Executive Ballroom 210A	Executive Ballroom 210C	Executive Ballroom 210D	Executive Ballroom 210H

CLEO: QELS-Fundamental Science

08:00–10:00
QF1A • Quantum Nanooptics & Detectors
Presider: TBA

QF1A.1 • 08:00 Invited

Quantum Plasmons and Magnetic Metafluids, Jennifer Dionne[1], Jon Scholl[1], Aitzol Garcia-Etxarri[1], Sassan Sheikholeslami[1], Hadiseh Alaeian[1], Ashwin Atre[1], Ai Leen Koh[1]; [1]*Stanford Univ., USA.* We explore optical-frequency quantum and magnetic plasmon modes. Our results demonstrate the quantum-to-classical transition in individual nanoparticles and in nanoparticle dimers, as well as the emergence of optical-frequency magnetism in a metamaterial fluid.

QF1A.2 • 08:30

Single-emitter quantum electrodynamics in a one-dimensional dielectric continuum far beyond the diffraction limit, Pavel Kolchin[1], Nitipat Pholchai[1], Maiken Mikkelsen[1], Jinyong Oh[2], Sadao Ota[1], M. Saif Islam[2], Xiaobo Yin[1], Xiang Zhang[1,3]; [1]*NSF Nanoscale Science and Engineering, University of California Berkeley, USA;* [2]*Department of Electrical and Computer Engineering, University of California Davis, USA;* [3]*Materials Science Division, Lawrence Berkeley National Laboratory, USA.* We demonstrate a single emitter all-dielectric QED system that concentrates light at nanometer scale. The emitter exhibits a record high 31-fold emission enhancement with strongly suppressed blinking. 80% of emission couples into a waveguide mode.

QF1A.3 • 08:45

Enhancement of Spontaneous Emission Rate in an InGaN Quantum Dot Coupled to a Plasmonic Cavity, Brandon Demory[1], Pei-Cheng Ku[1]; [1]*Electrical Engineering and Computer Science, University of Michigan, USA.* An enhanced spontaneous emission rate was experimentally observed from a single semiconductor quantum dot, exhibiting photon antibunching, coupled to a silver plasmonic cavity.

08:00–10:00
QF1B • Quantum Sensing & Imaging
Presider: Franco N.C. Wong; MIT, United States

QF1B.1 • 08:00

Improved Target-Detection Signal-to-Noise Ratio via Quantum Illumination, Sara L. Mouradian[1], Franco N.C. Wong[1], Jeffrey H. Shapiro[1]; [1]*Massachusetts Institute of Technology, USA.* We report the first experimental demonstration of quantum illumination's signal-to-noise ratio advantage over classical (laser-light) illumination for target detection in a lossy, noisy scenario.

QF1B.2 • 08:15

High Photon Efficiency Computational Range Imaging using Spatio-temporal Statistical Regularization, Ahmed Kirmani[1], Dheera Venkatraman[1], Andrea Colaco[1], Franco N.C. Wong[1], Vivek K. Goyal[1]; [1]*Electrical Engineering, Massachusetts Institute of Technology, USA.* We demonstrate 1 photon-per-pixel photon efficiency and sub-pulse-width range resolution in megapixel laser range imaging by using a joint spatio-temporal statistical processing framework and by exploiting transform-domain sparsity.

QF1B.3 • 08:30 Invited

Dispersion-cancelled Biological Imaging and Quantum Nonlinear Optics with Shaped Light Pulses, Kevin Resch[1]; [1]*Univ. of Waterloo, Canada.* I will introduce chirped-pulse interferometry and show how it can be applied to dispersion-cancelled optical coherence tomography. I will describe our recent results using chirped laser and single-photon pulses for compression of single photon spectra.

08:00–10:00
QF1C • XUV & X-ray Sources Based on High-harmonic Generation
Presider: Oliver D. Mücke; Deutsches Elektronen Synchrotron, Germany

QF1C.1 • 08:00

A few tens of microjoule full-coherent EUV-FEL seeded by high-order harmonic beam, Eiji J. Takahashi[1], Tadashi Togashi[2], Makoto Aoyama[3], Koichi Yamakawa[3], Takahiro Sato[4,5], Atsushi Iwasaki[5], Shigeki Owada[5], Kaoru Yamanouchi[5], Toru Hara[4,2], Shinichi Matsubara[2], Kanade Ogawa[4], Haruhiko Ohshima[4], Yuichi Okayasu[2], Yuji Otake[4,2], Hitoshi Tanaka[4,2], Takashi Tanaka[4], Hiromitsu Tomizawa[4,2], Takahiro Watanabe[2], Makina Yabashi[4,2], Katsumi Midorikawa[1], Tetsuya Ishikawa[4]; [1]*RIKEN, Advanced Science Institute, Japan;* [2]*Japan Synchrotron Radiation Research Institute, Japan;* [3]*Japan Atomic Energy Agency, Japan;* [4]*RIKEN, SPring-8 Center, Japan;* [5]*The University of Tokyo, Japan.* Output energy exceeding 20 uJ has been achieved in the EUV region at 61 nm by the harmonic seeded FEL scheme. Event ratio of the seeded FEL operation has been dramatically improved by a feedback system with an electro-optic sampling technique.

QF1C.2 • 08:15

Efficient table-top source of ultrashort XUV pulses at 50-kHz repetition rate, HE WANG[1], Stefan Ulonska[1], Yiming Xu[1], Predragr Ranitovic[1], Robert A. Kaindl[1]; [1]*Materials Sciences Division, Lawrence Berkeley National Laboratory, USA.* We demonstrate a high-flux XUV harmonics source at 50-kHz repetition rate, exploiting favorable wavelength scaling and phasematching in ultraviolet generation fields. Direct isolation of individual narrowband harmonics between 7.9 eV and 22.3 eV is achieved.

QF1C.3 • 08:30

Carrier-Envelope Phase-Dependent High Harmonic Generation in the Water Window by Few-Cycle IR Pulses, Nobuhisa Ishii[1], Keisuke Kaneshima[1], Kenta Kitano[1], Teruto Kanai[1], Shuntaro Watanabe[2], Jiro Itatani[1]; [1]*Institute for Solid State Physics, Japan;* [2]*Tokyo University of Science, Japan.* We report on the generation of carrier-envelope phase-dependent high harmonics in the water window using few-cycle IR pulses. The results suggest the production of a 50-eV-wide isolated attosecond continuum at the carbon K edge.

QF1C.4 • 08:45

Generation of attosecond pulse in carbon K-edge (284 eV) with only 247 μJ driving laser using generalized double optical gating, Hiroki Mashiko[1], Katsuya Oguri[1], Tetsuomi Sogawa[1]; [1]*NTT Basic Research Laboratories, Japan.* We studied attosecond pulse generation in the carbon K-edge with generalized double optical gating. With the gating effect, the emphasized harmonics in the cut-off region are observed with only 247 μJ driving laser energy.

08:00–10:00
QF1D • Integrated Devices and EIT
Presider: Marco Peccianti, Institute for Complex Systems, Italy

QF1D.1 • 08:00 Invited

Optical Diodes and Transistors on a Silicon Chip, Minghao Qi[1,2], Leo T. Varghese[1], Jian Wang[1], Li Fan[1], Yi Xuan[1], Ben Niu[1,2], Chookiat Tansarawiput[1], Justin C. Wirth[1], Andrew M. Weiner[1], Fuwan Gan[2], Xi Wang[2]; [1]*School of Electrical and Computer Engineering, Purdue Univ., USA;* [2]*State Key Laboratory of Functional Materials for Informatics, Shanghai Institute of Microsystem and Information Technology, China.* An add-drop filter with asymmetric coupling to bus waveguides, cascaded with a notch filter, achieves diode and transistor effects, and realizes NAND and NOR logic without physically altering the device, emulating the function of neurons.

QF1D.2 • 08:30

Chip-Scale Broadband Optical Isolation via Bragg Scattering Four-Wave Mixing, Kasturi Saha[1], Yoshitomo Okawachi[1], Onur Kuzucu[1], Michael Menard[2], Michal Lipson[2,3], Alexander L. Gaeta[1,3]; [1]*School of Applied and Engineering Physics, Cornell University, USA;* [2]*School of Electrical and Computer Engineering, Cornell University, USA;* [3]*Kavli Institute at Cornell for Nanoscale Science, Cornell University, USA.* We report the first demonstration of a broadband optical isolation using a Silicon nanowaveguide via Bragg scattering four-wave mixing. We achieve an isolation ratio of 4 dB over a bandwidth of 8 nm.

QF1D.3 • 08:45

Formation of quartic solitons in silicon-based slot waveguides, Samudra Roy[1], Fabio Biancalana[2,1]; [1]*Max-Planck-Inst Physik des Lichts, Germany;* [2]*School of Engineering and Physical Sciences, Heriot-Watt University, United Kingdom.* We investigate the possibility to excite the so-called quartic solitons (QSs) in specially designed silicon based slot waveguides. The proposed waveguides exhibit ideal dispersion profile and realistic operational conditions to support true QSs.

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Executive Ballroom 210G	Executive Ballroom 210F	Executive Ballroom 210E

CLEO: Science & Innovations

08:00–10:00
CF1E • Applications of Fiber Nonlinearities
Presider: Axel Schulzgen; University of Central Florida, United States

CF1E.1 • 08:00
Widely Wavelength-Tunable Ultra-Flat Frequency Comb and Short Pulse Generation from an Actively Mode-Locked Laser Using a Bismuth-Based Erbium-Doped Fiber and a Bismuth-Based Highly Nonlinear Fiber, Yutaka Fukuchi[1], Joji Maeda[1]; [1]*Department of Electrical Engineering, Tokyo University of Science, Japan.* We generate a frequency comb from a wavelength-tunable 10-GHz actively mode-locked laser using a bismuth-based erbium-doped fiber and a bismuth-based highly nonlinear fiber. Flat 30 comb lines within 10-dB variation and 3.0-ps pulses are generated.

CF1E.2 • 08:15
Sub-50 fs Pulses from Frequency Comb Generated by Cascaded Four-wave Mixing in Highly-nonlinear Fiber, Anton Ryabtsev[1], Bai Nie[1], Marcos Dantus[1]; [1]*Michigan State University, USA.* Phase measurements of a laser source based on generation of frequency comb in highly-nonlinear fiber were performed via line-by-line pulse shaping. Design optimization and compression of second order distortion allowed generation of sub-50 fs pulses.

CF1E.3 • 08:30 Invited
Ultrafast Optical Signal Processing Using Fiber Nonlinearities, Shu Namiki[1], Mingyi Gao[1], Ken Tanizawa[1], Takayuki Kurosu[1], Junya Kurumida[1], Takashi Inoue[1], Hung Nguyen Tan[1]; [1]*Natl Inst of Adv Industrial Sci & Tech, Japan.* This talk will address the role of ultrafast optical signal processing in the energy efficient all-optical network for future, and reports on key applications such as tunable regenerators with chirp control for various modulation formats.

08:00–09:30
CF1F • High Power and Nitride Semiconductor Lasers
Presider: Boon Ooi; King Abdullah Univ of Sci & Technology, Saudi Arabia

CF1F.1 • 08:00
Demonstration of True Green ITO Clad Semipolar (2021) InGaN/GaN Laser Diodes, Matthew Hardy[1,2], Casey O. Holder[1,2], Shuji Nakamura[1,2], James S. Speck[1,2], Dan A. Cohen[1,2], Steven P. DenBaars[1,2]; [1]*Materials, University of California, Santa Barbara, USA;* [2]*Solid State Lighting and Energy Center, University of California, Santa Barbara, USA.* Non-epitaxial cladding layers have advantages for green laser diodes in terms of reduced p-cladding resistance and reduced active region thermal damage . We demonstrate true green semipolar InGaN/GaN laser diodes with ITO cladding grown on semipolar GaN substrates.

CF1F.2 • 08:15
Lasing characteristics of metal-coated GaN with grating structure at Room temperature, Kuo-Ju Chen[1], Wan-Hai Hsu[1], Wei-Chun Liao[1], Min-Hsiung Shih[2], Hao-chung Kuo[1]; [1]*National Chiao Tung University, Taiwan;* [2]*Research Center for Applied Sciences, Academia Sinica, Taiwan.* The lasing action from a metal-coated GaN with grating structure was observed and the wavelength is approximately 368 nm with the quality factor of 570 due to the surface plasmon polaritons and dielectric mode.

CF1F.3 • 08:30
Effect of index-antiguiding on the threshold of GaN-based narrow ridge-waveguide laser diodes, Luca Redaelli[1], Hans Wenzel[1], Thomas Weig[2], Gerrit Lükens[2], Sven Einfeldt[1], Ulrich T. Schwarz[2], Michael Kneissl[1,3], Günther Tränkle[1]; [1]*Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik, Germany;* [2]*Fraunhofer Institute for Applied Solid State Physics IAF, Germany;* [3]*Institute for Solid State Physics, Technical University Berlin, Germany.* The effect of index antiguiding on GaN-based blue and violet laser diodes has been investigated. Strong antiguiding effects are proposed to be responsible for the large dependence of the threshold current density on the ridge etch depth.

CF1F.4 • 08:45
Single frequency operation of continuous-wave high-power Optically-Pumped Semiconductor Lasers, Alexandre Laurain[1], Jorg Hader[1], Stephan Koch[2,1], Bernd Heinen[2], Bernardette Kunert[2], Jerome Moloney[1]; [1]*College of Optical Sciences, University of Arizona, USA;* [2]*Material Sciences Center and Department of Physics, Philipps-Universität, Germany.* We report on our research in power scaling OPSL to exceed 100W. We used these optimized chips to achieve a single frequency output power of 15W with a M2 of 1.2 and a linewidth <7.5MHz.

08:00–10:00
CF1G • Frequency Combs and Arbitrary Waveform Generation
Presider: Jungwon Kim; Korea Advanced Inst of Science & Tech, Korea, Republic of

CF1G.1 • 08:00
Low Noise Microwave Generation with High Power, High Linearity Photodiodes, tara fortier[1], Franklyn Quinlan[1], Archita Hati[1], Craig Nelson[1], Jennifer Taylor[1], Yang Fu[2], Joe C. Campbell[2], Scott A. Diddams[1]; [1]*Time and Frequency, NIST, USA;* [2]*Electrical and Computer Engineering, University of Virginia, USA.* We use modified uni-traveling carrier photodetectors in conjunction with a Ti:sapphire-based optical frequency divider to generate 10 GHz microwaves with +14 dBm power, <3 fs absolute timing jitter and phase noise floors of -177 dBc/Hz.

CF1G.2 • 08:15
Microwave Photonic Arbitrary Waveform Generation With Radically Increased Time Bandwidth Product, Amir Dezfooliyan[1], Andrew M. Weiner[1]; [1]*Electrical and Computer Engineering, Purdue University, USA.* The far-field condition sets strict limits on RF waveform generation via spectral shaping and frequency-to-time mapping. We present a new technique which overcomes previous restrictions and achieves high fidelity arbitrary waveforms with radically increased time-bandwidth product.

CF1G.3 • 08:30
Bandwidth Scaling of Phase-modulated CW Comb through Four-Wave Mixing on Silicon Nano-waveguide, Yang Liu[1], Andrew J. Metcalf[1], Victor T. Company[1,3], Rui Wu[1], Li Fan[1,2], Leo T. Varghese[1,2], Minghao Qi[1,2], Andrew M. Weiner[1,2]; [1]*School of Electrical and Computer Engineering, Purdue University, USA;* [2]*Birck Nanotechnology Center, Purdue University, USA;* [3]*Microtechnology and Nanoscience department (MC2), Chalmers University of Technology, Sweden.* We demonstrate a scheme to scale the bandwidth of a frequency comb generated by phase modulation of CW lasers using four-wave mixing in a silicon nano-waveguides, resulting in >100 comb lines spaced by 10-GHz within 5-dB bandwidth.

CF1G.4 • 08:45
Ultraflat Optical Frequency Comb Generation Using Dispersion Based Chirp Linearization, Yanfei Xing[1], Li Huo[1], Qiang Wang[1], Caiyun Lou[1]; [1]*Tsinghua National Laboratory for Information Science and Technology and State Key Laboratory of Integrated Optoelectronics,Department of Electronic Engineering, Tsinghua University, China.* we propose to use a dispersive element to linearize the phase-modulation-induced chirp for ultraflat optical frequency comb generation. The spectral power variation is reduced to less than 1 dB in both the simulation and experiment.

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Meeting Room 212A-C

CLEO: Applications & Technology

08:00–10:00
AF1H • Lasers for Imaging & Data Transmission
Presider: Cheryl Asbury, Jet Propulsion Laboratory, USA

AF1H.1 • 08:00 Invited
Laser-driven Radiation Sources for Penetrating Imaging, Robert Deas[1]; [1]*DSTL, United Kingdom.* The use of laser plasma acceleration to produce high energy radiation suitable for penetrating imaging is discussed. Analyses of experimental results and Monte Carlo modelling are used to investigate the properties of such laser-driven sources.

AF1H.2 • 08:30 Invited
High Power Laser Generated Fast Neutrons and their Applications, Satyabrata Kar[1], talk will be presented by Anatoly Maksimchuk; [1]*School of Mathematics and Physics, Queen's University Belfast, United Kingdom.* High power laser driven ions can be deployed in beam-fusion reactions in order to produce high flux, beamed source of MeV neutrons for many applications. Recent developments in this direction will be presented.

Meeting Room 212D-B

CLEO: Science & Innovations

08:00–10:00
CF1I • Fabrication and Characterization of Optical Gain Materials
Presider: Yuji Oki; Kyushu University, Japan

CF1I.1 • 08:00
photoluminescence characteristics of Fe2+ doped ZnSe polycrystal with quantum cascade laser pumping, Yu Song[1], Sergey B. Mirov[2], Jacob Khurgin[3], Claire F. Gmachl[1]; [1]*Electrical Engineering, Princeton University, USA;* [2]*Physics, University of Alabama at Birmingham, USA;* [3]*Electrical and Computer Engineering, Johns Hopkins University, USA.* The Photoluminescence spectra and lifetime of Fe2+ doped ZnSe crystal with quantum cascade laser pumping is measured. At room temperature the photoluminescence lifetime is ~ 0.38 us, which increases to ~ 100 us at 80K

CF1I.2 • 08:15
InAs Quantum Dot Growth Using Bismuth as a Surfactant for Optoelectronic Applications, Vaishno Dasika[1], Erica M. Krivoy[1], Hari P. Nair[1], Scott J. Maddox[1], Keun W. Park[1], Daehwan Jung[2], Minjoo L. Lee[2], Edward T. Yu[1], Seth Bank[1]; [1]*Microelectronics Research Center, The University of Texas at Austin, USA;* [2]*Department of Electrical Engineering, Yale University, USA.* We report the use of a bismuth surfactant to increase self-assembled InAs quantum dot emission intensity, decrease the linewidth, and extend the emission wavelength with increasing InAs deposition, without the concomitant loss of dot density.

CF1I.3 • 08:30
Gain and Recovery Dynamics of Lithographically-Defined Quantum Dot Amplifiers, Kevin Silverman[1], Luis Miaja-Avila[1], Richard P. Mirin[1], James Coleman[2], Varun Verma[1]; [1]*National Inst of Standards & Technology, USA;* [2]*University of Illinois, USA.* We directly measure the optical gain and threshold current of lithographically-defined quantum dots. A peak groundstate gain of 1.8 cm-1 is determined. We also measure recovery dynamics with the device biased above and below transparency using ultrafast differential transmission spectroscopy.

CF1I.4 • 08:45
C- and L-Band Erbium-Doped Aluminum Oxide Lasers with Silicon Nitride Distributed Bragg Reflector Cavities, Jonathan Bradley[1], Purnawirman Purnawirman[1], Ehsan S. Hosseini[1], Jie Sun[1], Thomas Adam[2], Gerald Leake[2], Douglas D. Coolbaugh[2], Michael R. Watts[1]; [1]*Research Laboratory of Electronics, Massachusetts Institute of Technology, USA;* [2]*College of Nanoscale Science and Engineering, University at Albany, USA.* We demonstrate erbium-doped waveguide lasers with lithographically-defined silicon nitride distributed Bragg reflectors. We measure output powers of up to 5 mW and show emission over a wide wavelength range (1536, 1561 and 1596 nm).

Marriott San Jose Salon I & II

CLEO: Applications & Technology

08:00–10:00
AF1J • Applied Optical Measurements in Fabrication Processes and Products I
Presider: John Lehman; National Inst of Standards & Technology, United States

AF1J.1 • 08:00 Invited
An Optically Enabled Biosensor for Medical Diagnostics, Chris J. Myatt[1]; [1]*Mbio Diagnostics, USA.* Near patient diagnostics remain a critical need for infectious disease management. MBio Diagnostics has developed a low-cost cartridge and fluorescence imaging system for multiplexed point-of-care assays. Data for three modes of operation will be presented.

AF1J.2 • 08:30
Gas sensing using a resilient polymer photonic crystal nanocavity with ultra-high quality factor, Hannah Clevenson[1], Pierre Desjardins[2], Xuetao Gan[2], Dirk Englund[1]; [1]*Electrical Engineering and Computer Science, Research Laboratory of Electronics, MIT, USA;* [2]*Columbia University, USA.* We present a high-sensitivity, multi-use optical gas sensor based on a one-dimensional polymer photonic crystal cavity. With an experimental Q exceeding 13100, we predict detection levels on the parts-per-billion range for a variety of gases.

AF1J.3 • 08:45
Single-Shot 60 dB Dynamic Range Laser Contrast Measurement Using Fourth-Order Cross-Correlation from Self-Referencing-Spectral-Interferometry (FOX-SRSI), Sasikumar Palaniyappan[1], Rahul Shah[1], Randall Johnson[1], Tsutomu Shimada[1], Daniel Jung[1], Donald Gautier[1], Manuel Hegelich[2], J.C. Fernandez[1]; [1]*P-24 Plasma Physics, Los Alamos National Laboratory, USA;* [2]*University of texas, USA.* Fourth-order cross-correlation of the laser pulse is obtained from the spectral interferogram produced from the laser pulse and a self-created reference pulse. High dynamic range contrast measurement (60 dB) is demonstrated by measuring an imposed pre-pulse.

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Marriott San Jose Salon III

JOINT

08:00–10:00
JF1K • Symposium on Nonlinear THz Science and Technology I
Presider: Peter Jepsen; Danmarks Tekniske Universitet, Denmark

JF1K.1 • 08:00 Invited
Experimental Observation of Electron-Hole Recollisions in Semiconductors, Mark S. Sherwin[1]; [1]*University of California Santa Barbara, USA.* A strong quasi-cw terahertz electric field repeatedly collides electrons with holes, modulating a NIR laser to create a frequency comb with teeth separated by twice the terahertz frequency in this excitonic analog of high-order harmonic generation.

JF1K.2 • 08:30
Few-cycle Synthetic Multi-THz Waveforms with Asymmetric Temporal Envelope, Denis V. Seletskiy[1], Christian Schmidt[1], Bernhard Mayer[1], Alexej Pashkin[1], Alfred Leitenstorfer[1]; [1]*Department of Physics and Center for Applied Photonics, University of Konstanz, Germany.* Intense few-cycle synthetic multi-THz waveforms with strongly symmetry-broken temporal envelope are generated and field-resolved. Access to these waveforms sets an exciting platform for novel experiments in THz nonlinear optics.

JF1K.3 • 08:45
Highly Efficient THz Pulse Generation from Optical Rectification in Cryogenically Cooled Lithium Niobate, Wenqian R. Huang[1], Shu-Wei Huang[1], Eduardo Granados[1,2], Kyung-Han Hong[1], Luis E. Zapata[1], Franz X. Kärtner[1,3]; [1]*Electrical Engineering and Computer Science and Research Laboratory of Electronics, Massachusetts Institute of Technology, USA;* [2]*IKERBASQUE, Spain;* [3]*Center for Free-Electron Laser Science, DESY and Department of Physics, University of Hamburg, Germany.* We demonstrate high optical-to-THz conversion efficiency of 3.8% by optical rectification in cryogenically-cooled lithium niobate using near-optimum 680 fs, 1.2 mJ pump pulses centered at 1 μm. Spatial and temporal characterization will be presented.

Marriott San Jose Salon IV

CLEO: Applications & Technology

08:00–10:00
AF1L • Biosensing & Control
Presider: Laura Marcu; University of California Davis, United States

AF1L.1 • 08:00 Tutorial
Optogenetics: Molecular and Optical Tools for Controlling Life with Light, Ed Boyden[1,*]; [1]*MIT, USA.* Optogenetic tools are genetically-encoded reagents that, when targeted to specific brain cells, enable their activity to be controlled by light. These tools are having broad impact on science, and may serve clinical roles as well.

Ed Boyden is Associate Professor of Biological Engineering and Brain and Cognitive Sciences, at the MIT Media Lab and the MIT McGovern Institute. He leads the Synthetic Neurobiology Group, which develops tools for analyzing and engineering the circuits of the brain. These technologies, created often in interdisciplinary collaborations, include 'optogenetic' tools, which enable the activation and silencing of neural circuit elements with light, 3-D microfabricated neural interfaces, and robotic methods for performing single-cell analyses in living brain. He has received the NIH Director's New Innovator Award, the Society for Neuroscience Research Award for Innovation in Neuroscience, the Paul Allen Distinguished Investigator Award, the Perl/UNC prize, the A. F. Harvey Prize, the Grete Lundbeck "Brain" Prize, amongst other recognitions. He has contributed to over 300 peer-reviewed papers, current or pending patents, and articles, and has given over 200 invited talks on his work.

Marriott San Jose Salon V & VI

CLEO: Science & Innovations

08:00–10:00
CF1M • Novel Light Emitters
Presider: Jonathan Wierer, Sandia National Lab, USA

CF1M.1 • 08:00 Tutorial
Quantum Dots for Displays and Lighting, Seth Coe-Sullivan[1]; [1]*QD Vision Corporation, USA.* Quantum dots (QDs) are interesting material options for the lighting and display markets, however, several limitations have limited QD applicability. This tutorial will review both limitations and breakthroughs in QD performance that has led to their recent commercialization in both of these markets.

Dr. Seth Coe-Sullivan is co-founder, member of the Board of Directors, and Chief Technology Officer of QD Vision. He received his Ph.D. in Electrical Engineering from the Massachusetts Institute of Technology in May 2005, where his thesis work led to the formation of QD Vision. Seth's technology expertise includes quantum dot materials and devices for solid state lighting and displays, as well as the environmental health and safety implications of quantum dots and nanomaterials. His role as CTO spans technology and intellectual property strategy, technical marketing, fundraising, and business development for advanced projects. Seth was awarded Technology Review Magazine's TR35 Award in 2006, naming him one of the top 35 innovators under the age of 35. Under his technology leadership, QD Vision won the Wall Street Journal's Innovation Award in 2009, New England Clean Energy Council's Emerging Company of the Year Award in 2010, and the SEMI Award for North America in 2012.

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Executive Ballroom 210A	Executive Ballroom 210C	Executive Ballroom 210D	Executive Ballroom 210H

CLEO: QELS-Fundamental Science

QF1A • Quantum Nanooptics & Detectors—Continued

QF1A.4 • 09:00
Ultrafast Electrical Modulation of the Exciton Energy for the Dynamic Control of Cavity Quantum Electrodynamics, Francesco Pagliano[1], Frank V. Otten[1], Tian Xia[1], Lianhe Li[2], Edmund Linfield[2], Andrea Fiore[1]; [1]*COBRA Research Institute, Eindhoven University of Technology, Netherlands;* [2]*School of Electronic and Electrical Engineering, University of Leeds, United Kingdom.* We report quantum dot photonic crystal microcavity diodes where single exciton lines can be spectrally tuned at frequencies above 2GHz. This opens the way to the ultrafast control of cavity quantum electrodynamics on chip

QF1A.5 • 09:15
Microcavity Enhanced Quantum Well Infrared Photodetector, Yuk Nga CHEN[1], Yanko Todorov[1], Benjamin Askenazi[1], Angela Vasanelli[1], Giorgio Biasol[2], Raffaele Colombelli[3], Lucia Sorba[4], Carlo Sirtori[1]; [1]*Laboratoire Matériaux et Phénomènes Quantiques, Université Paris Diderot, France;* [2]*Laboratorio TASC, Area Science Park, Italy;* [3]*Institut d'Electronique Fondamentale, Université Paris-Sud, France;* [4]*Istituto Nanoscienze-CNR and Scuola Normale Superiore, Italy.* We have demonstrated a QWIP photodetector embedded in metallic microcavity array with highly sub-wavelength pixel separation. This geometry allows for a drastic reduction of the effective area of the device and enhances light in-coupling with a lower number of absorbing quantum wells.

QF1A.6 • 09:30
Membrane-integrated superconducting nanowire single-photon detectors, Faraz Najafi[1], Jacob Mower[1], Xiaolong Hu[1], Francesco Bellei[1], Prashanta Kharel[1], Andrew Dane[1], Yachin Ivry[1], Lin Lee Cheong[1], Kristen Sunter[1], Dirk Englund[1], Karl K. Berggren[1]; [1]*Massachusetts Institute of Technology, USA.* We integrated superconducting nanowire single-photon detectors on sub-400-nm-thick silicon nitride membranes, which can then be transferred and aligned to photonic structures on a secondary chip with sub-micron placement accuracy.

QF1B • Quantum Sensing & Imaging—Continued

QF1B.4 • 09:00
Entanglement-enhanced probing of a delicate material system, Florian Wolfgramm[1], Chiara Vitelli[2], Federica Beduini[1], Nicolas Godbout[3], Morgan W. Mitchell[1,4]; [1]*ICFO - Institute of Photonic Sciences, Spain;* [2]*Center of Life Nanoscience, La Sapienza, Istituto Italiano di Tecnologia, Italy;* [3]*COPL, Département de Génie Physique, École Polytechnique de Montréal, Canada;* [4]*ICREA-Institució Catalana de Recerca i Estudis Avançats, Spain.* Using atom-tuned narrowband NooN states we demonstrate non-destructive probing of an atomic ensemble with sensitivity per photon and sensitivity per damage to the ensemble beyond the standard quantum limit.

QF1B.5 • 09:15
Imaging High-Dimensional Spatial Entanglement with Compressive Sensing, Gregory A. Howland[1], John C. Howell[1]; [1]*University of Rochester, USA.* We use compressive sensing to efficiently image spatial correlations from spontaneous parametric downconversion at high resolution and witness entanglement. This technique efficiently scales to large dimensions and efficiently handles very low flux signals.

QF1B.6 • 09:30
Quantum Back-action Limited Optomechanical Cavity Using Microresonator: Towards Calibration of Quantum Noises for LIGO, Robinjeet Singh[1], Joseph Bowers[1], Garrett May[1], Garrett D. Cole[2,3], Thomas Corbitt[1]; [1]*Physics and Astronomy, Louisiana State University, USA;* [2]*Vienna Center fro Quantum Science and Technology, Austria;* [3]*University of Vienna, Austria.* We observe the radiation pressure effects of light on micromechanical resonator. Such measurements serve as initial steps towards testing macroscopic quantum mechanics and hence developing Quantum Non Demolition techniques for future Laser Interferometer Gravitational Observatory.

QF1C • XUV & X-ray Sources Based on High-harmonic Generation—Continued

QF1C.5 • 09:00
Generation of High-Flux Attosecond XUV Continuum with a 10 TW Driving Laser, Yi Wu[1], Eric Cunningham[1], Jie Li[1], Huaping Zang[1], Michael Chini[1], Xiaowei Wang[1], Yang Wang[1], Kun Zhao[1], Zenghu Chang[1]; [1]*CREOL, The College of Optics & Photonics, University of Central Florida, USA.* An XUV continuum supporting 280 as isolated attosecond pulses is generated in argon with a 200 mJ, 17 fs Ti:Sapphire laser using the GDOG technique. The energy of the XUV pulse is over 100 nJ at generation location.

QF1C.6 • 09:15
Isolated optical attosecond pulses, Tran Trung Luu[1], Mohammed T. Hassan[1], Antoine Moulet[1], Olga Razskazovskaya[2], Nick Kaprowicz[1], Vladimir Pervak[2], Ferenc Krausz[1,2], Eleftherios Goulielmakis[1]; [1]*Max-Planck-Institut fur Quantenoptik, Germany;* [2]*Department für Physik, Ludwig-Maximilians-Universität, Germany.* We report on the precise synthesis and control of intense isolated attosecond pulses in optical frequencies and the use of them for unprecedented controls of electrons in atoms and molecules.

QF1C.7 • 09:30
Sparsity-based super-resolution coherent diffractive imaging of (practically) 1D images using extreme UV radiation, Pavel Sidorenko[1], Avner Fleischer[1], Yoav Shechtman[1], Yonina C. Eldar[2], Moti Segev[1], Oren Cohen[1]; [1]*Physics, Technion Israel Institute of Technology, Israel;* [2]*Electrical Engineering, Technion Israel Institute of Technology, Israel.* We demonstrate experimentally sparsity-based super-resolution of coherent diffraction imaging (CDI) with extreme UV radiation. We also present the first experimental CDI of a practically one-dimensional object, overcoming the well-known ambiguity problem in one-dimensional phase retrieval.

QF1D • Integrated Devices and EIT—Continued

QF1D.4 • 09:00
Enhancement of Backward-Propagating Anti-Stokes Raman Scattering from Ti-diffused Lithium Niobate Waveguides, Da Li[1], Zhaojun Liu[1,2], Pengda Hong[1], Yujie J. Ding[1], Lei Wang[1,2], Ping-Rang Hua[3], De-Long Zhang[3]; [1]*Electrical and Computer Engineering, Lehigh University, USA;* [2]*Information of Science and Engineering, Shandong University, China;* [3]*Precision Instruments and Optoelectronics Engineering, Tianjin University, China.* We have observed enhancement factors of up to 21 for backward-propagating anti-Stokes Raman signals generated by Ti-diffused lithium niobate waveguides under the microwatt pump power and using a single-photon detector.

QF1D.5 • 09:15
Soliton dynamics in the multiphoton plasma regime, Chad A. Husko[1], Pierre Colman[2], Sylvain Combrie[2], Jiangjun Zheng[1], Alfredo De Rossi[2], Chee Wei Wong[1]; [1]*Optical Nanostructures Lab, Columbia University, USA;* [2]*Thales Research and Technology, France.* We report first phase-resolved measurements of: (1)soliton splitting in integrated devices, (2)self-induced pulse acceleration and (3) suppressed periodic recurrence in chi(3) semiconductor waveguides(1.5mm), revealing novel physics governing ultrafast nonlinear dynamics in nanophotonic chips.

QF1D.6 • 09:30
All optical analogue to Electromagnetically Induced Transparency and Autler-Townes effect, Charles Ciret[1,2], Virginie Coda[1,2], Andon A. Rangelov[3], Germano Montemezzani[1,2]; [1]*Université de Lorraine, LMOPS, France;* [2]*Supélec, LMOPS, France;* [3]*Department of physics, Sofia university, Bulgaria.* We investigate theoretically and demonstrate experimentally using reconfigurable structures that light propagation in a system of three coupled waveguides can behave in full analogy to Electromagnetically Induced Transparency and Autler-Townes effect.

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Executive Ballroom 210G	Executive Ballroom 210F	Executive Ballroom 210E

CLEO: Science & Innovations

CF1E • Applications of Fiber Nonlinearities—Continued

CF1E.4 • 09:00
Cladding pumped Q-switched fiber laser using a tapered fiber saturable absorber, Sean Moore[1], Daniel B. Soh[1], Scott E. Bisson[1], Brian Patterson[1], Wen Hsu[1]; *[1]8128, Sandia National Laboratories, USA.* We report a passively Q-switched all-fiber laser using a large mode area Yb3+-doped fiber cladding-pumped at 915 nm and an unpumped single-mode Yb3+-doped saturable absorber fiber. 60 μJ 80 ns pulses at 1030 nm are reported.

CF1E.5 • 09:15
Mapping Dispersion Fluctuations along Optical Fibers Using Brillouin Probing and a Fast Analytic Calculation, fatemeh alishahi[1], Armand Vedadi[1], Andrey Denisov[1], Marcelo A. Soto[1], Khashayar Mehrany[2], Camille S. Brès[1], Luc Thévenaz[1]; *[1]Electrical Engineering, Ecole Polytechnique Fédérale de Lausanne, Switzerland; [2]Electrical and Electronics Engineering, Sharif University of Technology, Islamic Republic of Iran.* A simple analytic formula is derived to extract tiny dispersion fluctuations along highly nonlinear fibers from distributed measurements of parametric gain. A refined BOTDA scheme, suitable to track Kerr processes, enables low noise measurements.

CF1E.6 • 09:30
Chalcogenide microwires based Raman lasers, Raja Ahmad[1], Martin Rochette[1], *[1]McGill University, Canada.* We present telecommunications band, chalcogenide microwires based Raman lasers in two cavity configurations. One cavity is a fiber loop type (chalcogenide microwire-plus-silica fiber), while the other cavity is an all chalcogenide Fabry-Perot type.

CF1F • High Power and Nitride Semiconductor Lasers—Continued

CF1F.5 • 09:00
Watt-Class, Nanosecond-Pulse Semiconductor Laser with Integrated Driver, Dominic F. Siriani[1], Gary M. Smith[1], George Jordy[1], Andrew M. Siegel[1], Joseph P. Donnelly[1], Erik Duerr[1], Leo J. Missaggia[1], Michael K. Connors[1], David C. Mathewson[1], Pablo I. Hopman[1], Andrew K. Stimac[1], Paul Juodawlkis[1]; *[1]MIT Lincoln Laboratory, USA.* We report short (5 ns), high-power (>1 W), spectrally narrow optical pulses generated by a 1060-nm slab-coupled optical waveguide laser (SCOWL) soldered directly to a custom BiCMOS driver chip.

CF1F.6 • 09:15
High-brightness laser arrays integrated with a phase-shifter designed for single-lobe far-field pattern, Lei Liu[1], Jianxin Zhang[1], Shaodong Ma[1], Aiyi Qi[1], Hongwei Qu[1], Yejin Zhang[1], Wan-hua Zheng[1]; *[1]Chinese Acad Sci Inst of Semiconductor, China.* High-brightness 910 nm wavelength edge-emitting laser arrays integrated with a phase-shifter have been designed. Over 450 mW/facet with $M^2 < 3$ is achieved experimentally. Such devices show bright future for low cost and easy fabrication.

CF1G • Frequency Combs and Arbitrary Waveform Generation—Continued

CF1G.5 • 09:00
Dual-polarization frequency comb from a diode-pumped solid-state laser, Marc Brunel[1], Jérémie Thévenin[1], Marc Vallet[1]; *[1]Universite de Rennes I, France.* A mode-locked laser containing two quarter-wave plates emits synchronously two combs associated to the polarization eigenstates of the cavity. Experiments are in agreement with a modal analysis predicting the polarization sequences of the pulse train.

CF1G.6 • 09:15
High-efficiency carrier-envelope offset locking in a 2f-to-3f self-referencing interferometer with a dual-pitch PPLN ridge waveguide, Kenichi Hitachi[1], Atsuhi Ishizawa[1], Tadashi Nishikawa[2], Masaki Asobe[3], Tetsuomi Sogawa[1]; *[1]NTT Basic Research Laboratories, NTT Corporation, Japan; [2]Department of Electrical and Electronic Engineering, Tokyo Denki University, Japan; [3]NTT Photonics Laboratories, NTT Corporation, Japan.* We generated second- (third-) harmonic light with high efficiency with a single- (dual-) pitch periodically poled lithium niobate ridge waveguide, and locked the carrier-envelope offset frequency at a telecommunications wavelength with a 2f-to-3f self-referencing interferometer.

CF1G.7 • 09:30
Carrier Envelope Phase Drift of Picosecond Frequency Combs from an Ultrahigh Finesse Fabry-Perot Cavity, Peter Jojart[1,2], A. Borzsonyi[1,2], Ronic Chiche[3], Viktor Soskov[3], Alessandro Variola[3], Fabian Zomer[3], Eric Cormier[4], Karoly Osvay[1,5]; *[1]Optics and Quantum Electronics, University of Szeged, Hungary; [2]CE Optics Kft., Hungary; [3]Laboratoire de l'Accélérateur Linéaire, Université Paris Sud, France; [4]CELIA, Université de Bordeaux, France; [5]ELI-Hu Nkft, Hungary.* The carrier envelope phase shift of a stacked picosecond pulse train for Compton scattering experiments have been measured to an accuracy of 80 mrad by spectrally resolved interference pattern of a stabilized multiple beam interferometer.

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Meeting Room 212A-C

CLEO: Applications & Technology

AF1H • Lasers for Imaging & Data Transmission—Continued

AF1H.3 • 09:00
Structural Thermal Optical (STOP) Analysis of the Space-Qualified Laser Transmitter for the ICESat-2 Mission, Nicholas Sawruk[1]; [1]*Fibertek Inc., USA.* The successful completion of environmental testing of a space-qualified laser transmitter was enabled by a detailed and validated structural thermal optical analysis of the system. The modeling approach, predications and experimental results are presented.

AF1H.4 • 09:15
Femtosecond Fiber Timing Distribution System for the Linac Coherent Light Source, Heng Li[1,3], Li-Jin Chen[5], Haynes Pak-Hay Cheng[5], Justin May[4], Steve Smith[4], Kerstin Muehlig[4], Josef C. Frisch[4], Alan R. Fry[4], Franz X. Kärtner[6,7], Philip H. Bucksbaum[1,2]; [1]*Stanford PULSE Institute, Stanford University, USA;* [2]*Department of Physics, Stanford University, USA;* [3]*Department of Applied Physics, Stanford University, USA;* [4]*SLAC National Accelerator Laboratory, USA;* [5]*Idesta Quantum Electronics, LLC, USA;* [6]*Department of Electrical Engineering, and Computer Seience, and Research Laboratory of Electronics, Massachusetts Institute of Technology, USA;* [7]*Center for Free-electron Laser Science, Physics Department, Deutsches Elektronen-Synchrotron, University of Hamburg, Germany.* We present the design and progress towards implementation of a femtosecond fiber timing distribution system for the Linac Coherent Light Source at SLAC enabling machine diagnostic at the 10 fs level.

AF1H.5 • 09:30
Two Dimensional Encrypted Optical Steganography Based on Amplified Spontaneous Emission Noise, Ben Wu[1], Zhenxing Wang[1], Bhavin J. Shastri[1], Yue Tian[1], Paul R. Prucnal[1]; [1]*Princeton University, USA.* We demonstrate an optical steganography method with two dimensional encryption to dramatically improve the privacy of optical networks. The transmitted stealth signal carried by noise is secretly hidden under the public channel.

Meeting Room 212D-B

CLEO: Science & Innovations

CF1I • Fabrication and Characterization of Optical Gain Materials—Continued

CF1I.5 • 09:00
Degradation self-recovery and durability extension on solid-state dye laser in blue region, Hiroaki Yoshioka[1], Yusuke Itoh[2], Ayumu Kiyomori[2], Yuji Oki[1]; [1]*Kyushu University, Japan;* [2]*Shin-Etsu Chemical Co., Japan.* We developed a degradation-recoverable PDMS dye laser using a new fluorene-based chromophore. The chromophore has dimethylsiloxane chains to enhance its solubility in the PDMS matrix. It extended the durability by a factor of 20.

CF1I.6 • 09:15
Extremely Large Signal Enhancement in an Erbium Chloride Silicate Single-Crystal Nanowire, Zhicheng Liu[1], Leijun Yin[1,2], Cun-Zheng Ning[1]; [1]*School of Electrical, Computer, and Energy Engineering, Arizona State University, USA;* [2]*Department of Physics, Arizona State University, USA.* We study the signal enhancement at 1.53 μm in a high Erbium concentration, long lifetime single-crystal Erbium Chloride Silicate (ECS) nanowire. 644 dB/cm signal enhancement is measured from a single ECS nanowire via pump-probe method.

CF1I.7 • 09:30
Blue- and red-shifting amplified spontaneous emission of CdSe/CdS core/shell colloidal quantum dots, Yusuf Kelestemur[1], Ahmet Fatih Cihan[1], Burak Guzelturk[1], Ozan Yerli[1], Ulas Kurum[2], Halime Gul Yaglioglu[2], Ayhan Elmali[2], Hilmi Volkan Demir[1,3]; [1]*Department of Electrical and Electronics Engineering, Department of Physics, UNAM--Institute of Materials Science and Nanotechnology, Bilkent University, Turkey;* [2]*Department of Engineering Physics, Ankara University, Turkey;* [3]*Microelectronics Division, School of Electrical and Electronics Engineering, and Physics and Applied Physics Division, School of Physical and Mathematical Sciences, Nanyang Technological University, Singapore.* We report blue- and red-shifting amplified spontaneous emission of CdSe/CdS quantum dots, controlled by varying core/shell dimensions and modifying exciton-exciton interactions, with low optical gain threshold of two-photon absorption pumping.

Marriott San Jose Salon I & II

CLEO: Applications & Technology

AF1J • Applied Optical Measurements in Fabrication Processes and Products I—Continued

AF1J.4 • 09:00
Polarization-Sensitive Optical Coherence Tomography for Characterization of Size and Shape of Nano-Particles, Simon Schneider[1], Alexandra Krämer[1], Florian Eppler[1], Hanna Alemye[1], Christof Huebner[3], Irma Mikonsaari[3], Juerg Leuthold[1,2], Wolfgang Freude[1,2], Christian Koos[1,2]; [1]*Institute of Photonics and Quantum Electronics (IPQ), Karlsruhe Institute of Technology (KIT), Germany;* [2]*Institute of Microstructure Technology (IMT), Karlsruhe Institute of Technology (KIT), Germany;* [3]*Fraunhofer Institute for Chemical Technology (ICT), Germany.* Polarization-sensitive optical coherence tomography is used for determining the size of nano-spheres with 143 nm and 246 nm diameter. The shape-anisotropy of randomly oriented nanoparticles is characterized by polarization-sensitive measurements.

AF1J.5 • 09:15
Monitoring the formation of oxide apertures in micropillar cavities, Morten Bakker[1]; [1]*Leiden University, Netherlands.* A monitoring technique of the wet thermal oxidation of an AlAs layer embedded between DBR mirrors in a micropillar is presented, providing a reliable way to produce high Q-factor and small mode volume optical cavities.

AF1J.6 • 09:30 Invited
Recent advances in acousto-optic tunable filters for hyper-spectral imaging with real-time spectral unmixing, Christopher N. Pannell[1]; [1]*Gooch & Housego, USA.* Acousto-optic tunable filters allow the realization of fast hyper-spectral imagers, with apertures to 25mm. With optimized electronics, wavelengths can be changed in 200 microseconds. Using the CUDA platform, we demonstrate real-time unmixing of microscope images.

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Marriott San Jose Salon III

JOINT

JF1K • Symposium on Nonlinear THz Science and Technology I—Continued

JF1K.4 • 09:00

A Scaling Mechanism for Increasing the Terahertz Emission from Ionization of Air, Matteo Clerici[1,2], Marco Peccianti[3], Bruno E. Schmidt[1], Lucia Caspani[1], Mostafa Shalaby[1], Mathieu Giguère[1], Antonio Lotti[4,5], Arnaud Couairon[5], François Légaré[1], Tsuneyuki Ozaki[1], Daniele Faccio[2], Roberto Morandotti[1]; *[1]INRS-EMT, Canada; [2]School of Engineering and Physical Sciences, Heriot-Watt University, United Kingdom; [3]Institute for Complex Systems, CNR, Italy; [4]Dipartimento di Scienza e Alta Tecnologia, Università degli Studi dell'Insubria, Italy; [5]Centre de Physique Théorique, Ecole Polytechnique, France.* A significant enhancement of the terahertz generation efficiency via two-color laser-induced air ionization, up to 10^{-3}, is observed with increasing pump wavelength. Terahertz peak fields up to 4.4 MV/cm were obtained using 400 μJ pulse energy.

JF1K.5 • 09:15

Evolution of the THz Beam Profile from a Two-Color Air Plasma Through a Beam Waist, Andrew C. Strikwerda[1], Pernille Klarskov[1], Peter U. Jepsen[1]; *[1]DTU Fotonik-Department of Photonics Engineering, Technical University of Denmark, Denmark.* We experimentally measure the profile of a THz beam generated by a two-color air plasma as it passes through a beam waist, and show that it can be approximated as a Bessel-Gauss beam.

JF1K.6 • 09:30 Invited

Multi-THz Nonlinear Optics and Sub-cycle Control of Charge and Spin, Olaf Schubert[1,4], Michael Porer[1,4], Alexander Sell[1], Friederike Junginger[1], Bernhard Mayer[1], Christian Schmidt[1], Sebastian Maehrlein[1,2], Alexej Pashkin[1], Tobias Kampfrath[2], Martin Wolf[2], Kyungwan Kim[3], Alfred Leitenstorfer[1], Rupert Huber[1,4]; *[1]Department of Physics, University of Konstanz, Germany; [2]Fritz-Haber-Institut, Max-Planck-Gesellschaft, Germany; [3]Department of Physics, Chungbuk National University, Republic of Korea; [4]Department of Physics, Universitaet Regensburg, Germany.* Strong THz electric and magnetic fields are harnessed to coherently control charge and spin in solids with sub-cycle resolution. Exploiting coherent THz phonons we transiently induce and destroy spin density wave order in pnictides.

Marriott San Jose Salon IV

CLEO: Applications & Technology

AF1L • Biosensing & Control—Continued

AF1L.2 • 09:00

Label-Free Kinetic Screening Of Proteins And Virus Binding In A 51,200 Small-Molecule Library With A High-Throughput Ellipsometric Scanning Microscope, Galina Malovichko[1], James P. Landry[1], Andrew P. Proudian[1], Xiangdong Zhu[1]; *[1]Physics, University of California, Davis, USA.* Using a label-free high-throughput optical scanning microscope we detected endpoints and binding kinetics of RNPC1a, Pyl(1&2) proteins and influenza virus A/PR/8/34 with a library of 51,200 small-molecule compounds from the NCI Developmental Therapeutics Program.

AF1L.3 • 09:15

Clinical Application of a Mid-infrared Quantum Cascade Laser Based Sensor for Multianalyte Detection in Human Blood Plasma, Markus Brandstetter[1], Tamara Sumalowitsch[1], Andreas Genner[1], Valentin Fuhrmann[2], Bernhard Lendl[1]; *[1]Institute of Chemical Technologies and Analytics, Vienna University of Technology, Austria; [2]Gastroenterology and Hepatology, Vienna General Hospital, Austria.* A portable point-of-care sensor employing a broadly tunable External Cavity Quantum Cascade Laser was applied for clinical multianalyte detection in human blood plasma. Glucose, triglyzerides, total protein, albumin, cholesterol and fibrinogen could be succesfully quantified.

AF1L.4 • 09:30

Singlet Oxygen luminescence detection with a fiber-coupled superconducting nanowire single-photon detector, Nathan Gemmell[1], Aongus McCarthy[1], Baochang Liu[2], Michael G. Tanner[1], Sander N. Dorenbos[3], Valery Zwiller[3], Michael S. Patterson[2], Gerald S. Buller[1], Brian C. Wilson[4], Robert H. Hadfield[5]; *[1]School of Engineering and Physical Sciences, Heriot Watt University, United Kingdom; [2]Juravinsky Cancer Centre, McMaster University, Canada; [3]Kalvi Institute of Nanoscience, Delft University of Technology, Netherlands; [4]Department of Medical Biophysics, Ontario Cancer Institute & University of Toronto, Canada; [5]School of Engineering, University of Glasgow, United Kingdom.* We report on the direct monitoring of singlet oxygen luminescence at 1270 nm wavelength using a fiber coupled superconducting nanowire single-photon detector. These results open the pathway to practical dose monitoring in photodynamic therapy.

Marriott San Jose Salon V & VI

CLEO: Science & Innovations

CF1M • Novel Light Emitters—Continued

CF1M.2 • 09:00

Excitonically driven quantum dot light-emitting diodes: exLEDs, Burak Guzelturk[1], Pedro Ludwig Hernandez Martinez[1,2], Vijay Kumar Sharma[1], Yasemin Coskun[1], Vusala Ibrahimova[1], Xiao Wei Sun[2], Donus Tuncel[1], Hilmi Volkan Demir[1,2]; *[1]Department of Electrical and Electronics Engineering, Department of Physics, and UNAM - Institute of Materials Science and Nanotechnology, Bilkent University, Turkey; [2]LUMINOUS! Centre of Excellence for Semiconductor Lighting and Displays, School of Electrical and Electronic Engineering, School of Mathematical and Physical Sciences, Nanyang Technological University, Singapore.* A hybrid platform of colloidal quantum dots integrated into conjugated polymers is reported for excitonically driven light-emitting diodes having pure quantum dot emission in the electroluminescence spectrum with substantially enhanced efficiency.

CF1M.3 • 09:15

Printed Hybrid Quantum Dot Light-Emitting Diodes For Lighting Applications, Michael Z. McCreary[1], Menaka Jha[2], Delaina A. Amos[1,2]; *[1]Department of Chemical Engineering, University of Louisville, USA; [2]Conn Center for Renewable Energy Research, University of Louisville, USA.* Novel quantum dot (QD) materials are explored to generate light and color. Inkjet printing of a QD single layer hybrid device is used to generate light. The QD/conjugated polymer interface is controlled via ligand attachments.

CF1M.4 • 09:30

Study of III-nitride laser diodes for solid-state lighting, Jonathan J. Wierer[1], Dmitry S. Sizov[2], Alexander Neumann[3], Steven R. Brueck[3], Jeffrey Y. Tsao[1]; *[1]Sandia National Laboratories, USA; [2]Corning Inc., USA; [3]Center for High Technology Materials, University of New Nexico, USA.* III-nitride laser diodes are explored as a next-generation light source for solid-state lighting. State-of-the-art and improved laser diodes and light-emitting diodes are compared in the areas of color rendering, efficiency, and economics.

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Executive Ballroom 210A	Executive Ballroom 210C	Executive Ballroom 210D	Executive Ballroom 210H

CLEO: QELS-Fundamental Science

QF1A • Quantum Nanooptics & Detectors—Continued

QF1A.7 • 09:45
Near-field Probing of Plasmonic Nanostructures with a Single Quantum Dot, Chad Ropp[1], Zachary Cummins[2], Sanghee Nah[3], John T. Fourkas[3], Benjamin Shapiro[2], Edo Waks[1]; *[1]Department of Electrical and Computer Engineering, University of Maryland, USA; [2]Fischell Department of Bioengineering, University of Maryland, USA; [3]Department of Chemistry and Biochemistry, University of Maryland, USA.* Individual colloidal quantum dots are manipulated in a microfluidic device and used as near-field optical probes for visualizing the plasmonic mode of a silver nanowire.

QF1B • Quantum Sensing & Imaging—Continued

QF1B.7 • 09:45
Structure-Based Super-Resolution in Quantum Information, Dikla Oren[1], Yoav Shechtman[1], Yonina C. Eldar[2], Mordechai Segev[1]; *[1]Physics and Solid State Instituite, Technion, Israel; [2]Electrical Engineering, Technion, Israel.* We show that prior information, such as that a quantum state is sparse in a known mathematical basis, enables algorithmic reconstruction of an initial three-photon state from two-photon coincidence measurements, thereby achieving quantum super-resolution.

QF1C • XUV & X-ray Sources Based on High-harmonic Generation—Continued

QF1C.8 • 09:45
Single-Shot Wavefront Measurement of an Injection-Seeded Table-Top Soft X-Ray Laser, Shoujun Wang[1], Lu Li[2], Yong Wang[1], Eduardo Oliva[2], Liang Yin[1], Brad Luther[1], Gilles Maynard[3], D. Ros[3], Philippe Zeitoun[2], Jorge Rocca[1]; *[1]Colorado State University, USA; [2]Laboratoire d'Optique Appliquée (LOA), France; [3]Laboratoire de Physique des Gaz et des Plasmas, Université Paris-Sud, France.* The wavefront of a λ=18.9 nm soft x-ray beam from an injection-seeded plasma amplifier was measured using a Hartmann sensor. An optical quality superior to that of the seed, up to λ/7 rms, was obtained.

QF1D • Integrated Devices and EIT—Continued

QF1D.7 • 09:45
Increasing The Giant Kerr Effect By Narrowing The EIT Window Beyond The Signal Bandwidth, Greg Dmochowski[1], Amir Feizpour[1], Matin Hallaji[1], Chao Zhuang[1], Alex Hayat[1], Aephraim Steinberg[1]; *[1]Physics, University of Toronto, Canada.* We experimentally show that giant EIT-based Kerr nonlinearities may make use of EIT windows narrower than the signal bandwidth, allowing for experiments with short signal pulses to benefit from this enhancement, e.g. for QND measurements

10:00–10:30 Coffee Break, *Concourse Level*

NOTES

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Executive Ballroom 210G	Executive Ballroom 210F	Executive Ballroom 210E

CLEO: Science & Innovations

CF1E • Applications of Fiber Nonlinearities—Continued

CF1E.7 • 09:45
Stimulated-Brillouin-Scattering suppression in high power single frequency fiber amplifiers, Lei Zhang[1], Shuzhen Cui[1], Jinmeng Hu[1], Jianhua Wang[1], Chi Liu[1], Jun Zhou[1], Yan Feng[1]; [1]*Shanghai Key Laboratory of Solid State Laser and Application, Shanghai Institute of Optics and fine Mechanics, Chinese Academy of Sciences, China.* We report our recent works on suppression of stimulated-Brillouin-scattering in high power, single frequency, linearly polarized, 1178 nm Raman fiber amplifiers and 1064 nm ytterbium-doped fiber amplifiers by applying longitudinally varied strain in the gain fibers.

CF1F • High Power and Nitride Semiconductor Lasers—Continued

CF1G • Frequency Combs and Arbitrary Waveform Generation—Continued

CF1G.8 • 09:45
Full Frequency Comb Model for the Temporal Talbot Effect, Itan Barmes[1], Axel Ruehl[2]; [1]*VU University Amsterdam, Netherlands;* [2]*Deutsches Elektronen-Synchrotron (DESY), Germany.* We present a new approach to study repetition-rate multiplication of pulse trains via the Talbot-effect. Periodic functions are utilized to represent the spectral phase, enabling the calculation of temporal phase patterns for the first time.

10:00–10:30 Coffee Break, *Concourse Level*

NOTES

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Meeting Room 212A-C

CLEO: Applications & Technology

AF1H • Lasers for Imaging & Data Transmission—Continued

AF1H.6 • 09:45
Secure Storage of Cryptographic Keys within Random Volumetric Materials, Roarke Horstmeyer[1], Benjamin Judkewitz[1], Ivo Vellekoop[2], Changhuei Yang[1]; *[1]Electrical Engineering, California Institute of Technology, USA; [2]University of Twente, Netherlands.* We present a device to optically access gigabits of random keys stored within an object's microscopic randomness. We demonstrate how this device may allow two parties to securely communicate without digitally saving any sensitive information.

Meeting Room 212D-B

CLEO: Science & Innovations

CF1I • Fabrication and Characterization of Optical Gain Materials—Continued

CF1I.8 • 09:45
Grating-Coupled Strain-Enhanced Light Emission from Mechanically Stressed Germanium Nanomembranes, Cicek H. Boztug[1], Jose Sánchez Pérez[2], Jian Yin[1], Faisal Sudradjat[1], Deborah Paskiewicz[2], Rb Jacobson[2], Max G. Lagally[2], Roberto Paiella[1]; *[1]Department of Electrical and Computer Engineering and Photonics Center, Boston University, USA; [2]Department of Materials Science and Engineering, University of Wisconsin-Madison, USA.* Direct-bandgap light emission from Ge nanomembranes is strongly enhanced and red-shifted through the application of tensile strain, combined with the use of a periodic array of amorphous-Si nanopillars to outcouple the strain-enhanced luminescence.

Marriott San Jose Salon I & II

CLEO: Applications & Technology

AF1J • Applied Optical Measurements in Fabrication Processes and Products I—Continued

10:00–10:30 Coffee Break, *Concourse Level*

NOTES

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Marriott San Jose Salon III

JOINT

JF1K • Symposium on Nonlinear THz Science and Technology I—Continued

Marriott San Jose Salon IV

CLEO: Applications & Technology

AF1L • Biosensing & Control—Continued

AF1L.5 • 09:45

A Faraday Rotation Spectrometer for study of NO isotopes in breath, Yin Wang[1], Frank Cikach[2], Jarrod Barnes[2], Luma Dababneh[2], David Groye[2], Serpil Erzurum[2], Suzy Comhair[2], Christina Kao[3], Raed Dweik[2], Gerard Wysocki[1]; [1]*Princeton University, USA;* [2]*Cleveland Clinic, USA;* [3]*Baylor College of Medicine, USA.* Nitric oxide isotope sensing in breath using a transportable Faraday rotation spectrometer(FRS) is reported. Sensitivity of 0.49 ppbv/Hz1/2 for 15NO and 3.59 ppbv/Hz1/2 for 14NO were achieved using a quantum cascade laser based dual-modulation FRS.

Marriott San Jose Salon V & VI

CLEO: Science & Innovations

CF1M • Novel Light Emitters—Continued

CF1M.5 • 09:45

GaN-Based Dual Color LEDs with P-Type Insertion Layer for Balancing Two-Color Intensities, Kai-Lun Chi[1], Shu-Ting Yeh[2], Yu-Hsiang Yeh[3], Kun-Yan Lin[1], Jin-Wei Shi[1], Yuh-Renn Wu[2], Jinn-Kong Sheu[3]; [1]*Dept. of EE, National Central University, Taiwan;* [2]*Institute of Photonics and Optoelectronics, National Taiwan University, Taiwan;* [3]*Deaprtment of Photonics, National Cheng-Kung University, Taiwan.* By inserting p-type layers into active regions of dual-color GaN LEDs to uniform carrier distribution, the output intensities from quantum-wells near n- and p-sides can be balanced under a low driving-current density (< 45 A/cm^2).

10:00–10:30 Coffee Break, *Concourse Level*

NOTES

2013CLEO Friday.indd 12 5/17/13 2:30 PM

Executive Ballroom 210A	Executive Ballroom 210C	Executive Ballroom 210D	Executive Ballroom 210H

CLEO: QELS-Fundamental Science

10:30–12:30
QF2A • Nano-antennas, Coupling & Absorbers
Presider: Uriel Levy; Hebrew University of Jerusalem, Israel

QF2A.1 • 10:30
Thermal Plasmomechanical Infrared Detector, fei yi[1], Hai Zhu[1], Jason Reed[1], Ertugrul Cubukcu[1]; [1]*Materias Science and Engineering, University of Pennsylvania, USA.* We demonstrated a thermal plasmomechanical device platform for infrared detection. It integrates an optical antenna absorber on a nanomechanical resonator together with a fiber-optic interferometric readout. Performances of proof-of-concept devices are discussed.

QF2A.2 • 10:45
Merging Magnetic and Electric Resonances for All-Dielectric Nanoantenna Arrays, Isabelle Staude[1], Andrey E. Miroshnichenko[1], Tumasang Fofang[2], Sheng Liu[2], Edward Gonzales[2], Jason Dominguez[2], Manuel Decker[1], Ting S. Luk[2], Dragomir N. Neshev[1], Igal Brener[2], Yuri S. Kivshar[1]; [1]*Nonlinear Physics Centre, Australian National University, Australia;* [2]*Center for Integrated Nanotechnologies (CINT), Sandia National Laboratory, USA.* We spectrally overlap the magnetic and electric resonances in all-dielectric silicon nanodisk arrays by tuning the disk aspect ratio. This offers new opportunities for functional metasurfaces and conceptually new all-dielectric unidirectional nanoantennas.

QF2A.3 • 11:00
Efficient Channeling of Single Photons into Single Mode Optical Fiber, Ramachandrarao Yalla[1], Fam Le Kien[1], Makoto Morinaga[2], Kohzo Hakuta[1]; [1]*Center for Photonic Innovations, University of Electro-Communications, Japan;* [2]*Institute for Laser Science, University of Electro-Communications, Japan.* We experimentally demonstrate the efficient channeling of fluorescence photons from single q-dots into single-mode optical fiber, by measuring the photon-count rates through the guided and radiation modes simultaneously for various diameters of nanofiber.

QF2A.4 • 11:15
Plasmon-enhanced luminescence from silicon nanocrystals, Julie Goffard[1,2], Davy Gerard[1], Patrice Miska[2], Anne-Laure Baudrion[1], Michel Vergnat[2], Jérôme Plain[1]; [1]*Universite de Technologie de Troyes, France;* [2]*Institut Jean Lamour, France.* We report on the plasmon-enhanced emission of silicon nanocrystals located at a controlled distance from gold nanoparticles. A maximum enhancement factor of 6 is observed at the optimum distance.

10:30–12:30
QF2B • Quantum Metrology & Tomography
Presider: Almut Beige, University of Leeds, UK

QF2B.1 • 10:30
Ultimate Limits to Quantum-Enhanced Optical Phase Tracking, Dominic Berry[1], Howard M. Wiseman[2], Michael J. Hall[2]; [1]*Department of Physics and Astronomy, Macquarie University, Australia;* [2]*School of Biomolecular and Physical Sciences, Griffith University, Australia.* We use the quantum Fisher information to show the ultimate limit to the accuracy of measurement of a fluctuating phase with a squeezed state. This measurement accuracy is achievable using an adaptive phase measurement.

QF2B.2 • 10:45
Surpassing the conventional Heisenberg limit using classical resources, Xianmin Jin[1,2], Martin Lebrat[3], Lijian Zhang[1], Kachung Lee[1], Tim Bartley[1], Marco Barbieri[1], Joshua Nunn[1], Animesh Datta[1], Ian A. Walmsley[1]; [1]*Department of Physics, University of Oxford, United Kingdom;* [2]*Department of Physics, Shanghai Jiao Tong University, China;* [3]*Institute for Quantum Electronics, ETH Zurich, Switzerland.* We report the experimental estimation of the Kerr coefficient of an optical fiber. Using bright classical fields and shot-noise-limited detection, we show the precision scaling of $1/N^{3/2}$ in a room-temperature, all-optical system.

QF2B.3 • 11:00
Enhancing entangled-state phase estimation by combining classical and quantum protocols, Omar S Magana Loaiza[1], Heedeuk Shin[2], Mehul Malik[1], Malcolm O'Sullivan[1], Robert W. Boyd[1,3]; [1]*The Institute of Optics, University of Rochester, USA;* [2]*Sandia National Laboratories, USA;* [3]*Department of Physics, University of Ottawa, Canada.* We present a protocol that combines quantum and classical resources to increase the sensitivity of a phase measurement. The superresolution is achieved through the use of N00N states and multiple passes through a prism pair.

QF2B.4 • 11:15
Beating the Standard Quantum Limit for Nonorthogonal Multi-State Discrimination, Francisco E. Becerra Chavez[1], Jingyun Fan[1], G. Baumgartner[2], Julius Goldhar[3], J. Kosloski[2], Alan Migdall[1]; [1]*National Inst of Standards & Technology, USA;* [2]*Laboratory for Telecommunications Sciences, USA;* [3]*Department of Electrical and Computer Engineering, University of Maryland, USA.* We demonstrate a quantum receiver that discriminates four nonorthogonal states with error probabilities below the standard quantum limit (SQL) for a wide range of input powers and as much as 6 dB below the SQL.

10:30–12:30
QF2C • Attosecond Spectroscopy of Atoms and Molecules
Presider: Alexander Pirozhkov; APRC, JAEA, Japan

QF2C.1 • 10:30 Invited
Attosecond Absorption Spectroscopy in molecules, Giuseppe Sansone[1], Maurizio Reduzzi[1], Antoine Dubrouil[1], Chengyong Feng[1], Mauro Nisoli[1], Francesca Calegari[1], Chii Dong Lin[3], Wei Chun Chu[3], Luca Poletto[2], Fabio Frassetto[2]; [1]*Physics, Politecnico di Milano, Italy;* [2]*Institute of Photonics and Nanotechnologiesarch, National Council for Research, Italy;* [3]*Physics, Kansas State University, USA.* We present results on attosecond transient absorption in small molecules. Ultrafast relaxation dynamics in nitrogen can be temporally resolved by combining an isolated attosecond pulse and an intense synchronized CEP-stabilised IR pulse. Lifetime of different Fano resonances can be retrieved.

QF2C.2 • 11:00
Probing Electron Wave-packet Interference, Jens Herrmann[1], Matteo Lucchini[1], André Ludwig[1], Mazyar Sabbar[1], Reto Locher[1], Lukas Gallmann[1], Ursula Keller[1]; [1]*Department of Physics, Institute of Quantum Electronics, ETH Zurich, Switzerland.* We use attosecond transient absorption spectroscopy to investigate electron dynamics around the first ionization threshold of helium. Our results expose that electron wave-packet interference effects are insufficient to explain all the observed phenomena.

QF2C.3 • 11:15
Stabilized Interferometric Attosecond Timing Measurements, Cord L. Arnold[1], Diego Guénot[1], David Kroon[1], Imre Balogh[2], Erik Månsson[1], Miguel Miranda[1], Marija Kotur[1], Esben Witting-Larsen[1], Per Johnsson[1], Johan Mauritsson[1], Stacy Ristinmaa-Sörensen[1], Mathieu Gisselbrecht[1], Anne L'Huillier[1]; [1]*Department of Physics, Lund University, Sweden;* [2]*Department of Optics and Quantum Electronics, University of Szeged, Hungary.* We perform interferometric attosecond timing measurements to study XUV photo-ionization in noble gases, to diagnose macroscopic phase-matching conditions in high-order harmonic generation, and to investigate single-photon double-ionization by detecting electron pairs in coincidence.

10:30–12:30
QF2D • Nonlinear Frequency Conversion
Presider: Alessia Pasquazi, University of Sussex, UK

QF2D.1 • 10:30
Entropy Driven Multi-Photon Frequency Up-Conversion, assaf manor[1], Nimrod Kruger[3], Carmel Rotschild[2]; [1]*Russell Berrie Nanotechnology Institute, Technion, Israel;* [2]*Mechanical Engineering, Technion, Israel;* [3]*Grand Energy program, Technion, Israel.* We experimentally demonstrate a fundamentally new, entropy driven photon up-conversion mechanism, where 10.6μ photons are tenfold up-converted to 1μ with efficiency of 10%. This work opens novel ways of converting thermal-radiation to electricity.

QF2D.2 • 10:45
Coherent Control of Simultaneously Generated XUV and THz Radiation in Strongly Polar-Asymmetric Excitation, Aram Gragossian[1], Denis V. Seletskiy[2], Mansoor Sheik-Bahae[1]; [1]*Physics and Astronomy, University of New Mexico, USA;* [2]*Physics and Center for Applied Photonics, University of Konstanz, Germany.* Simultaneous coherent generation and detection of XUV and terahertz has been performed using two-color asymmetric laser fields. Understanding correlations between XUV and terahertz radiation will provide valuable information about the generation processes.

QF2D.3 • 11:00
THz Frequency Up-Conversion in Transverse Configuration by Exploiting Polariton Resonance: from Complete Photon Conversion to Single-Photon Detection, Yujie J. Ding[1]; [1]*Lehigh University, USA.* Transversely-propagating THz radiation can be up-converted to an optical wave propagating in the waveguide. Complete photon conversion and single-photon detection can be reached.

QF2D.4 • 11:15
X-ray / Optical Sum Frequency Generation, Ernest Glover[1]; [1]*Lawrence Berkeley National Laboratory, USA.* We report observation of x-ray and optical sum frequency generation. An ultrafast optical pulse drives charge oscillations to the chemical bonds in diamond. A co-propagating x-ray pulse probes the accompanying atomic-scale chemical bond distortion.

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Executive Ballroom 210G	Executive Ballroom 210F	Executive Ballroom 210E

CLEO: Science & Innovations

10:30–12:30
CF2E • Photon Manipulation for Improved Efficiency
Presider: Craig Moe; Crystal IS, Inc., United States

CF2E.1 • 10:30
Effects of Strain Relaxation on Luminescent Properties of InGaN/GaN Nanorods from 2D to 0D Transition, Chu-Hsiang Teng[1], Lei Zhang[2], Tyler Hill[2], Brandon Demory[1], Hui Deng[2], Pei-Cheng Ku[1]; *[1]Electrical Engineering and Computer Science, University of Michigan, USA; [2]Physics, University of Michigan, USA*. We characterized the luminescent properties of InGaN nanodisks in quantum well and quantum dot regimes. The luminescent efficiency increases as strain is relaxed in quantum well regime but peaks at the transition from well to dot.

CF2E.2 • 10:45
Plasmonic Collimation and Beaming from LED Active Materials, Jeffrey DiMaria[1], Emmanouil Dimakis[1], Theodore D. Moustakas[1], Roberto Paiella[1]; *[1]Electrical and Computer Engineering, Boston University, USA*. Plasmonic nanostructures consisting of an ultrathin Ag film supporting a nanoscale Ag grating are used to demonstrate strong collimation and beam steering of the radiation output of a multiple-quantum-well visible light emitting sample.

CF2E.3 • 11:00 Invited
III-nitride Nanowire LEDs, Nathan Gardner[1], P. Svensson[1], Y-l Chang[1], O. Krylioukk[1], L. Romano[1], L. Samuelson[1]; *[1]Glo USA, Inc, USA*. III-nitride nanowire LEDs grown by MOCVD are demonstrated with external quantum efficiency exceeding 10% at 20 A/cm2 with a peak wavelength of 520 nm. Advantages of this device structure over planar LEDs will be described.

10:30–12:15
CF2F • Surface-emitting Semiconductor Lasers
Presider: TBA

CF2F.1 • 10:30
Surface-Emitting Slab-Coupled Optical Waveguide Lasers, Kevin Anglin[1,2], Kevin Creedon[2], Adam Hanninen[2], Michael K. Connors[2], Leo J. Missaggia[2], Jeanne Porter[2], George W. Turner[2], Antonio Sanchez-Rubio[2], William Goodhue[1,2], Reuel Swint[2]; *[1]Physics and Applied Physics, University of Massachusetts Lowell, USA; [2]MIT Lincoln Laboratory, USA*. A surface-emitting SCOWL is demonstrated using a deep etched 45° turning mirror, achieving 1 W q-CW output power, a diffraction-limited beam, and comparable efficiency to conventional edge-emitters. This design offers 2-D laser array scalability.

CF2F.2 • 10:45
In-Phase Bottom-Emitting Vertical Cavity Laser Array, Matthew Johnson[1], Dominic F. Siriani[2], Paul Leisher[3], Kent D. Choquette[1]; *[1]Electrical and Computer Engineering, U. of Illinois, USA; [2]MIT Lincoln Laboratories, USA; [3]Physics and Optical Engineering, Rose-Hulman Institute of Technology, USA*. We demonstrate the first clearly in-phase emission and first continuous-wave operation from a bottom-emitting, coherent VCSEL array. A 2x1 array with an antiguided index profile was used, representing a critical step towards coherent, high-brightness arrays.

CF2F.3 • 11:00
CMOS-Compatible Photonic Crystal VCSEL Arrays for Wavelength Division Multiplexing, Corrado Sciancalepore[1], Badhise Ben Bakir[2], Sylvie Menezo[1], Xavier Letartre[1], Damien Bordel[2], Pierre Viktorovitch[1]; *[1]Nanophotonics, INL-CNRS-Universite de Lyon, France; [2]Optronics and CMOS Photonics, CEA-Leti, France.* Arrays of CMOS-compatible double photonic crystal mirror vertical-cavity surface-emitting lasers (PCM-VCSELs) for dense wavelength division multiplexing (DWDM) are presented. An optically-pumped 16xλ VCSEL array emitting in the C-band with a frequency channel spacing of 100 GHz is demonstrated.

CF2F.4 • 11:15
Linewidth Measurement of 1550 nm High Contrast Grating MEMS-VCSELs, Weijian Yang[1], Yi Rao[2], Chris Chase[2], Michael C. Huang[2], Connie Chang-Hasnain[1]; *[1]University of California Berkeley, USA; [2]Bandwidth10 Inc., USA*. A new measurement scheme to characterize MEMS-VCSEL linewidths is demonstrated. Linewidth in the range of 40~60MHz is measured for 1550-nm high contrast grating VCSELs. We identify key contributors of the Brownian-motion-induced broadening for future optimization.

10:30–12:30
CF2G • Ultrafast Measurement & Spectroscopy
Presider: Seth Bank, University of Texas-Austin, USA

CF2G.1 • 10:30
Characterizing Relaxation Dynamics in Multi-Chiral Carbon Nanotube Ensembles, Jessica Ames[1], Celia Cunningham[1], Jeramy Zimmerman[1], Stephen R. Forrest[1], Theodore Norris[1]; *[1]University of Michigan, USA*. We measured ultrafast relaxation in a deliberately heterogeneous ensemble of carbon nanotubes. Complex differential transmission signatures revealed competition between ground state bleaching and excited state absorption from nanotubes of different chiralities.

CF2G.2 • 10:45
Nanograting Orientation Influence on Stress Induced by Femtosecond Laser in Fused Silica, Audrey Champion[1], Yves Bellouard[1], Peter Kazansky[2], Martynas Beresna[2]; *[1]Mechanical Engineering, Eindhoven University of Technology, Netherlands; [2]Optoelectronics Research Centre, University of Southampton, United Kingdom*. Under certain conditions, femtosecond lasers can be used to introduce self-organized nanogratings in the bulk of fused silica. Here, we report that the nanogratings orientation influences the induced stress distribution around laser affected zones

CF2G.3 • 11:00
Phase-Locked Pulse Pair for Two-Dimensional Spectroscopy by a Birefringent Delay Line, Daniele Brida[1], Cristian Manzoni[2], Giulio Cerullo[2]; *[1]University of Konstanz, Germany; [2]Politecnico di Milano, Italy.* We introduce a device for the generation of collinear, interferometrically locked ultrashort pulse pairs. Their delay is controlled with attosecond precision and stability<λ/360 in the spectral range from UV to mid-IR.

CF2G.4 • 11:15
Stable Time-domain Spectroscopy of Femtosecond Thermal-infrared Pulses using a Carrier-envelope-phase Locked System, Sheng Liu[1,2], Thomas S. Mahony[1,2], Daniel A. Bender[1], Michael B. Sinclair[1], Igal Brener[1,2]; *[1]Sandia National Laboratories, USA; [2]Center for Integrated Nanotechnologies, Sandia National Laboratories, USA*. We generate stable carrier-envelop-phase thermal-infrared pulses by phase-lock two generating near-infrared pulses in a difference frequency mixing setup. Our newly developed phase-matched electro-optic sampling system completely (amplitude and phase) characterizes the Mid-infrared transients.

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Meeting Room 212A-C

CLEO: Applications & Technology

10:30–12:30
AF2H • Lasers for Spectroscopy and Detection
Presider: Cheryl Asbury, Jet Propulsion Laboratory, USA

AF2H.1 • 10:30 Invited
Electron-beam Based Coherent Radiators and Traditional Lasers for Security and Defense, Sandra G. Biedron[1]; [1]*Colorado State Univ., USA.* A broad spectrum of electromagnetic radiation from many sources continue to serve the security and defense communities -- light sources from laboratory-based materials investigations to field-based asset defense will discussed.

AF2H.2 • 11:00
Standoff detection and imaging of explosives using CARS, Arthur Dogariu[1]; [1]*Princeton University, USA.* We demonstrate real-time standoff detection and imaging of trace explosives using collinear, backscattered Coherent Anti-Stokes Raman Spectroscopy (CARS): We present identification in milliseconds and provide hyperspectral images of nanograms of explosives from meters away.

AF2H.3 • 11:15
Miniature, Compact Laser System for Ultracold Atom Sensors, Juan Pino[1], Ben Luey[1], Mike H. Anderson[1]; [1]*Vescent Photonics, USA.* We present a butterfly packaged laser source that is both frequency-agile and absolutely referenced to an atomic transition for ultracold-atomic sensors. We also present the entire laser system, roughly the size of a paperback novel.

Meeting Room 212D-B

CLEO: Science & Innovations

10:30–12:30
CF2I • Microresonators, Waveguides and their Characterization
Presider: Carl Poitras; Cornell, United States

CF2I.1 • 10:30 Invited
Chemically Etched Ultra-high-Q Resonators, Hansuek Lee[1], Tong Chen[1], Jiang Li[1], Kerry J. Vahala[1]; [1]*Applied Physics, California Institute of Technology, USA.* Using a wet etch process, optical resonators with quality factor as high as 875 million are demonstrated. These silicon-chip-based devices are fabricated without reflow, thereby expanding the range of integration opportunities and possible applications.

CF2I.2 • 11:00
Polarization-resolved Transmission Measurements of High-Contrast Cascaded Silicon Microring Optical Filter, Jun R. Ong[1], Ranjeet Kumar[1], Shayan Mookherjea[1]; [1]*University of California San Diego, USA.* Polarization-sensitive swept wavelength interferometry is used to measure the transmission spectrum and group delay spectrum of a coupled silicon microring filter, showing high on-off contrast between passband transmission and off-band extinction.

CF2I.3 • 11:15
MAP-Fabricated Acrylic Double Ring Resonators (DRRs) with Expanded Free Spectral Range (FSR), sijia qin[1,2], Pak Cho[2], Dong Hun Park[2], Victor Yun[2], Yongzhang Leng[2], Ping-Tong Ho[2], Julius Goldhar[2], Warren N. Herman[1,2], John T. Fourkas[2]; [1]*Department of Chemistry and Biochemistry, Univeristy of Maryland, College Park, USA;* [2]*Laboratory for Physical Sciences, USA.* MAP was used to fabricate polymer DRRs as its high resolution allows precise control on the coupling/transmission coefficients. Pedestal acrylic DRRs with 34nm 33nm FSR and -15dB isolation were fabricated and showed good qualitative agreement with simulation results.

Marriott San Jose Salon I & II

CLEO: Applications & Technology

10:30–12:30
AF2J • Symposium on Applied Optical Measurements in Fabrication Processes and Products II
Presider: John Lehman; National Inst of Standards & Technology, United States

AF2J.1 • 10:30 Invited
The Impact of Fiber Laser Technology on the World Wide Material Processing Market, Bill Shiner[1]; [1]*IPG Photonics Corp, USA.* The first fiber lasers appeared on the scene in the late 1990's with the first kilowatt class fiber lasers appearing in early 2002. Since that time the output power of these devices have rapidly increased for both single mode and multimode devices. During 2012 the first 20 kilowatt single mode fiber laser was delivered followed by the first 100 kW multimode fiber laser in early 2013. Fiber Laser technology has gained worldwide acceptance in all major markets involved in material processing.

AF2J.2 • 11:00
Finding defects in a 22 nm node wafer with visible light, Renjie Zhou[1], Gabriel Popescu[1], Lynford L. Goddard[1]; [1]*Univ of Illinois at Urbana-Champaign, USA.* Despite a diffraction limited lateral resolution of 360 nm, we detected 20 nm by 110 nm defects in a patterned 22 nm node wafer using quantitative phase and amplitude images from epi-illumination diffraction phase microscopy

AF2J.3 • 11:15
High Resolution Electrical, Optical, and Thermal Metrology for Sub-Micron Optoelectronic Devices, Janice A. Hudgings[1]; [1]*Mount Holyoke College, USA.* We demonstrate a commercialization-ready metrology tool for electrical, optical, and thermal characterization of operating optoelectronic devices, with a spatial resolution of 250nm. Applications are demonstrated to a wide range of electrical and photonic devices.

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Use hashtag **#CLEO13**.

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Marriott San Jose Salon III

Marriott San Jose Salon IV

Marriott San Jose Salon V & VI

JOINT

CLEO: Science & Innovations

10:30–12:30
JF2K • Symposium on Nonlinear THz Science and Technology II
Presider: Junichiro Kono; Rice University, United States

JF2K.1 • 10:30 Invited
Nonlinear THz Optics in Cuprate Superconductors, Andrea Cavalleri[1]; [1]*Max-Planck Structural Dynamics Center, Germany.* Intense THz pulses are used to drive cuprate superconductors. The deformation of the gauge invariant order parameter phase leads to non-dissipative quantum plasmonics, THz Josephson oscillations and excitation of Josephson plasma solitons.

JF2K.2 • 11:00
Depletion of the Superconducting Condensate in Bi2Sr2CaCu2O8+δ Induced by Intense Multi-THz Pulses, Alexander Grupp[1], Bernhard Mayer[1], Christian Schmidt[1], Sebastian Maehrlein[1], Alfred Leitenstorfer[1], Alexej Pashkin[1]; [1]*Department of Physics and Center for Applied Photonics, University of Konstanz, Germany.* The superconducting state of the high-Tc cuprate Bi2Sr2CaCu2O8+δ is resonantly excited by intense multi-THz pulses and the following quasiparticle dynamics is probed. The dependence of the pump-probe signal on excitation fluence shows a super-linear behavior.

JF2K.3 • 11:15
Terahertz Excitation of a Coherent Lambda-Type Three-Level System of Exciton-Polariton Modes in a Quantum-Well Microcavity, Yun-Shik Lee[1], Joseph L. Tomaino[1], Andrew D. Jameson[1], Galina Khitrova[2], Hyatt M. Gibbs[2], Andrea C. Klettke[3], Mackillo Kira[3], Stephan W. Koch[3]; [1]*Physics, Oregon State University, USA;* [2]*Optical Sciences Center, University of Arizona, USA;* [3]*Fachbereich Physik and Material Sciences Center, Philips University, Germany.* Strong THz pulses induce pronounced nonlinear optical effects in a QW microcavity, resonantly driving exction-polariton polarizations coupled to an optically dark 2p-exciton polarization. The coherent coupling between the polarizations dephases within a few picoseconds.

10:30–12:30
JF2L • Symposium on Optogenetics and Optical Control of Biological Processes
Presider: ??????

JF2L.1 • 10:30 Invited
Optical Control of Protein-protein Interactions to Modulate Cellular Function, Amir Taslimi[1], Gopal Pathak[1], Justin Vrana[1], Chandra Tucker[1]; [1]*Pharmacology, University of Colorado School of Medicine, USA.* An emerging field centers on the use of light for protein control, allowing spatio-temporal control of biological activities. Here I will describe our current work in this area, using blue-light-induced CRY/CIB dimerizers and other light-responsive domains.

JF2L.2 • 11:00 Invited
Brain Activity Mapping with Optogenetic Functional Magnetic Resonance Imaging, Jin-Hyung Lee[1]; [1]*Stanford Univ., USA.* Optogenetic functional magnetic resonance imaging (ofMRI) technology enables us to control brain circuit elements with high precision while tracking the multi-synapse activity across the whole brain in vivo. This talk will describe new approaches to studying brain activity dynamics with ofMRI and its application to neurological disease network analysis including epilepsy.

10:30–12:30
CF2M • Non-reciprocity in Nanophotonics/ Quantum Photonic Devices
Presider: Wolfgang Freude; Karlsruher Institut für Technologie, Germany

CF2M.1 • 10:30 Tutorial
Routes to Non-reciprocity in Nanophotonics: with or without Magneto-optics, Shanhui Fan[1]; [1]*Stanford Univ., USA.* We review the basic requirement for isolators, and reiterate the well known fact that isolators require non-reciprocity. We then discuss means to achieve non-reciprocity, either with or without magneto-optics.

Shanhui Fan is a Professor of Electrical Engineering at the Stanford University. He received his Ph. D in 1997 in theoretical condensed matter physics from the Massachusetts Institute of Technology (MIT), and was a research scientist at the Research Laboratory of Electronics at MIT prior to his appointment at Stanford. His research interests are in computational and theoretical studies of solid state and photonic structures and devices, especially photonic crystals, plasmonics, and meta-materials. He has published over 260 refereed journal articles that were cited over 17,000 times, has given over 210 invited talks, and was granted 44 US patents. Prof. Fan received a National Science Foundation Career Award (2002), a David and Lucile Packard Fellowship in Science and Engineering (2003), the National Academy of Sciences Award for Initiative in Research (2007), and the Adolph Lomb Medal from the Optical Society of America (2007). He is a Fellow of the IEEE, the American Physical Society, the Optical Society of America, and the SPIE.

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Executive Ballroom 210A	Executive Ballroom 210C	Executive Ballroom 210D	Executive Ballroom 210H

CLEO: QELS-Fundamental Science

QF2A • Nano-antennas, Coupling & Absorbers—Continued

QF2A.5 • 11:30
Impact of Förster coupling on quantum statistics in metal-semiconductor hybrid systems, T. Sverre Theuerholz[1], Alexander Carmele[1], Marten Richter[1], Andreas Knorr[1]; *[1]Institut für Theoretische Physik, Technische Universität Berlin, Germany.* We investigate the influence of the Förster interaction in hybrid systems consisting of a metal nanoparticle and two semiconductor quantum dots. We show that this interaction strongly influences the emission statistics of the hybrid system.

QF2A.6 • 11:45
Radiation Pattern of Plasmonic Yagi-Uda Antennas in a Homogeneous Medium Realized by Liquid-Immersion Method, Takafumi Sugita[1], Satoshi Maeda[1], Holger F. Hofmann[1], Yutaka Kadoya[1]; *[1]Hiroshima University, Japan.* The radiation pattern of plasmon-based optical Yagi-Uda antenna was measured in a quasi-homogeneous medium. The directional gain of the 5-element antenna was found to be about 3.7, consistently with the theoretical prediction.

QF2A.7 • 12:00
Plasmonic Antennas Hybridized with Dielectric Waveguides, Felipe Bernal Arango[1], A. Femius Koenderink[1]; *[1]FOM Inst for Atomic & Molecular Physics, Netherlands.* With the aim of using plasmonics in an integrated-circuit scheme where single quantum emitters can be probed efficiently, we comprehensively study the scattering properties of single gold Yagi-Uda antennas placed on one-dimensional silicon nitride waveguides.

QF2A.8 • 12:15
Radiation and Receiving Gain of Nano-optical Yagi-Uda Antenna Embedded in Slab Dielectric Waveguide, Kaori Yanazawa[1], Yusuke Tobisu[1], Satoshi Maeda[1], Holger F. Hofmann[1], Yutaka Kadoya[1]; *[1]Hiroshima University, Japan.* The plasmonic optical Yagi-Uda antennas embedded in a dielectric waveguide were characterized. The coupling efficiency was found to be about four times that of the single dipole both in the radiation and receiving modes.

QF2B • Quantum Metrology & Tomography—Continued

QF2B.5 • 11:30
Experimental remote state preparation and estimation for spatial qubits, Piotr L. Kolenderski[1,2], Kelsey Jonsen[1], Carmelo Scarcella[3], Deny Hamel[1], Krister Shalm[1], Simone Tisa[4], Alberto Tosi[3], Kevin Resch[1], Thomas Jennewein[1]; *[1]Institute for Quantum Computing, University of Waterloo, Canada; [2]Institute of Physics,, Nicolaus Copernicus University, Poland; [3]Dipartimento di Elettronica e Informazione, Politecnico di Milano, Italy; [4]Micro Photon Device, Italy.* An estimation and remote state preparation for qubits are demonstrated by implementing a 28 element quantum measurement using an array of detectors and carefully designed imaging optics.

QF2B.6 • 11:45
Quantum Tomography of Inductively Created Multiphoton States, Eli Megidish[1], Assaf Halevy[1], Tomer Shacham[1], Tom Dvir[1], Hagai Eisenberg[1]; *[1]Racah Inst. of Physics, Hebrew University, Israel.* Using the measured density matrix of a four photon GHZ state, created in our unique inductive setup, we calculated the density matrices of possible states with higher photon numbers and their entanglement and non-locality violation.

QF2B.7 • 12:00
Reconstruction of High-Dimensional States Entangled in Orbital Angular Momentum Using Mutually Unbiased Measurements, Daniel Giovannini[1], Jacqui Romero[1,2], Jonathan Leach[3], Angela Dudley[4], Andrew Forbes[4,5], Miles Padgett[1]; *[1]School of Physics & Astronomy, University of Glasgow, United Kingdom; [2]Department of Physics, University of Strathclyde, United Kingdom; [3]School of Engineering and Physical Sciences, Heriot-Watt University, United Kingdom; [4]CSIR National Laser Centre, South Africa; [5]School of Physics, University of KwaZulu-Natal, South Africa.* Efficient quantum state reconstruction of a high-dimensional multi-partite quantum system can be performed by considering mutually unbiased measurements of the individual parts. We illustrate this approach experimentally using a bipartite photonic system entangled in orbital angular momentum.

QF2B.8 • 12:15
Mode reconstruction by multi-photon statistics, Elizabeth Goldschmidt[1], Fabrizio Piacentini[3], Ivano Ruo Berchera[3], Sergey Polyakov[1], Silke Peters[2], Stefan Kueck[2], Giorgio Brida[3], Ivo Degiovanni[3], Alan Migdall[1], Marco Genovese[3]; *[1]Joint Quantum Institute, USA; [2]Physikalisch-Technische Bundesanstalt Braunschweig, Germany; [3]Istituto Nazionale di Ricerca Metrologica, Italy.* Knowing the mode structure of light aids in minimizing loss and decoherence of quantum information. We present and experimentally implement reconstruction of the mode distributions of classical and non-classical light using measured photon number distributions.

QF2C • Attosecond Spectroscopy of Atoms and Molecules—Continued

QF2C.4 • 11:30
Measurement of Attosecond Photo-ionization Delay in Xenon, Aart Verhoef[1], Alexander Mitrofanov[1], Maria Krikunova[2,3], Nikolay M. Kabachnik[4,5], Markus Drescher[2], Andrius Baltuska[1]; *[1]Institut für Photonik, Technische Universität Wien, Austria; [2]Institut für Experimentalphysik, Universität Hamburg, Germany; [3]Institut für Optik und Atomare Physik, Technische Universität Berlin, Germany; [4]Institute of Nuclear Physics, Moscow State Universtity, Russian Federation; [5]European XFEL GmbH, Germany.* We present first results of simultaneous attosecond streaking measurements of shake-up electrons and Auger electrons emitted from xenon. The spectral overlap of the electronic wavepackets allows for reliable reconstruction of the relative phases.

QF2C.5 • 11:45
Observation of ultrafast electron dynamics in N2 molecules induced by attosecond pulses, Francesca Calegari[1], Andrea Trabattoni[1], Sunilkumar Anumula[1], Matteo Lucchini[2], Lifeng Wang[3], Fabio Frassetto[4], Luca Poletto[4], Majdi Hochlaf[5], Giuseppe Sansone[1], Mark Vrakking[6], Mauro Nisoli[1]; *[1]Physics, Politecnico di Milano, CNR-IFN, Italy; [2]Physics, ETH, Switzerland; [3]Institute of Physics, CAS, China; [4]CNR-IFN, Italy; [5]MSME, Université Paris-Est, France; [6]MBI, Germany.* We used velocity-map imaging to measure ultrafast electron dynamics in N2 initiated by attosecond pulses. A time-to-space mapping of autoionization channel is demonstrated. A sub-cycle oscillatory dynamics related to quantum interference is also observed.

QF2C.6 • 12:00
Dissociative Ionization Dynamics of Nitrogen Molecule with Interferometric Autocorrelation of a-few-pulse Attosecond Pulse Train, Tomoya Okino[2,1], Yusuke Furukawa[1], Abdolreza Amani Eilanlou[1], Yasuo Nabekawa[1], Eiji J. Takahashi[1], Kaoru Yamanouchi[2,1], Katsumi Midorikawa[1]; *[1]Laser Technology Laboratory, RIKEN, Japan; [2]Department of Chemistry, The University of Tokyo, Japan.* We found a significant difference between the interferometric fringes on the intensity-autocorrelation and those on anisotropy-autocorrelation of an atttosecond pulse train. This result can discriminate multiple two-photon processes ionizing a nitrogen molecule.

QF2C.7 • 12:15
Ultrafast recovery of valence electrons in 1,3-butadiene probed by time-resolved photoelectron spectroscopy with high harmonic pulses, Ayumu Makida[1], Hironori Igarashi[1], Takehisa Fujiwara[1], Taro Sekikawa[1]; *[1]Applied Physics, Hokkaido University, Japan.* Ultrafast recovery of the valence electrons to the ground state in 1,3-butadiene with time constants of 53~99 fs after photoexcitation was observed by time-resolved photoelectron spectroscopy using high harmonic pulses for the first time.

QF2D • Nonlinear Frequency Conversion—Continued

QF2D.5 • 11:30 Invited
Bosonic Cascade Terahertz Lasers, Alexey Kavokin[1]; *[1]University of Southampton, United Kingdom.* Bosonic stiumlation of terahertz emission of radiation allows for realisation of bosonic cascade terahertz lasers based on exciton-polariton condensates confined in parabloc traps. The quantum efficiency of such lasers is estimated to be as high as 700%.

QF2D.6 • 12:00
Nonlinear Mixing of Transverse-Optical Phonon Frequencies through Strong Anharmonicity of LiTaO3: Enhancing THz Generation, Ruolin Chen[1], Guibao Xu[1], Guan Sun[1], Yujie J. Ding[1]; *[1]Lehigh University, USA.* A phonon peak at 127 cm-1 due to nonlinear mixing of two transverse-optical phonon frequencies through anharmonicity of LiTaO3 is used to explain enhancements of effective second-order nonlinear coefficients by factors of up to 3.7.

QF2D.7 • 12:15
Large Enhancement of Nonlinear Terahertz Absorption in Intrinsic GaAs by Plasmonic Nano Antennas, Young-Gyun Jeong[1,2], Michael Paul[1], Seung-Hyun Kim[3,4], Ki-Ju Yee[3], Dai-Sik Kim[2], Yun-Shik Lee[1]; *[1]Department of Physics, Oregon State University, USA; [2]Center for Subwavelength Optics and Department of Physics and Astronomy, Seoul National University, Republic of Korea; [3]Department of Physics, Chungnam National University, Republic of Korea; [4]GRAST, Chungnam National University, Republic of Korea.* Strong THz fields produce pronounced changes in the THz transmission of a nano-antenna-array-patterned GaAs film. The nonlinear absorption of the nano-antenna/GaAs composite is significantly larger than that of bare GaAs due to field enhancement by the nano-antennas.

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Executive Ballroom 210G

Executive Ballroom 210F

Executive Ballroom 210E

CLEO: Science & Innovations

CF2E • Photon Manipulation for Improved Efficiency—Continued

CF2E.4 • 11:30
Enhancement of Light Harvesting and Power Conversion Efficiency in GaAs solar cells using flexible textured PDMS film, Hau-Vei Han[1], Hsin-Chu Chen[1], Chien-Chung Lin[2], Yu-Lin Tsai[1], Yun-Ling Yeh[1], Yi-An Chang[3], Hao-chung Kuo[1], Pei-Chen Yu[1]; [1]*Department of Photonics and Institute of Electro-Optical Engineering, National Chiao Tung University, Taiwan;* [2]*Institute of Photonic System, National Chiao Tung University, Taiwan;* [3]*Department of Physics, National Changhua University of Education, Taiwan.* Light trapping of textured polydimethylsiloxane films for antireflection is investigated. The efficiency of GaAs solar cell with textured PDMS film reach 28% enhancement. Numerical analysis successfully rebuilds the surface profile close to the real situation.

CF2E.5 • 11:45
Plasmonic-enhanced Si Schottky Barrier Solar Cell, Chong Tong[1], Juhyung Yun[1], Qiaoqiang Gan[1], Wayne Anderson[1]; [1]*State University of New York at Buffalo, USA.* By introducing plasmonic silver nanoparticles on top of a SiO2 spacer layer, we enhance the power conversion efficiency of a Si-based Schottky barrier solar cell by 80% (from 2.5% to 4.5%).

CF2E.6 • 12:00
Interaction of two plasmon modes in the organic photovoltaic devices with patterned back-electrode, Dawei Lu[1], Elisabeth Rengnath[1], Yonghao Cui[1], Won Park[1]; [1]*University of Colorado at Boulder, USA.* Localized surface plasmon (LSP) and surface plasmon polaritons (SPP) are identified in silver grating structure on back-electrode organic photovoltaic (OPV) devices. Their strong interaction indicated by anti-crossing behavior affects absorption enhancement of OPV devices.

CF2E.7 • 12:15
Optical Absorption Enhancement in Solar Cell Employing Plasmonic Nanowire as the Core of C-Si Nanowire, Md Ibrahim Khalil[1], Atiqur Rahman[1], Arshad M. Chowdhury[1,2], Gee-Kung Chang[2]; [1]*Department of Electrical Engineering and Computer Science, North South University, Bangladesh;* [2]*School of Electrical and computer Engineering, Georgia Institute of Technology, USA.* We propose a simple plasmonic nanostructure based nanowire crystalline Silicon solar cell by integrating silver core with nanowire. We found 63% better ultimate efficiency compared to conventional nanowire structures for fixed filling ratio and length.

CF2F • Surface-emitting Semiconductor Lasers—Continued

CF2F.5 • 11:30
Modeling of Long-Wavelength High Contrast Grating VCSELs and Comparison with Experiment, Pengfei Qiao[1], Guan-Lin Su[1], Yi Rao[2], Connie Chang-Hasnain[2], Shun Lien Chuang[1]; [1]*Univ of Illinois at Urbana-Champaign, USA;* [2]*University of California at Berkeley, USA.* A comprehensive theoretical model for the high contrast grating tunable VCSELs is presented. The tunability of the resonance and the L-I curves are investigated. Our theoretical results agree very well with the experimental data.

CF2F.6 • 11:45
Spatio-spectrally resolved Stokes parameters of Vertical-Cavity Surface-Emitting Lasers, Andreas Molitor[1], Sébastien Hartmann[1], Pierluigi Debernardi[2], Wolfgang Elsässer[1,3]; [1]*Technische Universität Darmstadt, Institute of Applied Physics, Germany;* [2]*Istituto di Elettronica e di Ingegneria dell'Informazione e delle Telecomunicazioni, Italy;* [3]*Technische Universität Darmstadt, Center of Smart Interfaces, Germany.* We show that only spatio-spectrally resolved Stokes parameters of VCSELs in comparison with their numerically simulated counterparts will grant an insight into the complex polarization behavior of VCSELs.

CF2F.7 • 12:00
Record Low Thermal Resistance of Mode-Confined VCSELs using AlAs/AlGaAs DBRs, Guowei Zhao[1], Xu Yang[2], Yu Zhang[2], Mingxin Li[2], Dennis G. Deppe[1,2], Chuanshun Cao[3], Jacob Thorp[3], Prabhu Thiagarajan[3], Mark McElhinnery[3]; [1]*sdPhotonics, LLC, USA;* [2]*CREOL/The College of Optics and Photonics, University of Central Florida, USA;* [3]*Lasertel North America, USA.* The influence of AlAs placed at various locations in oxide and non-oxide mode-confined VCSELs is studied. Experimental results show that removing oxide and introducing AlAs in various locations of the VCSEL DBRs can dramatically reduce the thermal resistance.

CF2G • Ultrafast Measurement & Spectroscopy—Continued

CF2G.5 • 11:30
Spectral Multiplexing for Single-shot Ultrafast Tomographic Imaging, Nicholas H. Matlis[1], Andrew Axley[1], Wim P. Leemans[1]; [1]*Lawrence Berkeley National Laboratory, USA.* We demonstrate for the first time single-shot, ultrafast computed-tomography reconstructions using spectral multiplexing. High-precision, picosecond-resolved, position and morphology measurements of a multiple-filament plasma object are presented.

CF2G.6 • 11:45
Pico-second Flat-Top Pulse-Shaper based on a Linearly-Chirped Fiber Bragg Grating in Transmission, María R. Fernández-Ruiz[1], Ming Li[1], Mansour Dastmalchi[2], Alejandro Carballar[3], Sophie LaRochelle[2], Jose Azana[1]; [1]*Énergie, Matériaux et Télécommunications, Institut National de la Recherche Scientifique, Canada;* [2]*Centre d'Optique, Photonique et Laser, Canada;* [3]*Dep. Ingeniería Electrónica, E.T.S. de Ingeniería, Spain.* Reshaping of ultrashort (400fs-FWHM) Gaussian-like pulses into 2ps-flat-top pulses is experimentally demonstrated using a specially apodized linearly-chirped fiber Bragg grating (LC-FBG) working in transmission.

CF2G.7 • 12:00
Ultrafast spectrum observation based on visualized spectro-temporal analyzer (ViSTA), Chi Zhang[1], Po Ching Chui[1], Kenneth K. Y. Wong[1]; [1]*Department of Electrical and Electronic Engineering, The University of Hong Kong, Hong Kong.* We present an ultrafast optical spectrum analyzing modality known as visualized spectro-temporal analyzer, which leverages the time-lens focusing mechanism, can realize frame rate as high as 100 MHz, with 0.02-nm resolution and -30-dBm detection sensitivity.

CF2G.8 • 12:15
Characterization of Highly Dispersive Components Using Direct Instantaneous Frequency Measurements, Christophe Dorrer[1]; [1]*University of Rochester, USA.* The instantaneous frequency of a chirped pulse is directly measured by combining spectral and temporal interferometry, allowing for characterization of the stretcher of a chirped-pulse-amplification system over several nanoseconds with picosecond precision.

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Meeting Room 212A-C

CLEO: Applications & Technology

AF2H • Lasers for Spectroscopy and Detection—Continued

AF2H.4 • 11:30 Invited

Optimal Use of Laser Resources for Molecular Detection, Herschel A. Rabitz[1]; [1]*Princeton Univ., USA.* Optimal Use of Laser Resources for Molecular Detection The discrimination of one type of molecule over another very similar one in a sample will be expressed in terms of optimally utilizing shaped laser fields as "photonic reagent" resources to enhance detection.

AF2H.5 • 12:00

A frequency comb and precision spectroscopy experiment in space, Tobias Wilken[1,2], Matthias Lezius[2], Theodor W. Hänsch[1], Anja Kohfeldt[3], Andreas Wicht[3], Vladimir Schkolnik[4], Markus Krutzik[4], Hannes Duncker[5], Ortwin Hellmig[5], Patrick Windpassinger[5], Klaus Sengstock[5], Achim Peters[3,4], Ronald Holzwarth[1,2]; [1]*Max-Planck-Institute of Quantum Optics, Germany;* [2]*Menlosystems GmbH, Germany;* [3]*Ferdinand-Braun-Institut, Germany;* [4]*Humboldt Universität Berlin, Germany;* [5]*Universität Hamburg, Germany.* A frequency comb, DFB diode laser and rubidium spectroscopy cell have been developed and commissioned on a sounding rocket mission to demonstrate their technological maturity. The first laser spectroscopy experiment on an optical transition in space is performed.

AF2H.6 • 12:15

Femtosecond Laser Electronic Excitation Tagging (FLEET) for Imaging Flow Structure in Unseeded Air, Arthur Dogariu[1], Matthew Edwards[1], James B. Michael[1], Nathan Calvert[1], Richard B. Miles[1]; [1]*Princeton University, USA.* We present a non-intrusive laser based technique for tagging flows. The femtosecond laser electronic excitation tagging (FLEET) is based on writing patterns in air and following the nitrogen pink afterglow.

Meeting Room 212D-B

CLEO: Science & Innovations

CF2I • Microresonators, Waveguides and their Characterization—Continued

CF2I.4 • 11:30

High Q SiC on Silicon Microresonators, Jaime Cardenas[1], Mian Zhang[1], Christopher Phare[1], Shreyas Shah[1], Carl B. Poitras[1], Michal Lipson[1,2]; [1]*Cornell University, USA;* [2]*Kavli Institute at Cornell, USA.* We demonstrate a 20um radius suspended microring resonator with Q=19,000 fabricated on SiC-on-silicon substrates. We estimate the fundamental material losses to be less than 3.3 dB/cm indicating that quality factors greater than 10^5 are possible.

CF2I.5 • 11:45

CMOS-compatible Titanium Dioxide Deposition for Athermalization of Silicon Photonic Waveguides, Kuanping Shang[1], Stevan S. Djordjevic[1], Jun Li[2], Ling Liao[3], Juthika Basak[3], Hai-Feng Liu[3], S. J. Ben Yoo[1]; [1]*Department of Electrical and Computer Engineering, University of California, USA;* [2]*Department of Chemical Engineering and Material Science, University of California, USA;* [3]*Intel Corporation, USA.* We discuss titanium dioxide material development for CMOS compatible fabrication and integration of athermal silicon photonic components. Titanium dioxide overclad ring modulators achieved athermal operation (< 0.2 GHz/K).

CF2I.6 • 12:00

Whispering gallery modes of a single crystalline zinc oxide microsphere at visible wavelengths, Pi-Ju Cheng[1,2], Rakesh Singh Moirangthem[1,3], Ching-Hang P. Chien[1], Buu Trong Huynh Ngo[1,4], Shu-Wei Chang[1,2], Yia Chung Chang[1,2], Chung-Hao Tien[2], Buu Trong Huynh Ngo[5]; [1]*Research Center for Applied Sciences,, Academia Sinica, Taiwan;* [2]*Department of Photonics, National Chiao Tung University, Taiwan;* [3]*Max-Planck-Institut fur Eisenforschung, Max-Planck-Strasse 1, Germany;* [4]*Nano Science and Technology Program, TIGP, Academia Sinica, Taiwan;* [5]*Department of Engineering and System Science, National Tsing Hua University, Taiwan.* We present photoluminescence spectra of ultrasmall zinc oxide microspheres with sharp resonances of whispering gallery modes covering the whole visible window and compare with theoretical analyses.

CF2I.7 • 12:15

High-Q sapphire WGM cavities fabricated by crystal growth, Hiroshi Kudo[1], Ryo Suzuki[1], Atsushi Yokoo[2,3], Takasumi Tanabe[1]; [1]*Department of Electronics and Electrical Engineering, Keio University, Japan;* [2]*NTT Nanophotonics Center, NTT Corporation, Japan;* [3]*NTT Basic Research Laboratories, NTT Corporation, Japan.* We fabricated sapphire whispering gallery mode cavities using laser-heated pedestal growth. By optimizing the growth condition we fabricated a cavity with a circular cross-section and obtained a Q of 16,000.

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CLEO: Applications & Technology

AF2J • Symposium on Applied Optical Measurements in Fabrication Processes and Products II—Continued

AF2J.4 • 11:30

Terahertz non-invasive sub-surface nanoscanner, Anis Rahman[1], Aunik K. Rahman[1]; [1]*Applied Research and Photonics Inc., USA.* A terahertz sub-surface scanner is introduced that utilizes reflection mode non-contact interrogation of surfaces and interior layers of composite substrates with resolution of ~1 nm. Quantitative measurements are done by implementing a modified Beer-Lambert's law.

AF2J.5 • 11:45

Crosstalk Suppression of Corrugated Waveguides in an Optical Phased Array Using 2D Photonic Crystal Slab, David Kwong[1], John L. Covey[1], Amir Hosseini[2], Xiaochuan Xu[1], Yang Zhang[1], Swapnajit Chakravarty[2], Ray T. Chen[1]; [1]*University of Texas at Austin, USA;* [2]*Omega Optics, USA.* A 16 element corrugated waveguide array fabricated in a single step is demonstrated to achieve over 15° of steering via wavelength tuning. Optical crosstalk suppression is achieved by inserting 2D photonic crystal between array elements.

AF2J.6 • 12:00 Invited

Laser Material Processing Inspired by Digitally-Scripted Genotype Sequencing, Henry Helvajian[1]; [1]*The Aerospace Corporation, USA.* Precise real time modulation of the laser energy flux during material processing enables the regulation of specific chemical/physical properties on a highly localized scale. The presentation focuses on a control-system architecture and its implementation that delivers well defined photon exposures at the proper location and time.

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Marriott San Jose Salon III

Marriott San Jose Salon IV

Marriott San Jose Salon V & VI

JOINT

CLEO: Science & Innovations

JF2K • Symposium on Nonlinear THz Science and Technology II—Continued

JF2K.4 • 11:30
Nonlinear Terahertz Spectroscopy of Single-Layer Graphene, Michael Paul[1], Jenna Wardini[1], Zack J. Thompson[1], Andrew Stickel[1], Ethan Minot[1], Yun-Shik Lee[1]; [1]*Physics, Oregon State University, USA*. We demonstrate large THz transmission enhancement (>15%) in single-layer CVD graphene at high THz intensities (E_THz>10 kV/cm). The nonlinear effects exhibit non-Drude behavior in the THz conductivity, where THz fields induce extreme non-equilibrium electron distributions.

JF2K.5 • 11:45
Berry Phases in Quantum Trajectories of Optically Excited Electron-hole Pairs in Semiconductors under Intense Terahertz Fields, Fan YANG[1], Ren-Bao Liu[1]; [1]*The Chinese University of Hong Kong, Hong Kong*. In semiconductors, the quantum trajectories of electron-hole pairs under strong terahertz fields accumulate Berry phases. For monolayer MoS2 with time-reversal related valleys, the Berry phases appear as the Faraday rotation angles of the emission signal.

JF2K.6 • 12:00 Invited
Nonlinear Terahertz Spectroscopy and Coherent Control in Solid, Liquid, and Gas Phases, Keith A. Nelson[1]; [1]*Massachusetts Institute of Technology, USA*. Terahertz fields reaching MV/cm levels induce nonlinear responses in a wide range of materials. Highly nonlinear electronic and structural phase transitions and coherent control over multiple gas-phase rotational coherences will be highlighted.

JF2L • Symposium on Optogenetics and Optical Control of Biological Processes—Continued

JF2L.3 • 11:30 Invited
Shining Light on the Brain: Optogenetic Dissection of the Cortical Circuits of Vision, Hillel Adesnik[1]; [1]*Department of Molecular and Cell Biology, University of CA, Berkeley, United States*. By optogenetically dissecting the neural circuits of vision we reveal a fundamental circuit that mediates lateral inhibition in the cortex to sharpen the spatial representation of sensory objects in the external world.

JF2L.4 • 12:00 Invited
Mechanisms of Direct Neural Stimulation with Infrared Light, Mikhail Shapiro[1]; [1]*Univ. of California Berkeley, USA*. Infrared light excites cells without any chemical or genetic pretreatment, and is thus an attractive stimulation modality in a variety of scientific and clinical applications. This talk will describe two highly general thermally mediated mechanisms underlying mid-IR and far-IR stimulation.

CF2M • Non-reciprocity in Nanophotonics/ Quantum Photonic Devices—Continued

CF2M.2 • 11:30 Invited
Quantum Photonic Circuits, Jeremy L. O'Brien[1]; [1]*Univ. of Bristol, United Kingdom*. Quantum photonics will deliver disruptive information, communication and sensor technologies by harnessing quantum effects. Of the various approaches, photons are particularly appealing for their low-noise properties and ease of manipulation at the single qubit level. We report efforts to develop the key components—single photon sources and detectors, and reconfigurable waveguide circuits—and their integration and address issues surrounding.

CF2M.3 • 12:00
Photon-Pair Comb Generation in a Silicon Microdisk Resonator, Wei C. Jiang[1], Xiyuan Lu[2], Jidong Zhang[3], Oskar Painter[4], Qiang Lin[1,3]; [1]*Institute of Optics, University of Rochester, USA;* [2]*Dept of Physics and Astronomy, University of Rochester, USA;* [3]*Dept of Electrical and Computer Engineering, University of Rochester, USA;* [4]*Thomas J. Watson, Sr., Laboratory of Applied Physics, California Institute of Technology, USA*. We demonstrate an on-chip single photon source that produces ultra-bright high-purity photon pairs in a comb fashion, achieving a spectral brightness of 6.24 × 10^7 pair/s/mW^2/GHz which is the highest performance reported up to date.

CF2M.4 • 12:15
Wide-span and thermoelectrically-tunable photon pairs from a silicon nanophotonic chip, Ranjeet Kumar[1], Jun R. Ong[1], Kartik Srinivasan[2], Shayan Mookherjea[1]; [1]*Electrical and Computer Engineering, University of California, San Diego, USA;* [2]*National Institute of Standards and Technology, USA*. We demonstrate tunable-wavelength, high-brightness photon pairs in multiple lines of a frequency comb, giving the capability to generate photon pairs at arbitrary telecommunications-band wavelengths from a compact CMOS-compatible silicon chip.

Presentations selected for recording are designated with a ▶. Access these by visiting www.cleoconference.org and clicking on the View Presentations button.

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