QMA1 • 8:00 a.m. ❖ Invited Engineering Optical Space with Metamaterials, Vladimir M. Shalaev, A. V. Kildishev, Yu. P. Drachev, W. Cai, H. K. Yuan, U. Chetia, A. V. Bolnassar; Purdue Univ., USA, "Technical Univ. of Denmark, Denmark. Metamaterials-enabled transformation optics allows one to engineer space for light, with a family of new "metadevices." By designing required distributions of material parameters on can arbitrarily "curve" optical path and control light in unprecedented way.

QMA2 • 8:30 a.m. ❖ Invited Metal-Dielectric Layered Nanoostructures as Epsilon-Near-Zero (ENZ) Circuit Boards for Optical Nanocircuits, Nader Engheta, Andrea Alù; The Technion, Israel, "Purdue Univ., USA, "Cornell Univ., USA. We report on an ytterbium-doped, single-polarization, single-mode large-mode-area rod-type PCF. The active core possesses a diameter of 70 µm and a single-polarization window ranging from 1030-1090 nm. In a laser experiment 163 W of output power are obtained.

QMA3 • 8:45 a.m. Contribution of Electric Quadrupole Resonance in Optical Metamaterials, David J. Cho, Feng Wang, Xiang Zhang, Y. Ran Shen; Univ. of California at Berkeley, USA. Contribution of electric quadrupole resonance is studied in optical metamaterials through numerical simulation. For nanoostructures, its radiation is often comparable to that from magnetic dipole. Their individual contributions can be determined by angle-resolved scattering spectroscopy.

Ballroom A1 and A8

QELS

8:00 a.m.–9:45 a.m. QMA • Metamaterials I Presider to Be Announced

Ballroom A2 and A7

JOINT

8:00 a.m.–9:30 a.m. JMA • Joint CLEO/QELS Symposium on Novel Resonators: Superconducting Cavities and Cqubits Markus Aspelmeyer; Austrian Acad. of Sciences, Austria, Presider

Ballroom A3 and A6

CLEO

8:00 a.m.–9:45 a.m. CMA • High-Power Fiber Lasers Andy Chong, Cornell Univ., USA, Presider

Ballroom A4 and A5

8:00 a.m.–9:45 a.m. CMB • Large Mode Area Fibers Liang Dong; IMRA America Inc., USA, Presider

JMA1 • 8:00 a.m. Quantum Information with Superconducting Cqubits and Cavities, Raymond W. Simmonds; NIST, USA. We have implemented cavity quantum-electrodynamic dynamics, in the strong coupling regime, using superconducting phase qubits and a resonant transmission line cavity. We have observed coherent quantum interactions with cavity decay times over 1 microsecond.

JMA2 • 8:30 a.m. Superconducting Microwave Cavities as Quantum Nanomechanical Transducers, Gerard J. Milburn, 1 M. I. Woolley, 1 A. C. Doherty, 2 K. C. Schwab; 1Univ. of Queensland, Australia, "Cornell Univ., USA. We show how a superconducting coplanar microwave cavity can be used as a quantum limited displacement transducer for a nanomechanical resonator by demonstrating that nanomechanical squeezing can be detected in the cavity field.

CMA1 • 8:00 a.m. Cladding-Pumped Distributed Feedback Phosphate Glass Fiber Lasers, Li Lei, Axel Schulzgen, Valery L. Tempskii, J. Spiegelberg, Dan T. Nguyen, Xiuduan Zhu, Jerome V. Moloney, Jacques Albert; Nauer Phenomenan; "College of Optical Sciences, Univ. of Arizona, USA, "NP Photonics Inc., USA, "Dept. of Electronics, Carleton Univ., Canada. Distributed feedback (DBF) phosphate glass fiber lasers that are cladding pumped with multimode diodes have been demonstrated. Single and cascaded DBF lasers with outputs up to 160 mW and 1 W, respectively, have been achieved.

CMA2 • 8:15 a.m. Wavelength Selection in High-Power Cladding-Pumped Er,Yb and Yb Fiber Lasers Using Volume Bragg Gratings, Ji Won Kim, Pär Jöger; Pu Wang, J. K. Sahra, Fredrik Laurell, W. A. Clarkson; "Optoelectronics Res. Ctr., Univ. of Southampton, UK, "Dept. of Applied Physics, Royal Inst. of Technology, Sweden. We report high-power operation of double-clad Yb-doped and Er,Yb-doped fiber lasers at 1066 nm and 1553 nm, respectively, using volume Bragg gratings for wavelength selection. Both lasers yielded output powers over 100 W limited by available pump power.

CMA3 • 8:30 a.m. Suppression of Self-Pulsations in Dual-Clad, Ytterbium Doped Fiber Lasers, Weihua Guan, John R. Marcozzi, Inst. of Optics and Lab for Laser Engineering, Univ. of Rochester, USA. Regimes of self-pulsing in fiber lasers have been characterized. Experiments show that the addition of a long section of passive fiber in the laser cavity can stabilize the laser and largely suppress the self-pulsations.

CMB1 • 8:00 a.m. Invited Effectively Single-Mode Large Core Passive and Active Fibers with Chirally Coupled-Core Structures, Almantas Galvanauskas, M. Craig Swan, Chi-Hung Liu; Univ. of Michigan, USA. Chirally coupled-core fibers with core sizes well exceeding those of conventional LMA provide robust single-mode output irrespective of mode excitation and fiber coating, are spicable and can preserve mode-area in tight bends and reduce nonlinear effects.

CMB2 • 8:30 a.m. Single-Polarization Large-More Area Yb-Doped Photonic Crystal Fiber, Oliver Schmidt, Ian Rathbun, Tino Eikard, Fabian Röser, Jens Limper; Andreas Tümmermann, Kim P. Hansen, C. Jakobsen; "Inst. of Applied Physics, Friedrich-Schiller-Univ. Jena, Germany, "Crystal Fibre A/S, Denmark. We report on an ytterbium-doped, single-polarization, single-mode large-mode-area rod-type PCE. The active core possesses a diameter of 70 µm and a single-polarization window ranging from 1030-1090 nm. In a laser experiment 163 W of output power are obtained.

CMB3 • 8:30 a.m. Single-Mode Laser Emission from a Multimode Core Surrounded by a Tailored Cladding, Laute Laroute, Philipp Bay, Sebastian Furrer, Raphaël Lamière, Kay Schüster, Jens Kohlke, Stephan Grimm; "XLIM, Unité Mixte de Recherche, Ctr. Natl. de la Recherche Scientifique, Univ. de Limoges, France, "IPHT, Inst. of Photonics Technology, Germany. We report the transversally-single-mode laser emission from a large ytterbium-doped core exhibiting a normalized frequency of 7.25. Strong interaction between the core and an array of high refractive index rods leads to single-mode emission.
Room C1 and C2

**QELS**

8:00 a.m.–9:45 a.m.

**QMB • Foundations of Quantum Mechanics**

John Howell; Univ. of Rochester, USA, Presider

QM1 • 8:00 a.m.

Experimental Demonstration of Macroscopic Quantum Coherence in Gaussian States, Christoph Marquardt1, Ulrik L. Andersen1,2, Gerid Leuchs3, Yuishi Takeno1, Mitsuyoshi Yukawa1, Hidehiro Yonezawa1, Akira Furusawa1; Inst. of Optics, Information and Photonics, Germany, 1Dept. of Physics, Technical Univ. of Denmark, Denmark, 2Dept. of Applied Physics, Univ. of Tokyo, Japan. We experimentally proved the existence of macroscopic coherences in Gaussian quantum states using a criterion by Cavalcanti and Resid. We show coherences with remarkable distances in phase space for squeezed, entangled and even coherent states.

QM2 • 8:15 a.m.

The CHSH-Bell Inequality and Tseretilson’s Bound with Postselection, Dominic W. Berry1, Hyunsuk Jang2, Magdalena Stobińska3, Timothy C. Ralph4; Ctr for Quantum Computer Technology, Macquarie Univ., Australia, 1Ctr. for Quantum Computer Technology. Dept. of Physics, Univ. of Queensland, Australia, 2Inst. Fizyki Teoretycznej, Poland. We show the necessary and sufficient conditions on loss for valid CHSH-Bell experiments, and propose an experiment with loss which should violate Tseretilson’s bound for entangled states.

QM3 • 8:30 a.m.

Entanglement, Decoherence and Quantum Information, Luis Davidovich; Univ. Federal do Rio de Janeiro, Brazil. Multiphoton entangled states are important for quantum cryptography, quantum computation, precise measurements and subtle tests of quantum mechanics. I will review recent progress in this area, emphasizing some basic applications and the role of decoherence.

Luis Davidovich got his Ph.D. at the University of Rochester, NY, USA, in 1976. He is a member of the Brazilian Academy of Sciences, the Academy of Sciences for the Developing World and foreign associate of the National Academy of Sciences (USA). He works on quantum optics and quantum information.

Room C3 and C4

**CLEO**

8:00 a.m.–9:45 a.m.

**CMC • Precision Optical Metrology**

Erich Ippen; MIT, USA, Presider

CMC1 • 8:00 a.m. 

Tutorial

Metrology with Cold Atoms, Mark Kasevich; Stanford Univ., USA. Abstract, biography and photo not available.

CMC2 • 8:15 a.m.

Terahertz Transmission through Rectangular Apertures: Far- and Near-Field Studies, D. S. Kim1, J. W. Lee2, M. A. Seo1, A. J. L. Adam3, D. H. Kang4, J. H. Kang5, Q. H. Park5, P. C. M. Planken6; 1Seoul Natl. Univ., Republic of Korea, 2Univ. of Technology Delft, Netherlands, 3Univ. of Technology, Delft, Netherlands, 4Seoul Natl. Univ., Republic of Korea, 5Univ. of Technology, Republic of Korea. We report that the terahertz transparency occurs at the fundamental shape resonance of the rectangular holes regardless of the areal coverage. The funneling of energy at the fundamental resonance is also confirmed at the near-field.

Room B1 and B2

**QELS**

8:00 a.m.–9:45 a.m.

**CMD • THz Near-Field Optics and Plasmonics**

John F. O’Hara; Los Alamos Natl. Lab, USA, Presider

CMD1 • 8:00 a.m.

Spectral Effects in Terahertz Apertureless Near-Field Microscopy, Victoria Astley, Hui Zhan, Daniel M. Mittleman; Rice Univ., USA. We observe dramatic changes in the spectrum of radiation scattered from a near-field tip with decreasing tip-sample distance. This arises from a balance between direct tip scattering and signals associated with the near-field image dipole.

CMD2 • 8:15 a.m.

Sub-Wavelength Measurements of the Near-Field of a Metal Aperture, Aurèle Adam1, Min Ah Seo1, Kwang hun Ahn1, Dai Sil Kim2, B Han Kang2, Q Han Park3, Michael Nagel4, Paul Planten5; 1Univ. of Technology Delft, Netherlands, 2Univ. of Technology, Delft, Netherlands, 3Univ. of Technology, Republic of Korea, 4Korea Univ., Republic of Korea. We measure the THz near-field measurements of sub-wavelength apertures in metal films. Our results allow us to test, with unprecedented detail, the near-field predictions made by the well-known Berthe-Bouwkamp model.

CMD3 • 8:30 a.m.

Enhanced Transmission through Subwavelength Aperture Arrays with Short Range Order, Amit R. Agrawal1, Tsutomichi Matsui1, Vitaly Vardeny1, Ajay Shah2; Dept. of Electrical and Computer Engineering, Univ. of Utah, USA, 1Dept. of Electrical and Computer Engineering, Mic Univ., Japan, 2Physics Dept., Univ. of Utah, USA. We measure the THz transmission properties of subwavelength aperture arrays that possess short-range order (SRO), but lack long-range order (LRO). We demonstrate that transmission enhancement still occur through these structures despite the absence of LRO.

CMD4 • 8:45 a.m.

Aperture Arrays with Short-Range Order, Tatsunosuke Matsui1, Kwang Jun Ahn2, P. C. M. Planken3; 1Univ. of Technology Delft, Netherlands, 2Univ. of Technology, Republic of Korea, 3Univ. of Technology, Delft, Netherlands. We report that the terahertz transparency occurs at the fundamental shape resonance of the rectangular holes regardless of the areal coverage. The funneling of energy at the fundamental resonance is also confirmed at the near-field.

Room J2

**QELS**

8:00 a.m.–9:45 a.m.

**QMC • Nonlinear Optics and Resonators**

Charles C. Harb; Univ. of New South Wales, Australia, Presider

QMC1 • 8:00 a.m. 

Invited

Broadband Cascaded Four-Wave Mixing in High-Q Silica Microspheres, Imad H. Agha, Yoshitomo Okawachi, Alexander L. Gaeta; School of Applied and Engineering Physics, Cornell Univ., USA. We demonstrate broadband, continuous-wave cascaded four-wave mixing parametric oscillation in the anomalous dispersion regime of a high-Q silica microsphere with an overall bandwidth greater than 100 nm and spectral features smaller than 10 MHz.

QMC2 • 8:30 a.m.

Surface Nonlinear Light Generation in the Whispering Gallery Modes of Spherical Microresonators, Jorge Luis Dominguez-Juarez1, Gregory Kazymyrov2, Jordi Martorell1,3; Inst. de Ciencies Fotoniques, Spain, 2Univ. Politecnica de Catalunya, Spain, 3Univ. Libre de Bruxelles, Belgium. We measured second harmonic generation in the whispering gallery modes of a microspherical cavity from a monolayer of nonlinear molecules on the sphere surface. Such monolayer is placed with the appropriate configuration for phase matching.

QMC3 • 8:45 a.m.

Transverse Patterns for All-Optical Switching, Andrew M. C. Dawes, Daniel J. Gauthier; Duke Univ., USA. Transverse optical patterns, generated by nonlinear interactions, rotate in the presence of a weak switch beam. Using an experimental system with increased symmetry, we observe that the switch can be actuated by ~2100 photons.

Concurrent sessions are grouped across four pages. Please review all four pages for complete session information.
Based on Slow and Fast Light Effects, Analysis of an Effective Optical Filtering Technique to Enhance Microwave Phase Shifts

CMF1 • 8:00 a.m.
Coherent Phonon Excitation and Manipulation in Bismuth Using Temporally Shaped Ultrafast Pulses, Alexander Q. Yu, Xianjun Xu, Andrew M. Weiner, Purdue Univ., USA. This presentation discusses generation of coherently polarized phonons during ultrafast laser interaction with materials and its effect on materials removal. Ultrafast pulse shaping is used to produce THz pulse trains to enhance phonon generation.

CMF2 • 8:30 a.m.
Non-Reciprocal Femtosecond Laser Micromachining, Peter G. Kazansky, Weijia Yang, Yueri Svirko, Institute of Experimental Physics, University of Idaho, USA. We continue to develop laser sources for high-speed gas absorption spectroscopy. A recent source cycles through 14 wavelengths in the 1325-1666 nm range every 33 μs for combined measurements of gas temperature, H₂O, and CH₄.

CMF3 • 8:45 a.m.
Plasma Properties during the Formation of "Nanograting" Structures inside Fused Silica, Arnaud Bajot1, Lionel Canioni2, Girma M. Kandiggi2, Philippe Caudal2, University of Bordeaux 1, France. This paper summarizes recent advances on optical processing using InAs/InP quantum dot semiconductor mode-locked lasers, in particular, all-optical clock recovery at 40 and 160 Gbit/s with low time jitter will be demonstrated using these lasers.

CMF4 • 9:00 a.m.
Optical Signal Processing Using InP-Based Quantum-Dot Semiconductor Mode-Locked Lasers, Guang-Bin Du, Alcatel-Thales V Lab, France. The influence of accumulation effects on the creation of "nanograting" structures has been investigated. Furthermore, the plasma electron density has been measured with a spectral interferometry pump-probe technique.

CMG1 • 8:00 a.m.
A Novel Optical Correlator and Its Application to Packet-Header Recognition, David F. Geraghty, Reza Salem, Mark A. Foster, Alexander L. Gaeta, Cornell Univ., USA. We demonstrate a novel time lens based on four-wave mixing in a silicon nanowaveguide. The lens is used for 20x temporal magnification of a signal with 3-ps features, which permits measurement by a 20-GHz detector.

CMG2 • 8:15 a.m.
A Novel Optical Correlator, and Its Application to Packet-Header Recognition, David F. Geraghty, Reza Salem, Mark A. Foster, Alexander L. Gaeta, Cornell Univ., USA. We propose a novel, fiber-based correlator for processing temporal optical signals. We demonstrate its operation by performing all-optical packet-header recognition at 100 Gb/s.

CMG3 • 8:30 a.m.
Non-Fundamentals of Femtosecond Laser/Material Donald Harter IMRA America Inc., USA, Presider

CMG4 • 9:00 a.m.
Time Lens for Ultrafast Measurements Based on Four-Wave Mixing in Silicon, Reza Salem, Mark A. Foster, David F. Geraghty, Alexander L. Gaeta, Cornell Univ., USA. We demonstrate a novel time lens based on four-wave mixing in a silicon nanowaveguide. The lens is used for 20x temporal magnification of a signal with 3-ps features, which permits measurement by a 20-GHz detector.

CMH1 • 8:00 a.m.
Continuously Tunable Compact Single-Mode Quantum Cascade Laser Source for Chemical Sensing, Benjamin G. Lee, Mikhail A. Belkin1, Jim Mackay, Mark A. Foster, Alexander L. Gaeta, Cornell Univ., USA. We demonstrate a compact, single-mode quantum cascade laser source continuously tunable over 8% of its center wavelength of 9 μm. We integrate the source into a compact mid-infrared spectrometer for absorption spectroscopy of liquids and gases.

CMH2 • 8:15 a.m.
Fast Hyperspectral Imaging Using a Mid-Infrared External Cavity Quantum Cascade Laser, Mark C. Phillips, Nicholas Ho, Pacific Northwest Natl. Lab, USA. A hyperspectral imaging system using an external cavity quantum cascade laser and a focal plane array acquiring images at 25 Hz from 985 cm⁻¹ to 1075 cm⁻¹ with a resolution of 0.3 cm⁻¹ is demonstrated.
8:00 a.m.–9:45 a.m.
CMI • Gallium Nitride Lasers
Stephane Calvez, Inst. of Photonics, Univ. of Strathclyde, UK, Presider

CMI1 • 8:00 a.m.
The Lasing Action of GaN-Based Two-Dimensional Surface-Emitting Photonic Crystal Lasers, Tien-Chang Lu, Tsung-Ting Kao, Shih-Wei Chen, Chih-Chang Kuo, Li-Fan Lin, Tsu-Wei Liu, Hao-Chung Kuo, Shing-Chang Wang, Dept. of Photonics and Inst. of Electro-Optical Engineering, Natl. Chiao Tung Univ., Taiwan. We report fabrication of GaN-based two-dimensional surface-emitting photonic-crystal lasers and successful demonstration of lasing action at room temperature with the emission wavelength at 424.3 nm and low threshold pumping energy density of 3.5 mJ/cm².

CMI2 • 8:15 a.m.
Self-Consistent Optical Gain Analysis and Epitaxy of Strain-Compensated InGaN-AlGaN Quantum Wells for Laser Applications, Hongping Zhao, Ronald A. Arif, G. S. Huang, Yik-Khoon Ee, Nelson Tanou, Lehigh Univ., USA. Self-consistent optical gain analysis of strain-compensated InGaN-AlGaN quantum wells (QWs) using 6-band k·p formalism shows 28% improvement, which is suitable for laser active regions. MOCVD-grown strain-compensated InGaN QW exhibited 62.7% improvement in integrated luminescence intensity.

CMI3 • 8:30 a.m.
Invited
GaN Photonic-Crystal Surface-Emitting Laser Operating at Blue-Violet Wavelengths, Susumu Yoshimoto, Hideki Matsubara, Hirohisa Satoh, Yue Jianglin, Yoshinori Tanaka, Susumu Noda; Kyoto Univ., Japan. We report on a first successful operation of current-driven GaN photonic-crystal surface-emitting laser, which can operate in blue-violet wavelength regions at room temperature.

Concurrent sessions are grouped across four pages. Please review all four pages for complete session information.
QMA • Metamaterials I—Continued

QMA4 • 9:00 a.m.
3-D-Chiral Metamaterial with Artificial Magnetic Response, Eric Plum, Jianfeng Dang, Jiangfeng Zhou, Vassili A. Fedotov, Thomas Koschny, Costas S. Soukoulis, Nikolay I. Zheludev; Univ. of Southampton, UK, Ningbo Univ., China, Iowa State Univ., USA, Univ. of Crete, Greece. Artificial magnetism, negative permeability and zero refractive index are demonstrated in 3-D-chiral metamaterial that shows giant polarization rotation and circular dichroism.

QMA5 • 9:15 a.m.
Dispersionless Three-Dimensional Metamaterial with a Very High Refractive Index, Jonghyun Shin, Jung-Tsung Shen, Shanhui Fan; Stanford Univ., USA. We present metamaterials that can possess arbitrarily high refractive indices over very broad frequency range. Nearly independent control of permittivity and permeability can be achieved by geometrical designs, without using dispersive, resonant elements.

QMA6 • 9:30 a.m.
“Effective Index Method”: Is It Valid for Nano-Circuitry Based on Plasmonic Gaps? Eyal Feiglbaum, Gal Afraut, Gal Bitan; Mtr. Orenstein Technion, Israel. The effective index concept validity is studied for plasmonic gap nano-circuitry: waveguides, resonators and self-guiding. Contrary to unique and adverse characteristics of plasmonic modes in nano-devices, the EI analysis fairly agrees with the simulation results.

JMA • Joint CLEO/QELS Symposium on Novel Resonators: Superconducting Cavities and Qubits—Continued

JMA3 • 9:00 a.m. Invited
Coupling a Nanomechanical Resonator to a Cooper-Pair-Box Qubit, Matthew Laflaye, Junho Suh, Pierre Echternach, Keith Schwab; Michael Roukes; Kavli Nanoscience Inst., Caltech, USA. We demonstrate dispersive coupling between a Cooper-pair box (CPB) qubit and a VHF NEMS (nanoelectromechanical systems) resonator. The observed interaction strength is sufficient to pursue more advanced experiments to elicit quantum behavior in NEMS.

JMA5 • 9:00 a.m.
All-Fiber 32x1 Pump Combiner with High Isolation for High-Power Fiber Laser, Mathieu Faucher, Benoit Serinovy, Roger Perreault, Alexandre Wetter, Nigel Holehouse; ITF Labs, Canada. We present an all-fiber pump combiner with 32 ports. This device is designed to provide high isolation providing intrinsic pump protection. We demonstrated that over 200 W of pump power can be delivered in 20/400-um fiber.

JMA6 • 9:15 a.m.
Watt-Level Fluoride Fiber Laser at 1480 nm, Martin Bernier, Guillaume Androz, Dominic Faucher, Réal Vallée; Ctr. d’Optique, Photonique et Lasers, Univ. Laval, Canada. We report an advance in the power scaling of fluoride fiber lasers using FBGs. Watt-level output power at 1480 nm is demonstrated, which is four-fold greater than the best result obtained with external bulk mirrors.

CMA • High-Power Fiber Lasers—Continued

CMA5 • 9:00 a.m.
Pre-Compensated Resonant Higher-Order Mode Suppression in Coiled Large Mode Area Amplifier Fibers, John M. Fini; OFS Labs, USA. An improved strategy for resonant suppression of higher-order modes is presented. HOM suppressing structures in the cladding are pre-compensated for the bend-induced shift of coupling resonances. Simulations confirm that excellent HOM suppression is achieved.
**Concurrent sessions are grouped across four pages. Please review all four pages for complete session information.**

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**QMB • 9:30 a.m.**

Observation of the Entanglement Sudden Death, Marcelo P. Almeida, Fernando de Melo, Malena Hor-Meyll, Alejo Salles, Stephen P. Walborn, Paulo H. Souto-Ribeiro, Luiz Davidovich; Univ. Federal do Rio de Janeiro, Brazil.

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**CMC2 • 9:00 a.m.**

Fibered Laser System for Atom Interferometers Based on Telecom Technology at 1560 nm and Frequency Doubling, Olivier Carraz, Fabien Liebhart, Naomis Zehzam, Yannick Bidé, Alexander Dressau, Office Natl. d’Etudes et de Recherches Aérospatiales, France. We propose a compact and reliable laser system for onboard atom interferometers using Rubidium. Our system is based on the frequency doubling of a telecom fiber bench at 1560 nm.

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**CMC3 • 9:15 a.m.**

Radiation Pressure Force Measurement at the Thermal Noise Limit, Felix Mueller, Simon Hingel, Lijun Wang, Max-Planck Res. Group, Inst. of Optics, Information and Photonics, Univ. of Erlangen-Nuremberg, Germany. We report radiation force measurements to a precision of 100 femto-Newton using a high Q torsion balance oscillator. The optomechanically coupled oscillator can be cooled down to a temperature of 300 milli-Kelvin.

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**CMC4 • 9:30 a.m.**

Floating Micro-Structured Force Probe for 3-D Imaging and Force Microscopy on the Nanometre Scale, Michael Towne1, Stanley W. Bottchway2, Andrew I. Clarke1, Edward J. Freemantle1, Robert N. J. Haball1, Derek W. K. Jenkin1, Ian M. Loader1, Peter O’Neill1, Anthony W. Parker1, Mark L. Prydie2, Robert Stevens1, Renato Turchetta1, Andrew D. Ward2, Mark Pollard1; Central Laser Facility, Photon Science Dept., Science and Technology Facilities Council, Rutherford Appleton Lab, UK. We demonstrate, using an all-optical setup, the difference between local and global dynamics of entangled quantum systems coupled to independent environments. Even when the decay of each system is asymptotic, quantum entanglement may suddenly disappear.

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**CMD5 • 9:00 a.m.**

Metal-Dielectric Cavities for Subwavelength Light Confinement in the THz Regions, Yankao P. Todorov1, Jean Teissier1, Isabelle Sagner1, Carlo Saxtorp1; Lab de Matériaux et Phénomenes Quantiques, Univ. Paris 7, France; Lab de Photonique et Nanostructures CNRS, France. Experimental study of new type of plasmonic cavities is reported. We demonstrate the excitation of localized modes, with very high light confinement. The cavities are suitable for devices operating in the strong light-matter coupling regime.

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**CMD6 • 9:15 a.m.**

Electronically Switchable Extraordinary Terahertz Transmission through Metallic Hole Arrays Fabricated on a Semiconductor Substrate, Hsin-Tong Chen1, Hong Li2, Abdul K. Azad1, John F. O’Hear1, Arthur C. Gossard1, Richard D. Averitt1, Antoinette J. Taylor1; Los Alamos Natl. Lab, USA, 1Univ. of California at Santa Barbara, USA, 2Boston Univ., USA. We demonstrated electronically switchable extraordinary terahertz transmission through sub-wavelength metallic hole arrays fabricated on doped semiconductor substrates. A reverse voltage bias results in a controllable depletion, thus tuning the substrate loss and switching the transmission.

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**CMD7 • 9:30 a.m.**

Measurement of the Gouy Phase Shift for Surface Plasmon Polaritons, Wenqi Zhu, Amit K. Agrawal, Ayas Nishitani; Dept. of Electrical and Computer Engineering, Univ. of Utah, USA. We measure the Gouy phase-shift of converging surface-plasmons as they evolve through the focus using terahertz time-domain spectroscopy. We perform numerical simulations to determine the surface field distribution and associate it with the Gouy phase-shift.

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**QMC4 • 9:00 a.m.**

Instability-Induced All-Optical Switching in Planar Semiconductor Microcavities, Stefan Schumacher1, Hai H. Kwon1, Rolf Binder1, Arthur L. Smirnov2; College of Optical Sciences, Univ. of Arizona, USA; 2Lab for Photonics and Quantum Electronics, Univ. of Iowa, USA. Using a microscopic theory, we predict all optical switching in semiconductor microcavities where a weak beam switches a stronger signal. The scheme is similar to that recently demonstrated in atomic vapors [Dawes et al., Science 308,672(2005)].

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**QMC5 • 9:15 a.m.**

Orbital Angular Momentum Hall Effect via Multiple Filamentation in Nonlinear Kerr Media, Lunt T. Young, Alexander L. Gaeta; School of Applied and Engineering Physics, Cornell Univ., USA. We demonstrate that the orbital angular momentum Hall effect occurs during multiple filamentation in Kerr media. Counter-rotating instabilities accumulate different phases and result in the spatial separation of corepropagating orthogonal-polarization optical vortices of different helicity.

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**QMC6 • 9:30 a.m.**

Demonstration of Two-Pump Photorefractive Gain in a BaTiO3 Crystal for Realizing a Whitelight Cavity, Gour S. Pati, M. Salit, Md. S. Shhahriar; Northwestern Univ., USA. We demonstrate double-peaked gain in a BaTiO3 crystal using two non-degenerate pump beams. This shows that the negative dispersion necessary for a whitelight cavity for gravitational wave detection can be produced with photorefractive crystals.
simultaneously. The silicon region and the III-V active region waveguide has been investigated. This structure consisted of Si slab waveguide and III-V ridge waveguide. We investigated detuning and repetition-frequency dependencies of minimum polarization switching optical power for all-optical flip-flop operation using 1.55-µm polarization bistable VCSELs. We demonstrated it up to 3.1-GHz switching frequency by 10-fJ optical pulses.

CMF • Fundamentals of Femtosecond Laser/Material—Continued

CMF4 • 9:00 a.m.
Ultrashort-Pulse Laser Calligraphy, WeiJia Yang, Peter G. Kazansky, Taisuke Shimotsuma; Nara Inst. of Science and Technology, Japan, CREST, Japan Science and Technology Agency, Japan. We demonstrated a calligraphic style of writing. Anisotropic cavitation is observed in the vicinity of the irradiated region.

CMF5 • 9:15 a.m.
Material Dynamics from Laser Pulse Filamentation to Permanent Structural Modifications in Fused Silica, Dimitris Papazoglou2,2; Stelios Tsirtzakis1; Inst. of Electronic Structure and Laser, Foundation of Res. and Technology, Greece,1; Univ. of Crete, Greece. Using pump-probe imaging techniques we monitor the formation of plasma strings, the subsequent emergence of transient electronic defects, and their transformation to permanent refractive index modifications in fused silica following sub-picosecond ultraviolet laser pulse filamentation.

CMF6 • 9:30 a.m.
The Higher Mode Lasing Scheme of 1.56-µm Silicon-Ge Multi-Quantum Well Ridge Laser Diode, Young Ahn Leem, Young Min Kim; Queen’s Univ. at Kingston, Canada. We demonstrate simultaneous drilling and coaxial depth imaging of holes in stainless steel at axial rates of 46 klfm. Depth measurement with 6-µm resolution is performed using the machining beam via Fourier-domain interferometry.

CMF7 • 9:30 a.m.
High-Speed Observation of Ultrafast Machining Dynamics, Paul J. L. Webster, James M. Fraser; Queen’s Univ. at Kingston, Canada. We demonstrate simultaneous drilling and coaxial depth imaging of holes in stainless steel at axial rates of 46 klfm. Depth measurement with 6-µm resolution is performed using the machining beam via Fourier-domain interferometry.

CMG • Optical Signal Processing—Continued

CMG4 • 9:00 a.m.
Terabit Capacity Passive Polymer Optical Backplane, Joseph Beals IV, Nikolaus Bamardzka; Dow Corning Corp., USA, 3M, USA, 3M, USA. A novel, low-loss, low-crosstalk optical backplane with scalable architecture using a planar array of multimode polymer waveguides is presented. Passive strict non-blocking interconnection of 10-cards is enabled via 100 waveguides each capable of 10 Gb/s operation.

CMG5 • 9:15 a.m.
Widely Tunable Mirror Based on 3-D Hollow Waveguide for Tunable Photonic Integrated Circuits, Makesh Kumar, Takahiro Sakaguchi, Fumio Koyama; Microsystem Res. Ctr., Tokyo Institute of Technology, Japan. An-3-D hollow-waveguide-based tunable-mirror is proposed to realize widely tunable and temperature insensitive photonic devices. The giant tuning in wavelength of 150 nm is reported, exhibiting much larger tuning efficiency than that of slab hollow-waveguide-mirrors.

CMG6 • 9:30 a.m.
Adaptive Spectral Selection of a Super Continuum Source Using Optical MEMS for Biomedical Diagnoses, David Bouge, Christelle Levignes-Bay, Vincent Coudere, Aurelian Crameret, Philippe Lepeaux, Laurent Lefort, Pierre Blondy, XLIM, Ctr. Natl. de la Recherche Scientifique, Univ. of Limoges, France. We present an innovative approach for digital selection of precise spectral regions from a super-continuum beam using an array of electrostatically-actuated micro-mirrors. The device allows spectral and temporal encoding of selected spectral bands.

CMH • Hyperspectral and Diode-Laser Absorption Spectroscopy—Continued

CMH4 • 9:00 a.m.
Ultra-Sensitive Detection of Nitric Oxide at 5.33 µm Using an External Cavity QCL-Based Faraday Rotation Spectroscopic Sensor Platform, Ralf Lewicki, Gerard Wyneski, Jim Doty, Robert F. Curl Jr., Frank E. Tittel; Rice Quantum Inst., Rice Univ., USA. Magnetic rotation spectroscopy of nitric oxide at most favorable Q(3/2) transition at 1875.8 cm⁻¹ is reported. Detection limit (1σ) at 5 ppb level was obtained for ~44 cm long active optical path with 1s lock-in time constant.

CMH5 • 9:15 a.m.
Nitrous Oxide Isotope Ratio Determination by Mid-Infrared Laser Spectroscopy, Helen Waechter, Markus W. Sigrist; ETH Zurich, Switzerland. A fiber-coupled difference frequency generation laser-spectrometer for measuring isotopic compositions of N₂O at trace concentrations is presented. Using wavelength modulation 9% precision at 100 ppm is achieved. The accuracy is demonstrated with enriched samples.
CMI • Gallium Nitride Lasers—Continued

CMI4 • 9:00 a.m.
InGaN-GaNAs Type-II “W” Quantum Well Lasers for Emission at 450 nm, Ronald A. Arif, Hongping Zhao, Nelson Tansu; Lehigh Univ., USA.
Type-II InGaN-GaNAs quantum well gain media is analyzed for lasers emitting at 450 nm. Optical gain analysis, using 6-band $k\cdot p$ formalism, show 3-times improvement and 40% reduction in threshold current.

CMI5 • 9:15 a.m.
We demonstrated CW laser operation of GaN-based VCSELs under current injection at 77 K. CW laser action was achieved at a threshold current of 1.4 mA, emitting at 462 nm with a narrow linewidth of about 0.15 nm.

CMI6 • 9:30 a.m.
142 mW Tunable Blue Light Generation at 488 nm by Single-Pass SHG of an External Cavity Enhanced Broad-Area Laser Diode, Andreas Jechow, Ralf Menzel; Univ. of Potsdam, Germany.
142 mW visible light with a tuning range of 5 nm were generated by frequency doubling of an external cavity broad-area laser diode using a PPLN waveguide crystal. A wall-plug efficiency of 5.9% was obtained.

9:45 a.m.–10:15 a.m.
Coffee Break, Concourse Level
reveals the importance of bi-anisotropy. It is also suitable for three-dimensional structures. Chemical vapor deposition, an approach, which metamaterials via direct laser writing and silver nanoparticles demonstrates first examples of ultracompact plasmonic components.

### QMD1 • 10:15 a.m. • Invited Talk
**Title to Be Announced**
Peter Debye, University of Illinois, Urbana-Champaign
USA. Abstract not available.

### QMD2 • 10:45 a.m. • Invited Talk
**Nanophotonic Resonators: Opportunities and Challenges**
Evelyn Hu, Stanford University, USA

**CMJ1 • 10:15 a.m.**
Novel Photonic Crystal Fiber Sensors Using SPPs in a Degenerate Plasmonic Doublet
Hui Cao, Northwestern University, USA, President

**CMJ2 • 10:30 a.m.**
**Highly Thermally Responsive Hybrid In-Fiber Slab Waveguide Grating Structure with a Plastic Core and a Silica Cladding**
Kaiming Zhou, Xianfeng Chen, Yicheng Lai, Kaito Sugden, Lin Zhang, Ian Bennion, Photonic Res. Group, Aston Univ., UK. A 1.2 (height) × 125 (depth) × 50 (length) micro-slab was engraved along a fiber Bragg grating by chemically assisted femtosecond laser processing. By filling epoxy and UV-curing, waveguide with plastic-core and silica-cladding was created, presenting high thermal responding coefficient of 211 pm/°C.

**CMJ3 • 10:45 a.m.**
**All-Fiber Capillary Electrophoresis with Novel Axial In-Line Detection**
Par Jelger, Mårten Stratton, Walter Margulis, Valdas Piskarskis, Fredrik Laerum, Dept. of Applied Physics, Royal Inst. of Technology, Stockholm, Sweden, Dept. of Analytical Chemistry, Royal Inst. of Technology, Stockholm, Sweden, Acre AB, Sweden. An all-fiber capillary electrophoresis system is presented. It enables sensitive in-line electrophoresis separation and fluorescence detection. As a proof of concept, a biological sample (FTC-BSA) is electrophoretically separated and analyzed.

**CMJ4 • 11:00 a.m.**
**DNA Target Detection Using Gold-Coated Fibers**
Yamina Y. Stevanov, David A. D. Blair, Mark C. Derosa, Jacques Albert, Carleton Univ., Canada. Plasmon resonances in the transmission spectrum of a tilted Bragg grating in gold coated fibers are used to detect the binding of thiolated single stranded DNA and the further binding of the complementary target DNA.

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**Monday, May 5**

**QELS**

10:15 a.m.–12:00 p.m.
**QMD • Metamaterials II**
Presider to Be Announced

**QMD1 • 10:15 a.m. • Invited Talk**
**Nanoplasmonics: Subwavelength Waveguides, Resonators and Antennas**
Sergey I. Bozhevolnyi, Aalborg Univ., Denmark. Subwavelength waveguides, resonators and antennas utilizing surface plasmon polariton modes are considered, reviewing recent experimental investigations and demonstrating first examples of ultracompact plasmonic components.

**QMD2 • 10:45 a.m. • Invited Talk**
**Refraction of Surface Plasmons with Nanoparticle Arrays**
Ilya P. Radko, Alexandra Baltasera, Sergey I. Bozhevolnyi, Aalborg Univ., Denmark. Various shaped structures formed with a 100-nm-period square lattice of gold nanoparticles placed on a gold film are shown to possess an effective refractive index of about 1.08 for SPPs propagating through them.

**QMD3 • 11:00 a.m.**
**Photonic Metamaterials by Direct Laser Writing and Silver Chemical Vapor Deposition**
Michael Rief, Christine Blel, Michael Thiel, Martin Wegener, Georg von Freymann, Stefan Linden, Inst. für Angewandte Physik, Univ. Karlsruhe (TH), Germany. We fabricate planar magnetic photonic metamaterials via direct laser writing and silver chemical vapor deposition, an approach, which is also suitable for three-dimensional structures. Retrieval of the effective metamaterial parameters reveals the importance of bi-anisotropy.

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**CLEO**

10:15 a.m.–12:00 p.m.
**JMB • Joint CLEO/QELS Symposium on Novel Resonators: Cavity QED**
Hui Cao, Northwestern Univ., USA, President

**CMJ1 • 10:15 a.m.**
Novel Photonic Crystal Fiber Sensors Using SPPs in a Degenerate Plasmonic Doublet
Hui Cao, Northwestern University, USA, President

**CMJ2 • 10:30 a.m.**
**Highly Thermally Responsive Hybrid In-Fiber Slab Waveguide Grating Structure with a Plastic Core and a Silica Cladding**
Kaiming Zhou, Xianfeng Chen, Yicheng Lai, Kaito Sugden, Lin Zhang, Ian Bennion, Photonic Res. Group, Aston Univ., UK. A 1.2 (height) × 125 (depth) × 50 (length) micro-slab was engraved along a fiber Bragg grating by chemically assisted femtosecond laser processing. By filling epoxy and UV-curing, waveguide with plastic-core and silica-cladding was created, presenting high thermal responding coefficient of 211 pm/°C.

**CMJ3 • 10:45 a.m.**
**All-Fiber Capillary Electrophoresis with Novel Axial In-Line Detection**
Par Jelger, Mårten Stratton, Walter Margulis, Valdas Piskarskis, Fredrik Laerum, Dept. of Applied Physics, Royal Inst. of Technology, Stockholm, Sweden, Dept. of Analytical Chemistry, Royal Inst. of Technology, Stockholm, Sweden, Acre AB, Sweden. An all-fiber capillary electrophoresis system is presented. It enables sensitive in-line electrophoresis separation and fluorescence detection. As a proof of concept, a biological sample (FTC-BSA) is electrophoretically separated and analyzed.

**CMJ4 • 11:00 a.m.**
**DNA Target Detection Using Gold-Coated Fibers**
Yamina Y. Stevanov, David A. D. Blair, Mark C. Derosa, Jacques Albert, Carleton Univ., Canada. Plasmon resonances in the transmission spectrum of a tilted Bragg grating in gold coated fibers are used to detect the binding of thiolated single stranded DNA and the further binding of the complementary target DNA.
### Room C1 and C2

**QELS**

**10:15 a.m.–12:00 p.m.**

**QME • Quantum Logic**

Dominic Berry; Macquarie Univ., Australia, Presider

**QME1 • 10:15 a.m.**

Photonic Quantum Computing: Shor’s Algorithm and the Road to Fault-Tolerance, B. P. Lanyon, T. J. Weinhold, N. K. Langford, M. Barbieri, M. P. de Almeida, A. Gilchrist, D. F. V. James, Andrew G. White; Univ. of Queensland, Australia. We implement Shor’s algorithm in a photonic system, demonstrating for the first time the entangled states required for full-scale implementation. We introduce a general technique for comparing measured quantum-logic gate performance against predicted fault-tolerance thresholds.

**QME2 • 10:45 a.m.**

Complete Geometric Universal Single Qubit Operation of Cold Two-Level Atoms, Hiromita Inui, Atsuo Morinaga; Tokyo Univ. of Science, Japan. A complete geometric manipulation of universal single qubit operation on a two-level cold ensemble of sodium atoms was demonstrated using a combination of geometric rotations of the Bloch vector around axes 2 and 3.

**QME3 • 11:00 a.m.**

Fibre Implementation of a Controlled-NOT Gate, Jeremie Fulconis, Alexander Clark, John Rarity, Jeremy O’Brien, William Wadsworth; Univ. of Bristol, UK, “Univ. of Bath, UK. We demonstrate a fibre implementation of a Controlled-NOT gate using a fibre source of heralded single photons and three partially polarising couplers. We then estimate the bounds for the quantum process fidelity of this gate.

### Room C3 and C4

**CLEO**

**10:15 a.m.–12:00 p.m.**

**CML • Timing Stabilization and Distribution**

Christopher W. Oates; NIST, USA, Presider

**CML1 • 10:15 a.m.**

Sub-Femtosecond Timing Distribution of an Ultrafast Optical Pulse Train over Multiple Fiber Links, Jonathan A. Cia, Jungwoo Kim, Jian Chen, Franz X. Kneubuehler, MIT, USA. The distribution of ultrafast optical pulse trains across 300 meters of fiber with sub-femtosecond timing jitter and 43 femtoseconds of drift over 24 hours, as measured between the outputs from two independent links, is demonstrated.

**CML2 • 10:30 a.m.**

Fiber Length Stabilization System for Long-Baseline Phased-Array Radio Telescopes (ALMA), Mitsuhiro Maita, Ken-ichi Nakagawa, Ken-ichi Ueda, Masato Ishiguro, Akitsugu Ueda; ‘Univ. of Electro-Communications, Japan, ‘Na. Astronomical Observatory of Japan, Japan. We’ve developed a local oscillator dissemination system for ALMA. The high-purity 120 GHz local oscillator was delivered as a heterodyne beat signal over 25 km through length corrected optical fibers with phase fluctuation of 1° radian.

**CML3 • 10:45 a.m.**

Fibre Laser Pumped High Average Power Single-Cycle THz Pulse Source, Matthias C. Hoffmann, Ka-Le Yeh, Harold Y. Huang, Thomas S. Sosnowski, Linus Hebbing, Keith A. Nelson; MIT, USA, ‘Clark-MXR, Inc., USA, ‘Dept. of Experimental Physics, Univ. of Pecs, Hungary. Single-cycle THz radiation was generated by optical rectification of Yb-fiber laser pulses with 25 fs duration and 10 μJ energy. We obtained an average power of 0.5 mW at 1 MHz repetition rate.

### Room B1 and B2

**QMF • Ultrafast and Ultraintense**

**10:15 a.m.–12:00 p.m.**

**QMF1 • 10:15 a.m.**

Harnessing Attosecond Science for Visualizing the Nanoworld, Margaret M. Murnane, Jorge Roa, John Maas, Ronggui Yang, Keith Nelson, Eric Andersen, Martin Aeschlimann, Carmen Menoni, Marco Marconi, Henry C. K Apteyn; JILA and Univ. of Colorado, USA, ‘Colorado State Univ., USA, ‘Univ. of California at Los Angeles, USA, ‘MIT, USA, ‘Ctr. for X-Ray Optics, USA, ‘Univ. of Kaiserlautern, Germany. New science and technology is enabled by manipulating and controlling electrons on attosecond timescales. Applications range from new table-top sources of coherent x-rays to high-resolution tabletop coherent imaging of molecules, nanostructures and materials.

Margaret Murnane is a Fellow of JILA and a member of the faculty in the Departments of Physics and ECE at the University of Colorado. Her research interests include the development of ultrafast laser and x-ray sources, as well as pioneering the application of table-top coherent x-ray beams in imaging, holography, diffractive microcopy, photoacoustic metrology, surface science, molecular science, and radiation chemistry. She is a Fellow of the Optical Society of America and the American Physical Society, and is a Member of the US National Academy of Sciences.
Maximum output power of 20 W at 15°C and with Katrin J. Paschke, Sven Einfeldt, Armin Ginolas, für Höchstfrequenztechnik, Germany. Bugge, Martin Spreemann, Frank Dittmar, Ralf Ferdinand-Braun-Inst. für Höchstfrequenztechnik, Germany. Agnieszka Pietrzak, Paul Crump, Ralf Staske, Emitter Limited to 50-W by Carrier Escape from a 60-µm All Fiber Pulsed Lidar For Wake Vortex Monitoring, Agnos Dolfi-Bouteyre, Beatrix Augére, Agnes Dolfi-Bouteyre, Christophe Blanchat, Mathieu Vulla, Jean-Pierre Carusi, Olivier Petitcorps, Julius Lawon-Dakur, Office Natl. d’Etudes et de Recherches Aérospatiales, France. 1.5 µm All Fiber Pulsed Lidar For Wake Vortex Monitoring, Agnos Dolfi-Bouteyre, Beatrix Augére, Agnes Dolfi-Bouteyre, Christophe Blanchat, Mathieu Vulla, Jean-Pierre Carusi, Olivier Petitcorps, Julius Lawon-Dakur, Office Natl. d’Etudes et de Recherches Aérospatiales, France. 1.5 µm All Fiber Pulsed Lidar For Wake Vortex Monitoring, Agnos Dolfi-Bouteyre, Beatrix Augére, Agnes Dolfi-Bouteyre, Christophe Blanchat, Mathieu Vulla, Jean-Pierre Carusi, Olivier Petitcorps, Julius Lawon-Dakur, Office Natl. d’Etudes et de Recherches Aérospatiales, France. 1.5 µm All Fiber Pulsed Lidar For Wake Vortex Monitoring, Agnos Dolfi-Bouteyre, Beatrix Augére, Agnes Dolfi-Bouteyre, Christophe Blanchat, Mathieu Vulla, Jean-Pierre Carusi, Olivier Petitcorps, Julius Lawon-Dakur, Office Natl. d’Etudes et de Recherches Aérospatiales, France.
10:15 a.m.–12:00 p.m.
CMR • Organic LEDs for Solid-State Lighting
Zakya Kafafi; Natl. Science Foundation, USA, Presider

CMR1 • 10:15 a.m. [Tutorial]
OLEDs for Solid-State Lighting, Anil R. Duggal. GE Global Res., USA. Organic light emitting devices represent an exciting potential technology for solid state lighting. In this tutorial, key areas of progress in performance and low cost fabrication are described and compared to solid-state lighting needs.

Anil Duggal joined GE Global Research in 1992 where he has been active in the fields of optical and electrical materials and devices. He currently leads the Organic Electronics Advanced Technology Program for GE. Dr. Duggal has been issued more than 70 U.S. Patents and has authored a similar number of technical publications.
We derive the dispersion relation of light in the second-order correlation function, $g^{(2)}(t)$, of an NV center. The demonstrated value $g^{(2)}(0) = 0.028$ at powers of one photon per lifetime.

A new type of optical mode that possesses a formal analogy to the dark atomic state involved in Electromagnetically Induced Transparency. It displays a transparency and slow light behavior free from bandwidth-delay product constraint.

We demonstrate a robust double-capillary microfluidic optical sensor based on an embedded optical microfiber loop resonator. The device is capable of compensating the temperature and pressure variations and can be generalized to a multi-capillary lab-on-a-chip.

A new scheme of optical amplification and laser oscillation was easily made to have optical feedback cavities. The self-aligned with input/output fibers and can be proposed. The waveguides are self-aligned with input/output fibers and can be easily made to have optical feedback cavities. The optical amplification and laser oscillation were demonstrated.

Optical Amplification and Lasing in Self-Written Active Waveguide, Kenichi Yamashita, Akira Kitakobou, Eshim Fukuzawa, Masahiro Itoh, Kunita Oe, Kyoto Inst. of Technology, Japan. A novel type of self-formed active waveguide structure is proposed. The waveguides are self-aligned with input/output fibers and can be easily made to have optical feedback cavities. The optical amplification and laser oscillation were demonstrated.

A novel refractive-index waveguide excited by traveling excitons in a microcavity, Edward B. Flaug, Andreas Muller, John W. Robertson, Thierry Travers, Dennis G. Deppe', Juiyu Zhang, Weiguang Ma, Gregory Salamo, Chih-Kang Shih, Univ. of Texas at Austin, USA, Univ. of Central Florida, USA, Univ. of Arkansas, USA. We demonstrate strongly driven resonance fluorescence from a single InGaAs quantum dot in a planar microcavity by measuring the coherent oscillations in the second-order correlation function, $g^{(2)}(0)$, of the photoluminescence.

CMJ5 • 11:15 a.m.
Fiber Bragg Grating Interrogation for a Sensing System Based on a Continuous-Wave Fourier Domain Mode Locking Fiber Laser, Daru Chen, M. A. Noginov; Norfolk State Univ., USA. A fiber Bragg grating sensing system is demonstrated based on a continuous-wave Fourier domain mode locking fiber laser. Fiber Bragg grating interrogation is realized by mapping wavelength measurement to time measurement with an oscilloscope.

CMJ6 • 11:30 a.m.
Temperature and Pressure Compensated Microfluidic Optical Sensor, Mishra Subramanyam, Yury Sumetsky, Yuriy Dulashko, Robert S. Windeler; OFS Labs, USA. We demonstrate a robust double-capillary microfluidic ring resonator optical sensor imbedded into a solid polymer matrix. The device is capable of compensating the temperature and pressure variations and can be generalized to a multi-capillary lab-on-a-chip.

CMJ7 • 11:45 a.m.
High Sensitivity Refractometric Sensor Based on Embedded Optical Microfiber Loop Resonator, Felix K. Song, Valeria Prono", Vittoria Finazzi, Gilberto Brambilla, Optoelectronics Res. Ctr., Univ. of Southampton, UK, ECFO-Inst. de Ciencias Fotonicas, Spain, ICREA-Institucio Catalana de Recerca i Estudis Avançats, Spain. A novel refractive-index sensor based on an embedded optical microfiber loop resonator is presented. The device sensitivity has been studied in two typical configurations, and its dependence on the nanowire diameter and coating thickness determined.

CMJ8 • 12:00 p.m.–1:30 p.m., Lunch Break (on your own)
QME6 • 11:45 a.m.
Efficient Broadband Terahertz Microstrip Waveguide, Xiang Shou, Amit K. Agrawal, Ajay Sahana; Dept. of Electrical and Computer Engineering, Univ. of Utah, USA. We present a novel subwavelength microstrip architecture for efficient broadband THz waveguiding that utilizes dipole antennas at the input-face for enhanced THz coupling. Experiments as well as simulations demonstrate efficient broadband waveguiding capability.

QME5 • 11:30 a.m.
Continuous Variable CNOT Gate Based on Quadruparticle Box Cluster Optical Entangled States, Aihong Tan, Yu Wang, Xiaofei Jin, Xiaolong Su, Xianjun Jiao, Changke Xie, Kunchi Peng; State Key Lab of Quantum Optics and Quantum Optics Devices, Inst. of Opto-Electronics, Shanxi Univ., China. We experimentally prepared the quadruparticle box entangled states using a pair of Einstein-Podolsky-Rosen entangled optical beams and propose a scheme to demonstrate CNOT gate of continuous variables based on the prepared box cluster states.

QME4 • 11:15 a.m.
Influence of Erbium-Doped Fiber Amplifiers on the Timing Stability of Optical Pulse Trains, Florian Loebel, Vladimir Arsen, Matthias Felber, Kirsten Hacker, Bastian Lorbeer, Frank Ludwig, Karl-Heinz Matthiesen, Jost Mueller, Holger Schlarb, Bernhard Schmidt, Sebastian Schulz, Axel Winter, Johann Zemella; Deutsches Elektronen-Synchrotron, Germany. We demonstrated conditional exciton-biexciton Rabi rotations in a single self-assembled InGaAs quantum dot using picosecond optical excitation and photocurrent readout, added timing jitter of 0.5 fs was achieved.

QME3 • 11:00 a.m.
Interference between Monochromatic Terahertz Sources, Sascha Prew, Nicah Hurson, Jeremy D. Zimmerman, Stefan Malzer, Arthur C. Gossard, Geoffrey H. Dohlar, Lijun Wang; Max Planck Res. Group, Univ. Erlangen-Nuremberg, Germany, ‘Materials Dept., Univ. of California at Santa Barbara, USA. We report on a method to improve spatial resolution and available power at the same time by mutual coherent emission of distant CW-Terahertz photons by less than the coherence length of the mixing lasers.

QME2 • 11:15 a.m.
High Harmonic Spectral Minimum and Phase in Argon and Nitrogen, Brian K. McFarland, Joseph P. Farrell, Markus Gaehr, Philip H. Bucksbaum; Stanford PULSE Ctr., Stanford Univ., USA. Measurements of the high harmonic amplitude and phase in Argon and N₂ display amplitude and phase modulations which can be related to a Cosmopolitan Minimum in Argon and recombination interference in N₂.

QME1 • 11:00 a.m.
Passive Timing Synchronization between Passive Timing Synchronization between CW- and THz-TDS, Hideaki Suzuki, Kazuhiko Misawa, Takashi Onose, Takayuki Suzuki; RIKEN, Japan, 1‘Univ. of Electro-Communications, Japan, 2‘PRESTO, Japan Science and Technology Agency, Japan, 3‘Tokyo Univ. of Agriculture and Technology, Japan, 4‘CREST, Japan Science and Technology Agency, Japan. We generated a train of highly stable, ultrashort pulses with a repetition rate of 16.6 THz by synthesizing phase coherent rotational Raman-sidebands in para-hydrogen. We show full characterization of its temporal waveform based on a frequency-resolved-optical gating method.

CML6 • 11:45 a.m.
Highly Directed Terahertz Photonic Transmitter by Using the Design of Planar Antenna Arrays, Yu-Ru Huang, Chui-Min Chi, Hung-Ping Chen, Tzeng-Fu Kao; Dept. of Electrical Engineering, Graduate Inst. of Photonics and Optoelectronics, Natl. Taiwan Univ., Taiwan, 1‘Optical Sciences Ctr., Natl. Central Univ., Taiwan, 2‘Dept. of Electrical Engineering, Graduate Inst. of Photonics and Optoelectronics, Natl. Taiwan Univ., Taiwan, 3‘Res. Ctr. for Applied Sciences, Academia Sinica, Taiwan. By adopting a novel CPW-fed rampart slot array antenna, we demonstrate a compact highly-directed THz photonic transmitter with a single photodetector source. 3dB radiation beam widths in both E- and H-planes are significantly reduced.

CML5 • 11:30 a.m.
Interference of Einstein-Podolsky-Rosen pairs in cavity-enhanced Rabi rotations in a single self-assembled InGaAs quantum dot using picosecond optical excitation and photocurrent readout, thereby implementing a two-qubit controlled-rotation (C-rot) quantum logic gate.

CML4 • 11:15 a.m.
Microwave Signal Regeneration from Mode-Locked Lasers with 1.9×10⁻⁶ Stability, Jongwon Kim, Franz Kaeaeurter, MIT, USA. A 10.225-GHz microwave signal is regenerated from a 2005-MHz repetition rate mode-locked fiber laser with 6.8 fs rms relative timing jitter in 1-MHz bandwidth integrated over 10 hours. This corresponds to the stability of 1.9×10⁻⁶.

CML3 • 11:00 a.m.
Realizing Quantum Controlled Phase-Flip Gate through Quantum Dot in Silicon Photonic Crystal Waveguide, Jie Guo, Fangwen Sun, Xiaoxiang Yang, Chen Wei; Wong University, USA. Scheme to realize controlled phase gate through single quantum dot in slow-light silicon photonic crystal waveguide is proposed. Enhanced Purcell factor and β-factor lead to high gate fidelity over bandwidth frequencies compared to cavity-assisted system.

CML2 • 11:15 a.m.
Einstein-Podolsky-Rosen entangled optical beams of same frequency and opposite phase are generated a train of highly stable, ultrashort pulses with a repetition rate of 16.6 THz by synthesizing phase coherent rotational Raman-sidebands in para-hydrogen. We show full characterization of its temporal waveform based on a frequency-resolved-optical gating method.

CML1 • 11:00 a.m.
Continuous Variable CNOT Gate Based on Quadruparticle Box Cluster Optical Entangled States, Aihong Tan, Yu Wang, Xiaofei Jin, Xiaolong Su, Xianjun Jiao, Changke Xie, Kunchi Peng; State Key Lab of Quantum Optics and Quantum Optics Devices, Inst. of Opto-Electronics, Shanxi Univ., China. We experimentally prepared the quadruparticle box entangled states using a pair of Einstein-Podolsky-Rosen entangled optical beams and propose a scheme to demonstrate CNOT gate of continuous variables based on the prepared box cluster states.
output power of 26.4-dBm, the amplifier gain and (SCOW A) by employing multiple contacts. At an in a slab-coupled optical waveguide amplifier electrical-to-optical conversion efficiency increase MIT Lincoln Lab, USA.

Anish K. Goyal, Douglas C. Oakley, David C. Conductor Optical Amplifiers, Improving the Efficiency of High-Power Semi CMN7 • 11:45 a.m. Advances in Microwave Photonic Devices, Masayuki Izutac, Natl. Inst. of Information and Communication Technology, Japan. Devices for rf light signal conversions are very essential to build various microwave photonics systems. Among variety of photonic devices for MWP systems, the present talk will be focused especially on devices based on electrooptic modulation.

CMPS6 • 11:45 a.m. Invited

CMPP6 • 11:45 a.m. Laser-Induced Breakdown Spectroscopy (LIBS) for Aerosol Analysis, David Hahn, Prasoon K. Diwakar, Philip B. Jackson; Univ. of Florida, USA. This paper will focus on the status of LIBS for quantitative analysis of individual aerosol particles. Emphasis is on recent efforts to understand the laser-particle interactions, and the improvement of analyte response and precision.

CMQ5 • 11:15 a.m. Invited

CMQ6 • 11:45 a.m. Silicon Photomultiplier: Detector for Highly Sensitive Detection of Fluorescence Signals, Venit H. Dhulla, Lu Cheng, Georgiy Gudkov, Andriy Tsupryk, Ivan Tovkach, Vera Gorfinkel; Stony Brook Univ., USA. We demonstrate use of silicon photomultipliers (SiPMs) in single photon counting mode for detection of very weak laser induced fluorescence (LIF). Detection of LIF in DNA-sequencing has been performed with three different commercially available SiPMs.
CMR • Organic LEDs for Solid-State Lighting—Continued

CMR2 • 11:15 a.m.
Highly Efficient, Charge Balanced Blue Phosphorescent OLEDs Employing Wide Band Gap Host with p-i-n Architecture, Neetu Chopra, Jaewon Lee, Franky So; Univ. of Florida, USA. The use of a wide band gap host host p-bis (triphenylsilyl) benzene (UGH2) and a p-i-n structure was used to fabricate Flrpic based devices and EQE of 20% is achieved.

CMR3 • 11:30 a.m.
Paper Withdrawn

CMR4 • 11:45 a.m.
Triplet Energy Confinement Effect in Blue Phosphorescent Organic Light Emitting Devices, Jae-won Lee, Neetu Chopra, Franky So; Univ. of Florida, USA. The Effects of triplet energy confinement and charge balance by hole and electron transport layers are investigated on blue phosphorescent organic light emitting devices (PHOLEDs).

12:00 p.m.–1:30 p.m.
Lunch Break (on your own)
### QELS

<table>
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<tr>
<th>Time</th>
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<tr>
<td>1:30 p.m.–3:15 p.m.</td>
<td><strong>QMG • Metamaterials III</strong>&lt;br&gt;Demetrios Christodoulides;&lt;br&gt;College of Optics and Photonics,&lt;br&gt;Univ. of Central Florida, USA, Presider</td>
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<td>1:30 p.m.–3:15 p.m.</td>
<td><strong>JMC • Joint CLEO/QELS Symposium on Novel Resonators: Integrated Resonators</strong>&lt;br&gt;Kerry Vahala; Caltech, USA, Presider</td>
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<td>1:30 p.m.–3:15 p.m.</td>
<td><strong>CMS • Applications of Ultrafast Imaging</strong>&lt;br&gt;Randy Bartels; Colorado State Univ., USA, Presider</td>
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<td>1:30 p.m.–3:15 p.m.</td>
<td><strong>CMT • Supercontinuum Generation</strong>&lt;br&gt;John Harvey; Univ. of Auckland, New Zealand, Presider</td>
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### CLEO

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<td>1:30 p.m.–3:15 p.m.</td>
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### QMG1 • 1:30 p.m.
Three-Dimensional Metamaterials at Optical Frequencies, Na Liu1, Liwei Fu2, Hongyang Guo2, Stefan Kaiser2, Heinz Schweizer2, Harald Giessen2, 4th Physikalisches Inst., Univ. of Stuttgart, Germany. We experimentally demonstrate the implementation of three-dimensional optical metamaterials. We investigate the interaction between adjacent stacked layers using the method of plasmon hybridization and analyze the optical properties of stacked metamaterials with increasing layer numbers.

### QMG2 • 2:00 p.m.
Frequency Tunable Terahertz Metamaterials, Hsin-Tung Chen1, Abu K. Azad1, David Shirk-ehnamer1, Willie J. Padilla1, Richard D. Averitt1, Antoinette I. Taylor1, John F. O’Hara1, Los Alamos Natl. Lab, USA, UT, ‘Boston College, USA, ‘Boston Univ., USA. We present a hybrid metamaterial semiconductor device capable of 20% tunability of the center resonance frequency via photodcetion of the semiconductor regions, thereby addressing the metamaterials drawback of narrow bandwidth operation.

### QMG3 • 2:15 p.m.
Nonlinear Optical Spectroscopy of Photonic Metamaterials, Evgenia Kim1, Feng Wang1, Wei Wu1, Zhaoning Yu1, Ron Shore1, Univ. of California at Berkeley, USA, ‘HP Labs, USA. We probe the nonlinear optical properties of a fishnet metamaterial via second harmonic generation and third harmonic generation spectroscopy. We show that the resonance enhancement of nonlinear response in metamaterials is distinct from molecular case.

### JMC2 • 2:00 p.m.
Small Modal Volume Integrated Dielectric Resonator, Alexander Gondarenko, Michael Lipson, Cornell Univ., USA. We demonstrate a bowtie geometry in a silicon planar resonator with an ultra-small modal volume (18 nm). Bowtie ring resonators and 1-D and 2-D photonic crystal resonators are compared for tradeoffs in confinement and quality factors.

### JMC3 • 2:15 p.m.
Observation of Wavelength- and Loss-Splitting of Supermodes in Coupled Photonic-Crystal Microcavities, Kiriti Alaksoy, Karl Fredrik Karlsson, Alok Rautra, Benjamin Drwet, Eli Kapon, Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland. Splitting of mode wavelength and loss are observed in coupled photonic-crystal cavities. The characteristics of loss splitting are shown to have important impact on the optical energy transfer between such coupled resonators.

### CMS1 • 1:30 p.m.
Shortening of Laser Pulses at the Focus of a Chromatic Lens, Yulin Li, Argonne Natl. Lab, USA. We show that a long self-modulated laser pulse can be shortened at the focus of a chromatic lens as the result of a destructive superposition of the field due to the radius-dependent group delay.

### CMS2 • 1:45 p.m.
Supercontinuum Coherent Anti-Stokes Raman Spectroscopy, Kebin Shi, Peng Li, Zhiwen Liu, Dept. of Electrical Engineering, Pennsylvania State Univ., USA. We investigate broadband CARS spectroscopy in supercontinuum optical trap. Methods for suppressing or smoothing non-resonant background are demonstrated.

### CMS3 • 2:00 p.m.
Chromatic Two Photon Imaging, Qian Xu, Kebin Shi, Zhiwen Liu, Pennsylvania State Univ, USA. We report on a chromatic two-photon imaging technique which can effectively realize z-scanning by using a Fresnel lens to focus excitation pulses at different wavelengths to different depth positions. Preliminary imaging result will be presented.

### CMS4 • 2:15 p.m.
In vivo Cellular Level Imaging Using Nonlinear Optical Microscopy, Mark Schnitzer, Stanford Univ., USA. Multiple contrast modalities can be used to perform minimally invasive optical microendoscopy in live subjects. I will describe applications of second-harmonic generation and one- and two-photon excited fluorescence microscopy in the mammalian nervous system.

### CMT1 • 1:30 p.m.
Fiber Networks for Ultrastable Frequency Standards and Timing Distribution, Seth M. Forrest, Stanford Univ., USA. Optical fiber network employing active phase noise cancellation is discussed. Instabilities below 10^{-13} at 3-s and timing jitter below 0.08 fs (10 MHz to 10 MHz) are achieved for a 10-km-scale urban link.

### CMT2 • 2:00 p.m.
Generation of Ultrahigh-Power Supercontinuum and Self-Compressed Single-Cycle Pulses in Metal-Dielectric Hollow Waveguides, Anton Husakou, Joachim Herrmann, Max Born Inst. for Nonlinear Optics and Short Pulse Spectroscopy, Germany. We investigate a novel approach for ultrahigh-power soliton-induced supercontinuum generation based on argon-filled metal-dielectric hollow waveguides and predict the generation of MW/nm spectral power densities with ~0.1 mJ energy and self-compressed isolated 1.7-fs pulses.

### CMT3 • 2:15 p.m.
A New Model for CW Supercontinuum Generation, J. C. Travers, S. V. Popov, J. R. Taylor, Femtosecond Optics Group, Physics Dept., Imperial College London, UK. We have developed a new pump source model for CW supercontinuum generation which shows closer agreement to experiment, and rests on a stronger physical basis, than previous models.
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<th>Room C1 and C2</th>
<th>Room C3 and C4</th>
<th>Room B1 and B2</th>
<th>Room J2</th>
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<td><strong>QMH • Higher-Dimensional Entanglement</strong> Luiz Davidovich; Univ. Federal do Rio de Janeiro, Brazil, Presider</td>
<td><strong>CMU • Optical Frequency Control and Applications</strong> Kristan L. Corwin; Kansas State Univ., USA, Presider</td>
<td><strong>CMV1 • Thz QCL I</strong> Juraj Darmo; Inst. of Solid-State Electronics, Austria, Presider</td>
<td><strong>QMI • Slow Light and Multilevel Effects</strong> Stephen C. Rand; Division of Applied Physics, Univ. of Michigan, USA, Presider</td>
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<td><strong>QMH1 • 1:30 p.m.</strong> Angular Dimensionality of Two-Photon Entanglement Bart-Jan Pors, Sumant S. R. Oemrawsingh, Martin P. van Exter, Andrea Aiello, Gert W. W. Hoefl, Erik R. Ellek, Johannes P. Woerdman; Leiden Univ., Netherlands. We pass twin-photons through rotatable angular phase plates, and detect entanglement that has a continuously variable angular dimensionality D. Experimentally, D was varied from 2 to 6 and values up to 30 are practically feasible.</td>
<td><strong>CMU1 • 1:30 p.m.</strong> Time and Frequency Filtering of Optical Combs, Danielle A. Brage1, Matt Kirchner2, Tana Forrier2, Vela Mihelic1, Richard Fox3, Andrew M. Weiner3, Scott A. Diddams4; Le W. Helbig2; NIST, USA, 1Purdue Univ., USA, 2Fabry-Perot cavity filtering of broadband optical frequency combs is studied theoretically and theoretically. Effects of dispersion, mirror coatings, and carrier envelope offset frequency are analyzed while highlighting applications to waveform generation and spectroscopic references.</td>
<td><strong>CMV1 • 1:30 p.m.</strong> Terahertz Quantum Cascade Lasers: Design and Applications, Bréme Païat, Univ. of Neuchâtel, Switzerland. Operation of terahertz quantum cascade lasers has now been demonstrated between 1.2 and 4.9 THz. Extremely narrow linewidths and continuous tunability have been reported, with applications in imaging, radio-astronomy and process control.</td>
<td><strong>QMI1 • 1:30 p.m.</strong> Slow and Fast Light in Liquid Crystal Light Valves, Stefania Residori1, Umberto Borbone2, Jean-Pierre Huignard1; Inst. Non Lineaire de Nice, Univ. de Nice Sophia-Antipolis, France, 3Lub de Physique Statistique de l’ENS, France, 4Thales Res. &amp; Technology, France. We show that fast and slow light occurs in a liquid crystal light valve when two-wave mixing occurs in the Raman-Nath diffraction regime. Light pulses are slowed at group velocities as low as 0.2 mm/s.</td>
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<td><strong>QM2 • 1:45 p.m.</strong> Manipulation of Single-Photon States Encoded in Orbital Angular Momentum, Antonio Puig-i-Camacho, Gabriel Fernandez Calvo; Univ. Autònoma de Barcelona, Spain. We analyze capabilities to create/manipulate photon states encoded in spatial degrees of freedom. We show stringent limits for symmetric transforms acting on paraxial modes, and how to overcome these with novel classes of non-Gaussian operations.</td>
<td><strong>CMU2 • 1:45 p.m.</strong> Relative Phase Measurement of Multicolor Pulses for Characterization of Fourier-Synthesized Waveform, Dai Yohtsuno1, Yohes Kobayashi1, Kenji Tsurizuka1,2; Natl. Inst. of Advanced Industrial Science and Technology (AIST), Japan, 1Core Res. for Evolutional Science and Technology, Japan Science and Technology Agency, Japan. The phase relation among phase-locked multicolor pulses was measured by interference between dual simultaneous frequency-mixing processes in a thin nonlinear crystal for characterization of Fourier-synthesized waveform.</td>
<td><strong>CMV2 • 1:45 p.m.</strong> Application of Cavity Ring-Down Spectroscopy for the Measurement of Two-Color Optical Memory, Praveen K. Vudyasetu, John C. Howell; Univ. of Rochester, USA. Signal pulses and frequency-shifted idler pulses are simultaneously stored in an atomic vapor for up to 500 microseconds, and then released while maintaining separate waveforms.</td>
<td><strong>QMI2 • 1:45 p.m.</strong> Storage and Retrieval of Optical Pulses Using a Two-Color Optical Memory, Ryan M. Camacho, Praveen K. Vudyasetu, John C. Howell; Univ. of Rochester, USA. Signal pulses and frequency-shifted idler pulses are simultaneously stored in an atomic vapor for up to 500 microseconds, and then released while maintaining separate waveforms.</td>
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<td><strong>QM3 • 2:00 p.m.</strong> Extrinsic Orbital Angular Momentum Carried by Photon-Pairs in Spontaneous Parametric Down-Conversion, Sheng Feng, Prem Kumar; Northwestern Univ., USA. We show in theory that the down-converted photon-pairs carry extrinsic orbital angular momentum in the degrees of freedom of relative movement of one photon with respect to its twin in type-II spontaneous parametric down-conversion.</td>
<td><strong>CMU3 • 2:00 p.m.</strong> Fast and Simple High-Resolution Optical Spectrum Analyzer, Kai-Uwe Laubach1, Thomas Schneider1, Ronny Henker1, Max I. Amann2; Hochschule für Telekommunikation Leipzig, Germany, 1Dahlín Inst. of Technology, Ireland. A simple method for fast optical spectroscopy with high resolution is shown. The method is based on the narrowband Brillouin gain process in optical fibers.</td>
<td><strong>CMV3 • 2:00 p.m.</strong> Slow and Fast Light in Liquid Crystal Light Valves, Stefania Residori1, Umberto Borbone2, Jean-Pierre Huignard1; Inst. Non Lineaire de Nice, Univ. de Nice Sophia-Antipolis, France, 3Lub de Physique Statistique de l’ENS, France, 4Thales Res. &amp; Technology, France. We show that fast and slow light occurs in a liquid crystal light valve when two-wave mixing occurs in the Raman-Nath diffraction regime. Light pulses are slowed at group velocities as low as 0.2 mm/s.</td>
<td><strong>QMI3 • 2:00 p.m.</strong> Stored Light in Optical Fibers via Stimulated Brillouin Scattering, Zhaoming Zhu1,2, Daniel J. Gauthier1, Robert W. Boyd3; Dept. of Physics, Duke Univ., USA, 1Inst. of Optics, Univ. of Rochester, USA. We report a new method for storing and retrieving sequences of optical data pulses via induced acoustic excitations in an optical fiber through the process of stimulated Brillouin scattering.</td>
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<td><strong>QM4 • 2:15 p.m.</strong> Single-Photon Spin-Orbit Coupling and LOQC, Cody C. Leary, Michael Raymer; Oregon Ctr. for Optics, USA. When a photon propagates in an inhomogeneous medium, its spin and orbital degrees of freedom are coupled. We explore consequences of this effect for fiber-based cluster state linear optical quantum computing (LOQC).</td>
<td><strong>CMU4 • 2:15 p.m.</strong> An Accurate Positioning System Based on Optical Zooming Method, Makiko Kaihara, Hirokazu Matsunaga; Natl. Inst. of Advanced Industrial Science and Technology (AIST), Japan. A positioning system based on optical zooming interferometer was developed using stabilized diode lasers by fs-comb. It achieved 1.3 mm accuracy and 30 pm stability by simply the system and treatment of optical source’s polarization.</td>
<td><strong>CMV4 • 2:15 p.m.</strong> STRAP in Waveguides: Linear and Nonlinear Effects in an Adiabatic Three-Core System, Yoav Lahini1, Francesca Pozzi2, Mark Sorel1, Roberto Morandotti3, D. N. Christodoulides1, Y. Silberberg1,4; Weizmann Inst. of Science, Israel, 1Dept. of Electrical and Electronic Engineering, Univ. of Glasgow, UK, 2Inst. Natl. de la Recherche Scientifique, Canada, 3College of Optics and Photonics, CREOL, USA. We demonstrate an adiabatic passage between uncoupled waveguides, in analogy with the quantum effects of STIRAP. In the nonlinear regime the associated adiabatic light passage is found to critically depend on the excitation power levels.</td>
<td><strong>QMI4 • 2:15 p.m.</strong> STRAP in Waveguides: Linear and Nonlinear Effects in an Adiabatic Three-Core System, Yoav Lahini1, Francesca Pozzi2, Mark Sorel1, Roberto Morandotti3, D. N. Christodoulides1, Y. Silberberg1,4; Weizmann Inst. of Science, Israel, 1Dept. of Electrical and Electronic Engineering, Univ. of Glasgow, UK, 2Inst. Natl. de la Recherche Scientifique, Canada, 3College of Optics and Photonics, CREOL, USA. We demonstrate an adiabatic passage between uncoupled waveguides, in analogy with the quantum effects of STIRAP. In the nonlinear regime the associated adiabatic light passage is found to critically depend on the excitation power levels.</td>
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1:30 p.m.–3:15 p.m.  
CMW • VSEL I  
Presider to Be Announced

CMW1 • 1:30 p.m.  
High-Speed Single-Mode Photonic Crystal VSEL Design, Chen Chen1, Paul O. Leisher2, Kent D. Choquette1; "Univ. of Illinois at Urbana-Champaign, USA, 1Light Corp., USA. Photonic crystal VSELs engineer the spatial overlap between optical mode and gain for improved high-speed operation and reduced RIN. The implant aperture should be ≤4μm larger than the optical aperture to avoid excessive electrical parasitics.

CMW2 • 1:45 p.m.  
17 G Directly Modulated Datacom VSELs, Ralph H. Johnson1, Darwin K. Serkhdiri1; Finisar, USA. "This paper is a first look at whether directly modulated VSELs designed and targeted for production 17 G applications will be suitable. Design considerations and initial results are presented.

CMW3 • 2:00 p.m.  
25 Gbit/s-100°C Operation and High Reliability of 1.1-μm-Range VSELs with InGaAs/GaAsP Strain-Compensated MQWs, Hiroshi Hatakeyama1, Takashi Akagawa1, Kinjiro Fukatsu1, Naofumi Suzuki1, Kenichiro Yashiki1, Keiichi Toku1; Japan. "We developed 1.1-μm-range oxide-implant nanopatterning with 100 nm feature sizes. Application in pressure sensing with a 13-mm spatial resolution and 50-Hz sampling rate is demonstrated in optical fibers based on Brillouin optical correlation-domain reflectometry. This resolution is the best result ever reported in Brillouin-based reflectometers.

CMW4 • 2:15 p.m.  
107-GHz Resonance Frequency of 1.55-μm VSELs under Ultra-High Optical Injection Locking, Xuequn Zhai1, Erwin K. Lau1, Devang Patel1, Hau K. Tsang2; "Univ. of California at Berkeley, USA, 1School of Electronic and Electrical Engineering, Hong Kong Univ., Republic of Korea, 2Walter Schottky Inst., Technical Univ. of Munich, Germany. "We demonstrated a record resonance frequency enhancement of 1.55-μm VSELs from 10 GHz to 107 GHz under ultra-high optical injection locking. Detuning and injection-ratio dependence are characterized to show the broad applicability of the technique.

1:30 p.m.–3:15 p.m.  
CMX • Nano- and Micro-Processing of Materials with Femtosecond Laser Pulses  
Martin Richardson1; Univ. of Central Florida, USA, Presider

CMX1 • 1:30 p.m.  
Invited Laser Precision Engineering: From Microprocessing to Nanofabrication, Ming Hui Hong1, Z. Q. Huang1, Y. Lin1, J. Yun1, L. S. Tan1, L. P. Shi1, T. C. Chong1; Data Storage Inst., Agency for Science, Technology and Res. and Dept. of Electrical and Computer Engineering, Natl. Univ. of Singapore, Singapore. "Laser precision engineering has advantages of non-contact process, flexible setup and high speed processing. Combined with other advanced processing tools, laser nanofabrication will play a much more important role in the next generation manufacturing.

CMX2 • 1:45 p.m.  
On-Chip High-Order Frequency Filter with Fabrication Error Recovery, Nicolas Sherwood Drez1, Michael Schmidt1, Long Chen1, Hid Lipson1, Ian Lipson1; Cornell Univ., USA. "We demonstrate a high-order frequency filter based on microring pairs, capable of restoring distorted transmission functions by dynamically adjusting resonance parameters. Individual rings are thermo-optically tunable and are adjusted based on an evolutionary algorithm.

CMX3 • 2:00 p.m.  
Implementation of High Resolution Planar Wavelength Demultiplexers Using Strong Dispersion in Photonic Crystals, Babak Momeni1, Maya Sarmaz Chamranzad1, Elsayed Shokhou1, Muratza Askari1, Mohammad Sobhani1, Ali Abbasi1; Georgia Tech, USA. "We investigate the implementation of superprism-based planar photonic crystal wavelength demultiplexers in higher photonic bands to improve their spectral resolution. Major challenges in realization of these devices are examined and appropriate solutions are presented.

CMX4 • 2:15 p.m.  
Inhomogeneous Anisotropic Subwavelength Structures for the Excitation of Single Hollow Waveguide Modes, Arv Niv1, Yaron Yom-Tov1, Galivael Bienes1, Vladimir Kleiner1, Erez Hasman1; Technion-Israel Inst. of Technology, Israel. "We propose a general approach for coupling a free space uniformly polarized beam to a desired hollow waveguide mode, thus enabling a single mode operation. Required polarization manipulations are achieved by inhomogeneous anisotropic subwavelength structures.

1:30 p.m.–3:15 p.m.  
CMY • Optical Filters  
John M. Fini1; OFS Labs, USA, Presider

CMY1 • 1:30 p.m.  
Novel Long Period Fiber Grating-Based Filter Configuration Enabling Arbitrary Linear Filter Characteristics, Badur Shirik1, Yongwoo Park1, Jose Azade1, Mykola Kulishov2; Inst. of Photonics and Nanotechnologies, Acad. of Sciences of the Czech Republic, Czech Republic, 1Inst. Natl. de la Recherche Scientifique, Canada, 2IFIT Photomask Inc., USA. "The novel filtering scheme proposed here allows for implementation of arbitrary spectral transfer functions. It is demonstrated on design and realization of a fiber for transform-limited 1.6-ps flat-top pulse synthesis.

CMY2 • 1:45 p.m.  
Distributed Strain Sensing with a 13-mm Spatial Resolution and 50 Hz Sampling Rate, Yosuke Mizuno1, Zayuan He2, Kazuo Hotate3; Univ. of Tokyo, Japan. "Distributed strain sensing with a 13-mm spatial resolution and 50 Hz sampling rate is demonstrated in optical fibers based on Brillouin optical correlation-domain reflectometry. This resolution is the best result ever reported in Brillouin-based reflectometers.

CMY3 • 2:00 p.m.  
A Pressure Sensor Based on the Loss Birefringence of a Microstructured Optical Fiber Containing Metal Coated Elliptical Inclusions, Elif Pene1, Alireza Hassan1, Suzanne Lacroute1, Q. Huang2, Y. Lin3, J. Yun4, L. S. Tan5, L. P. Shi6; Hong Kong, 1School of Electronic and Information Technology, Acad. of Sciences of the Czech Republic, Czech Republic, 2Research Inst. of Optics, USA, 3School of Optical Science and Engineering, Acad. of Sciences of the Czech Republic, Czech Republic, 4School of Physics, North Carolina State University, USA, 5Department of Electronics, Acad. of Sciences of the Czech Republic, Czech Republic, 6School of Optical Science and Engineering, Acad. of Sciences of the Czech Republic, Czech Republic. "We report that by measuring splitting in the eigenvalues of maximum propagation losses of the two originally degenerate plasmonic/fiber modes, one can detect 84° tilt of the silver coated air inclusions. Application in pressure sensing is suggested.

CMY4 • 2:15 p.m.  
Large-Scale FBG Sensors Utilizing Code Division Multiplexing, Y. H. Huang3, Chao Lu1, P. K. A. Wai1, H. Y. Tam1; "Electronic and Information Engineering Dept., Hong Kong Polytechnic Univ., Hong Kong, 1Electrical Engineering Dept., Hong Kong Polytechnic Univ., Hong Kong. "We propose practical low-cost interrogation system for large scale FBG sensor arrays utilizing code division multiplexing. For 100 sensor system, detection speed can increase 250 times comparing with TDM based scheme without compromise on detection accuracy.
CMAA1 • 1:30 p.m.
Time-Resolved Optical Studies of InGaN LED Structures Grown on Semipolar and Nonpolar Bulk GaN Substrates, Gregory A. Garrett, Hengen Shin, Michael Wrobel, Anang Yang, Matthew C. Schmidt, Zhongyeun Jia, James S. Speck, Steven F. DenBaars, Shuai Nakamura; ARL, USA, “Univ. of California at Santa Barbara, USA. We present time-resolved photoluminescence on InGaN/GaN multiple-quantum well LEDs grown on nonpolar and semipolar bulk GaN substrates and investigate increasing indium concentrations toward higher power, longer wavelength light emitters.

CMAA2 • 1:45 p.m.
Spontaneous Recombination Rate and Luminescence Efficiency of Staggered InGaN Quantum Wells Light Emitting Diodes, Ronald A. Arif, Hangying Zhao, Yik-Khoon Ee, Samuel Efon Perin, Volkmar Dierolf, Nelson Tanou, Lehigh Univ., USA. Spontaneous emission characteristics and power-dependent cathodoluminescence of staggered InGaN quantum wells light emitting diodes were analyzed. The measurements indicated ~4-times improvement in integrated CL intensity and ~50% reduction in non-radiative recombination rate.

CMAA3 • 2:00 p.m.
The Origin of Efficiency Droop in GaN-Based Light-Emitting Diodes and Its Solution, Jong Kyu Kim, Min-Ho Kim, Martin F. Schubert, Qi Dai, Tan Sakong, Sukho Yoon, Cheolsoo Sone, Yongjo Park, Joachim Piprek, E. Fred Schubert; 1-Electrical, Computer and Systems Engineering Dept., Rensselaer Polytechnic Inst., USA, 2-Centui Re-D Inst., Samsung Electro-Mechanics, Republic of Korea, 3-Dept. of Physics, Applied Physics and Astronomy, Rensselaer Polytechnic Inst., USA, 4-NUSOD Inst. LLC, USA. The physical origin of efficiency droop in GaN-based light-emitting diodes when driven with high current is systematically investigated. Based on our simulations and experimental results, a polarization-matched active region is proposed as the solution.
QMG6 • 3:00 p.m.
Asymmetric Transmission through Chiral Symmetry Breaking in Planar Metamaterials, Eric Plam, Vassil A. Fedotov, Nikolay I. Zheltukhin; Univ. of Southampton, UK. We report that small chiral asymmetry of the unit cell of planar metamaterials leads to strong resonant asymmetric transmission for circularly polarized light due to excitation ofenantiotropically sensitive trapped modes.

JMC5 • 3:00 p.m.
Room Temperature Continuous Wave Operation of Single-Mode, Edge-Emitting Photonic Crystal Bragg Lasers, Lin Zhu, Xuanhai Sun, Guy DeRose, Axel Scherer, Amnon Yariv; Caltech, USA. We report the first room temperature CW operation of two dimensional single-mode edge-emitting photonic crystal Bragg lasers. Single-mode lasing with single-lobe, diffraction limited far-fields is obtained for 100 µm wide and 550 µm long on-chip devices.

QMG5 • 2:45 p.m.
From Positive- to Negative-Index Materials: Transitional Phenomena, Natalia M. Litchinitser, 1 Andrei I. Maimistov, 2 Vladimir M. Shalaev, 3 Institute for Nanotechnology, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, Germany. We measure the absolute extinction cross section spectra of individual split-ring resonators (fundamental magnetic resonance at 1.4-µm wavelength). The experiments are compared with a simple electric-circuit model and with microscopic calculations.

QMG4 • 2:30 p.m.
Absolute Extinction Cross Section of Individual Magnetic Split-Ring Resonators, Martin Huwik1, Matthias W. Klein1, Martin Wegener1, Michael König1, Jens Niegeman2, Kurt Busch2, Nils Fehl2, Stefan Linder1; Inst. für Angewandte Physik, Univ. Karlsruhe (TH), Germany, 1Inst. für Theoretische Festkörperphysik, Univ. Karlsruhe (TH), Germany, 2Inst. für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, Germany. We measure the absolute extinction cross section spectra of individual split-ring resonators (fundamental magnetic resonance at 1.4-µm wavelength). The experiments are compared with a simple electric-circuit model and with microscopic calculations.

QMG3 • 2:15 p.m.
Continued

JMC4 • 2:30 p.m.
Vertical Integration of Ultrafast Semiconductor Lasers, B. Rudin, D. J. H. C. Maas, A.-R. Balancelcourt, M. Golling, T. Südmeyer, Ursula Keller; Eidgenössische Technische Zürich, Switzerland. We discuss a passively modelocked VECSEL with both gain and saturable absorber integrated into a single semiconductor structure. We refer to this new kind of laser as the modelocked integrated external-cavity surface emitting laser (MIXSEL).

CM55 • 2:45 p.m.
Spectral Phase Shaping for High Resolution CARS Spectroscopy around 3000 cm⁻¹, Sytze Postma, Alexander C. W. van Rijn, Jeroen P. Korterik, Frans van der Heijden, Herman L. Offerhaus; Univ. of Twente, Netherlands. We demonstrate high resolution (cm⁻¹) spectroscopy around 3000 cm⁻¹ by combining a broadband shaped pulse (pump and probe) with a narrow Stokes pulse. We introduce new phase shaping strategies for the removal of the non-resonant background.

CMT6 • 3:00 p.m.
Quasi Super Continuum Generation Using Programmably Controlled Wavelength Tunable Soliton Pulses for Optical Coherence Tomography, Kazuhiko Nishizawa; Osaka Univ., Japan. We present a new kind of ultrafast laser for generating optical coherence tomography images. The laser can be tuned to any wavelength in the range between 450nm and 950nm. The laser is based on a microchip laser and can produce 100ps soliton pulses at a repetition rate of 10MHz. The soliton pulses are then amplified in a fiber amplifier and combined with a tunable filter to obtain a tunable bandwidth from 100nm to 1000nm. The laser is used to generate optical coherence tomography images of different materials, including human tissue.

CMT5 • 2:45 p.m.
Visible “White” Light Generation in Uniform Photonic Crystal Fiber Using a Microchip Laser, James M. Stone1, Jonathan C. Knight2, John Clowes2, 1Univ. of Bath, UK, 2Pliant Ltd., UK. We describe how to extend the bandwidth of the supercontinuum generated in uniform fibers pumped at 1064 nm. The spectra extend to ~400 nm, some 50nm deeper into the blue than previously with the same pump source.
Concurrent sessions are grouped across four pages. Please review all four pages for complete session information.
Monday, May 5

**CMX • Nano- and Micro-Processing of Materials with Femtosecond Laser Pulses—Continued**

**CMX4 • 2:30 p.m.**

Substrate Study of Tungsten Nano-Gratings Deposited by a Single Femtosecond Laser Beam, Mengshi Yang, Huijun Zhang, Yong-Hua Her; Univ. of North Carolina at Charlotte, USA. Sub-wavelength tungsten nano-gratings were grown using a single femtosecond laser beam on many substrates. Quantitative study of substrate reveals that substrates play a significant role in controlling the growth conditions and physical attributes of tungsten-nano-gratings.

**CMX5 • 2:45 p.m.**

Optically Injection-Locked VCSEL for Bi-Directional Optical Communication, Qing Gu, Werner Hofmann, Markus-Christian Amann, Lukas Chrostowski; Univ. of British Columbia, Canada. We propose and experimentally demonstrate for the first time a communication system scheme with an OIL-VCSEL acting both as a transmitter and as a receiver, under an identical forward-bias condition.

**CMX6 • 3:00 p.m.**

Long-Wavelength 2-D VCSEL Arrays for Optical Interconnects, Werner Hofmann, Markus-Gerthlik, Gerhard Böhm, Markus-Christian Amann, Liang Xie, Markus-Christian Amann; Walter Schottky Inst., Germany. "Vertislas GmbH, Germany. Natl. Res. Ctr. for Optoelectronic Technology, China. We present a monolithically integrated, individually addressable 2-D VCSEL array. These lasers, based on InP, emit at 1.55 µm and provide, with 10 GHz modulation bandwidth at moderate biasing conditions, high-speed capabilities for optical interconnects.

**CMX7 • 3:00 p.m.**

Laser Drilling Using a High Repetition Rate and High Average Power Femtosecond Fiber CPA System, Antonio Ancora; Katja Rademakers, Fabian Röser, Jens Limpert, Stefan Nolte, Andreas Tümmann; CEN-INEF Regional Lab, Italy. "Inst. of Applied Physics, Friedrich Schiller Univ. Jena, Germany. "Fraunhofer Inst. for Applied Optics and Precision Engineering IOF, Germany. We report on laser drilling experiments on copper and stainless steel samples using a novel ultrashort fiber CPA laser amplifier. Effects of particle shielding and heat accumulation at high average powers are discussed.

**CMY • Optical Filters—Continued**

**CMY5 • 2:30 p.m.**

Observation of Frequency Division and Chaos Behavior in a Laser Diode Driven by a Resonant Tunneling Diode, Bruna Romero, José M. L. Figuereido, Thomas J. Sliepcevich; Univ. of California, USA. We demonstrate an amplitude division modulation configuration that forms a self-oscillating circuit. Circuit behavior and laser output results are well predicted using Léviard's equation.

**CMY6 • 2:45 p.m.**

Digital Reconstruction of Nonlinear Beam Propagation, Christoph Barri, Woenje Wan, Jason W. Fleischer; Princeton Univ., USA. We experimentally verify the technique by reconstructing nonlinear wave dynamics within a self-defocusing medium and nonlinearly imaging through it.

**CMY7 • 3:00 p.m.**

268 nm Period Bragg Gratings and Integrated Circuits Produced by Direct UV Writing, Dmitro O. Kondys, James C. Gates, Huw E. Major, Corin B. Tijmen G. Scharrer; Peter G. R. Smith; Optoelectronics Res. Ctr., Univ. of Southampton, UK. We demonstrate 268nm period planar Bragg gratings and Mach-Zehnder interferometers fabricated by direct UV-writing. Grating reflectivities of ~30dB and FWHM of ~0.16nm were measured at operational wavelengths around 880nm.

**CMZ • Fiber-, Waveguide- and Cavity-Based Sensing I—Continued**

**CMZ5 • 2:30 p.m.**

Integration of Three-Dimensional Photonic Crystals for Refractive Index Sensing in Microfluidics, Jing Wu, Daniel Day, Min Gu; Ctr. for Micro-Photonics, Swinburne Univ. of Technology, Australia. We present the concept of a refractive index sensor based on integration of a three-dimensional photonic crystal with a microchannel by femtosecond laser fabrication. The sensor performance was characterized by FTIR spectroscopy.
CMAA4 • 2:30 p.m.
Efficiency of InGaN LEDs Incorporating Surface Plasmon Polaritons, Christopher Wiesmann¹, Norbert Linder¹, Ulrich T. Schwarz²; ¹OSRAM Opto semiconductor, Germany, ²Univ. Regensburg, Germany. We estimated the influence of Surface Plasmon Polaritons on the internal efficiency of LEDs by 3-D FDTD calculations. It turns out, that SPP LEDs outperform standard LEDs if non-radiative losses are high.

CMAA5 • 2:45 p.m.
Improving Quantum Efficiency with Nanostructured Semipolar III-Nitride Light Emitters, Taeil Jung, P. C. Ku; Univ. of Michigan, USA. We demonstrated nanostructured semipolar III-nitride light emitters on low cost c-plane GaN templates using one-step epitaxy. The total light emission efficiency is improved by a factor of 2.6 compared to polar emitters at room temperature.

CMAA6 • 3:00 p.m.
Nitride/Organic Hybrid Heterostructures for Photodetector Devices, Hyunjin Kim¹, Qiang Zhang¹, Arto Nurmikko², Qian Sun², Jong Han²; ¹Brown Univ., USA, ²Yale Univ., USA. We report on the study of incorporation of organic semiconductors with GaN to explore new types of optoelectronic devices. Photoelectrical effect and photoconductivity gain were demonstrated using Organic/Inorganic heterostructure, which offer new type of photodetectors.

3:15 p.m.–3:45 p.m.
Coffee Break, Concourse Level
### Ballroom A1 and A8

#### 3:45 p.m.–5:30 p.m.

**CMBB1** • 3:45 p.m.

**Nonlinear Mode Locking of Optical Parametric Oscillators: An Efficient Technique for Generating Sub-Picosecond Pulses**, Jacob B. Khurgin1, Jean Michel Mellouk2, Antoine Godard3, Michael Lefèvre3, Emmanuel Rosencher3; 1Johns Hopkins Univ., USA, 2Cnam, France, 3Laboratoire d'Optique de Paris and Laboratoire d'Optique Appliquée, France. We demonstrate a pair of strongly-coupled, stacked monoclinic silicon nitride microdisk resonators coupled to a tapered optical fiber. High-frequency optical-mechanical interactions between the two microdisks are induced by both optical force and photothermal effects.

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### Ballroom A2 and A7

#### 3:45 p.m.–5:30 p.m.

**JMD • Joint CLEO/QELS Symposium on Novel Resonators: Cavity Opto-Mechanics**

**Gerard Milburn**; Univ. of Queensland, Australia, President

**CMDB1 • 3:45 p.m.**

**Optomechanics of Strongly Coupled Stacked Monolithic Microdisks**, Matt Eichenfield, Okan J. Painter; Caltech, USA. We demonstrate a pair of strongly-coupled, stacked monoclinic silicon nitride microdisk resonators coupled to a tapered optical fiber. High-frequency optical-mechanical interactions between the two microdisks are induced by both optical force and photothermal effects.

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### Ballroom A3 and A6

#### 3:45 p.m.–5:30 p.m.

**CMCC • Short Wavelength Imaging**

**Paolo Villaroel**; Univ. degli Studi di Padova, Italy, President

**CMCC1 • 3:45 p.m.**

**Intense XUV Femtosecond Pulses Selected by a Time-Delay-Compensated Monochromator**, Enrico Benedetti, Federico Ferrari, Salvatore Stagira, Giuseppe Sansone, Maurizio Nisoli, Luca Pogliotti, Paolo Villaroel; Consiglio Naz. delle Ricerche, Inst. Nat. per la Fisica della Materia, Dept. di Fisica, Politecnico di Milano, Italy. Consiglio Naz. delle Ricerche, Inst. Nat. per la Fisica della Materia, DEI, Univ. di Padova, Italy. Extreme ultrafast pulses, produced by high-order-harmonic generation, have been spatially selected by a time-delay-compensated monochromator. Temporal characterization has been obtained using cross-correlation method: pulses as short as 8 fs, with high photon flux, have been measured.

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### Ballroom A4 and A5

#### 3:45 p.m.–5:30 p.m.

**CMDM • Supercontinuum Generation II**

**Mark A. Foster**; Cornell Univ., USA, President

**CMDD1 • 3:45 p.m.**

**High-Power 29 W CW Supercontinuum Source**, B. A. Cumberland, J. C. Travers, S. V. Popov, J. R. Taylor, Femtosecond Optics Group, Phys. Dept., Imperial College London, UK. We report a 29 W CW supercontinuum spanning 160-1.67 μm with a spectral power density of 50 mW/nm up to 1.4 μm generated in a double-zero PCE. The dynamics of formation are analyzed.

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**CMDD2 • 4:00 p.m.**

**Raman Response Function and Supercontinuum Generation in Chalcogenide Fiber**, Jonathan Hui, Curtis R. Menyuk, L. Brandon Shaw, Insu-binder S. Sanghera, Ishwai D. Aggarwala; Univ. of Maryland, Baltimore County, USA, NRIL, USA. We show the Raman response function and dispersion curve for a chalcogenide fiber. We then model and reproduce the experimental bandwidth of IR supercontinuum generation using a chalcogenide PCE.

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**CMDD3 • 4:15 p.m.**

**The Impact of Nonlinearity During Femtosecond Pulse Compression in Fibers on Continuum Coherence**, Jeffrey W. Nicholson, Andrew D. Yablon, Man F. Jan, Patrick Wisk, Jim Fleming, Eric Monberg, Frank Demarcilla, Ryan Bize, Dennis J. Trevor, John Allenza, Tom Steckart, OFS Labs, USA. Amplified erbium-fiber laser pulses compressed in large-mode-area fiber show significantly reduced nonlinearity compared to standard single-mode fiber. Consequently, supercontinuum generated with the pulses compressed in large-mode-area fiber show a 10 dB increase in cross-coherence fringe visibility.

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**CMDD4 • 4:30 p.m.**

**Waveguide Fabrication and Supercontinuum Generation in an Ultrafast Laser Inscribed Chalcogenide Glass Waveguide**, Nicholas D. Psaila, Robert B. Thomson, Henry T. Boosky, Ajoy K. Kar, Nicola Chiodo, Robert Otslame, Giulia Cerniello, Shanshing Shen, Animachel Jha, Heriot-Watt Univ., UK, Politecnico di Milano, Italy, Univ. of Leeds, UK. We report on the fabrication and characterisation of waveguides fabricated in a GeS based chalcogenide glass. A wide range of waveguiding structures were fabricated, and supercontinuum generation was demonstrated for a highly multimode waveguide.
Superconducting Nanowire Photon Number Resolving Detector at Telecom Wavelength, Francesco Marsilli1, David Bituilla2, Aleksander Divochij, Alessandro Gaggero, Roberto Leon1, Francesco Mattioli2, Alexander Karneeva3, Vitaly Selzner3, Natalya Kourava3, Olga Minina3, Gregory Goftman3, Konstantinos G. Lagoudakis3, Marzuhah Benkhaoual3, Francis Levy3, Andrea Fiore4, Eole Polychimie Fédrale de Lausanne (EPFL), Switzerland; Eindhoven Univ. of Technol., Netherlands, Moscow State Pedagogical Univ. (MSPU), Russia, Federal University of Ceará, Brazil. We report a novel photon-number-resolving (PNR) detector, based on parallel superconducting nanowires, capable of resolving up to 5 photons in the telecommunication wavelength range, with sensitivity and speed far exceeding existing approaches.

High-Fidelity Photon-Number-Resolution Using Multi-Element Superconducting Nanowire Single Photon Detectors, Eric A. Dualler1, Richard Molnar1, Andrew J. Kerman1, Joel K. W. Yang1, Karl K. Berggren2. 1MIT, 2MIT Lincoln Lab. USA. Achieving photon-number-resolution using superconducting nanowire single photon detectors (SNSPDs) can enable high-speed source characterization and high-rate conditional state preparation. We report improved fidelity photon-number-resolution using high system-detection-efficiency four-element SNSPDs.

Three-Dimensional Microscopic Interferometer by Frequency Sweep of Supercontinuum Frequency Comb, Samuel Olot1, Naoyuki Tamaura1, Ryo Seki1, Tatatoshi Shida1, Yousuke Tanaka1, Takashi Kurokawa1, Tokyo Univ. of Agriculture and Technology, Japan. We evidence the nanoscale nature of photodetection in superconducting nanowire single-photon detectors by a spatially-resolved efficiency measurement. A novel nanoscale detector, with 100x100 nm active area, is also demonstrated using an artificial construction.

Investigation of Local Photon Detection Efficiency Distributions in Nanowire Superconducting Single-Photon Detectors, Birun Bash1, Eric J. Garcia1, Michael T. Steiner1, Richard P. Mirin1, Sue Wow Nam1, Robert H. Hadfield1, Paul A. Dalgarno1, John A. O’Connor1, Evan Ramsay2, Richard J. Warburton2, 1NIST, 2Univ. of Central Florida, USA. We present our effort in investigating their local photon detection efficiency distribution in high spatial resolution.

Room C1 and C2

QELS
3:45 p.m.–5:30 p.m.
QMJ • Single-Photon Detectors
Sae Woo Nam; NIST, USA, Presider

Room C3 and C4

CLEO
3:45 p.m.–5:30 p.m.
CME • Advanced Optical Length Metrology
Koaru Miroshima; AIST, Japan, Presider

Room B1 and B2

CMFF • THz QCL II
 Hou-Tong Chen; Los Alamos Natl. Lab, USA, Presider

Room J2

QELS
3:45 p.m.–5:30 p.m.
QMK • Solitons
Demetrios Christodoulides; College of Optics and Photonics, Univ. of Central Florida, USA, Presider
CMGG1 • 3:45 p.m.
Ultra Thin HCG in a NEMO Tunable VCSEL, Michael C. Y. Huang, Ye Zhou, Connie J. Chang-Hanassian; Dept. of Electrical Engineering and Computer Sciences, Univ. of California at Berkeley, USA. We present nano-techno-mechanical optoelectronic (NEMO) tunable VCSELs utilizing ultra-thin electrostatic-actuated single-layer (140nm), high-contrast subwavelength grating designed to strongly reflect TE-polarized light. A 2mW single-mode (SMDR - 45dB) VCSEL with ultra-fast tuning speed ~90 ns is demonstrated.

CMGG2 • 4:00 p.m.
Characterization and Analysis of Micro-Fluidic VCSELs, Ishu D. Salkin, Anssi M. Koster, Dominic F. Strani, Kent D. Choquette; Univ. of Illinois, USA. A parametric study of micro-fluidic photonic crystal vertical-cavity surface-emitting lasers is carried out which shows a larger fluid-induced wavelength shift with smaller lattice constant. An effective index model is developed which is consistent with measurements.

CMGG3 • 4:15 p.m.
Visible Split Beam VCSEL for Compact Sensor Applications, Markus Maute1, Volker Gerhardt2, John D. Lambkin1, Stephen A. Slattery3, John P. Jovetic4, Steven P. Hegarty1, Guillaume Dayet1, Brian Corbett1; Firecomms, Ireland, ‘Tyndall Nat. Inst., Ireland.’ We present a visible VCSEL with integrated beam splitter. By focusing one beam onto a moving target and monitoring the power variation in the second beam, these devices can be used as Doppler-based velocity sensors.

CMGG4 • 4:30 p.m.
Invited
Threshold Current Reduction and Electrical Modulation of Degree of Circular Polarization in InAs/GaAs Quantum Dot Spin-VCSELs, Debashish Basu, Chung Chiang Wu, Dipankar Saha, Zetian Mi, Pallab Bhattachar, Univ. of Michigan, USA. Threshold current reduction and polarization modulation of an electrically injected spin-polarized VCSEL operating at 200 K have been investigated experimentally and theoretically.

3:45 p.m.-5:30 p.m.
CMHH • VCSEL II
Richard Jones; Intel Corp., USA, Presider

CMHH1 • 3:45 p.m.
Femtosecond and Nanosecond Laser-Induced Nanoeffects for Cell Surgery and Modifications of Glass, Alfred Vogel1, Norbert Lenz1, Sebastian Freidank1, Joachim Noack1, Gunther Paltauf1; Inst. of Biomedical Optics, Univ. of Luebeck, Germany. ‘Physik Inst., Karl-Franzens-Univ. Graz, Austria. Both femtosecond and nanosecond pulses can create low-density plasmas in transparent dielectrics suitable for nano-cell surgery and modification of glasses. The variation of mechanisms with pulse repetition rate and duration will be discussed.

CMHH2 • 3:45 p.m.
Tutorial
Femtosecond and Nanosecond Laser-Induced Nanoeffects in Optical Materials, Alfred Vogel1, Norbert Linz1, Günther Paltauf1, Sebastian Freidank1, Joachim Noack1, Gunther Paltauf1; Inst. of Biomedical Optics, Univ. of Luebeck, Germany. ‘Physik Inst., Karl-Franzens-Univ. Graz, Austria. The tutorial will present an overview of ultrafast laser-induced optical effects in optical materials with emphasis on femtosecond and nanosecond lasers. Applications include nanoholes, “nano-diamonds”, surface nanostructuring, self-focusing in glass, waveguides and transverse energy excitations in optical fibers.

CMII1 • 3:45 p.m.
7-ENOB Resolution Photonic Analog-to-Digital Conversion of Narrowband Microwave Signals at 40 GHz, Jungwon Kim, Matthew Park, Michael H. Perrott, Franz X. Kärner; MIT, USA. An optical sub-sampling downconversion receiver for analog-to-digital conversion of narrowband high-frequency microwave signals is demonstrated. The measured SNDR in 2-MHz bandwidth at 40-GHz carrier frequency is 44 dB corresponding to 7-ENOB resolution.

CMII2 • 4:00 p.m.
Demonstrations of Analog-to-Digital Conversion Using a Frequency Domain Stretched Processor, Randy B. Rehbel1, Calvin Harrington1, Jason Dahl1, Charles Ottrander2, Peter A. Rous1, R. Krishna Mohan3, Win, Randall Bubbert1, Trenton J. Berg2; Spectrum Lab, Montana State Univ., USA. ‘32 Corp., USA. Proof-of-concept analog-to-digital conversion demonstrations are presented for a photonics-based frequency-domain, stretched processor. Here 800 MHz bandwidths and >26dB dynamic range are shown, with models suggesting 10-bit performance over 20 GHz bandwidths.

CMII3 • 4:15 p.m.
Compensation Algorithm for Deterministic Phase Ripple, Josh A. Conway, George A. Sefler, George C. Valley; JASON T. Chou; Aerospace Corp., USA. Phase ripple arising from imperfections in novel dispersive devices can severely distort broadband optical signals. We experimentally and theoretically demonstrate an algorithm that corrects for these distortions while simultaneously reducing the effects of additive noise.

CMII4 • 4:30 p.m.
Adaptive Error Compensation for Photonic Analog-to-Digital Converters, Aminah Khilo, Jonathan R. Birge, Franz X. Kärner; MIT, USA. Factors limiting the accuracy of a wideband optically sampled analog-to-digital converter are discussed. An algorithm for adaptive error compensation in a post-processing step is proposed and shown to be effective against various system imperfections.

3:45 p.m.-5:30 p.m.
CMIII • A/D Conversion and Waveform Processing
Paul W. Juodawlkis; MIT Lincoln Lab, USA, Presider

CMJJ1 • 3:45 p.m.
Detection of Explosives and CO Dissolved in Water with an Evansen Field Sensor, Rosalia Ortega1, Ulrike Willer1, Magdalena Gierszewski1, Siegfried R. Waldvogel2, Wolfgang Schade1; ‘Inst. für Physik und Physikalische Technologie, Clausthal Univ. of Technology, Germany,’ Laser Ammershagens Centrum, Clausthal Univ. of Technol. Germany, ‘Kekule Inst. for Organic Chemistry and Biochemistry, Univ. Bonn, Germany.’ A fiber optic approach for the determination of the carbon dioxide concentration in the gas or fluid phase during sequestration as well as for the sensing of the explosive TNT will be presented.

CMJJ2 • 4:00 p.m.
Evanescent Field Sensing in Novel Flat Fiber, Christopher Holmes, F. R. Mahbub Aftab; Andrew I. Webb, James C. Gates, Colin B. E. Gwirth, Ioanna K. Saka, Peter G. R. Smith, David N. Payne; Optoelectronics Res. Ctr., Univ. of Southampton, UK. Recently developed novel ‘flat fiber’ substrate promises flexible, long-haul integrated optical devices. Here, we present the first demonstration of one such device; an evanescent field sensor, based upon direct UV written Bragg gratings.

CMJJ3 • 4:15 p.m.
Evanescent Field Sensing in Novel Flat Fiber, Christopher Holmes, F. R. Mahbub Aftab; Andrew I. Webb, James C. Gates, Colin B. E. Gwirth, Ioanna K. Saka, Peter G. R. Smith, David N. Payne; Optoelectronics Res. Ctr., Univ. of Southampton, UK. Recently developed novel ‘flat fiber’ substrate promises flexible, long-haul integrated optical devices. Here, we present the first demonstration of one such device; an evanescent field sensor, based upon direct UV written Bragg gratings.

CMJJ4 • 4:30 p.m.
Hollow Waveguide as an Online Microliter Spectroscopy Sensor for Gas Chromatography, Andrei Deev, Sheng Wu, Yongchun Tang; Caltech, USA. Quantum Cascade laser is coupled into Hollow Waveguide as an inline sensor after GC separation. We show the sensor has high ppbV sensitivity for carbon and other species, yet maintaining the GC peaks.
CMKK • Novel LED and OLED Device Structures
Franky So; Univ. of Florida, USA, Presider

CMKK1 • 3:45 p.m. Invited
OLEDs on Fibers and AFM Cantilevers, Max Stiefler, Brendan O’Connor, Yiying Zhao, Kevin P. Pipe; Dept. of Materials Science and Engineering, Univ. of Michigan, USA; Dept. of Mechanical Engineering, Univ. of Michigan, USA. This talk will discuss recent work on novel device architectures that include ITO-free OLEDs deposited on fibers, on highly corrugated surfaces and sharp tips for solid-state lighting and microscopy applications.

CMKK2 • 4:15 p.m.
High-Resolution Mapping of Electric Field inside Organic Optoelectronic Devices, Michele Celebrano, Calogero Scianna, Giudice Cerullo, Gaetano Lanzani, Politecnico di Milano, Italy. By combining confocal microscopy with electroreflectance spectroscopy we directly map electric field amplitude distribution between electrodes in a prototypical organic semiconductor device. We demonstrate this approach on a copper phthalocyanine photodetector.

CMKK3 • 4:30 p.m.
Emission Characteristics of a Surface-Emitting Composite Organic Photonic-Crystal Laser, Sidney L. Yang, Li-Wen Chang, Chong-Jie Huang; Inst. of Photonics Technologies, Natl. Tsing Hua Univ., Taiwan. Lasing action of a composite organic thin-film laser with a 2nd-order two-dimensional photonic crystal structure of triangular lattice is investigated. The analysis of band theory is adopted and the emission pattern is also presented.
Ballroom A1 and A8

CMBB • Nonlinear Wave Mixing—Continued

CMBB5 • 4:45 p.m.
Photorefractive Two-Wave Mixing in Sn,P$_3$S$_7$/Te at 1.55 μm, Roger Maximen*, Patrick Marty*, Myca Iazmik*, Peter Gunter*, Alexander A. Grubov*, Eidgenössische Technische Zürich, Switzerland, *Eindhoven Natl. Univ., Ukraine. We demonstrate fast photorefractive two-wave mixing with a cw-laser at the telecommunication wavelength 1.55μm for the first time in a bulk ferroelectric crystal (Sn,P$_3$S$_7$/Te). A high gain (6cm$^{-1}$) was achieved without applying an external E-field.

CMBB6 • 5:00 p.m.

CMBB7 • 5:15 p.m.
Apex-Enhanced Second Harmonic Generation from Asymmetric Nanoscale Arrays in a Gold Film, Fatemeh Eftekhari, Reuven Gordon, Univ. of Victoria, Canada. The second harmonic generation from a non-centrosymmetric nanostructure in gold film is studied comprehensively. The sunglass aperture shape is chosen to have an apex to increase the local field.

Ballroom A2 and A7

CJM • Joint CLEO/QELS Symposium on Novel Resonators: Cavity Opto-Mechanics—Continued

JMD4 • 4:45 p.m.
Optomechanical Effects in a Dispersively Coupled High Finesse Cavity and Micromechanical Membrane, Benjamin Zwicky*, Jeff E. Thompson*, Andrew M. Jayich*, Cheng Yang*, Florian Marquardt*, Steven M. Girvin*, Jack G. E. Harris*, Phys. Dept., Yale Univ., USA, *Physics Dept., Ctr. for Nanoscience, and Arnold Sommerfeld Ctr. for Theoretical Physics, Ludwig Maximilians Univ., Germany, *Dept. of Applied Physics, Yale Univ., USA. By dispersively coupling a dielectric membrane to an optical cavity, we laser-cooled it from 294K to 6.82mK. Further, the cavity couples to the square of the membrane’s displacement—a key for QND energy measurements.

JMD5 • 5:00 p.m.
Resolved Sideband Laser Cooling of a Micro-Mechanical Oscillator, Albert Schliesser, Rémi Rivière, Georg Anetsberger, Olivier Arcizet, Tobias Kippenberg; Max-Planck-Inst. of Quantum Optics, Germany. Mechanical oscillation-induced sidebands are resolved by the >20-times narrower resonances of ultra-high-finesse optical microcavities. Tuning a laser to the first lower sideband thus permits resolved sideband cooling from room temperature to phonon occupations below 6,000.

Ballroom A3 and A6

CMCC • Short Wavelength Imaging—Continued

CMCC5 • 4:45 p.m.
70nm Lensless Diffractive Microscopy Using Tabletop Soft X-Ray Sources, Richard L. Sandberg*, Chongyang Song*, Przemyslaw W. Wachulak*, Daisy A. Raymond*, Arvind Fau*, Bagrat Amirbekian*, Arne E. Sahuwala*, Edwin Lee*, Chan La-O*: Vorakiat*, Mario C. Marcon*, Carmen S. Menon*, Margaret M. Murnane*, Jorge J. Rocca*, Henry C. Kapteyn*, James Miao*; *JILA and Univ. of Colorado at Boulder, USA, **California Nanosystems Inst. and Dept. of Physics and Astronomy, Univ. of California at Los Angeles, USA, *Dept. of Electrical and Computer Engineering, Colorado State Univ., USA, *Ctr. for X-Ray Optics, Lawrence Berkeley Natl. Lab, USA. We use curvature correction and high-numerical-aperture imaging to demonstrate a soft-x-ray diffraction microscope with 70-90 nm resolution using two tabletop coherent sources. This near-diffraction-limited resolution of 1.3A is a first for x-ray diffractive imaging.

CMCC6 • 5:00 p.m.
Phase Coherent, Injection-Seeded Table-Top Soft X-Ray Lasers at Wavelengths down to 13.9 nm, Tong Wang, Francesco Pedaci, Mark Berrill, Brad Luther, E. Granados, Dave Alesci, Jorge J. Rocca; Colorado State Univ., USA. We have realized the first demonstration of soft x-ray lasers with essentially full spatial and temporal coherence at sub-20nm wavelengths by high harmonic seeding of soft x-ray plasma amplifiers created by irradiation of solid targets.

Ballroom A4 and A5

CMDD • Supercontinuum Generation II—Continued

CMDD5 • 4:45 p.m.
Low-Energy Threshold Supercontinuum Generated in Highly Nonlinear As$_2$Se$_3$, Chalcogenide Submicron Tapers, Dong-Il Yeom, Eri C. Maig*, Michael R. E. Lamont, Michael A. F. Redhead, Libin Fu, Benjamin J. Eggleton, ARC Ctr. for Ultrahigh Bandwidth Devices for Optical Systems, School of Physics, Univ. of Sydney, Australia. We fabricate sub-micron chalcogenide fiber tapers exhibiting ultra-high nonlinearity up to γ ~ 93 W/m. This high nonlinearity, in combination of tailored anomalous dispersion, enables low-energy threshold soliton fission leading to supercontinuum generation.

CMDD6 • 5:00 p.m.
Broadband Supercontinuum Using Single-Mode/Dual-Mode Tellurite Glass Holey Fibers with Large Mode Area, Xian Feng, Wei H. Loh, Angela Camerlingo, Senadi Dasgupta, Joanna C. Pamagan, Periklis Petropoulos, Ken E. Froncisz, Nicholas M. White, Harvey N. Rutt, David J. Richardson; Optoelectronics Res. Ctr., Univ. of Southampton, UK. We demonstrate broadband 1.0-2.4μm infrared supercontinuum generation with 0.4mW output, using single-mode and few-mode tellurite holey fibers with very large mode area, of up to 300μm$^2$.
Concurrent sessions are grouped across four pages. Please review all four pages for complete session information.
CMGG • VCSEL II—Continued

CMGG6 • 5:15 p.m.
Spatially Resolved Thermal Coupling in VCSEL Arrays Using Thermoreflectance Microscopy, Kathryn J. Greenberg, Joseph A. Summers, Maryam Farzaneh, Janice A. Hudgings; Mount Holyoke College, USA. Thermoreflectance microscopy is used for simultaneous, spatially-resolved temperature measurements of VCSELs in a 1-D array. Significant thermal effects such as thermal coupling between neighboring VCSELs and temperature distribution across the apertures are reported.

CMHH2 • 4:45 p.m.
Femtosecond Light Interaction with Skin: Microspectroscopy of Light-Induced Changes in Collagen Matrix, Vladislav V. Yakovlev1, Robert Thomas1, Gary Neele1, Michael Denton1; 1Univ. of Wisconsin at Milwaukee, USA, 2AFRL, RJISO, USA, 3Northrop Grumman Corp., USA. Femtosecond pulses derived from a Ti:sapphire oscillator are used to locally modify collagen-rich tissue. Raman and fluorescence microspectroscopy are employed for in situ observations of structural transformations of collagen matrix.

CMII5 • 4:45 p.m.
640 Ghz RZ Eye-Diagram Evaluation by Optical Sampling Oscilloscope without Post-Processing and ms Refresh Time, Francesco Freoli1, Andrea Chiuchiarelli1, Antonio Malacarne2, Luca Petti1, Antonella Bogni1; 1Scuola Superiore Sant’Anna, Italy, 2Consorzio Nazionale Interuniversitario per le Telecomunicazioni, Italy. A polarization insensitive quasi-asynchronous optical sampling oscilloscope with sub-ps resolution is presented. The scheme is able to resolve tens of ns and provides eye-diagram functionality. Experimental results for a 640 Gb/s data frame are reported.

CMHH4 • 5:15 p.m.
Fabrication of High Aspect Ratio Microfluidic Devices Using Direct Fs Ablation, Graham Smith1, Dimitris Karnakis1, Martin Knowles1, Alan Ferguson1, Ian Bennion1; 1Aston Univ., UK, 2Oxford Lasers Ltd., UK. We present a single stage direct fs ablation results which show that it is possible to make high quality and high aspect ratio devices in a single stage process using a CAD optimised approach.

CMII6 • 5:00 p.m.
Integrated Optical Sensing in a Lab-on-Chip by Femtosecond Laser Written Waveguides, Roberto Osellame1, Rebeca Martinez Vazquez2, Roberta Ramponi1, Giulio Ceriali1, Chaitanya Dongre1, Ronald Dekker1, Hugo J. W. Hoekestra1, Markus Pollnau1; 1IFN C.N.R., Italy, 2Politecnico di Milano, Italy, 3Univ. of Twente, Netherlands. Integrated optical detection in a commercial microfluidic chip for capillary electrophoresis has been implemented by means of femtosecond laser written optical waveguides for excitation and a high numerical aperture optical fiber for collection.

CMII7 • 5:15 p.m.
Reconfigurable RF Waveform Generation Using Optical Incoherent Sources, Victor Torres-Company1, Jesús Lascas1, Pedro Andrés2, Lawrence R. Chen2; 1Univ. de Jaume I, Spain, 2Univ. de Valencia, Spain, 3McGill Univ., Canada. An RF waveform generator operating with incoherent broadband light is successfully implemented. Complex RF ~10 GHz bandwidth waveforms are generated by means of incoherent wavelength-to-time mapping. Our technique can be scaled to the mm-wave range.

CMJ5 • 4:45 p.m.
Demonstration of a Refractometric Sensor Based on Optical Microfiber Coil Resonator, Gilberto Brambilla, Fei Xie; Optoelectronics Res. Ctr., Univ. of Southampton, UK. We experimentally demonstrated a novel refractometric sensor based on a coated optical microfiber coil resonator which is robust, compact, and comprises an intrinsic fluidic channel. The measured sensitivity has an excellent agreement with theoretical predictions.

CMJJ5 • 4:45 p.m.
On-Chip Gas Detection in Silicon Optical Microcavities, Jacob T. Robinson, Long Chen, Michael Lipson; Cornell Univ., USA. We detect acetylene gas on a silicon chip using photonic microcavities and a chip-scale gas cell. We measure refractive index differences as small as 10^-6 between air and acetylene at varying pressures in the near IR.

CMJJ6 • 5:00 p.m.
MEMS Chemical Sensors Using Waveguide Fabry-Perot Microcavities, Marcel W. Pruessner, Todd H. Stievaert, William S. Rabinovich, R. Andy McGill, Jennifer L. Stepnowski; NRL, USA. We detect acetylene gas on a silicon chip using photonic microcavities and a chip-scale gas cell. We measure refractive index differences as small as 10^-6 between air and acetylene at varying pressures in the near IR.
CMKK4 • 4:45 p.m.
Enhanced Light Extraction of Light-Emitting Diodes with Photonic Crystal Pattern Fabricated by Nanoimprint, Kyeong-Jae Byeon, Seon Yong Huang, Ki-Yeon Yang, Heon Lee, Chang-Hee Hong, Eun-Kyung Subi, Korea Univ., Republic of Korea. A hexagonal array of sub-micron sized holes was fabricated on InGaN/GaN quantum-well light-emitting diodes using nanoimprint lithography. Photoluminescence measurement confirms that light extraction of the LED was enhanced with two-dimensional photonic crystal patterns.

CMKK5 • 5:00 p.m.
Fabrication of Photonic Crystal Light-Emitting Diode with Photoelectrochemical Wet Etching and Phase Mask Interference, Cheng-Yen Chen, Cheng-Hung Lin, Dong-Ming Yeh, Chih-Feng Lu, Chi-Feng Huang, C. C. Yang, Natl. Taiwan Univ., Taiwan. We demonstrate the high light extraction efficiency by using the photoelectrochemical etching technique for forming photonic crystal structures on an InGaN/GaN quantum-well light-emitting diode through phase-mask interference. More than 90% increase of output power is observed.

CMKK6 • 5:15 p.m.
Size Effects and Light Extraction Efficiency Optimization of III-Nitride Light Emitting Diodes with SiOx/Polymer Micro lens Arrays, Yi-Khoon Er, Pirisit Kammarikaew, Ronald A. Arif, Hua Tong, James F. Gilchrist, Nelson Tansu, Lehigh Univ., USA. Optimization studies of InGaN quantum wells light emitting diodes employing SiOx/polymer micro lens arrays are conducted. The use of micro lens arrays leads to increase in light extraction efficiency by 2.7-times, in agreement with simulation.

5:30 p.m.–6:00 p.m.
Break (Civic Auditorium doors will open at 5:45 p.m. for the Plenary)

6:00 p.m.–7:30 p.m.
CLEO Plenary Session,
Civic Auditorium