon Photonics—Continued

CThAA5 • 5:45 p.m.
High-Q SiO_2-Clad Silicon Photonic Crystal Microcavities for Ultra-Low Energy Switching, ***Sean P. Anderson****, Philippe M. Fauchet; Univ. of Rochester, USA.* We outline the development of a SiO_2-embedded silicon photonic crystal microcavity with Q above 10,000, which forms the basis for a CMOS-compatible electro-optic modulator with switching energy below 0.1 fJ/bit.

CThAA6 • 6:00 p.m.
A Tunable Optical Channelizing Filter Using Silicon Coupled Ring Resonators, ***Po Dong****[1], Ning-Ning Feng[1], Dazeng Feng[1], Wei Qian[1], Hong Liang[1], Daniel C. Lee[1], Bradley J. Luff[1], Mehdi Asghari[1], Anjali Agarwal[2], Tom Banwell[2], Ron Menendez[2], Paul Toliver[2], Ted K. Woodward[2]; [1]Kotura Inc., USA, [2]Telcordia Technologies, USA.* We demonstrate a wavelength-tunable optical channelizing filter with a high extinction ratio (50 dB), a narrow bandwidth (2.4 GHz), and a large free spectral range (50 GHz) using high-order coupled silicon rings.

CThAA7 • 6:15 p.m.
Low Dispersion Silicon Slot Waveguides for Frequency Comb Generation with Equally Spaced Spectral Lines, ***Lin Zhang****[1], Yue Yang[1], Alan E. Willner[1], Raymond G. Beausoleil[2]; [1]Univ. of Southern California, USA, [2]HP Labs, USA.* A silicon slotted ring resonator with flattened dispersion in the cavity produces uniform spectral lines in on-chip frequency comb generations. Standard deviation of FSR is improved by 250x compared to a strip waveguide.

CThBB • Tunable Networks and Regeneration—Continued

CThBB5 • 5:45 p.m.
Tunable Broadband Optical Delay Using Phase Modulation, ***Feifei Yin****, Ming Xin, Cheng Lei, Hongwei Chen, Minghua Chen, Shizhong Xie; Tsinghua Univ., China.* A novle tunable broadband optical delay scheme using phase modulation is proposed and experimentally demonstrated. A 2ps Gaussian pulse is frequency-chirped, phase-modulated by a ramp signal and delayed up to 9 times of pulse width.

CThBB6 • 6:00 p.m.
All-Optical Regenerative Wavelength Conversion Based on a Modified Delayed Interference Signal Wavelength Converter, ***Xiaofan Zhao****[1], Dan Lu[1], Caiyun Lou[1], Shilong Pan[2]; [1]Tsinghua Univ., China, [2]Univ. of Ottawa, Canada.* All-optical regenerative wavelength converter is proposed and demonstrated based on the delayed interference signal wavelength converter followed by a SOA. Signal quality can be improved by the regenerative amplification of the SOA.

CThBB7 • 6:15 p.m.
Time-Lens Based Synchronizer and Retimer for 10 Gb/s Ethernet Packets with up to ±1MHz Frequency Offset., ***Janaina Laguardia Areal****, Hao Hu; DTU Fotonik, Technical Univ. of Denmark, Denmark.* We present a time-lens based all-optical 10Gb/s frame synchronizer and retimer. Our scheme can work with a 4096-bit frame, with frequency offset up to 1MHz, which is demonstrated by experimental results.

CThCC • Superresolution Imaging—Continued

CThCC2 • 5:45 p.m.
Double-Helix Microscopy for Wide-Field 3-D Single-Molecule Fluorescence Imaging, *Ginni Sharma[1], Sri Rama Prasanna Pavani[2], Sean Quirin[1],* ***Rafael Piestun****[1]; [1]Univ. of Colorado at Boulder, USA, [2]Caltech, USA.* We present methods to improve the localization accuracy in wide-field 3-D single-molecule double-helix microscopy. We analyze the optical efficiency of the system, the fundamental limit for 3-D localization, the estimation algorithms, and polarization sensitive detection.

CThCC3 • 6:00 p.m.
Localizing and Tracking Single Emitters in Three Dimensions Using a Double-Helix Point Spread Function, ***Michael A. Thompson****, Matthew D. Lew, Majid Badieirostami, W. E. Moerner; Stanford Univ., USA.* Single fluorescent emitters can be localized and tracked in 3-D with less than 1000 detected photons by using a DH-PSF. The tracking of quantum dots both in solution and inside a living cell is demonstrated.

CThCC4 • 6:15 p.m.
High-Resolution Fluorescence Microscopy Employing a Cyclic Sequential Multiphoton Excitation, ***Keisuke Isobe****[1], Akira Suda[1], Hiroshi Hashimoto[2], Fumihiko Kannari[2], Hiroyuki Kawano[3], Hideaki Mizuno[3], Atsushi Miyawaki[3], Katsumi Midorikawa[1]; [1]RIKEN Advanced Science Inst., Japan, [2]Keio Univ., Japan, [3]RIKEN Brain Science Inst., Japan.* We demonstrate high-resolution fluorescence microscopy based on a cyclic sequential multiphoton process, which gives rise to fluorescence emission following a sequence of cyclic transitions between the bright and dark states of a fluorophore.

6:30 p.m.–8:00 p.m. Dinner Break *(on your own)*

8:00 p.m.–10:00 p.m. CLEO/QELS Postdeadline Paper Sessions,
San Jose McEnery Convention Center, Rooms A6, A7 and A8

NOTES

QELS

QThJ • Quantum Coherence and Entanglement—Continued

QThJ4 • 5:45 p.m.
Using Hyperentangled Photons to Prepare Bound Entanglement, ***Aditya N. Sharma***[1]*, Julio T. Barreiro*[2]*, Paul G. Kwiat*[1]*; [1]Univ. of Illinois, USA, [2] Inst. fur Experimentalphysik, Univ. Innsbruck, Austria.* We present an experimental setup to prepare the bound-entangled Smolin state using hyperentangled photons produced by spontaneous parametric down-conversion. We can verify the state produced using quantum state tomography and "unlocking" of entanglement.

QThJ5 • 6:00 p.m.
Entanglement-Enhanced Measurement of a Completely Unknown Phase, ***Dominic W. Berry***[1]*, Guo-Yong Xiang*[2]*, Brendon L. Higgins*[2]*, Howard M. Wiseman*[2]*, Geoff J. Pryde*[2]*; [1]Inst. for Quantum Computing, Univ. of Waterloo, Canada, [2]Ctr. for Quantum Dynamics, Griffith Univ., Australia.* We demonstrate a method for achieving phase measurements with accuracy beyond the standard quantum limit using entangled states. A sophisticated feedback scheme means that no initial estimate of the phase is required.

QThJ6 • 6:15 p.m.
A Weak Value Inequality as a Test for Local Realism, *Justin Dressel,* ***Curtis J. Broadbent****, Andrew N. Jordan; Univ. of Rochester, USA.* We derive a weak value inequality for a particle pair that should be satisfied under specific assumptions of local realism. Any correlated quantum particle pair can produce unbounded violations of this inequality.

QThK • Single Emitters and Photons—Continued

QThK5 • 5:45 p.m.
Novel Narrow-Band Spectral Interference Filter with Very High Transmittance, ***Jan Bogdanski***[1]*, Ariel Danan*[2]*, Scott Jobling*[1]*, Kevin McCusker*[1]*, Stephan Quint*[3]*, Alex Z. Smith*[1]*, Jake Smith*[1]*, Paul G. Kwiat*[1]*; [1]Univ. of Illinois at Urbana-Champaign, USA, [2]Tel Aviv Univ., Israel, [3]Johannes Gutenberg Univ., Germany.* A single-photon source is an important component in many quantum information processing applications. One of the most widely used single-photon generation schemes utilizes parametric down-conversion (PDC).

QThK6 • 6:00 p.m.
Reversing the Weak Quantum Measurement for a Photonic Qubit, ***Yong-Su Kim****, Young-Wook Cho, Young-Sik Ra, Yoon-Ho Kim; Pohang Univ. of Science and Technology, Republic of Korea.* We demonstrate the conditional reversal of a weak quantum measurement on a photonic qubit. The state recovery fidelity, determined by quantum process tomography, is shown to be over 94% for partial-collapse strength up to 0.9.

QThK7 • 6:15 p.m.
Observation of Bohmian Trajectories of a Single Photon Using Weak Measurements, ***Lynden K. Shalm***[1]*, Sacha Kocsis*[1]*, Sylvain Ravets*[1]*, Boris Braverman*[1]*, Martin J. Stevens*[2]*, Richard P. Mirin*[2]*, Aephraim M. Steinberg*[1]*; [1]Dept. of Physics, Univ. of Toronto, Canada, [2]Optoelectronics Div., NIST, USA.* We use weak measurements to carry out the first direct observation of the trajectories followed by single photons in a two-slit interferometer. The measured trajectories correspond to those predicted by Bohmian mechanics.

QThL • Plasmonic and Nanophotonic Emission Control—Continued

QThL5 • 5:45 p.m.
Spectral Studies of Optical Coherence in DNA-Encapsulated Silver Clusters, ***Sumant S. R. Oemrawsingh***[1]*, Patrick O'Neill*[2]*, Rick Leijssen*[1]*, Eric R. Eliel*[1]*, Elizabeth G. Gwinn*[2]*, Deborah Kuchnir Fygenson*[2]*, Dirk Bouwmeester*[1,2]*; [1]Huygens Lab, Leiden Univ., Netherlands, [2]Univ. of California at Santa Barbara, USA.* Novel emitters consisting of silver nanoclusters that are bound to single-stranded DNA show great promise as accurately positioned single photon sources that can interact coherently. Here, we present first results of a spectroscopic study.

QThL6 • 6:00 p.m.
3-D Orientation of Single Molecules in an Optical λ/2-Microresonator, ***Raphael Gutbrod***[1]*, Alexey I. Chizhik*[1]*, Dmitry Khoptyar*[1,2]*, Anna M. Chizhik*[1]*, Sebastian Bär*[1]*, Alfred J. Meixner*[1]*; [1]Univ. of Tuebingen, Germany, [2]Lund Univ., Sweden.* We present a tunable microresonator which can be used to modify the optical properties of single quantum emitters. The 3-D orientation and position of a single molecule is determined with a radially polarized laser beam.

QThL7 • 6:15 p.m.
Single Crystal Diamond Photonic Crystal Nanocavity: Fabrication and Initial Characterization , ***Igal Bayn****, Boris Meyler, Joseph Salzman, Vladimir Richter, Rafi Kalish; Technion – Israel Inst. of Technology, Israel.* We present a photonic crystal high-Q nanocavity realized on a single crystal diamond membrane produced by ion implantation. The cavity is patterned by focused-ion-beam milling. The micro-photoluminescence exhibits $Q \approx 500$ at $\lambda = 612$nm and clear polarization dependence.

6:30 p.m.–8:00 p.m. Dinner Break *(on your own)*

8:00 p.m.–10:00 p.m. CLEO/QELS Postdeadline Paper Sessions,
San Jose McEnery Convention Center, Rooms A6, A7 and A8

NOTES

Room A8 | Room C1&2

QELS

QThM • Semiconductor Photonic Structures—Continued

QThM2 • 5:45 p.m.
Phonon-Induced Asymmetry in Vacuum Rabi Doublet for Coupled Quantum Dot-Cavity System, *Yasutomo Ota*[1,2], *Naoto Kumagai*[1], *Shunsuke Ohkouchi*[1,3], *Masayuki Shirane*[1,3], *Masahiro Nomura*[1], *Satomi Ishida*[1], *Satoshi Iwamoto*[1,2], *Shinichi Yorozu*[1,3], *Yasuhiko Arakawa*[1,2]; [1]*NanoQuine, Univ. of Tokyo, Japan,* [2]*Univ. of Tokyo, Japan,* [3]*NEC Labs, Japan.* We experimentally observed theoretically-predicted, phonon-induced asymmetry in vacuum Rabi doublet spectra for a coupled quantum dot-cavity system in the resonance. Asymmetry is also observed in the intensity of the off-resonant cavity mode emissions.

QThM3 • 6:00 p.m.
Bloch-Polaritons in Multiple-Quantum-Well Photonic Crystal Structures, *David Goldberg*[1], *Lev Deych*[1], *Alexander Lisyansky*[1], *Zhou Shi*[1], *Vadim Tokranov*[2], *Michael Yakimov*[2], *Serge Oktyabrsky*[2], *Vinod Menon*[1]; [1]*Queens College, CUNY, USA,* [2]*College of Nanoscale Science and Engineering, SUNY Albany, USA.* Here we report the observation of Bloch-polaritons in a GaAs/AlGaAs multiple-quantum-well structure. We observe three polariton states formed by the coherent interaction between light- and heavy-hole excitonic-lattices, and Bloch waves of the background photonic crystal.

QThM4 • 6:15 p.m.
Observation of Thermal Occupation of Room-Temperature J-Aggregate Microcavity Exciton-Polaritons, *M. Scott Bradley*, *Vladimir Bulović*; *MIT, USA.* We present a measurement of the lower-branch exciton-polariton occupation in room-temperature J-aggregate microcavity devices under low-density steady-state excitation. The observed occupation follows a Maxwell-Boltzmann distribution at T=300K, indicating efficient polariton relaxation, necessary for achieving lasing.

QThN • Quantum Imaging and Sensing—Continued

QThN5 • 5:45 p.m.
Nonclassical Nature of Nonlocal Dispersion Cancellation, *James Franson*; *Univ. of Maryland, Baltimore County, USA.* Shapiro recently suggested that nonlocal dispersion cancellation is essentially classical in nature. It is shown that his classical model gives identical dispersion in two beams of light and is not analogous to nonlocal dispersion cancellation.

QThN6 • 6:00 p.m.
Quantum Noise Limited and Entanglement-Assisted Magnetometry, *Kasper Jensen*, *Wojciech Wasilewski, Hanna Krauter, Jelmer J. Renema, Mikhail V. Balabas, Eugene S. Polzik; Niels Bohr Inst., Univ. of Copenhagen, Denmark.* We demonstrate a radio frequency atomic magnetometer with sub-femtoTesla/sqrt(Hz) sensitivity, mainly limited by projection noise of atoms. Furthermore, we demonstrate that Einstein-Podolsky-Rosen entanglement of atoms enhances the sensitivity to broadband magnetic fields.

QThN7 • 6:15 p.m.
Time-Symmetric Quantum Smoothing: A General Theory of Optimal Quantum Sensing, *Mankei Tsang*; *Univ. of New Mexico, USA.* The important problem of optimal waveform estimation for quantum sensing is solved using a time-symmetric approach. The theory generalizes prior work in classical and quantum estimation and can significantly out-perform previously proposed techniques.

San Jose Ballroom IV (San Jose Marriott)

CLEO

CThDD • FEC and Signal Processing—Continued

CThDD2 • 5:45 p.m.
DSP-Based Crosstalk Cancellation in WDM Interconnects, *Ramanan Thiruneelakandan*[1], *Philip Watts*[1,2], *Robert Killey*[1], *Madeleine Glick*[3]; [1]*Univ. College London, UK,* [2]*Univ. of Cambridge, UK,* [3]*Intel Res. Pittsburgh, USA.* We propose DSP-based crosstalk cancellation in WDM optical interconnects, and investigate the performance of the scheme at 10.7 Gb/s through experimental implementation of a transmitter-based DSP algorithm and optical link simulations.

CThDD3 • 6:00 p.m.
Fast SOP Variations Effects on a MLSE-Based Receiver Performances in a 1000 km Transmission Link, *Abdul-Rahman El Falou*, *Paulette Gavignet, Erwan Pincemin, Thierry Guillossou; Orange Labs, France.* This paper aims at presenting the influence of fast SOP variations on the performances of a MLSE-based receiver. Both pre-FEC and post-FEC BER are collected and analyzed. The impact of SOPMD emulation is also considered.

CThDD4 • 6:15 p.m.
Frequency Offset Estimation Using Kalman Filter in Coherent Optical Phase-Shift Keying Systems, *Shaoliang Zhang*[1], *Pooi Yuen Kam*[1], *Changyuan Yu*[1,2], *Jian Chen*[2]; [1]*Natl. Univ. of Singapore, Singapore,* [2]*A*STAR Inst. for Infocomm Res., Singapore.* We propose a novel frequency offset estimator using Kalman filter in coherent optical MPSK systems. Simulation shows that it can quickly search for frequency offset and approach the performance of an ideal frequency offset estimator.

6:30 p.m.–8:00 p.m. Dinner Break *(on your own)*

8:00 p.m.–10:00 p.m. CLEO/QELS Postdeadline Paper Sessions,
San Jose McEnery Convention Center, Rooms A6, A7 and A8

NOTES

JOINT

JThI • High Harmonic Generation—Continued

JThI4 • 5:45 p.m.
Scaling of High Harmonic Generation Efficiencies with 400-nm and 800-nm Driver Pulses, ***Edilson L. Falcao-Filho****, Chien-Jen Lai, Vasileios M. Gkortsas, Shu-Wei Huang, Li-Jin Chen, Kyung-Han Hong, Franz X. Kärtner; MIT, USA.* Scaling of high order harmonic generation (HHG) efficiency with drive-wavelengths is investigated using 800-nm and 400-nm pulses. We demonstrate good agreement with a recently established model for HHG taking laser and material parameters into account.

JThI5 • 6:00 p.m.
Plasmon-Enhanced High-Order Harmonic Generation in the Vicinity of Metal Nanostructures, ***Anton Husakou****, Song-Jin Im, Joachim Herrmann; Max-Born-Inst., Germany.* We simulate high-order harmonic generation by low-intensity pulses using plasmon field enhancement near metallic nanostructures and develop a formalism which includes the influence of the metal surface on the HHG process.

JThI6 • 6:15 p.m.
Emitter of Continues-Wave, Highly Coherent, Extreme Ultraviolet Radiation that is Driven by Low-Power Laser, ***Maxim Kozlov***[1]*, Oren Cohen*[1]*, Tal Carmon*[2]*, Harald G. L. Schwefel*[3]*;* [1]*Technion, Israel,* [2]*Univ. of Michigan, USA,* [3]*Max-Planck-Inst. for the Science of Light, Germany.* We propose emitter of high-order harmonics that is driven by a low-power continues-wave laser. The driving field is enhanced within a micro-resonator and further focused into sub-wavelength hot-spots by plasmonic nano-particles located near its surface.

CLEO

CThEE • Quasi-Phasematching Devices—Continued

CThEE5 • 5:45 p.m.
Efficient Single-Pass Second Harmonic Generation of a Continuous Wave Nd:YVO_4 - Laser at 1342 nm Using MgO:PPLN, ***Florian Lenhardt***[1]*, Achim Nebel*[2]*, Ralf Knappe*[2]*, Martin Nittmann*[3]*, Jürgen Bartschke*[3]*, Johannes A. L'huillier*[1]*;* [1]*Photonik-Zentrum Kaiserslautern e.V., Germany,* [2]*Lumera Laser GmbH, Germany,* [3]*Xiton Photonics GmbH, Germany.* We report efficient second harmonic generation of 20.5W continuous wave laser radiation at 1342nm using MgO:PPLN. A second harmonic power of 9.5W in a diffraction limited beam was reached, giving an efficiency of 46%.

CThEE6 • 6:00 p.m.
White Phasematching Noise: Random Duty-Cycle Errors in Quasi-Phase-Matching Devices, ***Jason S. Pelc****, Chris R. Phillips, Carsten Langrock, Derek Chang, Martin M. Fejer; Stanford Univ., USA.* Random duty-cycle errors in quasi-phase-matching gratings result in a phasematching pedestal, enhancing the efficiency of non-phasematched parasitic processes and thereby limiting device performance in many applications. We find good agreement between analytical modeling and experiments.

CThEE7 • 6:15 p.m.
Generalized Spatiotemporal Quasi Phase Matching, ***Alon Bahabad****, Margaret Murnane, Henry Kapteyn; JILA, NIST, Univ. of Colorado, USA.* We develop a description of nonlinear optics where quasi-phase-matching of both momentum and energy mismatch can be implemented by employing both spatial and temporal modulations. This generalized quasi-phase-matching technique could allow unique applications.

JOINT

JThJ • Standoff Laser Sensing—Continued

JThJ3 • 5:45 p.m.
Quantum Cascade Laser for Elastic-Backscattering LIDAR Measurement, ***Katrin Paschke***[1]*, Peter Q. Liu*[2]*, Anna P. M. Michel*[3]*, James Smith*[4]*, Fred Moshary*[5]*, Claire Gmachl*[2]*;* [1]*Ferdinand-Braun-Inst. für Höchstfrequenztechnik, Germany,* [2] *Dept. of Electrical Engineering, Princeton Univ., USA,* [3]*Inst. for the Science and Technology of Materials, Princeton Univ., USA,* [4] *Dept. of Civil and Environmental Engineering, Princeton Univ., USA,* [5] *Dept. of Electrical Engineering, CUNY, USA.* We present an experimental demonstration for an elastic-backscattering LIDAR system measurement using a Quantum Cascade laser (QCL). The laser emits a peak power of above 13W at 80K and with a wavelength of 4.5μm.

JThJ4 • 6:00 p.m.
Open-Path High Sensitivity Atmospheric Ammonia Sensing with a 9 μm Quantum Cascade Laser, ***David J. Miller****, Mark A. Zondlo; Princeton Univ., USA.* We develop a ground-based, non-cryogenic, open-path quantum cascade laser ammonia sensor operating at 9.06 um for high sensitivity atmospheric measurements. A cylindrical mirror multi-pass optical cell and wavelength modulation spectroscopy allow for pptv detection limits.

JThJ5 • 6:15 p.m.
Atmospheric Transmission Testing Using a Portable, Tunable, High Power Thulium Fiber Laser System, *Timothy S. McComb, R. Andrew Sims, Christina C. C. Willis, Pankaj Kadwani,* ***Lawrence Shah****, Martin Richardson; CREOL, College of Optics and Photonics, Univ. of Central Florida, USA.* A narrow linewidth thulium fiber laser is tuned from 1945 - 2090 nm to investigate atmospheric transmission at 1 km. Results confirm simulations with high transmission >2025 nm and strong atmospheric absorption <1960 nm.

6:30 p.m.–8:00 p.m. Dinner Break *(on your own)*

8:00 p.m.–10:00 p.m. CLEO/QELS Postdeadline Paper Sessions,
San Jose McEnery Convention Center, Rooms A6, A7 and A8

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