Room 318-320 | **Room 321-323** | **Room 324-326** | **Room 314**

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

07:30–12:00 Registration Open, *Baltimore Convention Center, Pratt Street, 300 Level Lobby*

08:00–09:45
QFA • Plasmonic Metamaterials
Gennady Shvets, The Univ. of Texas at Austin USA, Presider

QFA1 • 08:00
Multi-Spectral Plasmon Induced Transparency with Hybridized Metamaterials, *Alp Artar[1], Ahmet A. Yanik[1], Hatice Altug[1]; [1]Electrical and Computer Engineering, Boston Univ., USA.* We propose and demonstrate a scheme enabling construction of a scalable metamaterial supporting multi-spectral electromagnetically induced transparency-like effects through hybridization of coupled meta-atoms. Tailoring of intra- and inter-layer near-field interactions give rise to the discussed phenomenon.

QFA2 • 08:15
Towards 3D plasmon rulers, *Na Liu[1], Mario Hentschel[2], Thomas Weiss[2], Harald Giessen[2], A. Paul Alivisatos[1]; [1]Department of Chemistry, Univ. of California, Berkeley, and Materials Sciences Division, Lawrence Berkeley National Lab, USA; [2]4th Physics Inst., Univ. of Stuttgart, Germany.* We demonstrate a prototype 3D plasmon ruler based on coupled plasmonic oligomers in combination with high-resolution plasmon spectroscopy, rendering the retrieval of the complete spatial configuration and dynamics of complex macromolecules possible.

QFA3 • 08:30
Fano Resonances in Reduced Symmetry Metamaterials, *Chihhui Wu[1], Alexander B. Khanikaev[1], Nihal Arju[1], Burton Neuner[1], Gennady Shvets[1]; [1]Physics, UT Austin, USA.* We demonstrate the Fano resonance in reduced symmetry metamaterials with both inversion symmetry being broken. Experimental results are presented and demonstrate the onset of Fano resonances.

QFA4 • 08:45
Maxwell Fisheye and Eaton Lenses Emulated by Microdroplets, *Igor Smolyaninov[1], Vera Smolyaninova[2], Alexander Kildishev[3], Vladimir Shalaev[3]; [1]Univ. of Maryland, USA; [2]Department of Physics Astronomy and Geosciences, Towson Univ., USA; [3]Purdue Univ., USA.* We demonstrate that microlenses may act as a two-dimensional fisheye or an inverted Eaton lens. An asymmetric Eaton lens may exhibit considerable image magnification, which has been confirmed experimentally.

08:00–09:45
CFA • Optomechanics II
Kartik Srinivasan, NIST, USA, Presider

CFA1 • 08:00
Full Phononic Bandgap in 2D-Optomechanical Crystals, *Thiago P. Mayer Alegre[1], Amir H. Safavi-Naeini[1], Martin Winger[1], Oskar Painter[1]; [1]Thomas J. Watson, Sr., Lab of Applied Physics, California Inst. of Technology, USA.* We demonstrate simultaneous strong confinement and interaction of photons and phonons in a quasi two-dimensional (2D) slab.

CFA2 • 08:15
Low Power Resonant Optical Excitation of an Optomechanical Cavity, *Yiyang Gong[1], Armand Rundquist[1], Arka Majumdar[1], Jelena Vuckovic[1]; [1]Electrical Engineering, Stanford Univ., USA.* We demonstrate the actuation of a double beam optomechanical cavity with a sinusoidally varying optical input power. We observe the driven mechanical motion with only 200 nW coupled to the optical cavity mode.

CFA3 • 08:30
Optomechanically-coupled Fishbone-shaped Double-beam Nanoresonators, *Seung Hoon Lee[1], Jong-Bum You[1], Jee Soo Chang[1], Yong-Hee Lee[2], Seung S. Lee[1], Kwang-Cheol Lee[3], Bumki Min[1]; [1]Department of Mechanical Engineering, Korea Advanced Inst. of Science and Technology (KAIST), Republic of Korea; [2]Department of Physics, Korea Advanced Inst. of Science and Technology (KAIST), Republic of Korea; [3]Korea Research Inst. of Standards and Science, Republic of Korea.* We demonstrate gradient-force-induced mechanical oscillations in optomechanically-coupled fishbone-shaped double-beam nanocavities. Details in design, fabrication, and measurement will be discussed.

CFA4 • 08:45
Optomechanical coupling in slot-type photonic crystal cavities, *Ying Li[1], Jiangjun Zheng[1], Hung-Bing Tan[1], Mehmet Aras[1], A. Stein[2], Jie Gao[1], Jing Shu[1], Chee Wei Wong[1]; [1]Optical Nanostructures Lab, Columbia Univ., USA; [2]Brookhaven National Lab, USA.* We demonstrate a strong optomechanical coupling air-slot photonic crystal cavity (g_{om}=940GHz/nm). Optical and mechanical measurements are shown. Radio-frequency spectrum is obtained theoretically and experimentally.

08:00–09:45
CFB • Integration on Silicon
Amir Nejadmalayeri, MIT, USA, Presider

CFB1 • 08:00 Tutorial
Lasers on Silicon, John E. Bowers, *Univ. of California at Santa Barbara, USA.* A number of important breakthroughs in the past decade have focused attention on Si as a photonic platform. We review here recent worldwide progress in this field, focusing on efforts to make lasers on or in silicon and on silicon photonic integrated circuits. The impact active silicon photonic integrated circuits could have on data and telecommunications and on silicon electronics is reviewed.

John Bowers holds the Fred Kavli Chair in Nanotechnology, and is the Director of the Inst. for Energy Efficiency and a Professor in the Department of Electrical and Computer Engineering at UCSB. He is a cofounder of Aurrion, Aerius Photonics and Calient Networks. Dr. Bowers received his M.S. and Ph.D. degrees from Stanford Univ. and worked for AT&T Bell Laboratories and Honeywell before joining UC Santa Barbara. Dr. Bowers is a member of the National Academy of Engineering, a fellow of the IEEE, OSA and the American Physical Society, and a recipient of the OSA Holonyak Prize, the IEEE LEOS William Streifer Award and the South Coast Business and Technology Entrepreneur of the Year Award. He has published eight book chapters, 450 journal papers, 700 conference papers and has received 52 patents. He and coworkers received the EE Times Annual Creativity in Electronics (ACE) Award for Most Promising Technology for the hybrid silicon laser in 2007.

08:00–09:45
CFC • Optical Frequency Standards and Signal Dissemination
Chad Hoyt, Bethel Univ., USA, Presider

CFC1 • 08:00
Portable Acetylene Frequency References inside Sealed Hollow-core Kagome Photonic Crystal Fiber, *Chenchen Wang[1], Natalie V. Wheeler[2], Jinkang Lim[1], Kevin Knabe[1], Michael Grogan[2], Yingying Wang[2], Brian R. Washburn[1], Fetah Benabid[2], Kristan L. Corwin[1]; [1]Physics, Kansas State Univ., USA; [2]Physics, Univ. of Bath, UK.* A continuous-wave diode laser is stabilized to a near-infrared acetylene transition inside a sealed kagome photonic crystal fiber. Stability and absolute frequency are measured with a frequency comb, and polarization sensitivity is observed.

CFC2 • 08:15
Progress of the 171Yb Optical Lattice Clock at NMIJ, AIST, *Masami Yasuda[1,2], Takuya Kohno[1,3], Kazumoto Hosaka[1,2], Hajime Inaba[1,2], Yoshiaki Nakajima[1,2], Daisuke Akamatsu[1,2], Kana Iwakuni[1,4], Feng-Lei Hong[1,2]; [1]NMIJ, AIST, Japan; [2]CREST, JST, Japan; [3]Fukui Univ. of Technology, Japan; [4]Keio Univ., Japan.* Experimental efforts to reduce the uncertainty of the ytterbium (171Yb) optical lattice clock at NMIJ, AIST are shown. The signal-to-noise ratio of the spectrum was increased by 10 times by an atom number normalization scheme.

CFC3 • 08:30
Precision Calculation of Blackbody Radiation Shifts for Metrology at the 18th Decimal Place, *Marianna Safronova[1], Mikhail Kozlov[2], Charles W. Clark[3]; [1]Physics and Astronomy, Univ. of Delaware, USA; [2]PNPI, Russian Federation; [3]JQI, NIST and the Univ. of Maryland, USA.* We present a new approach for accurate calculation of atomic polarizabilities, apply it to evaluate BBR shifts in optical clock transitions in Al , B and In , and find uncertainties below 10^{-18} in some cases.

CFC4 • 08:45
Optical direct comparison of two ^{87}Sr lattice clocks using a >50km fiber link, *Tetsuya Ido[1], Miho Fujieda[1], Atsushi Yamaguchi[1], Motohiro Kumagai[1], Hidekazu Hachisu[1], Shigeo Nagano[1], Tetsushi Takano[2], Masao Takamoto[2], Hidetoshi Katori[2]; [1]Natinal Inst. of Information and Communictions Technology, Japan; [2]Univ. of Tokyo, Japan.* >50km optical fiber link connecting NICT and Univ. of Tokyo has enabled direct comparison of ^{87}Sr lattice clocks locating in each site. Transmission instability 2×10^{-14}@1s unveils sub-10Hz fluctuations of recently developed NICT clock.

Room 315	Room 316	Room 317
CLEO: Science & Innovations		CLEO: QELS-Fundamental Science

07:30–12:00 Registration Open, *Baltimore Convention Center, Pratt Street, 300 Level Lobby*

08:00–09:45
CFD • High Speed Lasers
Lukas Chrostowski, Univ. of British Columbia, Canada, Presider

CFD1 • 08:00
40-Gb/s Direct Modulation of Optical Injection-Locked Photonic Crystal Laser, *Chin-Hui Chen[1], Koji Takeda[1], Akihiko Shinya[2], Kengo Nozaki[2], Tomonari Sato[1], Yoshihiro Kawaguchi[1], Masaya Notomi[2], Shinji Matsuo[1]; [1]NTT Photonics Laboratories, NTT Corporation, Japan; [2]NTT Basic Research Laboratories, NTT Corporation, Japan.* We propose a three-terminal device based on an optical injection-locked photonic crystal laser to achieve high-speed off-chip interconnection to meet future network-on-chip needs. 40 Gb/s large-signal direct modulation and more than three times bandwidth enhancement are demonstrated.

CFD2 • 08:15
30 GHz Relaxation Resonance Frequency and 35 Gbit/s Data Rate in Single-Mode 850 nm VCSELs, *James Lott[1]; [1]VI-Systems GmbH, Germany.* We report single-mode 850 nm-range VCSELs with a relaxation resonance frequency as high as 30 GHz, peak output power up to 2.0 mW, and a record data rate of 35 Gbit/s.

CFD3 • 08:30
980-nm VCSELs for Optical Interconnects at 25 Gb/s up to 120 °C and 12.5 Gb/s up to 155°C, *Werner H. Hofmann[1], Philip Moser[1], Alex Mutig[1], Philip Wolf[1], Waldemar Unrau[1], Dieter Bimberg[1]; [1]Inst. of Solid State Physics & Center of Nanophotonics, Technische Universität Berlin, Germany.* We present high-speed high-temperature 980-nm VCSELs operating continuous-wave up to 200°C demonstrating clear open eyes at 12.5 Gb/s and 25 Gb/s at temperatures of 155°C and 120°C, respectively. 6- µm devices provide 1.4 mW at 155°C.

CFD4 • 08:45
Low Power Polarization Modulation of Vertical Cavity Surface Emitting Lasers, *Meng Peun Tan[1], Ansas M. Kasten[1], Timothy Strand[2], Kent D. Choquette[1]; [1]Electrical and Computer Engineering, Univ. of Illinois at Urbana-Champaign, USA; [2]Aerius Photonics, USA.* Vertical cavity surface emitting lasers with anisotropic cavity supports two orthogonal polarizations, and current injection direction selects the dominant polarization. Low-power, high extinction ratio modulation requiring < 200 mV is demonstrated.

08:00–09:45
CFE • Beam Combining and Stabilization of Fiber Amplifiers
Akira Shirakawa, Univ. of Electro-Communications Japan, Presider

CFE1 • 08:00
Collinear Coherent Beam Combining of Two Ytterbium Doped Single Frequency Fiber Amplifiers, *Henrik Tünnermann[1,3], Jan H. Pöld[2,3], Jörg Neumann[1,3], Dietmar Kracht[1,3], Benno Willke[2,3], Peter Wessels[1,3]; [1]Laser Zentrum Hannover e.V., Germany; [2]Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut) and Institut für Gravitationsphysik, Leibniz Universität Hannover, Germany; [3]Centre for Quantum Engineering and Space-Time Research - QUEST, Germany.* We collinearly combined two ytterbium doped fiber amplifiers with an output power of 11.4 W to 21.8 W. The system will be used to evaluate coherent beam combining in laser systems for gravitational wave detectors.

CFE2 • 08:15
Demonstration of coherent beam combination of fiber amplifiers in 100ns-pulse regime, *Laurent Lombard[1], Adrian Azarian[1], Kevin Cadoret[1], Pierre Bourdon[1], Didier Goular[1], Guillaume Canat[1], Veronique Jolivet[1], Yves Jaouën[2], Olivier Vasseur[1]; [1]ONERA, France; [2]Télécom ParisTech, France.* We present the first experimental coherent beam combining of two fiber amplifiers in 100ns pulse-regime using a signal leak between the pulses. The ~100W SBS-limited peak power pulses are combined with 95%efficiency and λ/27 phase error.

CFE3 • 08:30 Invited
Coherent Beam Combining of Fiber Amplifiers in a kW Regime, *Angel Flores[1], Thomas M. Shay[1], Chunte A. Lu[1], Craig Robin[1], Benjamin Pulford[1], Anthony D. Sanchez[1], Dane W. Hult[2], and Ken B. Rowland[3], [1]AFRL, USA, [2]TREX Enterprises Corp., USA, [3]Boeing LTS Inc., USA.* Single-frequency coherent beam combination (CBC) of 16 fiber lasers with kW class output power is presented. In addition, kW scale CBC of three Photonic Crystal Fiber (PCF) amplifiers in a filled aperture configuration is reported.

08:00–09:45
QFB • Plasmonics and Novel Structures
Harald Giessen, Univ. of Stuttgart, Germany, Presider

QFB1 • 08:00 Invited
Optical Antennas for Enhanced Light Absorption and Emission, *Lukas Novotny[1]; [1]Univ. of Rochester, USA.* Optical antennas consisting of plasmonic materials can be used to establish extreme light localization and small mode volumes, thereby boosting the sensitivity in applications ranging from single photon sources to photodetection.

QFB2 • 08:30
Towards unraveling the mechanism of third harmonic generation in plasmonic nanoantennas, *Mario Hentschel[1,2], Tobias Utikal[1,2], Markus Lippitz[1,2], Harald Giessen[1]; [1]4th Physics Inst. and Research Center SCoPE, Univ. of Stuttgart, Germany; [2]Max-Planck-Inst. for Solid State Research, Germany.* We study third harmonic generation from arrays of plasmonic nanoantennas. Specifically, we investigate the size, gap, and material dependence of the conversion efficiency and find it to be a function of the plasmon resonance energies.

QFB3 • 08:45
Nanoantenna-enhanced ultrafast nonlinear spectroscopy of a single plasmonic nanodisc, *Thorsten Schumacher[1,2], Kai Kratzer[1,2], Daniela Ullrich[1,2], Mario Hentschel[1,2], Harald Giessen[2], Markus Lippitz[1,2]; [1]Ultrafast Nanooptics, Max Planck Inst. for Solid State Research, Germany; [2]4th Physics Inst., Univ. of Stuttgart, Germany.* An optical nanoantenna increases the nonlinear transient absorption signal of a single 40 nm gold nanodisc by an order of magnitude. In agreement with our calculations the signal is spectrally shifted to the antenna resonance.

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CLEO: QELS-Fundamental Science	CLEO: Science & Innovations		

07:30–12:00 Registration Open, *Baltimore Convention Center, Pratt Street, 300 Level Lobby*

08:00–09:45 QFC • Nanophotonic and Plasmonic Confinement
Presider to Be Announced

QFC1 • 08:00 Invited
Octave-wide Photonic Band Gap in Three-Dimensional Plasmonic Bragg Structures, *Richard Taubert[1], Harald Giessen[1]; [1]4th Physics Inst. and Research Center SCoPE, Univ. of Stuttgart, Germany.* We demonstrate that a three-dimensional arrangement of particle plasmonic oscillators at Bragg distance leads to a superradiant plasmon mode. We observe the formation of a very broad photonic band gap that spans almost one octave.

QFC2 • 08:30
Nano-Structured Optical Nanofibers For Cavity-QED, *Kali P. Nayak[1], Fam Le Kien[1], Kiyomi Nakajima[2], Hideki Miyazaki[2], Yoshimasa Sugimoto[2], Kohzo Hakuta[1]; [1]Center for Photonic Innovation, Univ. of Electro-Communications, Japan; [2]Nanotechnology Innovation Center, National Inst. for Material Science, Japan.* Nanofiber cavity is realized by drilling periodic nano-grooves on a sub-wavelength diameter silica fiber using focused ion beam milling. The transverse and longitudinal confinement of the field makes such a nanofiber cavity promising for cavity-QED.

QFC3 • 08:45
Experimental verification of the "rainbow" trapping effect in adiabatic plasmonic gratings, *Qiaoqiang Gan[1], Yongkang Gao[1], Kyle Wagner[1], Dmitri Vezenov[1], Yujie J. Ding[1], Filbert Bartoli[1]; [1]ECE, Lehigh Univ., USA.* Direct measurements on graded grating structures show that light of different wavelengths in visible region is trapped at different positions along the grating, consistent with theoretical predictions, thus verifying the "rainbow" trapping effect.

08:00–09:45 CFF • Novel Raman Sensing Techniques I
Thomas Seeger, Univ. of Erlangen-Nuremberg, Germany, Presider

CFF1 • 08:00
High-Bandwidth, Spatially Resolved Thermometry in Reacting Flows Using Femtosecond-CARS Line Imaging, *Waruna D. Kulatilaka[1], Sukesh Roy[1], James R. Gord[2]; [1]Spectral Energies, LLC, USA; [2]Propulsion Directorate, Air Force Research Lab, USA.* Spatially resolved thermometry at speeds up to 1000 Hz is demonstrated using 1-D femtosecond CARS. Such measurements can provide invaluable data for validating turbulent combustion models as well as addressing spatio-temporal instabilities.

CFF2 • 08:15
Single-beam CARS Imaging for Reacting Flow Diagnostics, *Paul Wrzesinski[1], Dmitry Pestov[1], Vadim Lozovoy[1], Sukesh Roy[2], James R. Gord[3], Marcos Dantus[1,4]; [1]Chemistry, Michigan State Univ., USA; [2]Spectral Energies LLC, USA; [3]Propulsion Directorate, Air Force Research Lab, USA; [4]BioPhotonic Solutions Inc., USA.* Imaging of a CO_2 gas jet in ambient air via single-beam CARS method is demonstrated. This method will be applied to examine reacting flow systems and flames for diagnostic measurements.

CFF3 • 08:30 Invited
Broadband Coherent Anti-Stokes Raman Microspectroscopy With Shaped Femtosecond Pulses, *Jean Rehbinder[1], Christoph Pohling[1], Alexander Wipfler[1], Tiago Buckup[1], Marcus Motzkus[1]; [1]Physikalisch-Chemisches Institut, Universität Heidelberg, Germany.* Ultrabroadband excitation brings CARS microspectroscopy to the next level. An extended spectral range opens up a wealth of information, while shaping schemes tailor the excitation for optimal signal generation.

08:00–09:45 CFG • Ultrafast Pulse Shaping
Jungwon Kim, KAIST, Republic of Korea, Presider

CFG1 • 08:00
Line-by-Line Pulse-Shaping Reconfigurable at GHz Rates Using Injection-Locked VCSELs, *Sharad P. Bhooplapur[1], Nazanin Hoghooghi[1], Peter J. Delfyett[1]; [1]CREOL, College of Optics and Photonics, Univ. of Central Florida, USA.* We demonstrate pulse-shaping at reconfiguration rates at half the repetition rate of the laser. Injection-locked VCSELs independently modulate four optical comb lines at frequencies up to 3.125 GHz, changing the pulse shape from pulse-to-pulse.

CFG2 • 08:15
Line-by-line pulse shaping at spectral resolution below 1 GHz, *John T. Willits[1,2], Andrew M. Weiner[1,3], Steven Cundiff[1,2]; [1]JILA, Univ. of Colorado at Boulder, USA; [2]Electrical and Computer Engineering, Univ. of Colorado at Boulder, USA; [3]Electrical and Computer Engineering, Purdue Univ., USA.* Line-by-line pulse shaping is demonstrated on mode-locked titanium sapphire laser with a repetition rate < 1 GHz. The necessary high spectral resolution pulse shaper is described and its output analyzed.

CFG3 • 08:30
Precise Spectral Shaping of Mode-locked Oscillations, *Shai Yefet[1], Naaman Amer[1], Avi Pe'er[1]; [1]Physics department, Bar Ilan Univ., Israel.* We demonstrate a powerful method to control the spectrum of a mode-locked laser by placing the gain medium inside an intra-cavity pulse shaper.

CFG4 • 08:45
10-fs Deep-Ultraviolet Pulses without Second- and Third-Order Dispersions, *Yuichiro Kida[1,2], Jun Liu[1,2], Takayoshi Kobayash[1,2]; [1]Advanced Ultrafast Laser Research Center, and Department of Engineering Science, Faculty of Informatics and Engineering, The Univ. of Electro-Communications, Japan; [2]International Cooperative Research Project (ICORP), Japan Science and Technology Agency, Japan.* 10-fs deep-ultraviolet pulses are generated by broadband four-wave mixing and with a pulse compressor consisting of prisms and gratings. Pulse distortion in an ultrafast spectroscopic setup can be compensated by the compressor.

08:00–09:45 CFH • Access Networks
Chang-Hee Lee, KAIST, Republic of Korea, Presider

CFH1 • 08:00
Automatic Wavelength Control Method Using Rayleigh Rackscattering for WDM-PON with Tunable Lasers, *Sang-Rok Moon[1], Hoon-Keun Lee[1], Chang-Hee Lee[1]; [1]Electrical Engineering, Korea Advanced Inst. of Science and Technology, Republic of Korea.* We demonstrate an automatic wavelength control method using Rayleigh backscattering and wavelength modulation for tunable lasers in a WDM-PON. By measuring the spectrum of backscattered light, we identified and tracked the allocated wavelength.

CFH2 • 08:15
Optical Comb Sources for Suppression of Stimulated Brillouin Scattering in Long-Haul Analog Photonic Links, *Jason D. McKinney[1], John Briguglio[2], Vincent J. Urick[1]; [1]Photonics Technology Branch, Optical Sciences Division, U.S. Naval Research Lab, USA; [2]Department of Physics, Carnegie Mellon Univ., USA.* We demonstrate a 50-km repeater-less analog optical link with a record spur-free dynamic range of 105 dB-$Hz^{2/3}$. An optical comb source mitigates stimulated Brillouin scattering allowing increased launch power and reduced optical post-amplification.

CFH3 • 08:30
An Experimental Investigation of RoF-Enabled MIMO DAS in a Non-Light-of-Sight Environment, *Kun Zhu[1,2], Michael Crisp[1], Sailing He[2], Richard V. Penty[1], Ian H. White[1]; [1]Department of Engineering, Centre for Photonic Research, Univ. of Cambridge, UK; [2]Department of Optical Engineering, Centre for Optical and Electromagnetic Research, Zhejiang Univ., China.* The performance of a 3×3 MIMO system using RoF-enabled DAS technology is experimentally investigated in a Non-Line-Of-Sight environment. Reduced spatial correlation and improved SNR are achieved due to the larger antenna separation.

CFH4 • 08:45
A Low-cost, Bandwidth-efficient Fabry-Pérot Optical Millimeter-wave Generator Driven by Low RF Frequencies, *Jie Liu[1,2], Hung-Chang Chien[2], Sailing He[1,3], Gee-Kung Chang[2]; [1]Centre for Optical and Electromagnetic Research, Zhejiang Univ., China; [2]School of Electrical and Computer Engineering, Georgia Inst. of Technology, USA; [3]Division of Electromagnetic Engineering, Royal Inst. of Technology, Sweden.* Optical mm-waves are generated via a new frequency-tripling and quadrupling scheme, respectively, which is based on directly modulated optically injection locked Fabry-Pérot laser. Error-free transmission of millimeter-wave signal over 20-km SSMF has been demonstrated.

Room 339

CLEO: QELS-Fundamental Science

07:30–12:00
Registration Open,
Baltimore Convention Center, Pratt Street, 300 Level Lobby

08:00–09:45
QFD • Quantum Imaging and Phase Estimation
Norbert Lütkenhaus, Univ. of Waterloo, Canada, Presider

QFD1 • 08:00
Quantum spatial super-resolution by the optical centroid measurement method, *Heedeuk Shin[1], Kam Wai Chan[2], Hye Jeong Chang[3,1], Robert W. Boyd[4,1]; [1]Inst. of Optics, Univ. of Rochester, USA; [2]Rochester Optical Manufacturing Company, USA; [3]Korean Intellectual Property Office, Republic of Korea; [4]Department of Physics, Univ. of Ottawa, Canada.* We demonstrate experimentally a new procedure for obtaining spatial super-resolution in quantum imaging by measuring optical centroid. Our results show spatial resolution enhancement identical to that of quantum lithography but with higher detection efficiency.

QFD2 • 08:15
Correlated Imaging with Aberration Cancellation, *Alexander V. Sergienko[1], David S. Simon[1]; [1]Dept. of ECE/ENG, Boston Univ., USA.* We discuss an apparatus capable of producing correlated-photon "ghost" images that cancel all object-induced aberrations in a particular plane and all odd-order aberrations induced by the image-forming optics.

QFD3 • 08:30
The First Ghost Image Using Sun as a Light Source, *Sanjit Karmakar[1], Yan-hua Zhai[1], Hui Chen[1], Yanhua Shih[1]; [1]Physics, Univ. of Maryland, Baltimore County, USA.* This article reports first experimental demonstration on two-photon ghost imaging using the Sun as a light source.

QFD4 • 08:45
Fundamental Quantum Limit to Waveform Estimation, *Mankei Tsang[1], Howard M. Wiseman[2], Carlton M. Caves[1]; [1]Univ. of New Mexico, USA; [2]Griffith Univ., Australia.* We present a quantum Cramér-Rao bound to the error of waveform estimation in quantum sensing. For optomechanical force sensing, we show that the bound can be achieved using quantum estimation and control techniques.

NOTES

Room 318-320 | **Room 321-323** | **Room 324-326** | **Room 314**

CLEO: QELS-Fundamental Science

QFA • Plasmonic Metamaterials—Continued

QFA5 • 09:00 Invited
Plasmonic oligomers: the role of individual particles in collective behavior, *Mario Hentschel[1,2], Na Liu[3], Daniel Dregely[1], Harald Giessen[1]; [1]4th Physics Inst. and Research Center SCoPE, Univ. of Stuttgart, Germany; [2]Max-Planck-Inst. for Solid State Research, Germany; [3]Department of Chemistry, Univ. of California, Berkeley, and Materials Science Division, Lawrence Berkeley National Lab, USA.* We demonstrate the transition from isolated to collective optical modes in plasmonic oligomers. Specifically, we investigate the resonant behavior of planar plasmonic hexamers and heptamers with gradually decreasing the inter-particle gap separation.

QFA6 • 09:30
Experimental Observation of Field Enhancement at the Negative-Positive Index Interface, *Igor Smolyaninov[1], Vladimir Shalaev[3], Natalia Litchinitser[2], Ethan Gibson[2]; [1]Univ. of Maryland, USA; [2]Univ. at Buffalo, USA; [3]Purdue Univ., USA.* We have observed field enhancement at the interface between positive and negative index plasmonic crystal media. Numerical simulations of this experiment indicate good agreement with theoretical predictions.

CLEO: Science & Innovations

CFA • Optomechanics II—Continued

CFA5 • 09:00
Mechanically Compliant High Contrast Grating Mirrors for Radiation Pressure Cooling, *Utku Kemiktarak[1,2], Michael Metcalfe[1,2], Mathieu Durand[2], John Lawall[2]; [1]Joint Quantum Inst., Univ. of Maryland, USA; [2]National Inst. of Standards and Technology, USA.* We have developed micromechanical membranes with high reflectivity and low mass for optical cooling. By patterning silicon nitride membranes with grating structures we have achieved reflectivity of R=99% and a quality factor of Q=16000.

CFA6 • 09:15
Reflective silicon binary diffraction grating for visible wavelengths, *Zhen Peng[1], Andrei Faraon[1], David Fattal[1], Marco Fiorentino[1], Jingjing Li[1], Raymond G. Beausoleil[1]; [1]HP, USA.* We introduce a new device based on sub-wavelength resonant gratings. We built a silicon-on-oxide reflective binary grating for visible light that mimics the functionality of a blazed diffraction grating in a flat geometry.

CFA7 • 09:30
Gradient-Index Adiabatic Impedance Matching (GRIN-AIM) Antireflective Diffractive Optics, *Chih-Hao Chang[1,2], Jose A. Dominguez-Caballero[1], Hyungryul J. Choi[1], George Barbastathis[1,2]; [1]Mechanical Engineering, Massachusetts Inst. of Technology, USA; [2]Singapore-MIT Alliance for Research and Technology (SMART) Centre, Singapore.* We have experimentally demonstrated suppression of reflection diffracted orders by at least 100 in a silicon grating by tapered nanostructures emulating adiabatic index matching.

CFB • Integration on Silicon—Continued

CFB2 • 09:00
Multi-Layer Low-Temperature Deposited CMOS Photonics for Microelectronics Backend Integration, *Nicolás Sherwood-Droz[1], Michal Lipson[1,2]; [1]ECE, Cornell Univ., USA; [2]Kavli Inst. at Cornell, USA.* We experimentally show vertically-stacked, multi-layer, low-temperature deposited photonics for integration on processed electronics. Waveguides, microrings, and crossings are fabricated out of 400° PECVD Si_3N_4, in a two layer configuration.

CFB3 • 09:15
7 Gbit/s Data Transmission over 500 m Multimode Fiber with Monolithically Integrated Bidirectional VCSEL-Based Transceiver Chips, *Alexander Kern[1], Dietmar Wahl[1], Sujoy Paul[1], Mohammad Tanvir Haidar[1], Rainer Blood[1], Wolfgang Schwarz[1], Rainer Michalzik[1]; [1]Inst. of Optoelectronics, Ulm Univ., Germany.* We present design, fabrication and operation characteristics of AlGaAs-based transceiver chips with monolithically integrated VCSELs and PIN photodetectors. Up to 7 Gbit/s data transmission over a 500 m long standard multimode fiber is demonstrated.

CFB4 • 09:30
Hybrid-Integrated Germanium Photodetector and CMOS Receiver Operating at 15 Gb/s, *Benjamin G. Lee[1], Solomon Assefa[1], Clint Schow[1], William M. Green[1], Alexander Rylyakov[1], Richard A. John[1], Jeffrey A. Kash[1], Yurii A. Vlasov[1]; [1]IBM Research, USA.* A waveguide-integrated metal-semiconductor-metal photodetector is integrated with an analog 90-nm CMOS receiver. Error-free 15-Gb/s operation is achieved with an efficiency of 4.7 pJ/bit and a sensitivity of -8 dBm average power.

CFC • Optical Frequency Standards and Signal Dissemination—Continued

CFC5 • 09:00
Low-Noise Remote Transfer of a Phase-Encoded Frequency Comb through a 320m Phase-Stabilized Fiber, *Matthew Kirchner[1,2], Scott Diddams[1]; [1]National Inst. of Standards and Technology, USA; [2]Department of Physics, Univ. of Colorado, USA.* 640 frequency-stabilized comb modes are controlled in a line-by-line pulse shaper and transmitted through a noise-cancelled 320m fiber. This allows for transmission of phase-stable, high-fidelity shaped waveforms to a remote location.

CFC6 • 09:15
Ultra-Low Phase Noise Microwaves from Optical References, *Jennifer Taylor[1], Tara Fortier[1], Matthew Kirchner[1], Frank Quinlan[1], Nathan Lemke[1], Andrew Ludlow[1], Yanyi Jiang[1,2], Christopher Oates[1], Scott A. Diddams[1]; [1]National Inst. of Standards and Technology, USA; [2]East China Normal Univ., China.* We show a photonic oscillator providing 10 GHz microwaves having L(f)=-104 dBc/Hz at 1 Hz offset and fractional instability $\leq 8\times10^{-16}$ at 1 s. These values are verified by operation and comparison of two independent systems.

CFC7 • 09:30
Microwave generation with low residual phase noise from a femtosecond fiber laser with an intracavity EOM, *William Swann[1], Esther Baumann[1], Fabrizio Giorgetta[1], Nathan Newbury[1]; [1]NIST, USA.* A femtosecond fiber laser with an intracavity electro-optic modulator is phase-locked to a high-finesse cavity through two cw transfer lasers. The residual phase noise at the 300 MHz harmonic is -126 dBc/Hz at 1 Hz.

09:45–10:15 Coffee Break, *300 Level Foyer*

Thank you for attending CLEO: 2011. Look for your post-conference survey via email and let us know your thoughts on the program.

Room 315 | Room 316 | Room 317

CLEO: Science & Innovations

CFD • High Speed Lasers—Continued

CFD5 • 09:00
High-output-power 10.3-Gb/s Operation of 1.27-µm Quantum-dot DFB Lasers for 10G-EPON, *Kan Takada[1], Yu Tanaka[2,3], Takeshi Matsumoto[2], Masaomi Yamaguchi[3], Takeo Kageyama[3], Kenichi Nishi[3], Yoshiaki Nakata[2,3], Tsuyoshi Yamamoto[2], Mitsuru Sugawara[3], Yasuhiko Arakawa[1]; [1]Univ. of Tokyo, Japan; [2]Fujitsu Laboratories Ltd., Japan; [3]QD Laser Inc., Japan.* 1.27-µm high-density quantum-dot DFB lasers for 10G-EPON were developed. Fabricated lasers exhibited temperature-stable light-current characteristics and clearly-opened 10.3-Gb/s eye-diagrams with a high averaged output power of 4.5dBm from -10°C to 85°C.

CFD6 • 09:15
Multiple-Wavelength 25-Gb/s Surface-Emitting Laser Array for Short-Reach WDM Links, *Koichiro Adachi[1,2], Kazunori Shinoda[1,2], Daichi Kawamura[1], Takeshi Kitatani[1,2], Yasunobu Matsuoka[1], Toshiki Sugawara[1], Shinji Tsuji[1,2]; [1]Hitachi, Ltd., Japan; [2]Photonic Electronics Technology Research Association, Japan.* Multiple-wavelength 25-Gb/s operation of a 1.3-µm surface-emitting laser array was demonstrated. The fabricated laser, which consists of nine DFB stripes operating between 1260 and 1290 nm at 3.7-nm intervals exhibited clear 25-Gb/s eye openings.

CFD7 • 09:30
Enhanced Frequency Response in Monolithically Integrated Coupled Cavity Lasers and Electro-absorption Modulator, *Anna M. Tauke-Pedretti[1], Allen Vawter[1], Erik Skogen[1], Mark Overberg[1], Gregory Peake[1], Weng W. Chow[1], Zhenshan S. Yang[1], Charles Alford[1], Joel Wendt[1], David Torres[2]; [1]Sandia National Laboratories, USA; [2]LMATA Government Services LLC, USA.* We present the bandwidth enhancement of an EAM monolithically integrated with two mutually injection-locked lasers. An improvement in the modulation efficiency and bandwidth are shown with mutual injection locking.

CFE • Beam Combining and Stabilization of Fiber Amplifiers—Continued

CFE4 • 09:00
Fiber Laser CPA System Delivering 120 µJ Femtosecond Pulses Using Coherent Combining, *Arno Klenke[1], Enrico Seise[1,3], Sven Breitkopf[1], Andreas Tünnermann[1,2], Jens Limpert[1,2]; [1]Inst. of Applied Physics, Friedrich-Schiller Univ. Jena, Germany; [2]Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany; [3]Helmholtz-Inst. Jena, Germany.* We report on the coherent combination of two chirped pulsed fiber amplifiers using a polarization cube. Femtosecond pulses were combined with an efficiency of 91% obtaining a combined pulse energy of 120 µJ.

CFE5 • 09:15
High power carrier-envelop phase stabilized 1030 nm pulses amplified from a Ti:sapphire laser, *Hui Zhou[1], Wenxue Li[1], Wenxue Li[1], Kangwen Yang[1], Ming Yan[1], Jingxin Ding[1], Heping Zeng[1]; [1]East China Normal Univ., China.* High power carrier-envelop phase stabilized 1030 nm pulses was generated by amplifying the fractional output spectrum of a passive mode-locked Ti:sapphire laser, exhibited 4.89 mHz long-term frequency fluctuation and 1.9 mHz beat signal linewidth.

CFE6 • 09:30
Long-Term Stable Passive Synchronization of 50-µJ, 690-fs, 0.4-MHz Yb-Doped Fiber Amplifier with a Mode-Locked Ti:Sapphire Laser, *Dai Yoshitomi[1,2], Xiangyu Zhou[1,2], Yohei Kobayashi[3], Hideyuki Takada[1,2], Kenji Torizuka[1,2]; [1]Photonics Research Inst., National Inst. of Advanced Industrial Science and Technology (AIST), Japan; [2]Core Research for Evolutional Science and Technology (CREST), Japan Science and Technology Agency, Japan; [3]Inst. for Solid State Physics, Univ. of Tokyo, Japan.* We report long-term stable passive synchronization of a 50-µJ, 690-fs, 0.4-MHz Yb-doped fiber chirped-pulse amplifier with a mode-locked Ti:sapphire laser as long as 8 hours with a timing jitter of 42 fs.

CLEO: QELS-Fundamental Science

QFB • Plasmonics and Novel Structures—Continued

QFB4 • 09:00
Real-time and real-space observation of plasma oscillation in GaAs, *Brian A. Ruzicka[1], Lalani K. Werake[1], Hui Zhao[1]; [1]Physics and Astronomy, Univ. of Kansas, USA.* A plasma oscillation of electrons and holes is generated in GaAs by a quantum interference and control technique, and is temporally and spatially resolved by detecting an induced second-harmonic generation process.

QFB5 • 09:15
The Ultrafast Nonlinear Optical Properties of Induced Transmission Filters, *Canek Fuentes-Hernandez[1], Daniel T. Owens[1], James Hsu[1], Alfred R. Ernst[1], Joel M. Hales[2], Joseph W. Perry[2], Bernard Kippelen[1]; [1]School of electrical and computer engineering, Georgia Inst. of Technology, USA; [2]School of Chemistry and Biochemistry, Georgia Inst. of Technology, USA.* We report on the nonlinear optical properties of induced transmission filters with 30× enhancement compared with a 30 nm Ag film and with a peak transmittance of 63% in the visible.

QFB6 • 09:30
Near-field observation of zero index bandgaps in negative refraction photonic superlattices, *Pin-Chun Hsieh[1], Serdar Kocaman[1], Min-An Tsai[2], Ting-Gang Chen[2], Mehmet Aras[1], Dim-Lee Kwong[3], Aaron Stein[4], Chee Wei Wong[1]; [1]Mechanical Engineering, Columbia Univ., USA; [2]National Chiao Tung Univ., Taiwan; [3]The Inst. of Microelectronics, Singapore; [4]Brookhaven National Lab, USA.* We present near-field observations of tuned zero-index bandgaps in photonic crystal superlattices consisting of cascaded negative and positive index media.

09:45–10:15 Coffee Break, *300 Level Foyer*

Room 327

CLEO: QELS-Fundamental Science

QFC • Nanophotonic and Plasmonic Confinement—Continued

QFC4 • 09:00
Phonon-mediated exciton-photon coupling in site-controlled quantum-dot-nanocavity systems, *Milan Calic[1], Pascal Gallo[1], Marco Felici[1], Kirill A. Atlasov[1], Benjamin Dwir[1], Alok Rudra[1], Giorgio Biasiol[2], Lucia Sorba[3], Guillaume Tarel[1], Vincenzo Savona[1], Elyahou Kapon[1]; [1]EPFL, Switzerland; [2]Istituto Officina dei Materiali CNR, Italy; [3]Istituto Nanoscienze-CNR and Scuola Normale Superiore, Italy.* We show that far off-resonance exciton-photon coupling reported for self-assembled quantum dots in optical micro-cavities is not universal, and demonstrate that site-controlled dots exhibit clean phonon-mediated resonant coupling.

QFC5 • 09:15
Dressing Plasmons in Particle-in-Cavity Architectures, *Fumin Huang[1], Dean Wilding[1], Jonathon D. Speed[2], Andrea E. Russell[2], Philip N. Bartlett[2], Jeremy J. Baumberg[1]; [1]Cavendish Lab, Univ. of Cambridge, UK; [2]Chemistry, Univ. of Southampton, UK.* Metallic nanoparticles inside metal cavities show extremely strong plasmonic field enhancement. Plasmonic coupling gives a universal power-law dependence on particle-surface gap, both for field enhancement and resonant wavelength shift.

QFC6 • 09:30
A high-Q exterior plasmonic whispering gallery mode in a metal-coated microresonator, *Yun-Feng Xiao[1], Qihuang Gong[1]; [1]Peking Univ., China.* We propose a new kind of plasmonic whispering gallery modes that can be highly localized in the exterior of a metal-coated microresonator, and possesses high quality factors at room temperature.

Room 336

CLEO: Science & Innovations

CFF • Novel Raman Sensing Techniques I—Continued

CFF4 • 09:00
Advances in Fiber-Based Picosecond Coherent Anti-Stokes Raman Scattering Thermometry in Reacting Flows, *Paul S. Hsu[1], Waruna D. Kulatilaka[1], Anil K. Patnaik[2], Sukesh Roy[1], James R. Gord[2]; [1]Spectral Energies, LLC, USA; [2]Propulsion Directorate, Air Force Research Lab, USA.* A picosecond-laser-based, fiber-coupled CARS system employing multimode step-index fibers is developed for gas-phase thermometry in harsh combustion environments. Temperature measurements using this system are demonstrated in a Lab flame.

CFF5 • 09:15
Standoff Chemical Imaging of Trace Quantities Using Single-beam CARS, *Marshall T. Bremer[1], Vadim Lozovoy[1], Marcos Dantus[1]; [1]Chemistry, Michigan State Univ., USA.* The sensitivity and selectivity of single-beam CARS is explored at one meter standoff. Trace quantities of dinitrotoluene are detected within a complex polymer/solvent background. Chemical images demonstrate selectivity and quantify sensitivity.

CFF6 • 09:30
Combining Angle-Resolved Raman Scattering and Confocal Raman Microscopy for Rationally Designing Two-Dimensional Metallic Arrays as High Performing SERS Substrates, *Zhaolong Cao[1], Chung Yu Chan[1], Lei Zhang[1], Hock Chun Ong[1]; [1]Department of Physics, The Chinese Univ. of Hong Kong, Hong Kong.* We study the dependence of surface-enhanced Raman scattering from metallic arrays on geometry by angle-resolved Raman spectroscopy and confocal microscopy. It is found that both Raman profile and intensity are strongly dependent on hole size.

Room 337

CFG • Ultrafast Pulse Shaping—Continued

CFG5 • 09:00
Generation and Delivery of 496-GHz Optical Pulse Train over 25-km Single-Mode Fiber using a Line-by-Line Optical Pulse Shaper, *Hsiu-Po Chuang[1], Chen-Bin Huang[1]; [1]Inst. of Photonics Technologies, National Tsing Hua Univ., Taiwan.* A single line-by-line optical pulse shaper is used to experimentally generate and deliver 1.04 ps optical pulse train with 496 GHz repetition-rate over 25.33 km single-mode fiber without the need for dispersion-compensating fiber.

CFG6 • 09:15
Microwave Photonic Filters with > 65-dB Sidelobe Suppression Using Directly Generated Broadband, Quasi-Gaussian Shaped Optical Frequency Combs, *Rui Wu[1], Venkata Supradeepa[1], Christopher M. Long[1], Ehsan Hamidi[1], Daniel E. Leaird[1], Andrew M. Weiner[1]; [1]Purdue Univ., USA.* We present microwave photonic filters with record > 65dB sidelobe suppression using directly generated, broadband, quasi-Gaussian combs using cascaded-FWM based spectral broadening of combs generated from tailored E-O modulation of CW lasers.

CFG7 • 09:30
MHz update-rate reflectometry by direct mapping of the full axial-line profile in a single-shot oscilloscope trace, *Antonio Malacarne[1], Yongwoo Park[1], Jose Azana[1]; [1]INRS-EMT, Canada.* Concept is introduced for optical reflectometry based on real-time spectral interference pattern Fourier transformation, enabling direct axial-line profiles mapping with hundreds of sampling points in single-shot MHz update rates oscilloscope traces.

Room 338

CFH • Access Networks—Continued

CFH5 • 09:00
Effects of High-Order Laser Distortion Products in Radio over Free-Space Optical Links, *George S. Gordon[1], Michael Crisp[1], Richard V. Penty[1], Ian H. White[1]; [1]Univ. of Cambridge, UK.* RoFSO links are found to be susceptible to high-order laser distortion making conventional SFDR ineffective as a performance indicator. For the first time, peak input power is demonstrated as a service-independent bound on dynamic range.

CFH6 • 09:15
High-Speed Full-Duplex Optical Wireless Communication Systems for Indoor Applications, *Ke Wang[1,3], Ampalavanapillai Nirmalathas[2,3], Christina Lim[2,3], Efstratios Skafidas[1,3]; [1]National ICT Australia-Victoria Research Lab (NICTA-VRL), The Univ. of Melbourne, Australia; [2]Centre for Ultra-Broadband Information Networks (CUBIN), The Univ. of Melbourne, Australia; [3]Department of Electrical and Electronic Engineering, The Univ. of Melbourne, Australia.* A high-speed full-duplex optical wireless communication system with limited mobility for both a 10Gbps down-link and a 500Mbps up-link with localization is experimentally demonstrated with error-free operation (BER<10^{-9}).

CFH7 • 09:30
2.5-Gb/s broadcast signal transmission in a WDM-PON by using a mutually injected Fabry-Pérot laser diodes, *Sang-Hwa Yoo[1], Hoon-Keun Lee[1], Dong-Sung Lim[2], Jae-Hyun Jin[2], Leo Byun[2], Chang-Hee Lee[1]; [1]Electrical Engineering, Korea Advanced Inst. of Science and Technology, Republic of Korea; [2]Luxpert Technologies Co., Ltd, Republic of Korea.* We demonstrate broadcast signal transmission in a WDM-PON by using low noise broad-band light source based on a mutually injected Fabry-Pérot laser diodes. This novel multi-wavelength WDM source enables to transmit 2.5 Gb/s per channel.

09:45–10:15 Coffee Break, *300 Level Foyer*

Room 339

CLEO: QELS-Fundamental Science

QFD • Quantum Imaging and Phase Estimation—Continued

QFD5 • 09:00

Squeezing-enhanced adaptive optical phase estimation, *Hidehiro Yonezawa[1], Daisuke Nakane[1], Trevor A. Wheatley[2,3], Kohjiro Iwasawa[1], Shuntaro Takeda[1], Hajime Arao[1], Dominic W. Berry[4], Timothy C. Ralph[2,5], Howard M. Wiseman[2,6], Elanor Huntington[2,3], Akira Furusawa[1]; [1]The Univ. of Tokyo, Japan; [2]Centre for Quantum Computer Technology, Australia; [3]The Univ. of New South Wales, Australia; [4]Univ. of Waterloo, Canada; [5]Univ. of Queensland, Australia; [6]Griffith Univ., Australia.* We demonstrate squeezing-enhanced adaptive optical phase estimation for a stochastically varying phase. By using a continuous-wave phase squeezed beam, estimation accuracy is improved by a factor of 1.4 compared to a coherent beam case.

QFD6 • 09:15

Two-Mode Squeezed Vacuum: Phase Estimation and Parity Detection, *Petr M. Anisimov[1], William N. Plick[1], Gretchen M. Raterman[1], Hwang Lee[1], Jonathan P. Dowling[1], Girish Agarwal[2]; [1]Department of Physics and Astronomy, Louisiana State Univ., USA; [2]Department of Physics, Oklahoma State Univ., USA.* We present a parity-measurement-based phase estimation protocol with two-mode squeezed vacuum states; effects of loss and excess noise in squeezed vacuum are discussed; and a parity detection scheme without number-resolving detectors is proposed.

QFD7 • 09:30

Observation of Young's Double-Slit Interference with the Three-photon N00N state, *Yong-Su Kim[1], Osung Kwon[1], Sang Min Lee[2], Heonoh Kim[2,3], Sang-Kyung Choi[2], Hee Su Park[2], Yoon-Ho Kim[1]; [1]Dep. of Physics, POSTECH, Republic of Korea; [2]Division of Convergence Technology, Korea Research Inst. of Standard and Science, Republic of Korea; [3]Dept. of Physics, Univ. of Ulsan, Republic of Korea.* We report the first experimental observation of the spatial interference of a three-photon N00N state. Compared to a single-photon state, the three-photon entangled state generates interference fringes that are three times denser.

09:45–10:15 Coffee Break,
300 Level Foyer

NOTES

Room 318-320

CLEO: QELS-Fundamental Science

10:15–12:00
QFE • Active Plasmonics
Rupert Oulton, Imperial College London, UK, Presider

QFE1 • 10:15 Invited
Intraband Optical Transitions in Graphene, *Feng Wang[1]; [1]Univ. of California at Berkeley, USA.* We measured tunable interband and intraband transitions in graphene using infrared spectroscopy. Graphene electrons have strong intraband absorption at terahertz frequency range. The absorption spectrum is described by the Drude model.

QFE2 • 10:45
Interaction between Metamaterial Resonators and Intersubband Transitions in Quantum Wells, *Alon Gabbay[1], John Reno[1], Joel Wendt[2], Aaron Gin[1], Mike Wanke[2], Michael B. Sinclair[2], Eric A. Shaner[2], Igal Brener[1]; [1]Center for Integrated Nanotechnologies, Sandia National Laboratories, USA; [2]Sandia National Laboratories, USA.* Interaction between metamaterial elements and intersubband transitions in GaAs/AlGaAs quantum wells is observed in the mid-infrared. Transmission measurements were performed through metamaterial arrays, each having a different resonance frequency.

QFE3 • 11:00
Time Domain Model of a Gain Medium Fitted to Pump-Probe Experiments, *Jan Trieschmann[1], Shumin Xiao[1], Ludmila J. Prokopeva[2,1], Vladimir P. Drachev[1], Alexander V. Kildishev[1]; [1]Electrical and Computer Engineering, Birck Nanotechnology Center, USA; [2]Inst. for Computational Technologies, the Siberian Branch of Russian Academy of Sciences, Russian Federation.* We present an ADE-FDTD model of gain media fitted to pump-probe experiments with Rh800-epoxy composite deposited on glass substrate. The experiment-fitted parameters of the 4-level ADE system are instrumental to modeling active nanoplasmonic devices.

Room 321-323

CLEO: Science & Innovations

10:15–12:00
CFI • Photonic Crystal Devices
Chee Wei Wong, Columbia Univ., USA, Presider

CFI1 • 10:15
Ultralow-power All-optical Memory using Photonic Crystal Nanocavities with Novel Buried Heterostructure, *Kengo Nozaki[1], Akihiko Shinya[1], Shinji Matsuo[2], Tomonari Sato[2], Yoshihiro Kawaguchi[2], Masaya Notomi[1]; [1]NTT Basic Res. Laboratories, Japan; [2]NTT Photonics Labs, Japan.* We demonstrate an all-optical memory based on photonic crystal nanocavities with novel buried heterostructure, which solves the heating problem and enhances the carrier confinement, enabling long memory-time operation with sub-μW power consumption.

CFI2 • 10:30
Third-harmonic generation in engineered slow light photonic crystal waveguides in chalcogenide glasses, *Christelle Monat[2,1], Marcel Spurny[3], Christian Grillet[2], Liam O'Faolain[3], Thomas F. Krauss[3], Benjamin J. Eggleton[2], Douglas A. Bulla[4], Steve J. Madden[4], Barry Luther-Davies[4]; [1]ECL/INL, France; [2]School of Physics, CUDOS/ IPOS/ The Univ. of Sydney, Australia; [3]School of Physics and Astronomy, Univ. of St Andrews, UK; [4]CUDOS/ Laser Physics Centre/ The Australian National Univ., Australia.* We report third-harmonic generation in slow-light photonic crystal waveguides realized in chalcogenide glass membranes. This material enables a more uniform conversion along the waveguide and a higher efficiency than in comparable silicon structures.

CFI3 • 10:45
Highly-efficient four-wave mixing in a coupled-nanocavity waveguide, *Nobuyuki Matsuda[1], Takumi Kato[1,2], Ken-ichi Harada[1], Hiroki Takesue[1], Eiichi Kuramochi[1], Masaya Notomi[1]; [1]NTT Basic Research Laboratories, NTT Corporation, Japan; [2]Research Inst. of Electrical Communication, Tohoku Univ., Japan.* We demonstrate enhanced optical nonlinearity in a coupled-resonator optical waveguide comprised of 200 silicon photonic crystal nanocavities. We have obtained the effective nonlinear constant γ as 6,600 /W/m through the four wave mixing experiment.

CFI4 • 11:00
Transmission Properties of a Free-standing Lithium Niobate Photonic Crystal Waveguide, *Reinhard Geiss[1], Severine Diziain[1], Rumen Iliew[2], Christoph Etrich[2], Frank Schrempel[1], Falk Lederer[2], Ernst-Bernhard Kley[1], Thomas Pertsch[1]; [1]Inst. of Applied Physics, Friedrich-Schiller Univ. Jena, Germany; [2]Inst. of Condensed Matter Theory and Solid State Optics, Friedrich-Schiller Univ. Jena, Germany.* Transmission spectra of photonic crystal waveguides in freestanding lithium niobate membranes fabricated by means of ion-beam enhanced etching have been measured by scanning near-field optical microscopy show good agreement with 3DFDTD calculations.

Room 324-326

10:15–12:00
CFJ • Optical Components
Presider to Be Announced

CFJ1 • 10:15 Invited
Integration of semiconductor Mach-Zehnder modulator with Tunable-wavelength laser diode, *Yasuo Shibata[1]; [1]NTT Photonics Laboratories, Japan.* A InP Mach-Zehnder modulator was integrated with a tunable-wavelength LD by using monolithic and hybrid integration techniques. 40-Gb/s DPSK and 10-Gb/s NRZ modulations were successfully demonstrated for hybrid and monolithic devices, respectively.

CFJ2 • 10:45
In-line and compact QWIP for reference signal detection with Quantum Cascade lasers at 4.6μm, *Ekua N. Bentil[1], Germano M. Penello[2,1], William O. Charles[1], Claire F. Gmachl[1]; [1]Electrical Engineering, Princeton Univ., USA; [2]Physics Inst., Federal Univ. of Rio de Janeiro - UFRJ, Brazil.* By implementing quantum well infrared photodetectors as passive optical elements, we present a novel approach to obtain a reference signal needed in gas spectroscopy systems based on reflection and transmission properties of these photodetectors.

CFJ3 • 11:00
Chip-Scale Multiple Quantum Well Based Optical Interconnects, *Rohit Nair[1], Tian Gu[1], Michael Teitelbaum[1], Keith W. Goossen[1], Fouad Kiamilev[1], Michael W. Haney[1]; [1]Univ. of Delaware, USA.* Hybrid integration of multiple quantum well modulators with silicon is proposed for implementing chip-scale optical interconnects. Polymer waveguides with curved facets are used to couple light in and out of the MQW devices.

Room 314

10:15–12:00
CFK • Optical Frequency Combs
Jason Jones, Univ. of Arizona, USA, Presider

CFK1 • 10:15 Tutorial
Science and Technology with Optical Frequency Combs, *Scott Diddams, NIST, USA.* The basic operation, implementation and control of femtosecond laser optical frequency combs will be presented. The application of frequency combs in various scientific and technological fields will be described.

Scott Diddams received the B.A. in Physics from Bethel College, St. Paul, MN in 1989 and the Ph.D. degree in Optical Science from the University of New Mexico, Albuquerque in 1996. From 1996 through 2000, he did postdoctroral work at JILA, University of Colorado. In 1998 Dr. Diddams was awarded a National Research Council fellowship to work with Dr. John Hall (also at JILA) on the development of optical combs for frequency metrology. The techniques developed at that time have had a significant impact on the fields of ultrafast optics and optical frequency metrology. Since 2000, Dr. Diddams has been a staff member and project leader at the National Institute of Standards and Technology (NIST) where he and his coworkers have continued the development of optical frequency combs for optical clocks, waveform generation, low-noise microwave synthesis, spectroscopy and other applications. Dr. Diddams was a co-recipient of a Department of Commerce gold medal for "revolutionizing the way frequency is measured" and was additionally the recipient of the Presidential Early Career Award in Science and Engineering (PECASE) for his work on optical frequency combs. He is a Fellow of the OSA and APS and a member of IEEE.

Room 315 / Room 316 — CLEO: Science & Innovations

10:15–12:00
CFL • Novel Semiconductor Laser Materials
Shinji Tsuji, Hitachi, Japan, Presider

CFL1 • 10:15
Origin of the temperature dependence of threshold current in InP/AlGaInP Quantum Dot Lasers, *Peter M. Smowton[1], Stella N. Elliott[1], Sam Shutts[1], Gareth Michell[1], Mohammed S. Al-Ghamdi[2], Andrey B. Krysa[3]; [1]PHYSX, Cardiff Univ., UK; [2]Physics, King Abdulaziz Univ., Saudi Arabia; [3]EPSRC National Centre, Univ. of Sheffield, UK.* We quantitatively separate the factors that determine the threshold current temperature dependence at high tempertures in state-of-the-art InP quantum dot lasers and demonstrate a design with low threshold and reduced temperature sensitivity

CFL2 • 10:30
Band filling in p-doped InAs quantum dot lasers, *Matthew Hutchings[1], Ian O'Driscoll[1], Peter M. Smowton[1], Peter Blood[1]; [1]School of Physics and Astronomy, Cardiff Univ., UK.* Measurements of modal gain spectra show differences in band filling for un-doped and p-doped quantum dot samples which we show is associated with a transition to a non-thermal regime as the temperature is reduced.

CFL3 • 10:45 Invited
A Germanium-on-Silicon Laser for On-chip Applications, *Jurgen Michel[1], Jifeng Liu[2], Lionel Kimerling[1], Rodolfo Camacho-Aguilera[1], Jonathan Bessette[1], Yan Cai[1]; [1]MIT, USA; [2]Dartmouth College, USA.* Lasing from Ge was achieved by highly n-type doping and biaxially tensile strain to overcome free carrier absorption. High n-type doping and efficient carrier injection remain the most important issues for electrical excitation of lasing.

10:15–12:00
CFM • Optical Fiber Measurement
Ming-Jun Li, Corning, Inc. USA, Presider

CFM1 • 10:15
Theoretical Investigation of Length-Dependent Flicker-Phase Noise in Opto-electronic Oscillators, *Andrew Docherty[1], Olukayode Okusaga[2], Curtis Menyuk[1], Weimin Zhou[2], Gary M. Carter[1]; [1]Univ. of Maryland Baltimore County, USA; [2]U.S. Army Research Lab, USA.* We discuss possible sources for the experimentally-observed length-dependent phase noise in opto-electronic oscillators. We eliminate several possibilities and show that conversion of laser amplitude noise to phase noise is a likely candidate.

CFM2 • 10:30
All-normal-dispersion fiber lasers for frequency metrology, *Cagri Senel[1], Fatih Omer Ilday[1], Oguzhan Kara[2], Cengiz Birlikseven[3], Cihangir Erdogan[3], Ramiz Hamid[3]; [1]Physics, Bilkent Univ., Turkey; [2]Physics Engineering, Hacettepe Univ., Turkey; [3]National Metrology Inst., Turkey.* Development of an all-normal-dispersion Yb-doped fiber laser-based frequency comb is reported. Repetition-frequency stabilization to the cesium standard, amplitude and phase noise measurements indicate low-noise performance.

CFM3 • 10:45
Measurement Range Expansion in Brillouin Optical Correlation-Domain Analysis System, *Kwanil Lee[1], Ji Ho Jeong[1,2], Sang Bae Lee[1]; [1]Korea Inst. of Science and Technology, Republic of Korea; [2]Hanyang Univ., Republic of Korea.* We propose and experimentally demonstrate a novel method for extension of measurement range in a Brillouin optical correlation domain analysis (BOCDA) sensor system by cascading fibers with different Brillouin frequency shifts.

CFM4 • 11:00
High resolution S^2 mode imaging of photonic bandgap fiber, *A. DeSantolo[1], David J. DiGiovanni[1], F. V. DiMarcello[1], John M. Fini[1], M. Hassan[1], L. Meng[1], E. Monberg[1], Jeffrey W. Nicholson[1], R. Ortiz[1], R. Windeler[1]; [1]OFS Labs, USA.* Spatially and spectrally resolved mode imaging of a 19 cell photonic bandgap fiber with minimum loss at 1550 nm is demonstrated using a high resolution tunable laser and phosphor-coated CCD camera.

Room 317 — CLEO: QELS-Fundamental Science

10:15–12:00
QFF • Solitons and Nonlinear Waves
Amy Foster, Johns Hopkins Univ., USA, Presider

QFF1 • 10:15
Peregrine soliton in optical fiber-based systems, *Bertrand Kibler[1], Kamal Hammani[1], Julien Fatome[1], Christophe Finot[1], Guy Millot[1], Frederic Dias[2,3], Goery Genty[4], Nail Akhmediev[5], John M. Dudley[6]; [1]Laboratoire Interdisciplinaire Carnot de Bourgogne, France; [2]UCD School of Mathematical Sciences, Ireland; [3]CMLA, ENS Cachan, France; [4]Tampere Univ. of Technology, Finland; [5]Research School of Physics and Engineering, Australia; [6]Institut FEMTO-ST, France.* We report the first observation in optics of the Peregrine soliton, a novel class of nonlinear localized structure. Two experimental configurations are explored and the impact of non-ideal initial conditions is discussed.

QFF2 • 10:30
Time- and Frequency-Domain Measurements of Solitons in Subwavelength Silicon Waveguides Using Cross-correlation, *Wei Ding[1], Andrey Gorbach[1], William Wadsworth[1], Jonathan Knight[1], Dmitry Skryabin[1], Michael J. Strain[2], Marc Sorel[2], Richard De La Rue[2]; [1]Univ. of Bath, UK; [2]Univ. of Glasgow, UK.* Time-domain measurements of dispersion- and nonlinearity-induced chirpings of femtosecond pulses in silicon-on-insulator nanowires reveal nonlinear dispersion compensation. Spectral measurements show pronounced dispersive wave emission by solitons.

QFF3 • 10:45
Loss of Phase in the Interaction of Two Collapsing Beams, *Bonggu Shim[1], Samuel E. Schrauth[1], Moran Klein[2], Gadi Fibich[2], Alexander L. Gaeta[1]; [1]School of Applied and Engineering Physics, Cornell Univ., USA; [2]Department of Applied Mathematics, Tel Aviv Univ., Israel.* When two self-focusing beams with the fixed-initial-phase interact, we observe fluctuations in output mode profiles as predicted by simulations. We attribute these fluctuations to the loss of relative phase as the beams collapse.

QFF4 • 11:00
Magnetic Field Effects and Landau Solitons in Strained Photonic Graphene, *Mikael C. Rechtsman[1], Alexander Szameit[1], Mordechai Segev[1]; [1]Solid State Inst., Technion - Israel Inst. of Technology, Israel.* We show that strain can induce large magnetic field effects in "photonic graphene" (honeycomb photonic lattices) without time-reversal symmetry-breaking. Thus, we predict solitons bifurcating from Landau levels, and discuss how to observe them.

CLEO: QELS-Fundamental Science

Room 327

10:15–12:00
QFG • Single Photon Nano-Optics
Meir Orenstein, Technion Israel Inst. of Technology, Israel, Presider

QFG1 • 10:15
Ultra-bright and efficient single photon generation based on integrated nanodiamonds containing single defect centers, *Tim Schröder[1], Andreas W. Schell[1], Friedemann Gädeke[1], Günter Kewes[1], Thomas Aichele[1], Oliver Benson[1]; [1]Nano Optics Group, Inst. for Physics, Humboldt-Universität zu Berlin, Germany.* We present integrated, efficient single photon sources based on defect-centers in diamond as fundamental components for future implementations of quantum information technologies, achieving count rates of 2.4 Mcts/s and source efficiencies of 20.

QFG2 • 10:30
Efficient Single Photon Source at Telecommunication Wavelength, *Alexios Beveratos[1], David Elvira[1], Remy Braive[1], Richard Hostein[1], Matthieu Larqué[1], Bruno Fain[1], Gregoire Beaudoin[1], Luc Le Gratiet[1], Luc Le Gratiet[1], Jean-Christophe Girard[1], Christophe David[1], Zhao-Zhong Wang[1], Isabelle Robert-Philip[1], Izo Abram[1], Isabelle Sagnes[1], Ivan Maksymov[2], Mondher Besbes[2], Jean-Paul Hugonin[2], Philippe Lalanne[2]; [1]LPN-CNRS, France; [2]Laboratoire Charles Fabry de l'Institut d'Optique, France.* Single photon emission at telecom wavelength is observed in InAsP/InP QDs. These dots will be embedded in a metallic subwavelength plasmonic cavity allowing for broadband Purcell factors allowing the engineering of efficient entangled-photon sources

QFG3 • 10:45
Plasmonic Apertures: A Scalable Plasmonic Architecture for Enhanced Diamond Single Photon Sources, *Irfan Bulu[1], Birgit Hausmann[1], Jennifer Choy[1], Thomas Babinec[1], Marko Loncar[1]; [1]School of Engineering and Applied Sciences, Harvard Univ., USA.* We propose and demonstrate that plasmonic apertures provide a scalable architecture for diamond NV center applications. Our results show that emission rates can be enhanced up to 60 times with collection efficiencies up to %40.

QFG4 • 11:00
Single photons emitted by single quantum dots into waveguides: photon guns on a chip, *Thang B. Hoang[1], Johannes Beetz[2], Matthias Lermer[2], Martin Kamp[2], Sven Höfling[2], Laurent Balet[1,3], Nicolas Chauvin[1], Lianhe Li[3], Andrea Fiore[1]; [1]Applied Physics, COBRA Research Inst., Technical Univ. of Eindhoven, Netherlands; [2]Technische Physik and Wilhelm Conrad Röntgen Research Center for Complex Material Systems, Universität Würzburg, Germany; [3]Institut de photonique et d'électronique quantiques, Ecole Polytechnique Fédérale de Lausanne, Switzerland.* We report a study on single photons emitted by single quantum dots into ridge and photonic crystal waveguides using an extended micro-photoluminescence setup. Our results show promise for future applications in quantum photonic integrated circuits.

CLEO: Science & Innovations

Room 336

10:15–12:00
CFN • Novel Raman Sensing Techniques II
Terrence Meyer, Iowa State Univ., USA, Presider

CFN1 • 10:15
Double-Resonant Enhancement of Surface Enhanced Raman Scattering Using High Contrast Grating Resonators, *Vadim Karagodsky[1], Thai-Truong Tran[1], Ming Wu[1], Connie J. Chang-Hasnain[1]; [1]Department of Electrical Engineering and Computer Sciences, Univ. of California, Berkeley, USA.* We propose a high contrast grating double-resonator design, which can enhance SERS signal by $>10^5$ by simultaneously enhancing both the surface-normal incident pump and the Raman signal, whereby both enhancements are at the same spatial location.

CFN2 • 10:30
Plasmonic coupling of SiO_2-Ag "post-cap" nanostructures and silver film for surface-enhanced Raman scattering, *Hsin-Yu Wu[1], Brian T. Cunningham[1,2]; [1]Electrical and Computer Engineering, Univ. of Illinois at Urbana-Champaign, USA; [2]Bioengineering, Univ. of Illinois at Urbana-Champaign, USA.* We demonstrate a surface-enhanced Raman scattering substrate consisting of SiO_2–Ag "post-cap" nanostructures with an underlying silver film. Optimized coupling between Ag caps and the silver film results in a maximum enhancement factor of 2.38×10^9.

CFN3 • 10:45
Direct Imprinted Gratings on Nanoporous Gold as Effective SERS Substrates, *Yang Jiao[1], Judson Ryckman[1], Marco Liscidini[2], J. E. Sipe[3], Peter N. Ciesielski[4], Carlos A. Escobar[4], G. Jennings[4], Sharon M. Weiss[1]; [1]Department of Electrical Engineering and Computer Science, Vanderbilt Univ., USA; [2]Dipartimento di Fisica "A. Volta", Università degli Studi di Pavia, Italy; [3]Department of Physics and Inst. for Optical Sciences, Univ. of Toronto, Canada; [4]Department of Chemical and Biomolecular Engineering, Vanderbilt Univ., USA.* We demonstrate large area arrays of patterned nanoporous gold as effective surface enhanced Raman scattering (SERS) templates by using a direct imprinting process. The resulting substrates exhibit a 107 SERS enhancement factor for benzenethiol.

CFN4 • 11:00
Broadband polarization-insensitive arrayed waveguide gratings for Raman spectroscopy, *Nur Ismail[1], Fei Sun[1], Gabriel Sengo[1], Kerstin Worhoff[1], Alfred Driessen[1], Rene M. de Ridder[1], Markus Pollnau[1]; [1]IOMS, Univ. of Twente, Netherlands.* We present two arrayed waveguide gratings fabricated in silicon-oxynitride for near-infrared Raman spectroscopy. Our devices exhibit very low losses and polarization insensitivity over a large spectral range of 156 nm and 214 nm, respectively.

Room 337

10:15–12:00
CFO • Ultrafast Dynamics
Marcos Dantus, Michigan State Univ., USA, Presider

CFO1 • 10:15
SESAMs for high power oscillators: damage thresholds and design guidelines, *Clara Saraceno[1], Cinia Schriber[1], Mario Mangold[1], Martin Hoffmann[1], Oliver Heckl[1], Cyrill Baer[1], Matthias Golling[1], Thomas Südmeyer[1], Ursula Keller[1]; [1]ETH Zurich, Switzerland.* We present a systematic study of lifetime and damage of SESAMs for high-power oscillators, and give design guidelines. Optimized SESAMs with<0.1% nonsaturable losses withstand pulse fluences>0.2J/cm^2 and intensites>400GW/cm^2.

CFO2 • 10:30
Ultrafast nonlinear optical processes and free-carrier lifetime in silicon nanowaveguides, *Ali R. Motamedi[1], Amir H. Nejadmalayeri[1], Anatol Khilo[1], Franz X. Kaertner[1], Erich P. Ippen[1]; [1]Research Lab of Electronics, Department of Electrical Engineering and Computer Science, MIT, USA.* We report femtosecond studies of two-photon absorption, optical Kerr-effect and free-carrier index and loss in silicon nanowaveguides using heterodyne pump-probe. Proton bombardment reduced free-carrier lifetime to 33ps with only 8dB/cm added loss.

CFO3 • 10:45
Polarization anisotropy of transient carrier dynamics in single Si nanowires, *Minah Seo[1], Shadi A Dayeh[1], Prashanth C. Upadhya[1], S. T. Picraux[1], Julio A. Martinez[2], Brian S. Swartzentruber[2], Antoinette J. Taylor[1], Rohit P. Prasankumar[1]; [1]Los Alamos National Lab, USA; [2]Sandia National Laboratories, USA.* We present the first ultrafast time-resolved, polarization-dependent experiments on both single- and ensemble-silicon nanowires using non-degenerate spectroscopy. Anisotropy was observed for polarizations perpendicular and parallel to the nanowire.

CFO4 • 11:00
Multi Wavelength Characterization of Ultra Fast Carrier Dynamics in InAs/InP Quantum Dash Optical Amplifiers, *Amir Capua[1], Gadi Eisenstein[1], Johann P. Reithmaier[2]; [1]Electrical Engineering, Technion, Israel; [2]Technische Physik, Univ. Kassel, Germany.* Ultrafast cross saturation dynamics of inhomogeneously broadened InAs/InP quantum dash optical amplifiers were characterized by multi-wavelength pump probe spectroscopy. Carrier relaxation processes are identified and quantified for the first time.

Room 338

10:15–11:45
CFP • Measurement and Processing
Mark Feuer, AT&T Labs–Res., USA, Presider

CFP1 • 10:15
100-Gb/s RZ-DQPSK Signal Monitoring Using Time-stretch Enhanced Recording Oscilloscope, *Ali Fard[1], Jeng-Yuan Yang[2], Brandon Buckley[1], Jian Wang[2], Mohammad R. Chitgarha[2], Lin Zhang[2], Alan E. Willner[2], Bahram Jalali[1]; [1]Department of Electrical Engineering, Univ. of California Los Angeles, USA; [2]Department of Electrical Engineering, Univ. of Southern California, USA.* We report simultaneous I/Q-data monitoring of 100-Gb/s RZ-DQPSK signal using a two-channel time-stretch enhanced recording (TiSER) oscilloscope. TiSER offers a solution to monitoring of high bit rate data.

CFP2 • 10:30
All-optical logic gate for 160 Gbit/s DPSK signals in a highly nonlinear glass chip, *Trung D. Vo[1], Ravi Pant[1], Mark D. Pelusi[1], Jochen Schröder[1], Duk-Yong Choi[2], Sukhanta Debbarma[2], Stephen Madden[2], Barry Luther-Davies[2], Benjamin J. Eggleton[1]; [1]CUDOS, IPOS, School of Physics, Univ. of Sydney, Australia; [2]CUDOS, Laser Physics Centre, Australian National Univ., Australia.* We demonstrate a broadband/flexible wavelength operation photonic chip based all-optical XOR operation for 160 Gbit/s DPSK optical signals. This demonstrates the potential of broadband all-optical signal-processing on a chalcogenide (As_2S_3) chip.

CFP3 • 10:45 Invited
Automatic higher-order dispersion measurement and compensation of a 1.28 Tbaud signal, *Yvan Paquot[1], Jochen Schroeder[1], Jürgen Van Erps[2,1], Trung D. Vo[1], Mark D. Pelusi[1], Steve J. Madden[3], Duk-Yong Choi[3], Douglas A. Bulla[3], Barry Luther-Davies[3], Benjamin J. Eggleton[1]; [1]Centre for Ultrahigh-bandwidth Devices for Optical Systems (CUDOS), Australia; [2]Dept. of Applied Physics and Photonics, Vrije Universiteit Brussel, Belgium; [3]CUDOS, Laser Physics Centre, Australian National Univ., Canberra, Australia.* We present automatic and simultaneous compensation of combined higher-order dispersion and GVD fluctuations of a 1.28 Tbaud signal using a photonic-chip based RF-spectrum analyser and a spectral pulse-shaper.

Room 339

CLEO: QELS-Fundamental Science

10:15–12:00
QFH • Ion Traps and Nanomechanical Systems
Werner Vogel, Univ. Rostock, Germany, Presider

QFH1 • 10:15
A Cavity QED-Ion Trap System for a Scalable Quantum Network, *Le Luo[1], Andrew Manning[1], Jon Sterk[1], Chris Monroe[1]; [1]Joint Quantum Inst., Univ. of Maryland, USA.* We observe an enhancement of the spontaneous emission from a single trapped ytterbium ion into a cavity QED system. This technique helps to scale up an ion-photon quantum network.

QFH2 • 10:30
Microfabricated Surface Trap for Scalable Ion-Photon Interfaces, *Peter F. Herskind[1], Shannon X. Wang[1], Molu Shi[1], Yufei Ge[1], Marko Cetina[1], Isaac L. Chuang[1]; [1]MIT, USA.* We demonstrate a surface electrode ion trap microfabricated on top of a dielectric mirror, with the ion 169 μm above the trap surface. This represents a scalable approach to trapped ion quantum computing with photonic interconnects.

QFH3 • 10:45 Invited
Experimental repetitive quantum error correction with trapped ions, *Markus Hennrich[1], Philipp Schindler[1], Julio T. Barreiro[1], Thomas Monz[1], Volckmar Nebendahl[2], Daniel Nigg[1], Michael Chwalla[1], Rainer Blatt[1]; [1]Institut fuer Quantenoptik und Quanteninformation, Osterreichische Akademie der Wissenschaften, Austria; [2]Institut fuer Theoretische Physik, Universitaet Innsbruck, Austria.* For scalable quantum computation errors occurring during storage and processing need to be continuously corrected. Here we report on the experimental realization of repetitive quantum error correction with trapped ions.

NOTES

Room 318-320

CLEO: QELS-Fundamental Science

QFE • Active Plasmonics—Continued

QFE4 • 11:15
Photonic Crystal Nanolasers, Modulation and Coherence Characteristics, *Alexios Beveratos[1], Remy Braive[1], Richard Hostein[1], David Elvira[1], Xavier Hachair[1], Sylvain Barbay[1], Izo Abram[1], Isabelle Sagnes[1], Gregoire Beaudoin[1], Anne Talneau[1], Luc Le Gratiet[1], Isabelle Robert-Philip[1]; [1]LPN-CNRS, France.* We demonstrate coherent emission at 300K and at 1.55μm from photonic crystal nanolasers under gain-switched operation. 10GHz gain switching operation has been achieved with bit-pattern independent chirp.

QFE5 • 11:30
Optical Amplification of Propagating Surface Plasmon Polaritons, *Malte C. Gather[1,2], Norbert Danz[3], Klaus Meerholz[4], Kristjan Leosson[1]; [1]Science Inst., Univ. of Iceland, Iceland; [2]Wellman Center, Harvard Medical School, USA; [3]Fraunhofer Inst. for Applied Optics and Precision Engineering IOF, Germany; [4]Dept. of Chemistry, Univ. of Cologne, Germany.* We demonstrate amplified spontaneous emission of long-range surface plasmon polaritons in planar metallic waveguides embedded in a fluorescent polymer. A net gain coefficient of 8±2 /cm has been realized for propagation up to 2 mm.

QFE6 • 11:45
Surface plasmon assisted stimulated emission on smooth and corrugated silver surfaces, *John Kitur[1], Mikhail Noginov[1], Guohua Zhu[1]; [1]Norfolk State Univ., USA.* We study surface-plasmon-assisted stimulated emission of Rhodmine 6G and Rhodamine B laser dyes and find a striking difference of the stimulated emission behavior on smooth and corrugated silver surfaces.

Room 321-323

CLEO: Science & Innovations

CFI • Photonic Crystal Devices—Continued

CFI5 • 11:15
Multiply Resonant Photonic Crystal Nanocavities with Broadband Tunability, *Sonia Buckley[1], Kelley Rivoire[1], Jelena Vuckovic[1]; [1]Stanford Univ., USA.* A photonic crystal cavity allowing at least two separately tunable resonances is designed. Both frequency degenerate structures and structures with frequency separations of up to 500 nm are experimentally demonstrated.

CFI6 • 11:30
Photonic Bandgap Fusion by Magnetically Aligned 3D Photonic Bandgap Structures, *Hyoki Kim[1,2], Eun-Geun Kim[1,2], Sung-Eun Choi[1,2], Lily N. Kim[1,2], Sunghoon Kwon[1,2]; [1]Electrical Engineering and Computer Science, Seoul National Univ., Republic of Korea; [2]InterUniv. Semiconductor Research Center, Republic of Korea.* We demonstrate the photonic bandgap fusion by the sequential self-assembly of superparamagnetic nanoparticle and ultra-violet(UV) exposure.

CFI7 • 11:45
Bottom-up photonic crystal cavities formed by III-V nanopillar arrays, *Adam Scofield[1], Joshua N. Shapiro[1], Andrew Lin[1], Alex D. Williams[1], Ping-Show Wong[1], Baolai Liang[1], Diana L. Huffaker[1]; [1]Electrical Engineering, Univ. of California Los Angeles, USA.* We present the optical properties of bottom-up photonic crystal cavities formed by selective-area epitaxy of III-V nanopillars. Photoluminescence spectra demonstrates influence of the photonic band-gap on the emission. Resonant cavity modes are observed.

Room 324-326

CFJ • Optical Components—Continued

CFJ4 • 11:15
Hybrid-Integrated and Polarization Insensitive 25-Gbaud/s D(Q)PSK Receiver Based on Polymer PLC, *Jin Wang[1], Crispin Zawadzki[1], Nelson Mettbach[1], Walter Brinker[1], Detlef Schmidt[1], Ziyang Zhang[1], Norbert Grote[1], Martin Schell[1], Norbert Keil[1]; [1]Photonics component, Fraunhofer Heinrich Hertz Inst., Germany.* We demonstrate a DPSK receiver with a 2x25 GHz photodiode array hybrid-integrated on polymer PLC via 45° mirrors. With a half-wave plate and micro-heaters, the polarization-dependent frequency-shift of the delay-line interferometer can be eliminated.

CFJ5 • 11:30
Design of a Novel, Cost-Effective Wide Field-Of-View Surface-Normal Optical Phased Array, *Harish Subbaraman[1], Amir Hosseini[2], Xiaochuan Xu[2], Yang Zhang[2], Ray T. Chen[2]; [1]Omega Optics, Inc, USA; [2]Electrical and Computer Engineering, The Univ. of Texas at Austin, USA.* We propose a novel surface-normal slow-light photonic crystal waveguide optical phased array that can provide high speed (~MHz), wide angle (>45degreex45degree) beam scanning capability, with a reduced fabrication effort.

CFJ6 • 11:45
Adaptive Wavefront Aberration Correction in a Free-Space Fiber-Optic System based only on the Received Power, *David Sinefeld[1], Roy Ella[1], Ofer Zaharan[1], Yuval Valiano[1], Eliezer Mach[1], Dan M. Marom[1]; [1]Applied Physics, Hebrew Univ. of Jerusalem, Israel.* We introduce adaptive wavefront aberration compensation in a free-space communication system, using solely the fiber-coupled power metric. A custom algorithm operating a spatial light modulator is able to recover from losses as high as -30dB.

Room 314

CFK • Optical Frequency Combs—Continued

CFK2 • 11:15
Ultrabroadband Frequency Comb Generation at 1 μm in a Silicon-Nitride Ring Resonator, *Yoshitomo Okawachi[1], Kasturi Saha[1], Jacob S. Levy[2], Mark A. Foster[3], Michal Lipson[2,4], Alexander L. Gaeta[1]; [1]Applied and Engineering Physics, Cornell Univ., USA; [2]Electrical and Computer Engineering, Cornell Univ., USA; [3]Electrical and Computer Engineering, Johns Hopkins Univ., USA; [4]Kavli Inst. at Cornell for Nanoscale Science, Cornell Univ., USA.* We demonstrate broadband frequency comb generation from a single-frequency pump laser at 1 μm using parametric oscillation in a silicon nitride ring resonator. The comb spans 97 THz with a 230-GHz free spectral range.

CFK3 • 11:30
Optical frequency comb with sub-radian CEO phase noise from a SESAM-modelocked 1.5-μm solid-state laser, *Stephane Schilt[1], Vladimir Dolgovskiy[1], Nikola Bucalovic[1], Lionel Tombez[1], Max Stumpf[1,2], Gianni Di Domenico[1], Christian Schori[1], Selina Pekarek[2], Andreas E. H. Oehler[2], Thomas Südmeyer[2], Ursula Keller[2], Pierre Thomann[1]; [1]Laboratoire Temps-Fréquence, Université de Neuchâtel, Switzerland; [2]Inst. of Quantum Eletronics, ETH Zurich, Switzerland.* The noise properties of a fully stabilized 1.5-μm diode-pumped solid-state laser frequency comb are analyzed. The locked CEO-beat has an integrated phase noise of ~0.75 rad and the optical carrier stability is $5x10^{-13}$ at 1 sec.

CFK4 • 11:45
Attosecond Ti:Sapphire Pulse Train Phase Noise, *Andrew Benedick[1], Umit Demirbas[1], Duo Li[1], James G. Fujimoto[1], Franz X. Kaertner[1]; [1]Department of Electrical Engineering and Computer Science and Research Lab of Electronics, Massachusetts Inst. of Technology, USA.* Optical pulse trains from solid-state mode-locked lasers are expected to exhibit extremely low levels of phase noise. An optical measurement technique demonstrates an integrated phase noise of 20 as, 10 MHz to 4 kHz.

Room 315

CLEO: Science & Innovations

CFL • Novel Semiconductor Laser Materials—Continued

CFL4 • 11:15
Optical gain in GaInNAs and GaInNAsSb quantum wells, *Peter Blood[1], James Ferguson[1], Peter M. Smowton[1], Hopil Bae[2], Tomas Sarmiento[2], James S. Harris[2], Nelson Tansu[3], Luke J. Mawst[4]; [1]Physics and Astronomy, Cardiff Univ., UK; [2]Solid State Physics Lab, Stanford Univ., USA; [3]Electrical and Computer Engineering, Lehigh Univ., USA; [4]Electrical and Computer Engineering, Univ. of Wisconsin-Madison, USA.* Experiments show that 1.55micron GaInNAsSb wells have improved gain-radiative current characteristics over 1.3micron GaInNAs, one factor being less inhomogeneous broadening, suggesting that Sb could bring benefits for 1.3micron devices.

CFL5 • 11:30
Characteristics of GaN-based Vertical Cavity Surface Emitting Lasers with Hybrid Mirrors, *Tien-Chang Lu[1], Bo Siao Cheng[1], Tzeng-Tsong Wu[1], Shih-Wei Chen[1], Chien-Kang Chen[1], Cheng-Hung Chen[1], Bo-Min Tu[1], Zhen-Yu Li[1], Hao-chung Kuo[1], Shing-chung Wang[1]; [1]National Chiao Tung Univ., Taiwan.* We demonstrated CW current injection of GaN VCSELs with hybrid mirrors at room temperature. The laser characteristics, such as temperature dependent laser threshold current, spontaneous emission coupling factors, have been measured and discussed.

CFL6 • 11:45
Optical Gain and Green/Red Vertical Cavity Surface Emitting Lasing from CdSe-based Colloidal Nanocrystal Quantum Dot Thin Films, *Cuong Dang[1], Arto Nurmikko[1], Craig Breen[2], Jonathan Steckel[2], Seth Coe-Sullivan[2]; [1]School of Engineering, Brown Univ., USA; [2]QD Vision, USA.* We demonstrate robust excitonic gain from colloidal close-packed, CdSe-based QD thin films at record low threshold excitation energy of 90 μJ/cm^2 for ASE. The optical gain is employed in pulsed optically pumped quantum dot VCSEL.

Room 316

CFM • Optical Fiber Measurement—Continued

CFM5 • 11:15
Index Phase Profile and Pitch Measurement Technique of Fiber Bragg Gratings using UV-induced Blue Luminescence, *S. Tsyier[1], P. Yvernault[2], A. Millaud[2], I. Fsaifes[3], Y. Jaouën[1], R. Gabet[1], M. Douay[3]; [1]Institut Télécom/Télécom Paristech, UMR CNRS, France, [2]3S Photonics, France, [3]Laboratoire PhLAM, UMR CNRS 8523, IRCICA, Univ. de Lille 1, France.* We report experimental results on a phase and pitch (chirp) measurement technique of local index modulation along fiber-Bragg gratings, based on UV-induced blue luminescence. Experiments show good agreement compared to Bragg grating reconstruction by Layer-Peeling.

CFM6 • 11:30
Optical low-coherence interferometry for reconstruction of the modal-content in few-mode fibers, *Damian Schimpf[1], Roman Barankov[1], Kim Jespersen[2], Siddharth Ramachandran[1]; [1]Boston Univ. Photonics Center, USA; [2]OFS Fitel Denmark, Denmark.* A novel method for reconstructing the dispersion-corrected modal content of fibers is demonstrated. It provides the weights, profiles, group-delays, and dispersion of all the modes without making assumptions about the fiber under test.

CFM7 • 11:45
Low Distortion and High SNR Analog Signal Multicasting Using Self-Seeded Parametric Mixer, *Andreas O. Wiberg[1], Camille Bres[1], Alexander Danicic[1], Daniel J. Blessing[1], Evgeny Myslivets[1], Stojan Radic[1]; [1]Electrical and Computer Engineering, Univ. of California San Diego, USA.* We present noise and distortion measurements of multicast copies generated in a self-seeded parametric mixer. Linear mixer operation by distortion free SBS suppression results in high signal-to-noise and -distortion-ratio wavelength copies compatible for analog processing.

Room 317

CLEO: QELS-Fundamental Science

QFF • Solitons and Nonlinear Waves—Continued

QFF5 • 11:15
Spectral properties of laser solitons in coupled semiconductor resonators, *Patrice Genevet[1], Stéphane Barland[1], Massimo Giudici[1], Jorge R. Tredicce[1]; [1]Université de Nice sophia-Antipolis, Institut non linéaire de Nice, France.* We report on the multistable emission frequency of laser solitons and show that independent laser solitons are not mutually coherent while the peaks of a cluster have a well established mutual phase relationship.

QFF6 • 11:30
Emergence of rogue waves from optical turbulence, *Kamal Hammani[1], Bertrand Kibler[1], Christophe Finot[1], Antonio Picozzi[1]; [1]Laboratoire Interdisciplinaire Carnot de Bourgogne, France.* We show the emergence of rogue wave events from optical turbulence by analyzing the long term evolution of the field. In particular, we identify three turbulent regimes depending on the incoherence in the system.

QFF7 • 11:45
Can Quadratic Solitons Self-Accelerate? *Ido Kaminer[1], Moti Segev[1], Demetrios Christodoulides[2]; [1]Physics Department and Solid State Inst., Technion, Israel; [2]CREOL - College of Optics & Photonics, Univ. of Central Florida, USA.* We present accelerating self-trapped first- and second- harmonic beams in a phased-matched quadratic process. The acceleration results from the beams inner structure, which exhibit asynchronous interference and irregular power distribution.

Room 327

CLEO: QELS-Fundamental Science

QFG • Single Photon Nano-Optics—Continued

QFG5 • 11:15
Manipulation of Coupling Between Individual Nanoparticles, *Daniel Ratchford[1], Farbod Shafiei[1], Suenne Kim[1], Stephen Gray[2], Xiaoqin Li[1]; [1]Physics, Univ. of Texas at Austin, USA; [2]Chemistry Division and Center for Nanoscale Materials, Argonne National Lab, USA.* We investigate the emission dynamics of a single semiconductor quantum dot near a single Au nanoparticle. Due to coupling between the nanoparticles, the quantum dot exhibits a strong polarization dependence and reduced blinking.

QFG6 • 11:30
Nanocavity enhanced diamond nitrogen-vacancy center zero phonon line emission, *Paul Barclay[1,2], Kai-Mei Fu[3,4], Andrei Faraon[3], Charles Santori[3], Raymond G. Beausoleil[3]; [1]Physics and Astronomy, Univ. of Calgary, Canada; [2]National Inst. for Nanotechnology, NRC, Canada; [3]Hewlett-Packard Labs, USA; [4]Univ. of Washington, USA.* Resonantly enhanced emission of the zero phonon line of a diamond nitrogen-vacancy center in single crystal diamond is demonstrated experimentally using a hybrid whispering gallery mode nanocavity.

QFG7 • 11:45
Photon antibunching from diamond nitrogen-vacancy centers inside a dielectric micropillar cavity, *Katja Beha[1], Anton Batalov[1], Hauke Harms[1], Christopher Hinz[1], Tim Thomay[1], Fedor Jelezko[2], Joerg Wrachtrup[2], Alfred Leitenstorfer[1], Rudolf Bratschitsch[1]; [1]Department of Physics and Center of Applied Photonics, Univ. of Konstanz, Germany; [2]Inst. of Physics, Univ. of Stuttgart, Germany.* Diamond nanocrystals with single nitrogen-vacancy color centers are incorporated into dielectric micropillar resonators. We observe three-dimensional light confinement and antibunching in the photon emission.

Room 336

CLEO: Science & Innovations

CFN • Novel Raman Sensing Techniques II—Continued

CFN5 • 11:15
Surface Enhanced Raman Scattering Using Planar Dielectric Structures, *Aida Delfan[1], J. E. Sipe[1], Marco Liscidini[2]; [1]Department of Physics and Inst. of Optical Science, Univ. of Toronto, Canada; [2]Department of Physics "A. Volta" and CNSIM UdR Pavia, Univ. of Pavia, Italy.* We predict that large enhancement of spontaneous Raman scattering cross section can be achieved in an experimental scenario where the molecules are placed on planar dielectric structures supporting guided modes or Bloch Surface Waves.

CFN6 • 11:30
Temperature dependence of surface-enhanced Raman scattering on nanostructured plasmonic surfaces, *James T. Hugall[1], Sumeet Mahajan[1], Jeremy J. Baumberg[1]; [1]NanoPhotonics Centre, Cavendish Lab, Univ. of Cambridge, UK.* SERS of sub-monolayers of benzenethiol and quantum dots are studied over a wide temperature range on plasmonic nanostructures. Unusual changes are observed in the background shape and intensity as well as the vibrational signals.

CFN7 • 11:45
A New Approach for Fluorescence Subtraction in Raman Spectroscopy, *Qun Li[1], Kerith R. Wang[1], Sean X. Wang[1]; [1]B&W TEK, Inc., USA.* We report a new approach to extract weak Raman signal from a strong fluorescence background. The method utilizes a double-excitation technique with a laser and an LED as the excitation light sources.

Room 337

CFO • Ultrafast Dynamics—Continued

CFO5 • 11:15
Single-Shot Time-Frequency Imaging of Phonon-Polariton Dispersion in Ferroelectric $LiNbO_3$, *Ikufumi Katayama[1], Hiroyuki Sakaibara[2], Hideki Ichida[3], Yasuo Kanematsu[3], Jun Takeda[2]; [1]Interdisciplinary Research Center, Yokohama National Univ., Japan; [2]Graduate School of Engineering, Yokohama National Univ., Japan; [3]Center for Advanced Science and Innovation, Osaka Univ., Japan.* Single-shot observation of phonon-polariton dispersion in $LiNbO_3$ is demonstrated using optical Kerr-gate method with an echelon mirror. Forward- and backward- propagating phonon-polaritons are observed in the time-frequency two-dimensional image.

CFO6 • 11:30
Second Harmonic Nanoprobes for Femtosecond Laser Pulse Characterization in Complex Microstructures, *Haifeng Li[1], Zhe Zhang[1,2], Qian Xu[1], Kebin Shi[1], Yaoshun Jia[3], Baigang Zhang[3], Yong Xu[3], Zhiwen Liu[1]; [1]Electrical Engineering department, The Pennsylvania State Univ., USA; [2]College of Precision Instrument and Optoelectronics Engineering, Tianjin Univ., China; [3]Department of Electrical and Computer Engineering, Virginia Tech, USA.* Femtosecond pulse characterization in air-core region of a photonic crystal fiber is presented. The proposed nanoprobe can be a promising candidate for probing optical fields at nano-femto spatiotemporal scale in complex 3D micro- or nanostructures

CFO7 • 11:45
Lighthouse ultrafast spectroscopy: high speed scanning with a spinning birefringent delay crystal, *Randy Bartels[1,2], Jesse Wilson[1]; [1]Electrical and Computer Engineering, Colorado State Univ., USA; [2]Department of Chemistry and Biomedical Engineering, Colorado State Univ., USA.* A simple method for high speed pump probe spectroscopy that maintains interferometric stability is presented. The lighthouse scanner demonstrates significant improvement ultrafast nonlinear spectroscopy signal to noise level by averaging large number of scans.

Room 338

CFP • Measurement and Processing—Continued

CFP4 • 11:15
Autonomous Optical Buffer with Function of Storing Multiple Packets in Each of Fiber Delay Lines, *Hiroki Kishikawa[1], Hirotaka Umegae[1], Yoshitomo Shiramizu[2], Jiro Oda[2], Nobuo Goto[1], Shinichiro Yanagiya[1]; [1]The Univ. of Tokushima, Japan; [2]Toyohashi Univ. of Technology, Japan.* An autonomous first-in-first-out buffering system consisting of feedback-looped parallel fibers is proposed. Each fiber can store multiple packets. Buffering performances such as packet loss rate and delay time are improved compared to previously reported system.

CFP5 • 11:30
Very Simple Tunable Optical Data Storage of 8Bit 1Gbps Data Packets Up to 500ns, *Stefan Preussler[1], Kambiz Jamshidi[1], Andrzej Wiatrek[1], Thomas Schneider[1]; [1]Hochschule fuer Telekommunikation Leipzig, Germany.* We propose the tunable storage of 8Bit data packets for up to 500ns by extension of the Quasi-Light-Storage method. Easy tuning of the storage time in the whole range is possible using conventional telecommunication components.

Room 339

CLEO: QELS-Fundamental Science

QFH • Ion Traps and Nanomechanical Systems—Continued

QFH4 • 11:15

Quantum Optomechanical Measurement of the Phonon Number Dynamics of a Mesoscopic Mechanical Resonator, *Adil A. Gangat[1], Tom M. Stace[1], Gerard J. Milburn[1]; [1]Physics, Univ. of Queensland, Australia.* We analyse the generic case of an optomechanical system with coupling quadratic in the mechanical displacement. Using the stochastic master equation formalism, we establish constraints necessary to observe quantum jumps in the phonon number.

QFH5 • 11:30

Controlled optomechanical quantum phase gate of phonon states, *Jing Shu[1,2], Chee Wei Wong[1], Jie Gao[1], Ying Li[1], Jiangjun Zheng[1]; [1]Columbia Univ., USA; [2]Nanjing Univ. of Science and Technology, China.* We describe a scalable optomechanical array, with double-disk resonators, for two-qubit quantum phase gate of phonon states where mechanical systems exhibit significantly long lifetime. Simulation results show high fidelity and low photon loss.

QFH6 • 11:45

Cooling of a Micromechanical Oscillator into the Quantum Regime, *Stefan Weis[1,2], Rémi Rivière[2], Samuel Deléglise[1,2], Ewold Verhagen[1], Emanuel Gavartin[1], Olivier Arcizet[3], Albert Schliesser[1,2], Tobias Kippenberg[1,2]; [1]Ecole Polytechnique Fédérale de Lausanne, Switzerland; [2]Max-Planck-Institut für Quantenoptik, Germany; [3]Institut Neél, France.* Using optical sideband cooling, a micromechanical oscillator is cooled to a phonon occupancy below 10 phonons, corresponding to a probability of finding it in its quantum ground state more than 10% of the time.

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