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

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

10:00–11:00 Coffee Break (10:00-10:30) and Unopposed Exhibit Only Time, *Exhibit Halls 1, 2 and 3*

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

10:30–12:30 Market Focus Session I: Defense: Laser Interrogation for Standoff Detection of Hazardous Materials, *Exhibit Hall 3*

11:00–13:00
CTu1A • Silicon Photonics II
Milos Popovic, University of Colorado at Boulder, USA, *Presider*

CTu1A.1 • 11:00
Detection or Modulation at 35 Gbit/s with a Standard CMOS-processed Optical Waveguide, Dietmar Korn[1], Hui Yu[2], David Hillerkuss[1], Luca Alloatti[1], Christoph Mattern[1], Wim Bogaerts[2], Katarzyna Komorowska[2], Roel Baets[2], Joris Van Campenhout[3], Peter Verheyen[3], Johan Wouters[3], Myriam Moelants[3], Philippe Absil[3], Wolfgang Freude[1], Christian Koos[1], Juerg Leuthold[1]; [1]*Institute of Photonics and Quantum Electronics (IPQ) and Institute of Microstructure Technology (IMT), Karlsruhe Institute of Technology, Germany;* [2]*Department of Information Technology, Ghent University, Belgium;* [3]*imec, Belgium.* Light modulation and detection within a single SOI waveguide is demonstrated at 1550 nm. Multi-functional devices allow simplified transceiver systems. Savings in the number of fabrication steps increase the yield and reduce costs.

CTu1A.2 • 11:15
Compact Nano-Antenna Emitters for Optical Phased Array Applications. Katia Shtyrkova[1], Ami Yaacobi[1], Paul Davids[2], Douglas C. Trotter[2], Joel Wendt[2], Christopher DeRose[2], Rohan D. Kekatpure[2], Erich P. Ippen[1], Michael R. Watts[1]; [1]*EECS, MIT, USA;* [2]*Sandia National Labs, USA.* We propose and experimentally demonstrate nano-antenna emitters coupled to a dielectric waveguide. Initial measured emitter efficiencies are 4.9-13% with simulations predicting >50% efficiencies with bandwidths exceeding 300nm.

11:00–13:00
CTu1B • Terahertz Narrowband Sources
Hirumasa Ito, RIKEN, Japan, *Presider*

CTu1B.1 • 11:00
Generation of Tunable Narrowband Terahertz Pulses from Coherent Transition Radiation, Yuzhen Shen[1]; [1]*National Synchrotron Light Source, Brookhaven National Laboratory, USA.* We demonstrate the generation of tunable, narrow-band, few-cycle and multi-cycle terahertz pulses from a temporally modulated relativistic electron beam through coherent transition radiation.

CTu1B.2 • 11:15
Milliwatt-level power generated in the sub-terahertz range by photomixing in a metal-metal resonant cavity GaAs photoconductor, Emilien Peytavit[1], Sylvie Lepilliet[1], Francis Hindle[2], Christophe COinon[1], Tahsin Akalin[1], Guillaume Ducournau[1], Gaël Mouret[2], Jean F. Lampin[1]; [1]*IEMN CNRS/ Université de Lille, France;* [2]*LPCA CNRS/ Université du Littoral Côte d'Opale, France.* It is shown from on-wafer measurement that a continuous wave output power of 0.35 mW at 305 GHz can be generated by photomixing in a metal-metal Fabry-Pérot GaAs photoconductor.

11:00–13:00
QTu1C • Molecular Attosecond Dynamics
Laszlo Veisz, Max-Planck-Institut fur Quantenoptik, Germany, *Presider*

QTu1C.1 • 11:00 Tutorial
High Harmonic Spectroscopy of Attosecond Dynamics, Misha Ivanov[1,2]; [1]*Max Born Institute and Humboldt University, Germany;* [2]*Imperial College London, United Kingdom.* I will describe application of high harmonic generation for tracking attosecond dynamics of electrons and holes in molecules, including two-dimensional high harmonic spectroscopy which looks particularly sensitive to detecting electron-hole pair dynamics.

Misha Ivanov was born in Moscow in 1964. He graduated from the Moscow State University in 1987. After defending PhD in Physics in 1989, he joined the staff of the General Physics Institute. He moved to the National Research Council of Canada in 1992 as Research Associate, eventually becoming the Principal Research Officer and head of Theory and Computation Program at the Steacie Institute for Molecular Sciences NRC in 2005. In 2008 he took a chair in Attosecond physics at the Imperial College London. Since 2012 he holds appointments at the Humboldt University and the Max Born Institute in Berlin.

11:00–13:00
CTu1D • Laser Technology and Issues for High Average Power
Jonathan Zuegel, University of Rochester, USA, *Presider*

CTu1D.1 • 11:00
Intracavity coherent beam combining of 21 semiconductor gain elements using SPGD, Steven J. Augst[1], Juan Montoya[1], Kevin Creedon[1], Jan Kansky[1], T. Y. Fan[1], Antonio Sanchez-Rubio[1]; [1]*Massachusetts Institute of Technology, Lincoln Laboratory, USA.* Coherent beam combining (CBC) allows for achieving high output power in a single diffraction limited beam. We report on intracavity CBC of 21-element semiconductor array with 81% combining efficiency from a system maximum combining efficiency of 90%.

CTu1D.2 • 11:15
Lens-less edge-pumping high power single-mode Yb:YAG microchip laser, Kong Weipeng[1], Takunori Taira[1,2]; [1]*Laser Research Center TAIRA Group Room 304, The Graduate University for Advanced Studies, Japan;* [2]*Laser Research Center TAIRA Group Room 304, Institute for Molecular Science, Japan.* We report the first demonstration of compact, single mode, multi-direction lens-less edge-pumped all-ceramic Yb:YAG microchip laser. The preliminary result of 9-direction pump, single-mode, 33.7 W CW out power is successfully obtained.

Room A5	Room A6	Room A7

CLEO: QELS-Fundamental Science

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10:00–11:00 Coffee Break (10:00-10:30) and Unopposed Exhibit Only Time, *Exhibit Halls 1, 2 and 3*

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11:00–13:00
QTu1E • Detectors I
James Franson, University of Maryland, USA, *Presider*

QTu1E.1 • 11:00
On-chip, photon-number-resolving, telecom-band detectors for scalable photonic information processing, Thomas Gerrits[1], Nicholas Thomas-Peter[2], James C. Gates[3], Adriana E. Lita[1], Benjamin J. Metcalf[2], Brice Calkins[1], Nathan A. Tomlin[1], Anna E. Fox[1], Antia Lamas Linares[1], Justin B. Spring[2], Nathan K. Langford[2], Richard Mirin[1], Peter G. Smith[3], Ian A. Walmsley[2], Sae Woo Nam[1]; *[1]National Institute of Standards and Technology, USA; [2]Clarendon Laboratory, University of Oxford, United Kingdom; [3]Optoelectronics Research Centre, University of Southampton, United Kingdom.* We demonstrate an integrated photon-number resolving detector, operating in the telecom band at 1550 nm, employing an evanescently coupled design that allows the detector to be placed at arbitrary locations within a planar optical circuit.

QTu1E.2 • 11:15
Efficient Single Photon Detection From 0.5 To 5 Micron Wavelength, Francesco Marsili[1], Francesco Bellei[1], Faraz Najafi[1], Andrew Dane[1], Eric Dauler[2], Richard J. Molnar[2], Karl K. Berggren[1]; *[1]Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, USA; [2]Lincoln Laboratory, Massachusetts Institute of Technology, USA.* We developed superconducting nanowire single-photon detectors (SNSPDs) based on 30-nm-wide nanowires, which showed 2.6 % detection efficiency at 5 μm wavelength.

11:00–13:00
QTu1F • Nonlinear Plasmonics and Nanophotonics
Gennady Shvets, The University of Texas at Austin, USA, *Presider*

QTu1F.1 • 11:00
Nonlinear Effects in Subwavelength Plasmonic Directional Couplers, Arian Kriesch[1,2], Jing Wen[1,2], Daniel Ploss[1,2], Peter Banzer[1,2], Ulf Peschel[2,1]; *[1]Nonlinear Optics and Nanophotonics, Max Planck Institute for the Science of Light, Germany; [2]Institute of Optics, Information and Photonics and Cluster of Excellence Engineering of Advanced Materials, University of Erlangen-Nuremberg, Germany.* Plasmonic gap waveguides allow for subwavelength integration of optical circuitry. A side effect is extraordinarily high field enhancement. Here we present experimental and numeric results, which indicate nonlinear switching in a directional coupler.

QTu1F.2 • 11:15
Revealing nonlinear plasmon-photon interactions using k-space spectroscopy, Nicolai B. Grosse[1], Jan Heckmann[1], Ulrike Woggon[1]; *[1]Institut für Optik und Atomare Physik, Technische Universität Berlin, Germany.* We show how k-space spectroscopy distinguishes between the surface-plasmon (SP) and photon nonlinear interactions for SHG when metal films are excited in the Kretschmann-geometry, and confirm that two SP annihilate to create a second-harmonic photon.

11:00–13:00
QTu1G • Active and Nonlocal Metamaterials
Sasan Fathpour, CREOL, USA, *Presider*

QTu1G.1 • 11:00 Invited
Nonlocal Optical Phenomena in Metamaterials, Viktor A. Podolskiy[1], Brian Wells[1], Gregory A. Wurtz[2], Robert Pollard[3], William Hendren[3], Gary Wiederrecht[4], David Goztola[4], Anatoly V. Zayats[2]; *[1]Department of Physics and Applied Physics, University of Massachusetts Lowell, USA; [2]Department of Physics, King's College London, United Kingdom; [3]Centre for Nanostructured Media, Queen's University of Belfast, United Kingdom; [4]Center for Nanoscale Materials, Argonne National Laboratory, USA.* We demonstrate excitation of additional electromagnetic waves in plasmonic nanorod metamaterials. These waves arising from a nonlocal optical response of metamaterial results in strongly enhanced ultrafast nonlinear response.

Room A8	Room B2 & B3	Room C1 & C2	Room C3 & C4
CLEO: QELS-Fundamental Science	CLEO: Science & Innovations		JOINT

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Room A8 — CLEO: QELS-Fundamental Science

11:00–13:00
QTu1H • Ultrafast THz Dynamics
Peter Jepsen, Danmarks Tekniske Universitet, Denmark, *Presider*

QTu1H.1 • 11:00
Terahertz Excitation of Three-Level Λ-Type Exciton-Polariton Modes in Quantum-Well Microcavity, Yun-Shik Lee[1], Joseph L. Tomaino[1], Andrew D. Jameson[1], Galina Khitrova[2], Hyatt M. Gibbs[2], Andrea C. Klettke[3], Mackillo Kira[3], Stephan W. Koch[3]; [1]*Physics, Oregon State University, USA;* [2]*Optical Science Center, University of Arizona, USA;* [3]*Fachbereich Physik and Material Sciences Center, Philips University, Germany.* Interactions of strong few-cycle THz pulses with the induced optical polarization in a QW microcavity reveal that the exciton-polariton modes and the 2p-exciton state form a unique Λ-type three-level system of the coupled light-matter modes.

QTu1H.2 • 11:15
THz control of matter states: Coherent excitons beyond the Rabi-splitting, Benjamin Ewers[1], Niko S. Koester[1], Ronja Woscholski[1], Martin Koch[1], Sangam Chatterjee[1], Galina Khitrova[2], Hyatt M. Gibbs[2], Andrea C. Klettke[1], Mackillo Kira[1], Stephan W. Koch[1]; [1]*Faculty of Physics and Materials Sciences Center, Philipps-Universität Marburg, Germany;* [2]*College of Optical Sciences, The University of Arizona, USA.* We investigate the interaction of strong single-cycle THz pulses with a coherent excitonic population, observing the transition from Rabi flopping of the 1s-2p transition to multi THz-photon ionization with increasing field strength.

Room B2 & B3 — CLEO: Science & Innovations

11:00–13:00
CTu1I • Mode-Locked Fiber Lasers
Milos Popovic, University of Colorado at Boulder, USA, *Presider*

CTu1I.1 • 11:00
Passively Mode-Locked Erbium Doped Fiber Ring Laser with Charcoal Nano-particle Based Saturable Absorber, Yung-Hsiang Lin[1], Gong-Ru Lin[1]; [1]*Graduate Institute of Photonics and Optoelectronics, and Department of Electrical Engineering, National Taiwan University, Taiwan.* Free-standing charcoal nano-particles is used as the saturable absorber locating between connector end-faces in passively mode-locked erbium doped fiber ring laser (EDFL) to obtain the nearly transform-limited ultrashort laser pulsewidth of 1.96 ps.

CTu1I.2 • 11:15
Positively Chirped Pulses in a Mode-Locked Thulium Fiber Laser - Simulation and Experiment, Frithjof Haxsen[1,2], Dieter Wandt[1,2], Uwe Morgner[1,3], Jörg Neumann[1,2], Dietmar Kracht[1,2]; [1]*Laser Development Department, Laser Zentrum Hannover e.V., Germany;* [2]*Centre for Quantum Engineering and Space-Time Research - QUEST, Germany;* [3]*Institut für Quantenoptik, Leibniz Universität Hannover, Germany.* We report on positively chirped pulse operation of a passively mode-locked thulium-doped fiber laser with fiber-based dispersion management. Numerical simulations provide deeper insight into the evolution and the limitations of the pulse parameters.

Room C1 & C2 — CLEO: Science & Innovations

11:00–13:00
CTu1J • Laser Writing & Manipulation of Materials
Xianfan Xu, Perdue University, USA, *Presider*

CTu1J.1 • 11:00 Tutorial
Ultrafast Laser Writing in Transparent Materials: From Physics to Applications, Peter Kazansky[1]; [1]*University of Southampton, United Kingdom.* Properties of optical materials can be modified with sub-wavelength precision using intense ultrashort light pulses. New science and emerging applications of ultrafast laser writing in transparent materials are reviewed.

Peter G. Kazansky studied physics in Moscow State University and received Ph.D. from the General Physics Institute in 1985. He was awarded the Leninskii Komsomol Prize in 1989 for the pioneering work on "Circular photogalvanic effect in crystals". From 1989 to 1993 he led a group in the GPI, which unravelled the mystery of light-induced frequency doubling in glass. In 1992 he joined the Optoelectronics Research Centre at the University of Southampton where since 2001 he is a professor pursuing his interests in new optical materials and phenomena. He is a Fellow of the Optical Society of America and served as Vice-Chair of the Committee on Glasses for Optoelectronics of the International Commission on Glass.

Room C3 & C4 — JOINT

11:00–13:00
JTu1K • Symposium on Singular Light: Applications of Vortices, Orbital Angular Momentum, Bessel and Airy Beams I: Complex Light: Lasers & Sources
Miles Padgett, Glasgow University, UK, *Presider*

JTu1K.1 • 11:00 Invited
Direct Laser Generation and Amplification of Singular Light, Nir Davidson[1], Moti Fridman[1], Micha Nixon[1], Asher Friesem[1]; [1]*Weizmann Institute of Science, Israel.* A novel configuration for generating and amplifying singularly polarized light with fiber lasers and amplifiers is presented with > 85% polarization purity.

Marriott San Jose Salon I & II	Marriott San Jose Salon III	Marriott San Jose Salon IV
CLEO: Science & Innovations	JOINT	CLEO: Science & Innovations

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11:00–13:00
CTu1L • Optofluidic Lasers and Devices
Xudong Fan, University of Michigan, USA, *Presider*

CTu1L.1 • 11:00
Large-scale Plasmonic Microarray: A New Approach for Label-free High-throughput Biosensing and Screening, Min Huang[1], Tsung-Yao Chang[2], Ahmet A. Yanik[1], Hsin-Yu Tsai[2], Peng Shi[2], Serap Aksu[1], Mehmet F. Yanik[2,3], Hatice Altug[1]; [1]*Department of Electrical and Computer Engineering, Boston University, USA;* [2]*Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, USA;* [3]*Department of Biological Engineering, Massachusetts Institute of Technology, USA.* We present a large-scale label-free microarray with over one million plasmonic nanohole array sensors on microscope slide. A dual-color filter imaging method is invented to dramatically increase the sensor performance in a highly-multiplexed manner.

CTu1L.2 • 11:15
Tunable Electro-Optofluidic Resonators, Mohammad Soltani[1,3], Michal Lipson[1,2], Michelle Wang[1,3]; [1]*Cornell University, USA;* [2]*Kavli Institute at Cornell, USA;* [3]*Howard Hughes Medical Institute at Cornell, USA.* We design and demonstrate electrically-enabled optofluidic devices for tuning and reconfiguring lab-on-chip photonic elements in silicon platforms. Optofluidic resonators integrated with electric microheaters for resonance tuning are demonstrated.

11:00–13:00
JTu1M • Graphene & Carbon Advanced Photonics Materials
Yves Bellouard, Eindhoven University of Technology, Netherlands, *Presider*

JTu1M.1 • 11:00 Invited
Laser-Based Synthesis of Nanomaterials in the Solid State, Alberto Salleo[1]; [1]*Materials Science and Engineering, Stanford University, USA.* Lasers are used to synthesize novel nanomaterials in the solid state such as epitaxial graphene on SiC and Si nanoparticles in an SiO2 matrix. I will discuss advantages and future directions of these approaches.

11:00–13:00
CTu1N • Microcavity & Photonic Crystal Lasers
Mikhail Belkin, University of Texas at Austin, USA, *Presider*

CTu1N.1 • 11:00
Direction-Controllable, Single-Lobed Photonic Crystal Lasers for Beam Steering Functionality, Yoshitaka Kurosaka[1,2], Akiyoshi Watanabe[1], Takahiro Sugiyama[1], Kazuyoshi Hirose[1,2], Susumu Noda[2]; [1]*Central Research Laboratory, Hamamatsu Photonics K. K., Japan;* [2]*Department of Electronic Science and Engineering, Kyoto University, Japan.* We demonstrate direction-controllable, single-lobed photonic-crystal lasers. The obtained beam direction angles range from 10° to 50° with a narrow divergence angle. This is an important step for realizing single-lobed beam-steering lasers.

CTu1N.2 • 11:15
Continuous-Wave Operation of Electrically Driven Wavelength-Scale Embedded Active-Region Photonic-Crystal Lasers at Room Temperature, Koji Takeda[1], Tomonari Sato[1], Akihiko Shinya[2], Kengo Nozaki[2], Hideaki Taniyama[2], Masaya Notomi[2], Koichi Hasebe[1], Takaaki Kakitsuka[1], Shinji Matsuo[1]; [1]*NTT Photonics Laboratories, NTT Corporation, Japan;* [2]*NTT Basic Research Laboratories, NTT Corporation, Japan.* We fabricate electrically driven wavelength-scale embedded active-region photonic-crystal lasers using ion implantation and diffusion methods. The device begins continuous wave lasing at Room temperature, and has a threshold current of 0.48 mA.

Room A1

Room A2

Room A3

Room A4

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CTu1A • Silicon Photonics II—Continued

CTu1A.3 • 11:30
Integrated spectrometer and integrated detectors on Silicon-on-Insulator for short-wave infrared applications, Eva Ryckeboer[1,2], Alban Gassenq[1,2], Nannicha Hattasan[1,2], Bart Kuyken[1,2], Laurent Cerutti[3], Jean-Baptiste Rodriguez[3], Eric Tournie[3], Gunther Roelkens[1,2], Wim Bogaerts[1,2], Roel Baets[1,2]; *[1]department of information technology, Ghent University - imec, Belgium; [2]Center for Nano- and Biophotonics, Belgium; [3]IES - CNRS UMR5214, University of Montpellier, France.* We present a miniature spectrometer fabricated on a Silicon-on-Insulator substrate with center wavelength at 2.15 µm. We investigate heterogeneously integrated grating-assisted GaInAsSb photodiodes for future implementation as detector array.

CTu1A.4 • 11:45
10 Gb/s Error-Free Operation of an All-Silicon C-band Waveguide Photodiode, Richard Grote[1,2], Kishore Padmaraju[2], Jeffrey B. Driscoll[1,2], Brian Souhan[1,2], Keren Bergman[2], Richard Osgood[1,2]; *[1]Microelectronics Sciences Laboratories, Columbia University, USA; [2]Electrical Engineering, Columbia University, USA.* We experimentally demonstrate error-free operation of an all Si ion implanted CMOS compatible PIN photodiode at 1.55 µm with 2.5-Gb/s and 10-Gb/s data rates. Detector sensitivity as a function of bias voltage is measured.

CTu1A.5 • 12:00
Double-layer Photonic Devices Based on Transfer Printing of Silicon Nanomembranes for Three-dimensional Photonics, Yang Zhang[1], Andrew Carlson[2], Sang Yoon Yang[2], Amir Hosseini[3], David Kwong[1], John A. Rogers[2], Ray T. Chen[1]; *[1]Department of Electrical and Computer Engineering, The University of Texas at Austin, USA;[2]Department of Materials Science and Engineering, Univeristy of Illinois at Urbana-Champaign, USA; [3]Omega Optics Inc, USA.* We present a novel platform for three dimensional (3D) photonics. A double layer 1x12 multimode interference (MMI) coupler is fabricated using transfer printing of silicon nanomembranes. Optical tests confirm low insertion loss and uniform outputs.

CTu1A.6 • 12:15
Surface Plasmon Enhanced Schottky Barrier Detector Based on Nanodisk Array Structure for CMOS Compatible Optical Integrated Circuits, Mingxia Gu[1], Hong Son Chu[1], Ping Bai[1], Er-Ping Li[1]; *[1]Plasmoncis & Nanointegration Group, Institute of High Performance Computing, Singapore.* A Schottky-Barrier-Detector consisting of an array of metallic nanodisks embedded in Si-waveguide achieving ~96% of power absorption is proposed. This structure provides a step forward towards fully CMOS photonic-electronic integrated circuits.

CTu1B • Terahertz Narrowband Sources—Continued

CTu1B.3 • 11:30
Narrow linewidth tunable THz signal radiated by photomixing: coupling a unitravelling carrier photodiode and a two-axis dual-frequency laser, Antoine Rolland[1]; *[1]Institut de Physique de Rennes, France.* An optical beatnote provided by a dual-frequency laser is sent into a unitravelling carrier photodiode and radiated. The measured linewidth is 30 kHz and tunable from DC to 770 GHz with a minimum 30 dB dynamic range.

CTu1B.4 • 11:45
Generation of Record-Short Wavelengths by Periodically-Poled LiNbO3 Based on Backward Parametric Interaction, Yujie J. Ding[1], Guan Sun[1], Ruolin Chen[1], Guibao Xu[1], Ioulia B. Zotova[2]; *[1]Electrical & Computer Engineering, Lehigh University, USA; [2]ArkLight, USA.* The shortest wavelengths, generated by periodically-poled lithium niobate, are in the vicinity of 62.5 µm at the poling period of 7.1 µm. Large enhancements in the output powers from three gratings are demonstrated.

CTu1B.5 • 12:00
Narrowband Terahertz Wave Generation by Optical Rectification in Large-Area Periodically Poled Crystal, Caihong Zhang[1], Yuri Avetisyan[2], Masayoshi Tonouchi[1]; *[1]Institute of Laser Engineering, Osaka University, Japan; [2]Microwave Eng. Dept., Yerevan State University, Armenia.* A new scheme of optical rectification in PPLN crystal, which allows to easily control the bandwidth of THz generation is proposed and demonstrated. The minimal bandwidth is 17 GHz that is smallest for ever reported.

CTu1B.6 • 12:15
High-peak-power and Narrow-linewidth Terahertz-wave Generation Pumped by a Microchip Nd:YAG Laser, Shin'ichiro Hayashi[1], Kouji Nawata[1], Takunori Taira[2], Hiroaki Minamide[1], Kodo Kawase[3,1]; *[1]RIKEN ASI, Japan; [2]IMS, Japan; [3]Nagoya University, Japan.* We have developed injection-seeded terahertz-wave parametric generator pumped by a amplified microchip Nd:YAG laser. We observed tunable terahertz-wave, peak power of more than 120 W and linewidth of less than 10 GHz.

QTu1C • Molecular Attosecond Dynamics—Continued

QTu1C.2 • 12:00
Double ionization dynamics of ethylene in a strong laser field, Xinhua Xie[1], Stefan Roither[1], Markus Schöffler[1], Daniil Kartashov[1], Li Zhang[1], Erik Lötstedt[2], Atsushi Iwasaki[2], Kaoru Yamanouchi[2], Andrius Baltuška[1], Markus Kitzler[1]; *[1]Photonics Institute, Vienna University of Technology, Austria; [2]Department of Chemistry, School of Science, The University of Tokyo, Japan.* Dependence of ethylene double ionization on laser pulse duration and intensity was studied by Coulomb explosion imaging technique. It was found that multiple molecular orbitals are involved in the strong field double ionization of ethylene.

QTu1C.3 • 12:15
Ultrafast Dynamics of Ozone Exposed to Ionizing Radiation, Predrag Ranitovic[1], Craig W. Hogle[1], Leigh S. Martin[1], William Peters[2], Austin P. Spencer[2], Xiao Min Tong[3], David Jonas[2], Margaret M. Murnane[1], Henry C. Kapteyn[1]; *[1]University of Colorado - JILA, USA; [2]University Of Colorado - Chemistry Department, USA; [3]University of Tsukuba, Japan.* By irradiating ozone molecules with few-femtosecond soft x-ray pulses and probing the fragmentation pathways, we find that any excess energy is rapidly and efficiently transferred into internal excitation of the triatomic molecule.

CTu1D • Laser Technology and Issues for High Average Power—Continued

CTu1D.3 • 11:30 Invited
Reliable Laser Technology for Laser Peening Applications, Lloyd Hackel[1]; *[1]Curtiss-Wright Metal Improvement Company, USA.* Phase-conjugated Nd:glass laser delivering 20 J/pulse at 1 GW and 5 Hz prf is reliably employed for laser peening. The technology used for applications ranging from 787 Dreamliner engines to efficient gas and steam electrical-generator turbines.

CTu1D.4 • 12:00
Programmable mJ-Pulse Sequences from an 880 nm Pumped Nd:YVO4 Bounce Amplifier, Jonas Morgenweg[1], Kjeld Eikema[1]; *[1]Vrije Universiteit Amsterdam, Netherlands.* We report ps-pulses of up to 1.8 mJ pulse energy from an ultra-high gain, quasi-continuously pumped grazing-incidence amplifier. Fast programmable modulators enable tailored mJ-pulse-sequences with temporal spacings well into the microsecond range.

CTu1D.5 • 12:15
Highly Efficient 3rd Harmonic Generation in Nd:YAG Laser, Chao Chang[1], Pancho Tzankov[1], Lin Xu[1], David Stockwell[1], Jeffrey Wojtkiewicz[1]; *[1]Quantronix Corporation, USA.* A highly efficient 355nm Nd:YAG laser is developed in an intra-cavity triple resonance setup. By using novel harmonic configurations, we have eliminated the requirement of linear polarization on the fundamental laser and its consequent power loss.

Tuesday, 8 May

Room A5 | Room A6 | Room A7

CLEO: QELS-Fundamental Science

QTu1E • Detectors I—Continued

QTu1E.3 • 11:30
Four-state discrimination beyond heterodyne detection, Christian R. Mueller[1,2], Mario A. Usuga[4,1], Christoffer Wittmann[1,2], Masahiro Takeoka[3], Christoph Marquardt[1,2], Ulrik L. Andersen[4,1], Gerd Leuchs[1,2]; [1]*Max Planck Institute for the Science of Light, Germany;* [2]*Department of Physics, University of Erlangen-Nuremberg, Germany;* [3]*National Institute of Information and Communication Technology, Japan;* [4]*Department of Physics, Technical University of Denmark, Denmark.* We propose and experimentally demonstrate a hybrid discrimination scheme for the quadrature phase shift keying protocol, which outperforms heterodyne detection for any signal power.

QTu1E.4 • 11:45
Entanglement-assisted calibration of a photon-number-resolving detector, Fabrizio Piacentini[1], Giorgio Brida[1], Luigi Ciavarella[1], Mario Dagrada[1], Ivo P. Degiovanni[1], Marco Genovese[1], Alan Migdall[4], Maria G. Mingolla[1], Matteo G. Paris[2,3], Sergey V. Polyakov[4]; [1]*Optics division, INRIM, Italy;* [2]*Department of Physics, University of Milan, Italy;* [3]*Udr of Milan, CNISM, Italy;* [4]*Joint Quantum Institute and National Institute of Standard and Technology, USA.* We present the first experimental entanglement-assisted quantum characterization of an unknown photon-number-resolving detector, obtained by exploiting the quantum correlations of a twin-beam generated by parametric down conversion.

QTu1E.5 • 12:00
55% system detection efficiency with self-aligned WSi superconducting nanowire single photon detectors, Varun Verma[1], Francesco Marsili[1], Burm Baek[1], Adriana Lita[1], Thomas Gerrits[1], Jeffrey Stern[2], Richard Mirin[1], Sae Woo Nam[1]; [1]*NIST, USA;* [2]*JPL, USA.* We report a system detection efficiency of 55 % at 1500 nm with an amorphous tungsten-silicide (WSi) superconducting nanowire single photon detector (SNSPD) using a self-aligned packaging scheme for alignment of the detector and optical fiber.

QTu1E.6 • 12:15
Withdrawn

QTu1F • Nonlinear Plasmonics and Nanophotonics—Continued

QTu1F.3 • 11:30
Aluminum for Nonlinear Plasmonics: Resonance-driven Polarized Luminescence of Al, Ag, and Au Nanoantennas, Marta Castro-Lopez[1], Daan Brinks[1], Riccardo Sapienza[1], Niek Van Hulst[1,2]; [1]*Molecular Nanophotonics, ICFO-The Institute of Photonic Sciences, Spain;* [2]*ICREA - Inst. Catalana de Recerca i Estudis Avancats, Spain.* Resonant optical antennas are ideal for nanoscale nonlinear optical interactions due to their inherent strong local field enhancement. Aluminum good performance is shown by measuring the intensity, polarization and angular pattern of its TPPL signal.

QTu1F.4 • 11:45
Second Harmonic Generation from Metallic and Dielectric Spherical Nanoparticles, Sarina Wunderlich[1,4], Zhuromskyy Zhuromskyy[1,3], Benedikt Schürer[2,3], Christian Sauerbeck[2], Michael Haderlein[2,3], Wolfgang Peukert[2,3], Ulf Peschel[1,3]; [1]*University of Erlangen-Nuremberg, Institute of Optics, Information and Photonics, Germany;* [2]*Institute of Particle Technology, University of Erlangen-Nuremberg, Germany;* [3]*Cluster of Excellence Engineering of Advanced Materials, University of Erlangen-Nuremberg, Germany;* [4]*Erlangen Graduate School in Advanced Optical Technologies, University of Erlangen-Nuremberg, Germany.* Second Harmonic Generation, due to its surface selectivity, is a well suited tool to study the surface of nanoparticles. In this contribution we analyse and model experiments on SHG at dielectric, metallic and core-shell particles.

QTu1F.5 • 12:00
Size Resonances and Giant SHG from Metallic Nanoholes, Adi Salomon[1], Yehiam Prior[1], Joseph Zyss[2], Marcin Zielinski[2], Radoslaw Kolkowski[2]; [1]*Chemical Physics, Weizmann Institute of Science, Israel;* [2]*Laboratoire de Photonique Quantique et Moleculaire, Ecole Normale Superieure de Cachan, France.* Shape and size resonant plasmonic enhancement of Second Harmonic Generation (SHG) from individual and coupled nanoholes in thin metal films is studied, and giant signals are observed from individual hot spots.

QTu1F.6 • 12:15
Second Order Nonlinear Frequency Conversion Processes In Plasmonic Slot Waveguides, Shakeeb B. Hasan[1], Carsten Rockstuhl[1], Thomas Pertsch[2], Falk Lederer[1]; [1]*Institute of condensed matter theory and solid state optics, Friedrich Schiller University Jena, Germany;* [2]*Institute of Applied Physics, Friedrich Schiller University Jena, Germany.* We study quadratic nonlinear interactions in plasmonic slot waveguides. Demonstrating modal phase matching, we exploit this feature toward parametric amplification of the plasmonic mode by means of a pump.

QTu1G • Active and Nonlocal Metamaterials—Continued

QTu1G.2 • 11:30
Nonlinear fishnet metamaterials based on liquid crystal infiltration, Alexander Minovich[1], James Farnell[1], Dragomir N. Neshev[1], Ian McKerracher[2], Fouad Karouta[3], Jie Tian[3], David Powell[1], Ilya V. Shadrivov[1], Hark H. Tan[2], Chennupati Jagadish[2], Yuri S. Kivshar[1]; [1]*Nonlinear Physics Centre, Australian National University, Australia;* [2]*Elecrtonic Materials Engineering, Australian National University, Australia;* [3]*ANFF ACT Node, Australian National University, Australia.* We study experimentally the nonlinear properties of fishnet metamaterials infiltrated with liquid crystals. We find that moderate laser powers result in significant changes of their optical transmission, being further tunable by bias electric field.

QTu1G.3 • 11:45
Gain-Assisted Hyperbolic Metamaterials, Xingjie Ni[1], Satoshi Ishii[1], Mark D. Thoreson[1], Vladimir Shalaev[1], Seunghoon Han[2], Sangyoon Lee[2], Alexander Kildishev[1]; [1]*Birck Nanotechnology Center, School of Electrical and Computer Engineering, Purdue University, USA;* [2]*Samsung Advanced Institute of Technology, Samsung Electronics, Republic of Korea.* We study the dispersion relations of multilayer dye-doped hyperbolic metamaterials and show that metallic losses can be compensated by saturated gain. Two realizable applications, namely hypergratings and epsilon-near-zero materials, are proposed.

QTu1G.4 • 12:00
Photo-doped silicon in split ring resonator gap towards dynamically reconfigurable terahertz metamaterial, Dibakar Roy Chowdhury[1]; [1]*center for Integrated NanoTechnologies, Los Alamos National Laboratory, USA.* We demonstrate reconfigurable metamaterial by actively switching constituent resonators from split-ring to closed-ring configuration. Both fundamental and third order resonances damps out while the second order resonance emerges at high pump power.

QTu1G.5 • 12:15
Metamaterial Coherent Light Absorption - The Time-reversed Analogue of the Lasing Spaser, Jianfa Zhang[1], Kevin F. MacDonald[1], Nikolay I. Zheludev[1]; [1]*Optoelectronics Research Centre and Centre for Photonic Metamaterials, University of Southampton, United Kingdom.* We experimentally demonstrate a new coherent absorption phenomenon, through which a planar photonic metamaterial may resonantly absorb 100% of incident light. The effect is a time-reversed analogue 'Lasing Spaser' action.

Room A8

CLEO: QELS-Fundamental Science

QTu1H • Ultrafast THz Dynamics—Continued

QTu1H.3 • 11:30
High-Order Sideband Generation in Quantum Wells Driven by Intense THz Radiation: Electron-Hole Recollisions, Benjamin Zaks[1], Ren-Bao Liu[2], Mark S. Sherwin[1]; [1]*Department of Physics and Institute for Terahertz Science and Technology, University of California at Santa Barbara, USA;* [2]*Department of Physics and Centre of Optical Sciences, The Chinese University of Hong Kong, Hong Kong.* When optically excited excitons in InGaAs quantum wells are driven by an intense THz field, electron-hole recollisions occur and sidebands of up to 18th order are observed.

QTu1H.4 • 11:45
Ultrafast Coherent Manipulation of a THz-Intersubband Polarization in a Voltage-Controlled Single Quantum Well, Martin Wagner[1], Manfred Helm[1], Mark Sherwin[2], Dominik Stehr[1]; [1]*Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, Germany;* [2]*Physics Department, University of California Santa Barbara, USA.* Sub-picosecond terahertz pulses are used to refresh or switch off the macroscopic intersubband polarization of a quantum well at low temperature. This coherent switching is directly observed in the time-domain and agrees with model calculations.

QTu1H.5 • 12:00
Nonlinear THz spectroscopy of grapheme, Pamela Bowlan[1], Elias Martinez-Moreno[1], Klaus Reimann[1], Michael Woerner[1], Thomas Elsaesser[1]; [1]*Max-Born-Institut, Germany.* Carrier dynamics in graphene at low energies are studied using two-dimensional THz spectroscopy. Pump-probe signals much faster than the acoustic phonon energy are observed due to a combination of intra- and interband absorption.

QTu1H.6 • 12:15
Non-perturbative Four-wave Mixing in Bulk InSb Driven by Intense Off-resonant THz Pulses, Friederike E. Junginger[1], Christian Schmidt[1], Bernhard Mayer[1], Sebastian Mährlein[1], Olaf Schubert[1,2], Alexej Pashkin[1], Rupert Huber[1,2], Alfred Leitenstorfer[1]; [1]*Department of Physics and Center for Applied Photonics, University of Konstanz, Germany;* [2]*Department of Physics, University of Regensburg, Germany.* A high-field multi-THz source is used to study the nonlinear response of InSb under off-resonant excitation. Field-resolved four-wave mixing signals demonstrate clear signatures of a non-perturbative regime in agreement with numerical simulations.

Room B2 & B3 / Room C1 & C2

CLEO: Science & Innovations

CTu1I • Mode-Locked Fiber Lasers—Continued

CTu1I.3 • 11:30
Effect of the Birefringent Beat Length on Variability in Passively Modelocked Fiber Lasers, Brian S. Marks[1], Thomas F. Carruthers[1,2], Curtis R. Menyuk[1]; [1]*CSEE Department, University of Maryland, Baltimore County, USA;* [2]*The National Science Foundation, USA.* Birefringence leads to sensitivity of the power transfer to polarization controller settings in passively modelocked fiber lasers that use nonlinear polarization rotation for fast saturable absorption. Shorter beat lengths lead to easier modelocking.

CTu1I.4 • 11:45
Mode-locking by nanotubes of a Raman laser based on a highly doped GeO2 fiber, Carlos E. Schmidt Castellani[1], Edmund Kelleher[1], Daniel Popa[2], Zhipei Sun[2], Tawfique Hasan[2], Andrea C. Ferrari[2], Oleg I. Medvedkov[3], Evgeny Dianov[3], S. Vasiliev[3], Sergei Popov[1], James R. Taylor[1]; [1]*Physics, Imperial College of London, United Kingdom;* [2]*University of Cambridge, United Kingdom;* [3]*Fiber Optics Research Center, Russian Federation.* A mode-locked Raman laser, using 25 m of a GeO2 doped fiber as the gain medium, is reported employing carbon nanotubes. The oscillator generates 850 ps chirped pulses, which are externally compressed to 185 ps.

CTu1I.5 • 12:00 Tutorial
Modelocked fiber lasers, past present and future, Martin E. Fermann[1]; [1]*Research, IMRA America Inc., USA.* We review the development of industrial mode locked fiber lasers and discuss novel fiber laser designs inspired by the concept of frequency combs and their impact in ultrafast optics and precision spectroscopy.

Martin Fermann received his Ph.D. from Southampton University, U. K. in 1988. After spending 4 years as a postdoc and research associate at the Technical University of Vienna and Bellcore, he joined IMRA America Inc. in 1992. In 2001 he accepted a position as CTO at Boston Laser before rejoining IMRA in 2002 as Director of Laser System Research. He has been an author or co-author of around 350 technical papers and conference presentations and around 100 US patents and applications. Many of his patents have been

Continued on page 108

CTu1J • Laser Writing & Manipulation of Materials—Continued

CTu1J.2 • 12:00
Phase separation and pattern instability of laser-induced polymerization in liquid-crystal-monomer mixtures, YuanYao Lin[1], Ray-Kuang Lee[1], Jisha P. Chandroth[1]; [1]*Institute of Photonics Technologies, National Tsing Hua University, Taiwan.* Directly written by a ultra-short femto-second laser pulse, we report the phase separation, pattern formation and symmetry braking instabilities, i.e. transverse instability induced by polymerization in a liquid-crystal-monomer mixture.

CTu1J.3 • 12:15
Near-IR to Mid-IR Multimode Waveguides in Rare-Earth doped YAG by Ultrafast Laser Inscription, Yingying Ren[2,1], Stephen J. Beecher[1], Graeme Brown[1], Airan Rodenas[1], Feng Chen[2], Ajoy K. Kar[1]; [1]*Heriot Watt University, United Kingdom;* [2]*Shandong University, China.* We report near-infrared to mid-infrared (1.55 to 3.39 µm) multimode waveguiding in deep buried channel waveguides fabricated inside rare-earth ion doped ceramic YAG. Waveguiding is achieved by direct laser writing a tubular cladding region.

Room C3 & C4

JOINT

JTu1K • Symposium on Singular Light: Applications of Vortices, Orbital Angular Momentum, Bessel and Airy Beams I: Complex Light: Lasers & Sources—Continued

JTu1K.2 • 11:30
Bessel-Like Beams Generated by Photonic Crystal Fibre, Yong Chen[1], James M. Stone[1], William J. Wadsworth[1], Jonathan C. Knight[1], Tim A. Birks[1]; [1]*Centre for Photonics and Photonic Materials, Department of Physics, University of Bath, United Kingdom.* We report a photonic crystal fibre device whose output far field resembles that of an ideal Bessel beam over a wide wavelength range. The Bessel-like beam self-heals when the central peak is obstructed.

JTu1K.3 • 11:45
Bottle beam generated from fiber-based Bessel Beams, Yuhao Chen[1], Lu Yan[1], Paul Steinvurzel[1], Siddharth Ramachandran[1]; [1]*Boston University, USA.* We demonstrate an all-fiber method to generate a 28um x 6.5um optical bottle using coherent superpositions of fiber-grating-based Bessel beams. Our method enables precise beam control by tuning the relative modal weight and phase of the two beams.

JTu1K.4 • 12:00
Generation of ultrashort optical vortex pulses using optical parametric amplification, Keisaku Yamane[1,2], Yasunori Toda[1,2], Ryuji Morita[1,2]; [1]*Department of Applied Physics, Hokkaido University, Japan;* [2]*CREST, JST, Japan.* The generation of 2.3-cycle, 5.9-fs, 56-µJ ultrashort optical-vortex pulses by optical parametric amplification was performed. To the best of our knowledge, it is the first generation of optical vortex pulses in the few-cycle regime.

JTu1K.5 • 12:15
Hollow Beam creation with continuous diffractive phase mask at PHELIX, Christian Brabetz[2,1], Udo Eisenbarth[1], Oliver Kester[2,1], Thomas Stöhlker[1], Thomas Cowan[3], Bernhard Zielbauer[1], Vincent Bagnoud[1]; [1]*GSI Helmholtz Centre for Heavy Ion Research GmbH, Germany;* [2]*Johann Wolfgang Goethe University, Germany;* [3]*HZDR Helmholtz center Dresden Rossendorf, Germany.* We propose and demonstrate a method for shaping the focus of high intensity lasers into an annular or "donut" mode. The method, based on helical phase plates, has been implemented at the PHELIX laser facility.

Marriott San Jose Salon I & II

CLEO: Science & Innovations

CTu1L • Optofluidic Lasers and Devices—Continued

CTu1L.3 • 11:30
Optofluidic silicon-polymer integrated waveguides, Genni Testa[1]; [1]*IREA, CNR, Italy.* In this paper the design and the optical characterization of hybrid ARROW waveguide with a top layer of polydimethysiloxane (PDMS) is presented. The structure has been simulated and the results compared with the experimental one.

CTu1L.4 • 11:45
Rapid DNA Detection via Optofluidic Lasers using Saturation Dye, Wonsuk Lee[1,2], Xudong Fan[1]; [1]*Biomedical Engineering, University of Michigan, USA;* [2]*Electrical Engineering and Computer Science, University of Michigan, USA.* We demonstrate an optofluidic laser using the saturation dye and double-stranded DNA mixture, and develop a rapid and direct DNA detection technique relying on highly distinguishable lasing characteristics between the target DNA and the polymorphism.

CTu1L.5 • 12:00
Lasing From Living Biological Cells Expressing Green Fluorescent Protein, Malte C. Gather[1], Seok Hyun Yun[1]; [1]*Wellman Center, Harvard Medical School & Mass General Hospital, USA.* We show that GFP, a biologically produced material, is a viable optical gain medium and construct true biolasers, in which the optical gain is provided by living mammalian or bacterial cells synthesizing GFP.

CTu1L.6 • 12:15
Vitamin microdroplet laser, Sedat Nizamoglu[1], Malte C. Gather[1], Seok Hyun Yun[1]; [1]*Harvard Medical School and Wellman Center for Photomedicine, Massachusetts General Hospital, USA.* Stimulated emission from biomolecules enables a new class of biolasers for unconventional approaches in biomedical applications. We demonstrate vitamin microdroplet laser using riboflavin 5′-monophosphate sodium salt hydrate (a form of vitamin B2).

Marriott San Jose Salon III

JOINT

JTu1M • Graphene & Carbon Advanced Photonics Materials—Continued

JTu1M.2 • 11:30
Electrically Tunable Plasmonic Resonances with Graphene, Naresh K. Emani[1], Ting-Fung Chung[2], Xingjie Ni[1], Alexander Kildishev[1], Yong P. Chen[2], Alexandra Boltasseva[1,3], Alexandra Boltasseva[1,4]; [1]*Electrical and Computer Engineering and Birck Nanotechnology Center, Purdue University, USA;* [2]*Physics and Birck Nanotechnology Center, Purdue University, USA;* [3]*Photonics Engineering, Technical University of Denmark, Denmark;* [4]*Erlangen Graduate School of Advanced Optical Technologies, Universität Erlangen-Nürnberg, Germany.* Real time switching of a plasmonic resonance may find numerous applications in subwavelength optoelectronics, spectroscopy & sensing. We use electrically tunable interband transitions in graphene to control the strength of the plasmonic resonance.

JTu1M.3 • 11:45
High-speed electro-optic modulators using graphene in a sub-µm-thick structure, Chien-Chung Lee[1], Seiya Suzuki[2], Wanyan Xie[1], Thomas R. Schibli[1]; [1]*Physics, University of Colorado at Boulder, USA;* [2]*Graduate School of Engineering, Toyota Technological Institute, Japan.* We report a new type of graphene-based electro-optic modulators with low insertion loss, high modulation speed, and large active area. These modulators are suitable for pure amplitude modulation in laser cavities without parasitic phase modulation.

JTu1M.4 • 12:00
Large Area, Broadband, and Polarization-Sensitive Photodetectors Based on Aligned Carbon Nanotubes, Sebastien Nanot[1], Cary L. Pint[1], Aron W. Cummings[2], Francois Leonard[2], Robert H. Hauge[1], Junichiro Kono[1]; [1]*Rice University, USA;* [2]*Sandia National Laboratories, USA.* We have studied the photoresponse of highly aligned carbon nanotube devices in the visible, near-infrared, and mid-infrared. Using different metal combinations for electrodes, we designed detectors that work up to 10 µm under global illumination.

JTu1M.5 • 12:15
New concepts and geometries for graphene-based photodetectors, Thomas Mueller[1], Marco Furchi[1], Alexander Urich[1], Andreas Pospischil[1], Govinda Lilley[1], Karl Unterrainer[1], Hermann Detz[2], Pavel Klang[2], Aaron M. Andrews[2], Werner Schrenk[2], Gottfried Strasser[2]; [1]*Institute of Photonics, Vienna University of Technology, Austria;* [2]*Center for Micro- and Nanostructures, Vienna University of Technology, Austria.* We have investigated several new concepts and geometries for graphene-based photodetectors. In particular these are: a metal-graphene-metal photodetector, a photodetector with shadow masks, and a microcavity-enhanced graphene photodetector.

Marriott San Jose Salon IV

CLEO: Science & Innovations

CTu1N • Microcavity & Photonic Crystal Lasers—Continued

CTu1N.3 • 11:30
Photonic-crystal ring-cavity lasers emitting a beam with needle-like focus characteristics, Kyoko Kitamura[1], Masaya Nishimoto[1], Kyosuke Sakai[1,2], Susumu Noda[1]; [1]*Electronic Science and Engineering, Kyoto University, Japan;* [2]*Research Institute for Electronic Science, Hokkaido University, Japan.* Photonic-crystal ring-cavity lasers generating a beam with needle-like focus characteristics are developed. These are important for high-tolerance, super-resolution applications in a variety of compact optical systems.

CTu1N.4 • 11:45
Room temperature lasing in 6µm-diameter quantum dot microring laser on GaAs substrate, Natalia Kryzhanovskaya[1,2], Alexey Zhukov[1,2], Mikhail Maximov[1,2], Alexey Nadtochiy[1,2], Ilya Slovinskiy[1,2], Artem Saveliev[1,2], Marina Kuligina[2], Yury Zadiranov[2], Sergey Troshkov[2], Daniil A. Livshits[3], Sergey Mikhrin[3]; [1]*St. Petersburg Academic University, Russian Federation;* [2]*Ioffe Physico-Technical Institute, Russian Federation;* [3]*Innolume GmbH, Germany.* Room-temperature lasing around 1.3-µm was achieved under optical pumping in 6-µm diameter microrings with InAs/InGaAs quantum dots and (AlGa)xOy pedestal MBE-grown on GaAs substrate.

CTu1N.5 • 12:00 Invited
Ultra-Low Threshold and High Speed Electrically Driven Photonic Crystal Nanocavity Lasers and LEDs, Jelena Vuckovic[1], Bryan Ellis[1], Gary Shambat[1], Jan Petykiewicz[1], Arka Majumdar[1], Tomas Sarmiento[1], Marie Mayer[2], James Harris[1], Eugene Haller[2]; [1]*Electrical Engineering, Stanford Univ., USA;* [2]*Materials Science, UC Berkeley, USA.* We have demonstrated an electrically driven photonic crystal nanocavity laser with record low threshold (180nA) and a single mode photonic crystal nanocavity LED directly modulated at 10GHz speed with 0.25 fJ/bit energy consumption.

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

CTu1A • Silicon Photonics II—Continued

CTu1A.7 • 12:30
Unidirectional Optical Bloch Oscillations in Garnet/Silicon-On-Insulator Waveguide Arrays, Pradeep Kumar[1], Miguel Levy[1]; [1]*Department of Physics, Michigan Technological University, USA.* We demonstrate the existence of unidirectional optical Bloch oscillations in transversely magnetized, garnet/silicon-on-insulator waveguide arrays. This phenomenon enables the design and fabrication of multi-functional on-chip devices.

CTu1A.8 • 12:45
Compact Hybrid Plasmonic TE-pass Polarizer on SOI, Xiao Sun[1], Muhammad Alam[1], Sean J. Wagner[1], J. Stewart Aitchison[1], Mo Mojahedi[1]; [1]*Department of Electrical & Computer Engineering, University of Toronto, Canada.* The polarization diversity of the hybrid plasmonic waveguide can be used to implement a very compact TE-pass polarizer. Here we report the first experimental demonstration of such a device.

CTu1B • Terahertz Narrowband Sources—Continued

CTu1B.7 • 12:30
High-power tunable terahertz-wave source pumped by dual-wavelength injection-seeded optical parametric generator, Kouji Nawata[1], Takashi Notake[1], Hiroshi Kawamata[1], Takeshi Matsukawa[1], Feng Qi[1], Hiroaki Minamide[1]; [1]*Tera-Photonics Laboratory, RIKEN, Japan.* We demonstrated a high-power widely tunable terahertz-wave source by using a nonlinear organic crystal DAST pumped by an injection-seeded optical parametric generator. We generated high-power terahertz-wave in the range from 1.3 to 9 THz.

CTu1B.8 • 12:45
Simultaneous Generation of Multiple THz Frequencies Tunable for Novel Applications, Pu Zhao[1], Srinivasa Ragam[1], Lei Wang[1], Yujie J. Ding[1], Ioulia B. Zotova[2], Xiaodong Mu[3], Huai-Chuan Lee[3], Stephanie K. Meissner[3], Helmuth Meissner[3]; [1]*Electrical & Computer Engineering, Lehigh University, USA;* [2]*ArkLight, USA;* [3]*Onyx Optics Inc., USA.* By mixing three optical frequencies generated by an optical parametric oscillator under a novel configuration based in nonlinear crystals, multiple THz frequencies are efficiently generated. They can be used to pursue variety of novel applications.

QTu1C • Molecular Attosecond Dynamics—Continued

QTu1C.4 • 12:30
Attosecond pulse trains generated with Oriented Molecules. Eugene Frumker[1,2], Nathaniel Kajumba[1,2], Julien Bertrand[1], Hans Worner[1], Christoph Hebeisen[1], Paul Hockett[4], Michael Spanner[4], Serguei Patchkovskii[4], Gerhard Paulus[3,5], David M. Villeneuve[1], Paul B. Corkum[1]; [1]*JASLab, Canada;* [2]*Max-Plank Institute of Quantum Optics, Germany;* [3]*Physics, Texas A&M University, USA;* [4]*NRC, Canada;* [5]*4Institute of Optics and Quantum Electronics, Germany.* We report the measurement of high harmonics from oriented molecules in the gas phase. We show that attosecond and re-collision science provides a detailed and sensitive probe of electronic asymmetry in polar molecules.

QTu1C.5 • 12:45
Resolving Ultrafast Wave-packet Dynamics of D_2^+ Using Multiple Harmonic Pulses of Ti:sapphire laser, Yusuke Furukawa[1], Yasuo Nabekawa[1], Pengfei Lan[1], Eiji Takahashi[1], Tomoya Okino[2], Kaoru Yamanouchi[2], Katsumi Midorikawa[1]; [1]*RIKEN ASI, Japan;* [2]*the University of Tokyo, Japan.* We have resolved the vibrational wave-packet dynamics of D2+ with a period of ~20-fs generated with sub-10 fs XUV harmonic field. The real-time evolution is probed with the sub-10 fs VUV and DUV harmonic fields.

CTu1D • Laser Technology and Issues for High Average Power—Continued

CTu1D.6 • 12:30
The impact of lifetime quenching on relaxation oscillations in solid-state lasers, Laura Agazzi[1], Edward Bernhardi[1], Kerstin Wörhoff[1], Markus Pollnau[1]; [1]*IOMS group, University of Twente, Netherlands.* We show that the expression for the relaxation frequency in rare-earth-ion doped solid-state lasers needs to be modified when dealing with materials that suffer from lifetime quenching.

CTu1D.7 • 12:45
Model for the temperature dependent emission cross section of Nd laser media, Yoichi Sato[1], Takunori Taira[1]; [1]*Laser Research Center for Molecular Science, Institute for Molecular Science, Japan.* Numerical model for temperature dependent cross section of Nd-doped materials is proposed. Variation of cross section in Nd:YAG is -0.20%/°C, which is 40% and 54% of Nd:orthovanadates in π- and σ-polarization, respectively.

12:45–13:45 Power Lunch, *Exhibit Hall 3*

13:00–14:00 Unopposed Exhibit Only Time, *Exhibit Halls 1, 2 and 3 (concessions available)*

14:00–16:00 Market Focus Session II: BioPhotonics: Femtosecond Lasers and the Future of Vision Correction, *Exhibit Hall 3*

NOTES

Tuesday, 8 May

Room A5 | Room A6 | Room A7

CLEO: QELS-Fundamental Science

QTu1E • Detectors I—Continued

QTu1E.7 • 12:30
Time-Resolved Nonclassical Photon Field Characterization, Sergey V. Polyakov[1], Edward Flagg[1], Tim Thomay[1], Alan Migdall[1], Glenn S. Solomon[1]; [1]*Joint Quantum Institute, NIST, USA.* We demonstrate a new method to characterize nonclassical states that measures the temporal dependence of their statistical and coherent properties. We extract information about underlying physical processes in an InAs quantum dot in situ.

QTu1E.8 • 12:45
Determining the Lower Limit of Human Vision Using a Single Photon Source, Rebecca Holmes[1], Bradley G. Christensen[1], Whitney Street[2], R. Frances Wang[2], Paul G. Kwiat[1]; [1]*Department of Physics, University of Illinois at Urbana-Champaign, USA;* [2]*Department of Psychology, University of Illinois at Urbana-Champaign, USA.* We discuss the use of a source of single photons to investigate possible single-photon vision in humans.

QTu1F • Nonlinear Plasmonics and Nanophotonics—Continued

QTu1F.7 • 12:30
Efficient Harmonic Generation in Plasmonic System, Mohammad Mayy[1], Guohua Zhu[1], Amanda D. Webb[1], Mikhail A. Noginov[1]; [1]*Norfolk State University, USA.* As the first step toward parametric amplification of surface plasmon polaritons (SPPs), we demonstrate efficient (nearly 10^5 more efficient than previously reported) SPP-enhanced second harmonic generation in the MNA film in a Kretschmann geometry.

QTu1F.8 • 12:45
Plasmon-assisted Photoemission from Gold Nanopillars in Few-cycle Laser Fields, Joseph S. Robinson[1], Phillip M. Nagel[2], Bruce D. Harteneck[3], Mark J. Abel[2], James S. Prell[2], Daniel M. Neumark[2], Thomas Pfeifer[2], Stephen R. Leone[2], Robert A. Kaindl[1]; [1]*Materials Sciences Division, Lawrence Berkeley National Laboratory, USA;* [2]*Department of Chemistry, UC Berkeley and Chemical Sciences Division, Lawrence Berkeley National Laboratory, USA;* [3]*Molecular Foundry, Lawrence Berkeley National Laboratory, USA.* We report plasmon-assisted photoemission from gold nanopillars using few cycle near-IR laser pulses, along with simulations, showing strong acceleration and a scaling of the electron yield that indicates the transition into the strong-field regime.

QTu1G • Active and Nonlocal Metamaterials—Continued

QTu1G.6 • 12:30
Nonlinear mode competition in a lasing nanoplasmonic metamaterial, Sebastian Wuestner[1], Joachim Hamm[1], Andreas Pusch[1], Fabian Renn[1], Kosmas Tsakmakidis[1], Ortwin Hess[1]; [1]*Physics, Imperial College London, South Kensington Campus, United Kingdom.* Active nanoplasmonic metamaterials, pumped above lasing threshold, can exhibit dynamic competition between bright, radiative and dark, trapped modes of the structure. We study the spatio-temporal mode competition and explore methods of mode control.

QTu1G.7 • 12:45
Deep Sub-wavelength Beam Propagation, Beam Manipulation and Imaging with Extreme Anisotropic Meta-materials, Peter B. Catrysse[1], Shanhui Fan[1]; [1]*Edward L. Ginzton Laboratory, Stanford University, USA.* We demonstrate that meta-materials with extreme anisotropy allow for diffraction-free, deep sub-wavelength beam propagation and manipulation, as well as deep sub-wavelength imaging. We show a meta-material design using existing materials.

12:45–13:45 Power Lunch, *Exhibit Hall 3*

13:00–14:00 Unopposed Exhibit Only Time, *Exhibit Halls 1, 2 and 3 (concessions available)*

14:00–16:00 Market Focus Session II: BioPhotonics: Femtosecond Lasers and the Future of Vision Correction, *Exhibit Hall 3*

NOTES

Room A8

CLEO: QELS-Fundamental Science

QTu1H • Ultrafast THz Dynamics—Continued

QTu1H.7 • 12:30

Anomalous THz emission from quantum wells with optically injected Berry curvature, Kuljit S. Virk[1], John E. Sipe[2]; [1]*Chemistry, Columbia University, USA;* [2]*Physics, University of Toronto, Canada.* Anomalous THz emission is predicted for AlAs/GaAs superlattices excited by circularly polarized light and driven by linearly polarized THz. The anomalous radiation is a consequence, and a sensitive probe of Berry curvature in these systems.

QTu1H.8 • 12:45

Quantum-Well Electro-Absorption Sampling for Broadband THz Detection, Chia-Yeh Li[1], Denis Seletskiy[1,3], Jeffrey G. Cederberg[2], Mansoor Sheik-Bahae[1]; [1]*University of New Mexico, USA;* [2]*Sandia National Laboratories, USA;* [3]*Air Force Research Laboratory, USA.* Broad-band THz detection is demonstrated using GaAs/AlGaAs asymmetric double quantum-well structures. Transient electro-absorption modulation by the THz pulses is sampled coherently with detection bandwidth exceeding 10 THz.

Room B2 & B3

CLEO: Science & Innovations

CTu1I • Mode-Locked Fiber Lasers—Continued

licensed by third parties. He has been active in the committees of numerous technical conferences and served as General Chair for the Conference on Advanced Solid State Lasers. His main interests comprise ultrafast optics, precision spectroscopy and metrology, fiber and solid-state lasers. He is a fellow of The Optical Society.

Room C1 & C2

CTu1J • Laser Writing & Manipulation of Materials—Continued

CTu1J.4 • 12:30

Bistability of nematic liquid crystals confined in 3D scaffold produced by two-photon polymerization, Francesca Serra[1], Shane M. Eaton[3], Eleon Borlini[2], Roberto Cerbino[1], Marco Buscaglia[1], Giulio Cerullo[2], Roberto Osellame[3], Tommaso Bellini[1]; [1]*Dipartimento di Chimica, Biochimica e Biotecnologie per la Medicina, Università di Milano, Italy;* [2]*Department of Physics, Politecnico di Milano, Italy;* [3]*Institute for Photonics and Nanotechnologies, CNR, Italy.* We show that nematic liquid crystals confined inside cubic scaffolds made by two-photon polymerization exhibit bistability and large memory effects in response to electric fields, due to topological defects interacting with the solid structure.

CTu1J.5 • 12:45

Laser Direct-write Nanopatterning by Near-field Multiphoton Polymerization Using Optically Trapped Microspheres, Yu-Cheng Tsai[1], Karl-Heinz Leitz[2], Romain Fardel[1], Michael Schmidt[2], Craig Arnold[1,2]; [1]*Mechanical and Aerospace Engineering, Princeton University, USA;* [2]*Chair of Photonic Technologies and Erlangen Graduate School in Advanced Optical Technologies (SAOT), University of Erlangen-Nuremberg, Germany.* We use Gaussian beam to position a microsphere in a polymer precursor environment near a substrate. Pulsed laser is focused by a microsphere to induce multiphoton polymerization in the near-field, enabling additive direct-write nanoscale processing.

Room C3 & C4

JOINT

JTu1K • Symposium on Singular Light: Applications of Vortices, Orbital Angular Momentum, Bessel and Airy Beams I: Complex Light: Lasers & Sources—Continued

JTu1K.6 • 12:30

Polarization-sensitive Femtosecond Laser Ablation with Tightly Focused Vortex Pulses, Cyril Hnatovsky[1], Vladlen Shvedov[1], Natalia Shostka[1], Andrei V. Rode[1], Wieslaw Krolikowski[1]; [1]*Research School of Physics and Engineering, Australian National University, Australia.* We demonstrate that in a tight focusing geometry circularly polarized femtosecond laser vortex pulses ablate material differently depending on the handedness of light. This allows one to control laser micromachining on a sub-wavelength scale.

JTu1K.7 • 12:45

Accelerating Airy Beams Generated by Ultrafast Laser Induced Space-Variant Nanostructures in Glass, Mindaugas Gecevicius[1]; [1]*University of Southampton, United Kingdom.* We demonstrate new technique to generate accelerating Airy beam with femtosecond laser imprinted space variant birefringence produced by self-assembled nanostructures in fused silica. The technique enables dual Airy beam generation.

12:45–13:45 Power Lunch, *Exhibit Hall 3*

13:00–14:00 Unopposed Exhibit Only Time, *Exhibit Halls 1, 2 and 3 (concessions available)*

14:00–16:00 Market Focus Session II: BioPhotonics: Femtosecond Lasers and the Future of Vision Correction, *Exhibit Hall 3*

NOTES

Marriott San Jose Salon I & II

CLEO: Science & Innovations

CTu1L • Optofluidic Lasers and Devices—Continued

CTu1L.7 • 12:30 Invited

Integrated Lasers for Polymer Lab-on-a-Chip Systems, Timo Mappes[1], Christoph Vannahme[2], Tobias Grossmann[1,3], Torsten Beck[3], Tobias Wienhold[1], Uwe Bog[1,4], Felix Breithaupt[1], Marko Brammer[1], Xin Liu[1,4], Soenke Klinkhammer[4,1], Michael Hirtz[5], Thomas Laue[5], Mads B. Christiansen[2], Anders Kristensen[2], Uli Lemmer[4], Heinz Kalt[3]; [1]*Institute of Microstructure Technology, Karlsruhe Institute of Technology (KIT), Germany;* [2]*DTU Nanotech - Department of Micro and Nanotechnology, Technical University of Denmark (DTU), Denmark;* [3]*Institute of Applied Physics, Karlsruhe Institute of Technology (KIT), Germany;* [4]*Light Technology Institute, Karlsruhe Institute of Technology (KIT), Germany;*[5]*Institute of Nanotechnology, Karlsruhe Institute of Technology (KIT), Germany.* We develop optical Lab-on-a-Chips on different platforms for marker-based & label free biophotonic sensor applications. Our chips are based on polymers and fabricated by mass production technologies to integrate microfluidics & miniaturized lasers.

Marriott San Jose Salon III

JOINT

JTu1M • Graphene & Carbon Advanced Photonics Materials—Continued

JTu1M.6 • 12:30

Progresses in graphene optical modulator, Ming Liu[1], Xiang Zhang[1]; [1]*UC Berkeley, USA.* Graphene optical modulator has several prominent advantages, such as small footprint, fast modulation speed, broad operation bandwidth and insensitivity to the temperature. In this talk we will go over the recent progresses in our group.

JTu1M.7 • 12:45

Fully Implantable and Resorbable Metamaterials, Hu Tao[1], Sukwon Hwang[2], Mengkun Liu[3], Bruce Panilaitis[1], Mark A. Brenckle[1], David L. Kaplan[1], Richard D. Averitt[3], John A. Rogers[2], Fiorenzo G. Omenetto[1]; [1]*Biomedical Engineering, Tufts University, USA;* [2]*Materials Science and Engineering, UIUC, USA;* [3]*Physics, Boston University, USA.* In this paper, we present a series of fully implantable and resorbable metamaterial devices constituted by magnesium and silk protein with controllable degradation rate, which can be used for biological tracking and sensing applications.

Marriott San Jose Salon IV

CLEO: Science & Innovations

CTu1N • Microcavity & Photonic Crystal Lasers—Continued

CTu1N.6 • 12:30

Three-dimensional coupled-wave model for photonic-crystal surface-emitting lasers, Yong Liang[1], Chao Peng[1], Kyosuke Sakai[1], Seita Iwahashi[1], Susumu Noda[1]; [1]*Department of Electronic Science and Engineering, Kyoto University, Japan.* A coupled-wave model that affords an efficient treatment of the full three-dimensional structure of photonic-crystal surface-emitting lasers is developed. The accuracy and validity of the theory are verified via numerical simulations and experiments.

CTu1N.7 • 12:45

Characteristics of gan-based photonic crystal surface emitting lasers with central defects, Tzeng-Tsong Wu[1], Peng-Hsiang Weng[1], Yen-Ju Hou[1], Tien-Chang Lu[1]; [1]*Department of Photonics and Institution of Electro-Optical Engineering, National Chiao-Tung University, Taiwan.* The GaN-based Photonic crystal surface emitting lasers (PCSELs) with different central defects were fabricated and investigated. The characteristics for PCSELs with different central defects were calculated and matched well with experimental results.

12:45–13:45 Power Lunch, *Exhibit Hall 3*

13:00–14:00 Unopposed Exhibit Only Time, *Exhibit Halls 1, 2 and 3 (concessions available)*

14:00–16:00 Market Focus Session II: BioPhotonics: Femtosecond Lasers and the Future of Vision Correction, *Exhibit Hall 3*

NOTES

Room A1 — CLEO: Science & Innovations

14:00–16:00
CTu2A • Microwave Photonics: Components
Siva Yegnanarayanan, MIT Lincoln Laboratory, USA, *Presider*

CTu2A.1 • 14:00
Mach-Zehnder based balanced optical microwave phase detector, Amir H. Nejadmalayeri[1], Franz X. Kaertner[1,2]; [1]*RLE, MIT, USA;* [2]*CFEL, DESY, Germany.* A complementary dual output Mach-Zehnder modulator together with a balanced receiver are used as a phase detector in an optoelectronic PLL to lock a 10.2 GHz voltage controlled oscillator to a 509 MHz mode-locked laser.

CTu2A.2 • 14:15
120 dB.Hz2/3 Spur Free Dynamic Range from a Resonant Cavity Interferometric Linear Intensity Modulator, Nazanin Hoghooghi[1], Josue Davila-Rodriguez[1], Sharad Bhooplapur[1], Peter Delfyett[1]; [1]*CREOL,College of optics and photonics, University of Central Florida, USA.* A 120 dB.Hz 2/3 spur free dynamic range (SFDR) is achieved directly from a resonant cavity interferometric linear intensity modulator. Also, the dependence of the SFDR of this modulator on the bias point is studied.

CTu2A.3 • 14:30
Ultra-Low Vπ Suspended Quantum Well Waveguides, Todd H. Stievater[1], Doewon Park[1], William S. Rabinovich[1], Marcel W. Pruessner[1], Subramaniam Kanakaraju[3], Christopher J. K. Richardson[3], Jacob B. Khurgin[2]; [1]*Naval Research Laboratory, USA;* [2]*Johns Hopkins University, USA;* [3]*Laboratory for Physical Science, USA.* We demonstrate VπL values in the optical L-band in suspended quantum well waveguides between 109 and 199 mV-cm, which result from the strong out-of-plane index contrast that tightly confines the mode to the quantum well core.

CTu2A.4 • 14:45
Electro-Optically Tunable Vertically Integrated Chalcogenide Interferometer on LiNbO3, William T. Snider[1], Dwayne D. Macik[1], Yifeng Zhou[1], Christi K. Madsen[1]; [1]*Electrical and Computer Engineering, Texas A&M University, USA.* A vertically integrated As2S3 MZI side-coupled to a Ti:LiNbO3 waveguide is electro-optically tuned utilizing asymmetric coplanar strip electrodes along the chalcogenide path. Tuning of the TM polarization is demonstrated with Vπ=19.6V.

Room A2 — CLEO: Science & Innovations

14:00–16:00
CTu2B • Terahertz QCLs & Solid State Devices
Stefano Barbieri, Universite Paris-Diderot Paris VII, France, *Presider*

CTu2B.1 • 14:00
199.5 K Operation of THz Quantum Cascade Lasers, Saeed Fathololoumi[1,3], Emmanuel Dupont[1], Ivan C. Chan[2], Zbigniew R. Wasilewski[1], Sylvain R. Laframboise[1], Dayan Ban[3], Alpar Matyas[4], Christian Jirauschek[4], Qing Hu[2], Hc Liu[1]; [1]*Institute for Microstructural Sciences, National research council of Canada, Canada;* [2]*Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, USA;* [3]*Department of Electrical and Computer Engineering, University of Waterloo, Canada;* [4]*Institute for Nanoelectronics, Technische Universitat Munchen, Germany.* The density matrix based model is employed to design a THz quantum cascade laser with optimized oscillator strength and improved injection tunneling. A maximum operating temperature of 199.5 K has been recorded at 3.22 THz (1.28ħω/κb).

CTu2B.2 • 14:15
The intrinsic linewidth of THz quantum cascade lasers, Miriam Serena Vitiello[1,3], Luigi Consolino[2], Saverio Bartalini[2], Alessandro Tredicucci[3], Massimo Inguscio[1,2], Paolo De Natale[2]; [1]*CNR Dipartimento di Materiali e Dispositivi, Italy;* [2]*CNR- Istituto Nazionale di Ottica and LENS (European Laboratory for Non-linear Spectroscopy), Italy;* [3]*NEST CNR-Istituto Nanoscienze, Scuola Normale Superiore, Italy.* We report a complete overview of the frequency-noise power spectral density of THz QCLs, giving an experimental evaluation and a theoretical explanation of their intrinsic linewidth and a thorough investigation of the physics behind it.

CTu2B.3 • 14:30
Y-coupled Terahertz Quantum Cascade Lasers, Owen Marshall[1], Subhasish Chakraborty[1], Md Khairuzzaman[1], H. E. Beere[2], David A. Ritchie[2]; [1]*School of EEE, University of Manchester, United Kingdom;* [2]*Cavendish Laboratory, University of Cambridge, United Kingdom.* Two independently electrically driven terahertz quantum cascade lasers are optically coupled in a Y configuration. Total peak output powers and emission spectra of this Y-system differ from those of either arm and from their linear sum.

CTu2B.4 • 14:45
Surface emitting Terahertz Photonic Crystal Quantum Cascade Laser realized by Bragg boundary condition, Zhaolu Diao[1], Christopher Bonzon[2], Giacomo Scalari[2], Mattias Beck[2], Jerome Faist[2], Romuald Houdré[1]; [1]*Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland;* [2]*Eidgenössische Techniche Hochshule Zürich (ETHZ), Switzerland.* We theoretically and experimentally investigate a band edge Photonic Crystal (PhC) Quantum Cascade Laser (QCL) operating at 3.1 THz. The surface emission is achieved by using a second-order Bragg grating at the PhC tile boundaries.

Room A3 — CLEO: QELS-Fundamental Science

14:00–16:00
QTu2C • Quantum Control
Nir Davidson, Weizmann Institute of Science, Israel, *Presider*

QTu2C.1 • 14:00 Tutorial
Coherent Control of Cold Matter Waves, Ennio Arimondo[1]; [1]*Dipartimento di Fisica, Università di Pisa, Italy.* For a two-level system we developed quantum protocols in order to reach a final state in the shortest allowed time, with very high fidelity and robustness against imperfections in the experimental apparatus.

Ennio Arimondo is Professor of Physics at the University of Pisa, Italy. His research interests are centered on the interaction between light and atomic systems and the light manipulation of Bose-Einstein condensates. He is Fellow of the American Physical Society and Fellow of the Institute of Physics.

Room A4 — CLEO: Science & Innovations

14:00–16:00
CTu2D • 1.5 to 5um Lasers
Dennis Harris, Massachusetts Institute of Technology, USA, *Presider*

CTu2D.1 • 14:00
Diode Pumped Q-switched Ho:Lu_2O_3 Laser at 2.12 µm, Samir Lamrini[1,2], Philipp Koopmann[1,3], Karsten Scholle[1], Peter Fuhrberg[1], Günter Huber[3]; [1]*LISA laser products OHG, Germany;* [2]*Photonics and Terahertz-Technology, Ruhr-University Bochum, Germany;* [3]*Institute for Laser-Physics, University of Hamburg, Germany.* We present the first diode pumped Q-switched Ho:Lu2O3 laser. At Room temperature the maximum pulse energy exceeded 5 mJ at 100 Hz pulse repetition rate while the maximum peak power was 23 kW.

CTu2D.2 • 14:15
Multi-Watt Broadly-Tunable Diode-Pumped Cr:ZnSe Laser, Gregory J. Wagner[1], Andrew Schober[1], Glenn Bennett[1], John Marquardt[1], Timothy Carrig[1]; [1]*Lockheed Martin Coherent Technologies, USA.* We present record power of 3.7 W from a CW Cr:ZnSe laser pumped directly with a diode laser. Power >1.5 W over the tuning range of 2200-2600 nm is presented. A first-of-kind demonstration of electro-optic tuning is also presented.

CTu2D.3 • 14:30
Photoluminescence in a Fe2+ Doped ZnSe Crystal Using Near Absorption Edge Quantum Cascade Laser Pumping, Yu Song[1], Sergey B. Mirov[2], Claire Gmachl[1], Jacob B. Khurgin[3]; [1]*Princeton University, USA;* [2]*University of Alabama at Birmingham, USA;* [3]*Johns Hopkins University, USA.* Room temperature photoluminescence in Fe:ZnSe is observed under near-absorption-edge Quantum Cascade Laser pumping. Both the spectral characteristics (peak≈4.7um) and the luminescence lifetime (≈0.38us) are measured.

CTu2D.4 • 14:45
Passive Q-Switching of a Tm:YLF Laser, Valentin Petrov[1], Raffaele Faoro[1,2], Martin Kadankov[1,3], Daniela Parisi[2], Stefano Veronesi[2], Mauro Tonelli[2], Uwe Griebner[1], Martha Segura[4], Xavier Mateos[4]; [1]*Max-Born-Institute, Germany;* [2]*Pisa University, Italy;* [3]*Sofia University, Bulgaria;* [4]*Universitat Rovira i Virgili, Spain.* Stable passive Q-switching of a Tm:LiYF4 laser using polycrystalline Cr2+:ZnS saturable absorbers is demonstrated reaching pulse energies of 0.9 mJ and peak powers of 65 kW in 14-ns long pulses at ~1.9 µm.

Room A5 | **Room A6** | **Room A7**

CLEO: QELS-Fundamental Science

14:00–16:00
QTu2E • Theory
Antia Lamas-Linares, National University of Singapore, Singapore, *Presider*

QTu2E.1 • 14:00
Quantum benchmarks from any states of light, Nathan Killoran[1], Norbert Lutkenhaus[1]; [1]*Institute for Quantum Computing and Dept. of Physics and Astronomy, University of Waterloo, Canada.* Quantum benchmarks allow us to discriminate between classical and quantum communication devices (e.g. quantum memories, repeaters, and cryptography systems). We show how to construct simple, effective benchmarks using any type of optical test states.

QTu2E.2 • 14:15
From quantum multiplexing to fault-tolerant quantum computing, Ashley Stephens[1], Kae Nemoto[1]; [1]*National Institute of Informatics, Japan.* We present a scheme that permits the reliable creation of entanglement between pairs of distant qubits. We consider its application to the creation of a topological cluster state in a distributed quantum computer.

QTu2E.3 • 14:30
An Ion Trap Photonic Interface for Efficient Remote Entanglement, Rachel Noek[1], Emily Mount[1], So-Young Baek[1], Stephen Crain[1], Daniel Gaultney[1], Andre van Rynbach[1], Taehyun Kim[1], Peter Maunz[1], Jungsang Kim[1]; [1]*Electrical and Computer Engineering, Duke University, USA.* Efficient entanglement of remote quantum memories is a key resource for distributed quantum information processing. We present a surface ion trap designed for efficient coupling of a single ion to the mode of a cavity.

QTu2E.4 • 14:45
Parallelizing gates with high-dimensional ancillas, Katherine L. Brown[1,2], Suvabrata De[1], Viv Kendon[1]; [1]*School of Physics and Astronomy, University of Leeds, United Kingdom;* [2]*School of Physics and Astronomy, Louisiana State University, USA.* A qubus quantum computer can perform a quantum Fourier transform with a linear number of operations. This implies continuous-variable ancilla-driven quantum computation is equivalent to the quantum circuit model plus unbounded fan-out.

14:00–16:00
QTu2F • Plasmon-Emitter-Coupling
Meir Orenstein, Technion Israel Institute of Technology, Israel, *Presider*

QTu2F.1• 14:00 Invited
Magnetic Light-Matter Interactions: Quantifying and Exploiting Magnetic Dipole Transitions, Rashid Zia[1]; [1]*School of Engineering, Brown University, USA.* We will illustrate how the naturally occurring magnetic dipole transitions in lanthanide ions provide both a new way to probe magnetic light-matter interactions and a new degree of design freedom for photonic devices.

QTu2F.2 • 14:30
Multipolar and Unidirectional Emission of Quantum Emitters Coupled to Optical Antennas, Alberto G. Curto[1], Giorgio Volpe[1], Tim H. Taminiau[1], Mark P. Kreuzer[1], Romain Quidant[1,2], Niek Van Hulst[1,2]; [1]*ICFO - The Institute of Photonic Sciences, Spain;* [2]*ICREA - Institució Catalana de Recerca i Estudis Avançats, Spain.* Nanoscale quantum emitters behave generally as dipoles. Here, we report multipolar and unidirectional emission of a quantum dot by near-field coupling to nanowire and Yagi-Uda antennas, that determine its angular radiation pattern and polarization.

QTu2F.3 • 14:45
Strong Photon Bunching in Individual Nanocrystal Quantum Dots Coupled to Rough Silver Film, Young-Shin Park[1,2], Yongfen Chen[1,2], Yagnaseni Ghosh[1], Andrei Pirytinski[3], Ping Xu[2], Nathan H. Mack[2], Hsing-Lin Wang[2], Victor I. Klimov[2,4], Jennifer A. Hollingsworth[1], Han Htoon[1,2]; [1]*Center for Integrated Nanotechnologies, Los Alamos National Lab, USA;* [2]*Chemistry Division, Los Alamos National Lab, USA;* [3]*Theory Division, Los Alamos National Lab, USA;* [4]*Center for Advanced Solar Photophysics, Los Alamos National Lab, USA.* We demonstrate that sub-Poissonian statistics (photon antibunching) of photon emission from individual core-shell quantum dots can be transformed to super-Poissonian statistics (photon bunching) by coupling dots to a rough silver film.

CLEO: Applications & Technology

14:00–16:00
ATu2G • Instrumentation & Sensing
Brian Stadler, US Air Force Research Lab, USA, *Presider*

ATu2G.1 • 14:00
Quantum-enhanced optical vibrometer, Geoff Burdge[1], Peter Wasilousky[1], Michael Silver[1], Lee Burberry[1], Kevin Smith[1], Christopher Visone[1], William Deibner[1], Robert Peach[1]; [1]*Harris Corporation, USA.* System performance and design are presented for a quantum-enhanced vibrometer. The system uses a receiver with a phase-sensitive amplifier to provide ~0 dB NF amplification enabling <3.2 dB SNR improvement throughout 20 kHz acoustic bandwidth.

ATu2G.2 • 14:15
Dispersive Fourier transformation in the 800 nm spectral range, Chao Wang[1], Keisuke Goda[1,2], Morten Ibsen[3], Bahram Jalali[1,2]; [1]*University of California, Los Angeles, USA;* [2]*California NanoSystems Institute, USA;* [3]*University of Southampton, United Kingdom.* We report the first experimental demonstration of dispersive Fourier transformation in the industrially and biomedically important range of ~800-nm using a chirped fiber Bragg grating and discuss its utility to high throughput biological diagnostics.

ATu2G.3 • 14:30 Invited
Non-Destructive Remote Inspection for Heavy Constructions, Masayuki Fujita[1], Oleg Kotyaev[1], Yoshinori Shimada[1]; [1]*Institute for Laser Technology, Japan.* A laser-based system for remote non-destructive inspection of concrete structures has been developed, assembled and tested in the laboratory and field conditions. Detection of inner defects was demonstrated for Japan Railway Shinkansen tunnels.

Room A8

CLEO: QELS-Fundamental Science

14:00–16:00
QTu2H • Femtosecond-to-Attosecond Interferometry and Spectroscopy
Csaba Toth, Lawrence Berkeley National Laboratory, USA, *Presider*

QTu2H.1 • 14:00
Two-Dimensional CEP Interferometry, Christian Ott[1], Michael Schönwald[1], Philipp Raith[1], Andreas Kaldun[1], Yizhu Zhang[1], Kristina Meyer[1], Thomas Pfeifer[1]; [1]*Max-Planck Institute for Nuclear Physics, Germany.* CEP control combined with spectral interferometry (CEPSI) is applied to strong-field high-harmonic generation to separate electronic quantum paths resulting in multiple attosecond pulses. 54±16 asec pulse timing changes are measured.

QTu2H.2 • 14:15
Attosecond wavefunction retrieval by electron wavepacket interferometry, Xinhua Xie[1], Stefan Roither[1], Daniil Kartashov[1], Emil Persson[2], Diego Arbó[2,3], Li Zhang[1], Stefanie Gräfe[2], Markus Schöffler[1], Joachim Burgdörfer[2], Andrius Baltuska[1], Markus Kitzler[1]; [1]*Photonics Institute, Vienna University of Technology, Austria;* [2]*Institute for Theoretical Physics, Vienna University of Technology, Austria;* [3]*Institute for Astronomy and Space Physics - IAFE (FCEN-UBA Conicet), University of Buenos Aires, Argentina.* We demonstrate self-referenced wavefunction retrieval of a valence electron wavepacket during its creation by strong-field ionization with sub-10-attosecond precision, based on a distinct separation of interferences arising at different time-scales.

QTu2H.3 • 14:30
High-Resolution Attosecond Photoelecton Spectroscopy in Xenon, Aart J. Verhoef[1], Alexander V. Mitrofanov[1], Maria Krikunova[2], Nikolay M. Kabachnik[3,4], Markus Drescher[2], Andrius Baltuska[1]; [1]*Institut für Photonik, TU Wien, Austria;* [2]*Institut für Experimentalphysik, Universität Hamburg, Germany;* [3]*Institute of Nuclear Physics, Moscow State University, Russian Federation;* [4]*European XFEL GmbH, Germany.* Recent developments in attosecond science have revealed a delay in photo-emission of electrons from different quantum states. Here we present simultaneous attosecond streaking measurements of photo-emission in xenon leading to different ionic states.

QTu2H.4 • 14:45
Fractional high-order harmonic combs and energy tuning by split-spectrum field synthesis, Philipp Raith[1], Christian Ott[1], Christopher Anderson[1], Andreas Kaldun[1], Kristina Meyer[1], Martin Laux[1], Yizhu Zhang[1], Thomas Pfeifer[1]; [1]*Max-Planck-Institut für Kernphysik, Germany.* Combs of fractional high-order harmonics are generated by split-spectrum field control and explained by interference of two attosecond pulse trains. A change of the instantaneous laser frequency at the intensity maxima tunes the harmonics` energies.

Room B2 & B3 / Room C1 & C2

CLEO: Science & Innovations

14:00–16:00
CTu2I • Hybrid Silicon Photonics
Wolfgang Freude, Karlsruher Institut of Technologie, Germany, *Presider*

CTu2I.1 • 14:00
First Silicon-Organic Hybrid Laser at Telecommunication Wavelength, Dietmar Korn[1], Matthias Lauermann[1], Patrick Appel[1], Luca Alloatti[1], Robert Palmer[1], Wolfgang Freude[1], Juerg Leuthold[1], Christian Koos[1]; [1]*IPQ, Karlsruhe Institute of Technology, Germany.* Lasing in a silicon-organic hybrid (SOH) waveguide is demonstrated for the first time. The device combines SOI waveguides with active organic cladding materials, thereby enabling silicon-based optical sources at infrared wavelengths.

CTu2I.2 • 14:15
Bistable switching and gain recovery dynamics in hybrid III-V/SOI nanolasers, Alexandre Bazin[1], Yacine Halioua[1], Daniel Chastanet[1], Paul Monnier[1], Isabelle Sagnes[1], Rama Raj[1], Fabrice Raineri[1,2]; [1]*Laboratoire de Photonique et de Nanostructures- CNRS-Marcoussis, France;* [2]*Universite Paris Diderot, France.* We report on optical bistability based on injection locking of hybrid III-V/Silicon-on-Insulator (SOI) nanolaser. Switching power is measured below 40µW. 30ps switching time is deduced from gain recovery time measurement.

CTu2I.3 • 14:30
Hybrid III-V/SOI apodized wire cavity laser encapsulated in SiO2, Alexandre Bazin[1], Yacine Halioua[1], Paul Monnier[1], Rama Raj[1], Isabelle Sagnes[1], Fabrice Raineri[1,2]; [1]*Laboratoire de Photonique et de Nanostructures- CNRS-Marcoussis, France;* [2]*Universite Paris Diderot, France.* We report on the improvement of the thermal dissipation of hybrid III-V/SOI nanolasers by encapsulating the structures in Silica. Careful design was necessary to obtain theoretical quality factor above 106. CW operation was then obtained.

CTu2I.4 • 14:45
Flexible and tunable silicon photonic devices, Yu Chen[1], Huan Li[1], Mo Li[1]; [1]*Electrical and Computer Engineering, University of Minnesota- Twin Cities, USA.* We demonstrate flexible silicon photonic devices, including ring resonators and Mach-Zehnder interferometers, by transferring from SOI wafer to PDMS. Optical characteristics of these devices could be tuned by deforming the flexible substrate.

14:00–16:00
CTu2J • Quantum Wells and Dots
Xiuling Li, University of Illinois, USA, *Presider*

CTu2J.1 • 14:00
Light Emission in Ge Quantum Wells, Edward Fei[1], Yijie Huo[1], Gary Shambat[1], Xiaochi Chen[1], Xi Liu[1], Stephanie Claussen[1], Elizabeth H. Edwards[1], Theodore I. Kamins[1], David A.B. Miller[1], Jelena Vuckovic[1], James Harris[1]; [1]*Stanford University, USA.* We present the Ge/SiGe quantum well structure as a strong candidate for CMOS compatible light source. Photoluminescence and electroluminescence show enhanced optical properties over bulk Ge. Further optical enhancement is observed in disk resonators.

CTu2J.2 • 14:15
Deep-Well Quantum Cascade Laser Structure on Metamorphic Buffer Layer, Toby J. Garrod[1], Jeremy D. Kirch[1], TaeWan Kim[1], Luke J. Mawst[1], Dan Botez[1], Steven Ruder[2], Thomas F. Kuech[2], Tom Earles[3]; [1]*Electrical and Computer Engineering, University of Wisconsin - Madison, USA;* [2]*Chemical and Biological Engineering, University of Wisconsin - Madison, USA;* [3]*Intraband LLC, USA.* A novel deep-well tapered-active quantum cascade laser design (λ~3.6 µm) on a metamorphic buffer layer (MBL) virtual substrate is achieved. Strain-compensated superlattice structures, representative of the QCL active region, are grown on the MBL.

CTu2J.3 • 14:30
Strikingly Different Behaviors of Photoluminescence Intensity and Terahertz Output Power versus Period of InGaN/GaN Quantum Wells, Guan Sun[1], Ruolin Chen[1], Yujie J. Ding[1], Hongping Zhao[1], Guangyu Liu[1], Jing Zhang[1], Nelson Tansu[1]; [1]*Electrical & Computer Engineering, Lehigh University, USA.* We demonstrate that as the period of multiple InGaN/GaN quantum wells is increased from 1 to 16, photoluminescence intensity exhibits strong saturation whereas output power of broadband THz pulses is scaled up superlinearly.

CTu2J.4 • 14:45
Selective-Area Growth of Ge and Ge/SiGe Quantum Wells in 3 µm Silicon-on-Insulator Waveguides, Stephanie Claussen[1], Krishna Coimbatore Balram[1], Edward Fei[1], Theodore I. Kamins[1], James Harris[1], David A.B. Miller[1]; [1]*Stanford, USA.* We demonstrate a robust process for growing high-quality bulk Ge and Ge/SiGe quantum wells in selected areas of 3 µm thick silicon-on-insulator waveguides, eliminating sidewall growth and hence facilitating low-insertion-loss optical modulators.

Room C3 & C4

JOINT

14:00–16:00
JTu2K • Symposium on Singular Light: Applications of Vortices, Orbital Angular Momentum, Bessel and Airy Beams II: Tweezers to Telecom
Siddharth Ramachandran, Boston University, USA, *Presider*

JTu2K.1 • 14:00 Invited
Optical Communications Using Light Beams Carrying Orbital Angular Momentum, Alan Willner[1], Jian Wang[1,2]; [1]*University of Southern California, USA;* [2]*Wuhan National Laboratory for Optoelectronics, Huzahonh University of Science and Technology, China.* We described recent progress on optical communications using light beams carrying orbital angular momentum (OAM). We achieved a 25.6-bit/s/Hz spectral efficiency using 16-QAM signals over pol-muxed four OAM beams.

JTu2K.2 • 14:30
Vortex Fiber Mode Amplitude Estimation, Steven Golowich[1], Nenad Bozinovic[2], Poul Kristensen[3], Siddharth Ramachandran[2]; [1]*MIT Lincoln Laboratory, USA;* [2]*Electrical and Computer Engineering, Boston University, USA;* [3]*OFS-Fitel, Denmark.* Fibers that support stable propagation of orbital angular momentum states require novel methods of characterization. We present a method for coherently estimating the mode amplitudes present in such fibers, from near-field intensity measurements.

JTu2K.3 • 14:45
Observation of Orbital Angular Momentum Spectrum in Propagating Mode through Seven-core Fibers, Yoshinari Awaji[1], Naoya Wada[1], Yasunori Toda[2]; [1]*National institute of information and communications technology, Japan;* [2]*Hokkaido university, Japan.* We successfully observed orbital angular momentum (OAM) spectra after propagation through multi-core fiber. The polarization of individual beam from each core rotates independently after the length of 500m, however, OAM spectra can also be observed.

Marriott San Jose
Salon I & II

Marriott San Jose
Salon III

Marriott San Jose
Salon IV

CLEO: Science & Innovations

14:00–16:00
CTu2L • Optofluidic Sensing and Control
Holger Schmidt, University of California Santa Cruz, USA, *Presider*

CTu2L.1 • 14:00
Mode splitting based single particle size measurement in water, Woosung Kim[1], Sahin Ozdemir[1], Jiangang Zhu[1], Lan Yang[1]; [1]*Electrical Engineering, Washington university, USA.* We report the first demonstration of single nanoparticle detection and size measurement in water using mode splitting in high-Q optical resonators. We achieved detecting and measuring polystyrene individual nanoparticles down to 75 nm in radius.

CTu2L.2 • 14:15
Opto-Thermophoretic Trapping of Microparticles in Air-Filled Hollow-Core Photonic Crystal Fiber, Oliver A. Schmidt[1], Martin K. Garbos[1], Tijmen G. Euser[1], Philip S. Russell[1]; [1]*Russell Division, Max Planck Institute for the Science of Light, Germany.* Dielectric microparticles optically propelled along an air-filled hollow-core PCF come to a halt just before an absorbing mark on the fiber coating, when radiation pressure is opposed by an equal and opposite thermophoretic force.

CTu2L.3 • 14:30
Microfluidic Pressure Measurements with Optical Trapping, Yuhang Jin[1], Kenneth B. Crozier[1]; [1]*Harvard University, USA.* We demonstrate a novel technique to measure pressure in microfluidic chips using optical trapping. The pressure drop across a single oil or water droplet is determined from the position of an optically-trapped bead.

CTu2L.4 • 14:45
Rotating microparticles and bacteria with optical propelling beams, Drake Cannan[1], Peng Zhang[1,2], Shima Fardad[1,3], Daniel Hernandez[1], Joseph Chen[4], Demetrios N. Christodoulides[3], Zhigang Chen[1,5]; [1]*1Department of Physics and Astronomy, San Francisco State Univ, USA;* [2]*1Department of 2NSF Nanoscale Science and Engineering Center, University of California, Berkeley,, USA;* [3]*3CREOL/College of Optics, University of Central Florida, USA;* [4]*Department of Biology, , San Francisco State University,, USA;* [5]*TEDA Applied Physics Schools, Nankai University, China.* We demonstrate optical trapping and rotation of microparticles and bacteria with propelling beams. The rotation is achieved in a tweezers-like setting and fully controlled by SLM without mechanical movement or phase-sensitive interference.

14:00–15:45
CTu2M • Pulsed Lasers and Amplifiers
Mike Messerly, Lawrence Livermore National Laboratory, USA, *Presider*

CTu2M.1 • 14:00
A Tunable Mid-Infrared (16-20 µm) Source from a Two-Color Yb: Fiber Chirped Pulse Amplifier, Mojtaba Hajialamdari[1], Donna Strickland[1]; [1]*Physics and Astronomy, Guelph-Waterloo Physics Institute, University of Waterloo, Canada.* We have demonstrated a tunable mid-infrared coherent source in the range from 16 µm to 20 µm by difference frequency mixing two near-infrared pulses from the output of a two-color Yb:fiber chirped pulse amplifier.

CTu2M.2 • 14:15
Nonlinear chirped-pulse amplification of a soliton-similariton laser to ~1 µJ at 1550 nm, Emrah Ilbey[1], Ihor A. Pavlov[1,3], Ebru Dulgergil[2], Bülent Öktem[1], Seydi Yavas[1], Andrey Rybak[3], Zuxing Zhang[1], F. Oemer Ilday[1]; [1]*Department of Physics, Bilkent University, Turkey;* [2]*Meteksan Savunma Inc., Turkey;*[3]*Institute of Physics, National Academy of Science of Ukraine, Ukraine.* We demonstrate all-fiber-integrated nonlinear CPA system operating at 1550 nm, seeded by a soliton-similariton laser. Chirped 2-µJ pulses are compressed to 700-fs, 0.5-µJ pulses at 1 MHz. Amplifier output is through a strictly singlemode fiber.

CTu2M.3 • 14:30
Megawatt Peak Power Picosecond Pulse Fiber Amplifier Based on Divided-Pulse Amplification, Luming Zhao[1], Simon Lefrancois[1], Dimitre Ouzounov[1], Frank W. Wise[1], Lingjie Kong[2,1], Changxi Yang[2]; [1]*Department of Applied Physics, Cornell University, USA;* [2]*Department of Precision Instruments, Tsinghua University, China.* We report the generation of 2.2 ps pulses with energy up to 2.5 µJ and peak power up to 1 MW through divided-pulse amplification, combined with the use of circular polarization.

CTu2M.4 • 14:45
Repetition rate-tunable high power fiber femtosecond laser system, Yunseok Kim[1], Seungman Kim[1], Seunghwoi Han[1], Sanguk Park[1], Jiyong Park[1], Seung-Woo Kim[1]; [1]*KAIST, Republic of Korea.*We developed a repetition rate-tunable, repetition rate-stabilized, high power fiber femtosecond laser system, which has average output power up to 13 W level at a pulse rate of 1 MHz ~ 50 MHz.

14:00–16:00
CTu2N • Diode Lasers
Nelson Tansu, LeHigh University, USA, *Presider*

CTu2N.1 • 14:00
Demonstration of High Temperature Operation in 1.3-µm-Range Metamorphic InGaAs Laser, Masakazu Arai[1], Yasuhiro Kondo[1], Shigeru Kanazawa[1], Takashi Tadokoro[1], Masaki Kohtoku[1]; [1]*NTT Photonics Laboratories, NTT Corporation, Japan.* A 1.3-µm-range metamorphic InGaAs laser with high characteristic temperature (T0 = 220 K) and the highest operating temperature (200 °C) ever reported for a metamorphic laser has been achieved.

CTu2N.2 • 14:15
Demonstration of a Relaxed Waveguide Semipolar (2021) InGaN/GaN Laser Diode, Matthew T. Hardy[1], Po Shan Hsu[1], Ingrid L. Koslow[1], Daniel Feezell[1], Shuji Nakamura[1,2], James S. Speck[1], Steven DenBaars[1,2]; [1]*Materials Department, University of California, Santa Barbara, USA;* [2]*Department of Electrical and Computer Engineering, University of California, Santa Barbara, USA.* Growth on relaxed buffers provides a potential route to reduce difficulties caused by high strain (~3%) in the active regions of green laser diodes (LDs). We demonstrate a blue LD with partially relaxed n- and p-side waveguide/cladding interfaces.

CTu2N.3 • 14:30 Invited
Electrically-pumped UV Nanowire Lasers, Jianlin Liu[1]; [1]*UC Riverside, USA.* We report electrically pumped Fabry-Perot (FP) type waveguide ultraviolet lasing from laser diodes that consist of Sb-doped p-type ZnO nanowires and n-type ZnO thin films. The diodes exhibit highly stable lasing at Room temperature.

Room A1 | Room A2 | Room A3 | Room A4

CLEO: Science & Innovations

CTu2A • Microwave Photonics: Components—Continued

CTu2A.5 • 15:00
Bandwidth-tunable optical filters in silicon photonics, Piero Orlandi[1,2], Michael J. Strain[2], Carlo Ferrari[3], Antonio Canciamilla[3], Andrea Melloni[3], Marc Sorel[2], Paolo Bassi[1], Francesco Morichetti[3]; *[1]Dipartimento di Elettronica, Informatica, Sistemistica, Università di Bologna, Italy; [2]School of Engineering, University of Glasgow, United Kingdom; [3]Department of Electronics and Information, Politecnico di Milano, Italy.* A silicon-on-insulator bandpass filter based on the integration of a Mach-Zehnder interferometer with ring resonators and phase shifters is fabricated. The device exhibits wide tunability over both the central wavelength and bandwidth of the filter.

CTu2A.6 • 15:15
On-chip, Tunable, Narrow-Bandpass Microwave Photonic Filter Using Stimulated Brillouin Scattering (SBS), Adam Byrnes[1], Ravi Pant[1], Christopher G. Poulton[2], Enbang Li[1], Duk-Yong Choi[3], Steve J. Madden[3], Barry Luther-Davies[3], Benjamin J. Eggleton[1]; *[1]School of Physics, The University of Sydney, Australia; [2]School of Mathematical Sciences, University of Technology, Sydney, Australia; [3]Laser Physics Centre, Australian National University, Australia.* We report the first demonstration of a narrow-bandpass (~20MHz), on-chip, tunable, photonic filter for RF signals, using SBS in a chalcogenide waveguide. Extinction ratios of over 20dB for a frequency range of 2-12GHz were realized.

CTu2A.7 • 15:30
High-Extinction Linear Cascaded-Microcavity Filters, Marcel W. Pruessner[1], Todd H. Stievater[1], Peter G. Goetz[1], William S. Rabinovich[1], Vincent J. Urick[1]; *[1]Photonics Technology, Naval Research Laboratory (NRL), USA.* We design cascaded waveguide microcavities. Using realistic design parameters based on previously demonstrated single-stage devices, we model filters with >60dB extinction, 100GHz FSR and 1GHz bandwidth. Initial experimental results are presented.

CTu2A.8 • 15:45
Self-reference temporal phase reconstruction based on causality arguments in linear optical filters, Mohammad H. Asghari[1], José Azana[1]; *[1]EMT, Énergie, Matériaux et Télécommunications (EMT), Canada.* We introduce and numerically prove a simple and general concept for direct reconstruction of the temporal phase profile of an optical signal from temporal intensity measurements at the input and output of an arbitrary linear optical filter.

CTu2B • Terahertz QCLs & Solid State Devices—Continued

CTu2B.5 • 15:00
Time-domain measurements of the sampling coherence of a quantum cascade laser, J. Maysonnave[1], Nathan Jukam[1], M. S. Ibrahim[2], Kenneth Maussang[1], Rakchanok Rungsawang[1], Julien Madeo[1], Pierrick Cavalie[1], Joshua R. Freeman[1], Paul Dean[2], S. Khanna[2], D. Steenson[2], Edmund H. Linfield[2], A. G. Davies[2], Sukhdeep S. Dhillon[1], Jerome Tignon[1]; *[1]Laboratoire Pierre Aigrain, Ecole Normale Supérieure, CNRS (UMR 8551), Université P. et M. Curie, Université D. Diderot ,, France; [2]School of Electronic and Electrical Engineering, University of Leeds, United Kingdom.* We measure the sampling coherence between a quantum cascade laser and a reference femtosecond laser. In addition to complete and incomplete sampling coherence, quantum cascade lasers can exhibit partial sampling coherence that varies with time.

CTu2B.6 • 15:15
Integrated injection seeded THz source and amplifier for time-domain spectroscopy, Jean Maysonnave[1], N. Jukam[1], M. S. Ibrahim[2], Kenneth Maussang[1], Julien Madeo[1], Pierrick Cavalie[1], Josh Freeman[1], Paul Dean[2], S. Khanna[2], D. Steenson[2], Edmund H. Linfield[2], A. G. Davies[2], Jerome Tignon[1], Sukhdeep S. Dhillon[1]; *[1]Laboratoire Pierre Aigrain, Ecole Normale Superieure, CNRS (UMR 8551), Université P. et M. Curie, Université D.Diderot, France; [2]School of Electronic and Electrical Engineering, University of Leeds, United Kingdom.* A quantum-cascade-laser (QCL) is used as an integrated injection seeded source and amplifier for terahertz (THz) pulses. A coupled-cavity scheme is implemented to generate THz pulses on the QCL and to saturate the amplified pulse.

CTu2B.7 • 15:30
Multiplicative Mixing and Detection of THz Signals with a Field Effect Transistor, Sascha Preu[1], Sangwoo Kim[2], Peter G. Burke[3], Mark S. Sherwin[4], Arthur C. Gossard[3]; *[1]Chair for Applied Physics, University of Erlangen-Nuremberg, Germany; [2]Tanner Research, USA; [3]Materials Department, University of California, Santa Barbara, USA; [4]ITST and Physics Dept., University of California, Santa Barbara, USA.* We report on a multiplicative mixing architecture for THz detection with a field effect transistor. The mixer multiplies the THz signal with an orthogonally polarized local oscillator signal for down-conversion in a homodyne detection scheme.

CTu2B.8 • 15:45
Ultrahigh Sensitive Plasmonic Terahertz Detection Using Asymmetric Dual-Grating Gate HEMT Structures, Takayuki Watanabe[1], Stephane Albon Boubanga Tombet[1], Yudai Tanimoto[1], Tetsuya Fukushima[1], Taiichi Otsuji[1], Denis Fateev[2], Viacheslav Popov[2], Dominique Coquillat[3], Wojciech Knap[3], Yahya Meziani[4], Yuye Wang[5], Hiroaki Minamide[5], Hiromasa Ito[5]; *[1]RIEC, Tohoku University, Japan; [2]Kotelnikov Inst. Radio Eng. Electron., RAS, Russian Federation; [3]DLC2 Labs., University of Montpellier-CNRS, France; [4]Dept. de Fisica Aplicada, Universidad de Salamanca, Spain; [5]Advanced Science Institute, RIKEN, Japan.* We report on ultrahigh sensitive broadband terahertz detection using asymmetric double-grating-gate high-electron-mobility transistors, demonstrating a record responsivity of 2.2 kV/W at 1 THz with a superior low noise equivalent power of 15 pW/√Hz.

CLEO: QELS-Fundamental Science

QTu2C • Quantum Control—Continued

QTu2C.2 • 15:00 Invited
Anderson Metal-insulator Transition with the Atomic Kicked Rotor, Dominique M. Delande[1,2]; *[1]Laboratoire Kastler-Brossel, Université Pierre et Marie Curie, France; [2]Ecole Normale Superieure, France.* Using the atomic kicked rotor, we study experimentally the metal-insulator Anderson transition in 3D, and the wavefunction near the critical point. We measure accurately the critical exponent and show its universality.

QTu2C.3 • 15:30
Single ion trapped in the focal spot of a deep parabolic mirror, Andrea Golla[1,2], Robert Maiwald[1,2], Martin Fischer[1,2], Marianne Bader[1,2], Benoit Chalopin[3], Markus Sondermann[1,2], Gerd Leuchs[1,2]; *[1]Max Planck Institute for the Science of Light, Germany; [2]Institute of Optics, Information and Photonics, University of Erlangen-Nuremberg, Germany; [3]. Laboratoire Collisions Agrégats Réactivité UMR5589, Université Paul Sabatier, France.* We report on trapping of single Ytterbium ions in the focal spot of a deep parabolic mirror providing a setup for efficient free space photon atom coupling.

QTu2C.4 • 15:45
Quantum Control of Cold Rubidium Atoms via Phase Gating, Sangkyung Lee[1], Han-gyeol Lee[1], Junwoo Cho[1], Chang Yong Park[2], Jaewook Ahn[1]; *[1]Physics, KAIST, Republic of Korea; [2]Korea Research Institute of Science and Stnadards, Republic of Korea.* We demonstrate π phase-gate control of cold rubidium atoms in a magneto-optical trap. For this, we utilize ultrafast pulse-shaping technique, and the quantum interference of two-photon ionization is tested as a function of the phase-gate position.

CLEO: Science & Innovations

CTu2D • 1.5 to 5um Lasers—Continued

CTu2D.5 • 15:00
Highly Efficient KY1-x-yGdxLuy(WO4)2:Tm3+ Channel Waveguide Lasers, Koop van Dalfsen[1], Shanmugam Aravazhi[1], Christos Grivas[2], Sonia M. Garcia-Blanco[1], Markus Pollnau[1]; *[1]MESA+ Institute for Nanotechnology, University of Twente, Netherlands; [2]School of Physics and Astronomy, University of Southampton, United Kingdom.* Laser experiments on 1.5at.%, 5at.%, and 8at.% Tm-Gd-Lu-Y co-doped, buried, ridge-type channel waveguides in a monoclinic potassium double tungstate demonstrate a maximum slope efficiency of 70% and output powers of 300 mW at ~1.9 µm.

CTu2D.6 • 15:15
Single-Frequency Passively Q-Switched Er:YAG Laser, Yuri Terekhov[1], Dmitri V. Martyshkin[1,2], Vladimir V. Fedorov[1,2], Igor Moskalev[2], Sergey B. Mirov[1,2]; *[1]Physics, UAB, USA; [2]Mid-IR Lasers, IPG Photonics Corporation, USA.* Passive Q-Switching of Er-fiber-Er:YAG hybrid laser was realized by Cr:ZnSe saturable absorber. Single and multimode regimes were analyzed experimentally and theoretically. Preliminary theoretical prediction is in agreement with experimental data.

CTu2D.7 • 15:30
1.5-µm high-gain and high-power laser amplifier using a Er,Yb:glass planar waveguide for coherent Doppler LIDAR, Takeshi Sakimura[1], Yojiro Watanabe[1], Toshiyuki Ando[1], Shumpei Kameyama[1], Kimio Asaka[1], Hisamichi Tanaka[1], Takayuki Yanagisawa[1], Yoshihito Hirano[1], Hamaki Inokuchi[2]; *[1]Information Technology R&D Center, Mitsubishi Electric Corporation, Japan; [2]Aviation Program Group, Japan Aerospace Exploration Agency, Japan.* We have developed a 1.5-µm high-power laser amplifier using Er,Yb:glass planar waveguide for a coherent Doppler LIDAR. The pulse energy of 1.9-mJ was achieved at the repetition rate of 4-kHz.

CTu2D.8 • 15:45
Diodes for Resonantly Pumped CW and Pulsed Er:YAG Lasers, Haro Fritsche[1], Bastian Kruschke[1], Stefan Heinemann[2], Xin Wang[1], Zhigang Zheo[1], Hans J. Eichler[1]; *[1]Institute of Optics and Atomic Physics, TU Berlin, Germany; [2]Center for Laser Technology, Fraunhofer USA, USA.* Eye safe laser radiation at 1.6 µm is realized by a resonantly pumped Er:YAG laser operating in cw and q-switched mode employing broad and narrow spectrum diodes intended for medical applications and trace gas detection.

16:00–16:30 Coffee Break, *Exhibit Halls 1, 2 and 3*

Tuesday, 8 May

Room A5 | Room A6 | Room A7

CLEO: QELS-Fundamental Science

CLEO: Applications & Technology

QTu2E • Theory—Continued

QTu2E.5 • 15:00
Resonance Fluorescence in a Waveguide Geometry, Sukru Ekin Kocabas[1], Eden Rephaeli[2], Shanhui Fan[3]; [1]*Electrical and Electronics Engineering, Koc University, Turkey;* [2]*Applied Physics, Stanford University, USA;* [3]*Electrical Engineering, Stanford University, USA.* We extend the quantum input-output formalism for a qubit embedded in a waveguide to derive analytical formulas for the first- and second-order statistics of the scattered fields for an arbitrary intensity coherent state input.

QTu2E.6 • 15:15
Signal-to-Noise Ratio Enhancement in Weak Measurement, and its Application to Observing Single-Photon-Level Nonlinearities, Amir Feizpour[1], Xingxgin Xing[1], Aephraim Steinberg[1]; [1]*Physics, University of Toronto, Canada.* We show theoretically that weak-value amplification can enhance the signal-to-noise ratio in the presence of noise with long correlation times, in particular for measurements of single-photon-level nonlinearities.

QTu2E.7 • 15:30
Universality of the Heisenberg Limit for Estimates of Random Phase Shifts, Dominic W. Berry[1], Michael J. Hall[2], Marcin Zwierz[2], Howard M. Wiseman[2]; [1]*Department of Physics and Astronomy, Macquarie University, Australia;* [2]*Centre for Quantum Dynamics, Griffith University, Australia.* Recent work has suggested that it is possible to perform phase measurements more accurately than the Heisenberg limit. We show that, when one averages over random phase shifts, the Heisenberg limit is universal.

QTu2E.8 • 15:45
Quantum limits in compressed sensing of optical images, Hui Wang[1,2], Shensheng Han[1], Mikhail Kolobov[2,3]; [1]*Key Laboratory of Quantum Optics, Shanghai Institute of Optics and Fine Mechanics, China;* [2]*Laboratoire PHLAM, University Lille 1, France;* [3]*Department of Mathematics and Statistics, Stanford University, USA.* We discuss the ultimate quantum limits in compressed sensing, a new technique which allows for accurate reconstruction of so-called "sparse" signals even when the sampling rate is far below the Nyquist limit.

QTu2F • Plasmon-Emitter-Coupling—Continued

QTu2F.4 • 15:00
Creating strong single molecule emitter using 3-dimensional plasmonic nano-cavity, Weihua Zhang[1], Fei Ding[1], Stephen Y. Chou[1]; [1]*Princeton University, USA.* We report strong fluorescence emissions from single IR dye molecules on a novel 3D plasmonic nanoantenna array. The measured emission cross-section is ~1E-13 cm2, 5 orders of magnitude than the value in solution.

QTu2F.5 • 15:15
Diamond-silver apertures with plasmonic gratings, Jennifer Choy[1], Irfan Bulu[1], Birgit Hausmann[1], Thomas Babinec[1], Marko Loncar[1]; [1]*School of Engineering and Applied Sciences, Harvard University-SEAS, USA.* We have designed plasmonic gratings to improve collection and modify the far field profile of the enhanced single photon emission from a diamond-silver aperture. We implemented a fabrication procedure to realize such structures.

QTu2F.6 • 15:30
Coupling of a Single Nitrogen Vacancy Center to the Gap Modes of a Dual Silver Nanowire System, Shailesh Kumar[1], Alexander Huck[1], Ulrik L. Andersen[1]; [1]*DTU Physics, Technical University of Denmark, Denmark.* We couple a nitrogen vacancy center in a diamond nano-crystal to a dual silver nanowire system by positioning the crystal in the gap between the two nanowires, and demonstrate a lifetime decrease of 8.3.

QTu2F.7 • 15:45
Coupled Metallic Thin-Film/Nanoparticle-Array Systems for Far-Field Engineering of Quantum-Well Luminescence, Jeffrey DiMaria[1], Emmanouil Dimakis[1], John Henson[1], Theodore Moustakas[1], Roberto Paiella[1]; [1]*Boston University, USA.* Metal nanostructures consisting of coupled Ag films and nanoparticle arrays are fabricated, characterized via measurements of their plasmonic dispersion curves, and used to demonstrate collimation of the emitted light from nitride quantum wells.

ATu2G • Instrumentation & Sensing —Continued

ATu2G.4 • 15:00
Phase Drift Cancellation for Long-term Transfer Using Electronic Compensation Loop, Bo Ning[1], Dong Hou[1], Quansheng Ren[1], Jianye Zhao[1]; [1]*Department of Electronics, Peking University, China.* We report a long-term stable frequency transfer experiment over a 20 km fiber link using an electronic compensation scheme. The data show that the phase drift was reduced from 1.59 ns to 6.3 ps.

ATu2G.5 • 15:15
Assessment of helicopter brownout with a scanning lidar, Gilles Roy[1], Xiaoying Cao[2], Simon Roy[1], Evan Trickey[2]; [1]*Defence Research Development Canada Valcartier, Canada;* [2]*Neptec Design Group Ltd, Canada.* There is very few quantitative data on Degraded Visual Environments (DVE) generated by the downwash of Rotary-Wing Platforms (RWP). A scanning lidar is used to measure the clouds generated by a helicopter hovering close to ground.

ATu2G.6 • 15:30
Multi-beam Laser Altimeter System Simulator for the Lidar Surface Topography (LIST) Mission, Anthony W. Yu[1], Michael Krainak[1], David J. Harding[1], James B. Abshire[1], Xiaoli Sun[1], John F. Cavanaugh[1], Susan R. Valett[1], Luis Ramos-Izquierdo[1]; [1]*Laser & Electro-Optics Branch, NASA Goddard Space Flight Center, USA.* In this paper we will discuss our development effort of a multi-beam airborne laser altimeter instrument as a pathfinder for the LIdar Surface Technology (LIST) mission.

ATu2G.7 • 15:45
Investigation of Erbium-doped Tellurite Glasses for a Planar Waveguide Power Amplifier at 1.57µm, Jacob I. MacKenzie1, G. S. Murugan1, T. Suzuki2, Y. Ohishi2, Anthony W. Yu3, James B. Abshire4; 1Optoelectronics Research Centre, University of Southampton, United Kingdom; 2Research Center for Advanced Photon Technology, Toyota Technological Institute, Japan; 3Laser & Electro-Optics Branch, NASA Goddard Space Flight Center, USA; 4Solar System Exploration Division, NASA Goddard Space Flight Center, USA. Compare gain in Er-doped tellurite glasses for CO2 absorption measurements, a maximum gain of 2.2dB/cm with 8 ms fluorescence lifetime has been obtained at 1572 nm using a 974 nm pump with intensity of 8kW/cm2.

16:00–16:30 Coffee Break, *Exhibit Halls 1, 2 and 3*

Tuesday, 8 May

Room A8

CLEO: QELS-Fundamental Science

QTu2H • Femtosecond-to-Attosecond Interferometry and Spectroscopy—Continued

QTu2H.5 • 15:00
Sub-10 fs RMS Measurement of X-Ray/Optical Delay, Mina R. Bionta[1], James Cryan[2,3], James M. Glownia[2,4], Doug French[1,5], C. Bostedt[1], Marco Cammarrata[1], Jean-Charles Castagna[1], Yuantau Ding[1], Steve Durbin[6], Yiping Feng[1], Alan Fry[1], Daniel J. Kane[7], Jacek Krzywinski[1], Henrik Lemke[1], Marc Messerschmidt[1], Adi Natan[2], Daniel Ratner[1], Sebastian Schorb[1], Michele Swiggers[1], Mariano Trigo[2], William White[1], Ryan Coffee[1]; [1]*The Linac Coherent Light Source, SLAC National Accelerator Laboratory, USA;* [2]*The PULSE Institute for Ultrafast Energy Science, SLAC National Accelerator Laboratory, USA;* [3]*Department of Physics, Stanford University, USA;* [4]*Department of Applied Physics, Stanford University, USA;* [5]*Department of Mechanical and Nuclear Engineering, The Pennsylvania State University, USA;* [6]*Department of Physics, Purdue University, USA;* [7]*Mesa Photonics, USA.* We present spectral-encoding of the relative delay between a soft x-ray FEL pulse and an optical laser. We measure a sub-10 fs x-ray induced modulated optical transmission that indicates a sub-10 fs RMS measurement error.

QTu2H.6 • 15:15
Characterization of Attosecond Pulses in Space and Time, Kyung Taec Kim[1]; [1]*Joint Attosecond Science Laboratory, University of Ottawa and National Research Council of Canada, Canada.* We present a novel spatio-temporal characterization method for the attosecond pulses produced through high harmonic generation. A spatio-temporal profile is reconstructed from the spatial modulation of the harmonic spectra in the far-field.

QTu2H.7 • 15:30
A High Order Harmonic Radiation Zeptosecond Phase Interferometer, Dane E. Laban[1], William C. Wallace[1], Thijs Clevis[1], Naylyn Gaffney[1], Michael Pullen[1], Adam Palmer[1], Dansha Jiang[2], Harry Quiney[2], Igor Litvinyuk[1], Dave Kielpinski[1], Robert T. Sang[1]; [1]*ARC Centre of Excellence for Coherent X-Ray Science and Centre for Quantum Dynamics, Griffith University, Australia;* [2]*ARC Centre of Excellence for Coherent X-Ray Science, University Melbourne, Australia.* We present an interferometer using XUV radiation generated in two spatially separated argon gas jets. We demonstrate how the interferometer may be used to provide a time delay for pump-probe experiments in the zeptosecond regime.

QTu2H.8 • 15:45
Pulse compression of phase-matched high harmonic pulses from a time-delay compensated monochromator, Hironori Igarashi[1], Ayumu Makida[1], Motohiko Ito[1], Taro Sekikawa[1]; [1]*Hokkaido University, Japan.* Pulse compression of single 32.6-eV high harmonic pulses from a time-delay compensated monochromator was demonstrated down to 11±3 fs by compensating the pulse front tilt. The photon flux was intensified up to 5.7×109 photons/s on target.

Room B2 & B3

CLEO: Science & Innovations

CTu2I • Hybrid Silicon Photonics—Continued

CTu2I.5 • 15:00 Tutorial
Hybrid III-V Semiconductor/Silicon Nanolasers, Fabrice Raineri[1,2]; [1]*Laboratoire de Photonique et de Nanostructures- CNRS, France;* [2]*Universite Paris Diderot, France.* Heterogeneous integration of III-V semiconductors on Silicon is one the key technology for next-generation on-chip optical interconnects. During this tutorial, I will show how we extended this hybrid approach to nanophotonics by using photonic crystals.

Fabrice Raineri got his PhD in Physics from Paris Sud University in 2004 and subsequently spent 1 year at the Institute of Photonic Sciences in Barcelona. Currently, he is an associate professor (Maître de conférences) at Paris Diderot University and conducts his research at Laboratoire de Photonique et de Nanostructures, CNRS in Marcoussis France. He has extensive experience in the domain of nonlinear optics, photonic crystals and processing technology. He has been involved in several European projects such as HISTORIC (optical memories and heterogeneous integration) and COPERNICUS (ultrafast all optical gates) as well as several national projects.

Room C1 & C2

CTu2J • Quantum Wells and Dots—Continued

CTu2J.5 • 15:00
ZnCdSe/ZnCdMgSe Quantum Well Infrared Photodetector, Arvind Pawan Ravikumar[1], Adrian Alfaro-Martinez[3], Guopeng Chen[2], Kuaile Zhao[2], Maria Tamargo[3], Claire Gmachl[1], Aidong Shen[2]; [1]*Electrical Engineering, Princeton University, USA;* [2]*Electrical Engineering, The City College of NewYork, USA;* [3]*Chemistry, The City College of NewYork, USA.* We present the design, fabrication and characterization of a II-VI ZnCdSe/ZnCdMgSe QWIP with a bound to quasi-bound transition centered at 8.7 μm. Absorption and photocurrent measurements yield results consistent with conventional III-V QWIPs.

CTu2J.6 • 15:15
Self-induced Thermal Nonlinearities in InAs/InGaAsP Quantum Dot Microtubes at Telecom Wavelengths, Zhaobing Tian[1], Pablo Bianucci[1], M. Hadi Tavakoli Dastjerdi[1], Zetian Mi[1], Philip J. Poole[2], David V. Plant[1]; [1]*Electrical and Computer Engineering, McGill University, Canada;* [2]*Institute for Microstructural Sciences, National Research Council of Canada, Canada.* We demonstrate, for the first time, dynamical thermal effects in InAs/InGaAsP quantum dot microtubes at telecom wavelengths. Such effect can be avoided or exploited for passive or active applications by choosing appropriate resonance wavelengths.

CTu2J.7 • 15:30
Dilute-Nitride Active Regions on GaSb for Mid-Infrared Semiconductor Diode Lasers, Hari P. Nair[1], Adam Crook[1], Seth Bank[1]; [1]*Electrical and Computer Engineering, The University of Texas at Austin, USA.* We present the first Room-temperature photoluminescence from GaSb-based dilute-nitrides, enabled by minimizing the incorporation of non-radiative defects. This material system could provide a pathway for covering the 3-5 μm regime with diode lasers.

CTu2J.8 • 15:45
Nanofabrication of Quantum Dots on InP by In-Situ Etching and Selective Growth, Yinggang Huang[1], Tae Wan Kim[1], Toby J. Garrod[1], Luke J. Mawst[1], Shisheng Xiong[2], Paul F. Nealey[2], Kevin Schulte[2], Thomas F. Kuech[2]; [1]*Electrical and Computer Engineering, University of Wisconsin-Madison, USA;* [2]*Chemical and Biological Engineering, University of Wisconsin-Madison, USA.* Diblock copolymer lithography followed by selective growth is used for the nanofabrication of InGaAs quantum dots (QDs) on InP substrate. Stronger photoluminescence intensity is observed when in-situ CBr4 etching is employed prior to QD growth.

Room C3 & C4

JOINT

JTu2K • Symposium on Singular Light: Applications of Vortices, Orbital Angular Momentum, Bessel and Airy Beams II: Tweezers to Telecom—Continued

JTu2K.4 • 15:00
Influence of thick atmospheric turbulence on the propagation of quantum states of light using spatial mode encoding, Brandon Rodenburg[1], Mehul Malik[1], Malcolm O'Sullivan[1], Mohammad Mirhosseini[1], Nicholas K. Steinhoff[2], Glenn A. Tyler[2], Robert W. Boyd[1,3]; [1]*Institute of Optics, University of Rochester, USA;* [2]*The Optical Sciences Company, USA;* [3]*Department of Physics, University of Ottawa, Canada.* The effects of thick turbulence on transverse modes of light carrying orbital angular momentum are studied theoretically and experimentally. These results have potentially important implications for free-space quantum communications systems.

JTu2K.5 • 15:15
Generation and detection of multiple coaxial vortex beams for free-space optical communications, Jaime A. Anguita[1], Joaquin Herreros[1], Jaime E. Cisternas[1]; [1]*College of Engineering and Applied Sciences, Universidad de los Andes, Chile.* The coherent propagation and detection of multiple coaxial beams carrying distinct orbital angular momentum states is experimentally demonstrated. High-contrast detection is obtained to demonstrate the applicability to free-space laser communications.

JTu2K.6 • 15:30 Invited
The Role of Optical Angular Momentum of Light in Optical Micromanipulation, Halina Rubinsztein-Dunlop[1]; [1]*University of Queensland, Australia.* Twists and torques of microscopic objects can be attained when using highly focused laser light. This is achieved through transfer of angular optical momentum of light in form of either spin or orbital momentum or both.

16:00–16:30 Coffee Break,
Exhibit Halls 1, 2 and 3

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

CLEO: Science & Innovations

CTu2L • Optofluidic Sensing and Control—Continued

CTu2L.5 • 15:00
Optofluidic microparticle splitters using multimode-interference-based power splitters, Hong Cai[1], Andrew W. Poon[1]; [1]*ECE, The Hong Kong University of Science and Technology, Hong Kong.* We demonstrate a microparticle splitter using a silicon nitride multimode-interference-based 1×2 power splitter. The 1um-sized polystyrene particles are routed to the two output-ports with various branching ratios upon tuning the laser wavelength.

CTu2L.6 • 15:15
An Ultra-narrow-linewidth Microlaser for Nanosensing, Tao Lu[1,2], Hansuek Lee[1], Tong Chen[1], Steve Herchak[2]; [1]*Applied Physics, California Institute of Technology, USA;* [2]*Electrical and computer engineering, University of Victoria, Canada.* We report the detection of 11.5-nm radius polystyrene beads in an aqueous environment at a signal-to-noise-ratio of 18:1 by monitoring the split frequency steps of a 5.7-KHz-linewidth microlaser. The thermal-optical effect is also observed.

CTu2L.7 • 15:30
Overcoming the Temperature Increase Hurdle in Photonic Crystal Molecular Tweezers, Xavier Serey[1], Yih-Fan Chen[2,3], Romy Fain[2], Pilgyu Kang[2], David Erickson[2]; [1]*Applied Physics, Cornell University, USA;* [2]*Sibley School of Mechanical and Aerospace Engineering, Cornell University, USA;* [3]*Kavli Institute at Cornell for Nanoscale Science, Cornell University, USA.* We study the thermal effects on flow and transport of species near 1550nm silicon photonic crystal nano-tweezers. With a silicon nitride based 1064nm alternative we reduce heating to 0.3K temperature increase and demonstrate molecular tweezing.

CTu2L.8 • 15:45
Agarose gel optical waveguides with encapsulation of live cells and integrated microfluidics, Aadhar Jain[1], David Erickson[1]; [1]*Mechanical and Aerospace Engineering, Cornell University, USA.* We demonstrate optical waveguides, with integrated microfluidics, fabricated out of agarose and capable of encapsulating live cells, thus allowing for the interaction of the direct optical mode with the biology rather than the weak evanescent field.

CTu2M • Pulsed Lasers and Amplifiers—Continued

CTu2M.5 • 15:00
10 W, 10 ns, 50 kHz all-fiber laser at 1.55 µm, Ihor A. Pavlov[1], Ebru Dulgergil[2], Emrah Ilbey[1], F. Oemer Ilday[1]; [1]*Department of Physics, Bilkent University, Turkey;* [2]*Meteksan Savunma Inc., Turkey.* We report on an all-fiber, singlemode MOPA system at 1.55 µm producing 10-ns, 200-µJ pulses with 20 kW of peak power and utilize it to micromachine crystalline Si, which is largely transparent at this wavelength.

CTu2M.6 • 15:15
Q-switched Thulium doped Photonic Crystal Fiber Laser as a Source for Nonlinear Generation, Pankaj K. Kadwani[1], Norbert Modsching[2], Andrew R. Sims[1], Lasse Leick[3], Jes Broeng[3], Lawrence Shah[1], Martin Richardson[1]; [1]*CREOL, College of Optics and Photonics, University of Central Florida, USA;* [2]*West Saxon University of Applied Sciences, Germany;* [3]*NKT Photonics A/S, Denmark.* We report a Q-switched thulium doped polarizing photonic crystal fiber producing 435 µJ, 49 ns pulses at 10 kHz. The 8.9 kW peak power is the highest of any nanosecond Tm:fiber oscillator published to date.

CTu2M.7 • 15:30
Sub-5ps High-Energy Pulses from a Fiber-Amplified and Compressed Passively Q-Switched Microchip Laser, Alexander Steinmetz[1], Florian Jansen[1], Fabian Stutzki[1], Reinhold Lehneis[1], Jens Limpert[1], Andreas Tuennermann[1,2]; [1]*Friedrich-Schiller-University Jena, Germany;* [2]*Fraunhofer Institute for Applied Optics and Precision Engineering, Germany.* Nonlinear pulse compression of Q-switched pulses (>500kHz) is obtained from a fiber-amplified microchip laser. The 92ps pulses are SPM-broadened in a double-stage fiber amplifier extracting energies over 100µJ and subsequently compressed to 4.7ps.

CTu2N • Diode Lasers—Continued

CTu2N.4 • 15:00
384nm AlGaN Diode Lasers on Relaxed Semipolar Buffers, Dan Haeger[1], Erin Young[1], Roy Chung[1], Feng Wu[1], Shuji Nakamura[1], Steven DenBaars[1], James S. Speck[1], Alexey Romanov[1], Daniel A. Cohen[1]; [1]*Materials, University of California Santa Barbara, USA.* We report operation of AlGaN laser diodes grown on semipolar buffer layers partially relaxed by misfit dislocation formation at heterointerfaces remote from the active region. This approach offers a pathway to mid-UV AlGaN based lasers.

CTu2N.5 • 15:15
Semipolar (20-2-1) Laser Diodes (λ=505nm) with Wavelength-Stable InGaN/GaN Quantum Wells, Chia-Yen Huang[1], Yuji Zhao[2], Mathew Hardy[1], Daniel Feezell[1], James S. Speck[1], Steven DenBaars[1,2], Shuji Nakamura[1,2]; [1]*Materials, University of California, Santa Barbara, USA;* [2]*Electrical and Computer Engineering, University of California, Santa Barbara, USA.* GaN-based semipolar (20-2-1) laser diodes (λ=505 nm) with a 4 nm wavelength blueshift from spontaneous emission to lasing are demonstrated. The minimal blueshift is attributed to the stable energy profile in the quantum wells.

CTu2N.6 • 15:30
Lasing modes in polycrystalline and amorphous structures, Jin-Kyu Yang[1,2], Heeso Noh[1], Seng Fatt Liew[1], Michael J. Rooks[1], Glenn S. Solomon[3], Hui Cao[1,4]; [1]*Applied physics, Yale university, USA;* [2]*Optical Engineering, Kongju National University, Republic of Korea;* [3]*Joint Quantum Institute, NIST, USA;* [4]*Physics, Yale University, USA.* We systematically studied the lasing characteristics in photonic polycrystalline and amorphous structures under optical pumping. The lasing modes are spatially localized, and blue shift as the structural order becomes short ranged.

CTu2N.7 • 15:45
Waveguide Engineering for Hybrid Si / III-V Lasers and Amplifiers, Reuel Swint[1], Steven J. Spector[1], Paul W. Juodawlkis[1], Chang-Lee Chen[1], Jason Plant[1], Theodore M. Lyszczarz[1]; [1]*MIT-LL, USA.* Using adiabatic tapers, hybrid silicon / III-V lasers and amplifiers are integrated with conventional thin (t = 0.25 µm) silicon waveguides. Amplifiers have ~12 dB intrachip gain, and similar lasers have thresholds of 35 mA.

16:00–16:30 Coffee Break, *Exhibit Halls 1, 2 and 3*

Room A1

CLEO: Science & Innovations

16:30–18:30
CTu3A • Microwave Photonics: Systems
Paul Juodawlkis, Massachusetts Institute of Technology, USA, *Presider*

CTu3A.1 • 16:30
Bandwidth Reconfigurable Radio-Frequency Photonic Filters Based on Directly Generated Gaussian-Shaped Comb, Rui Wu[1], Daniel Leaird[1], Andrew Weiner[1]; [1]*Purdue University, USA.* We demonstrate bandwidth reconfigurable radio-frequency photonic filters based on optical frequency combs. By changing the comb bandwidth with a manually tunable RF attenuator, the filter bandwidth can be increased by the maximum of 112%.

CTu3A.2 • 16:45
Simultaneous Downconversion and Reconfigurable Filtering of Microwave Signals by Programmable Comb Shaping, Victor Torres-Company[1,2], Andrew Weiner[1]; [1]*School of Electrical and Computer Engineering, Purdue University, USA;* [2]*Physics Department, Universitat Jaume I, Spain.* We perform photonic downconversion of microwave signals using an optical frequency comb in a dispersive-delay-line geometry. Programmable analog filtering in the 0-5GHz IF band is achieved through optical arbitrary waveform generation.

CTu3A.3 • 17:00
System-Scalable Waveform-Interleaved Multi-Channel Radio-Frequency Arbitrary Waveform Generator, Victor Torres-Company[1,2], Andrew J. Metcalf[1], Daniel Leaird[1], Andrew Weiner[1]; [1]*ECE, Purdue University, USA;* [2]*Department of Physics, Universitat Jaume I, Spain.* We demonstrate switching at the clock rate among four different optoelectronic frequency combs. After processing them with a 2D pulse shaper, this scheme enables temporal multiplexing of arbitrary radio-frequency signals.

Room A2

16:30–18:30
CTu3B • Terahertz Imaging & Sensing
David Zimdars, Picometrix LLC., USA, *Presider*

CTu3B.1 • 16:30
Terahertz Imaging and Spectroscopy of Single-Layer Graphene Embedded in Dielectrics, Michael J. Paul[1], Joseph L. Tomaino[1], Joshua Kevek[2], Tristan Deborde[1], Zachary J. Thompson[1], Paul L. McEuen[2,3], Ethan D. Minot[1], Yun-Shik Lee[1]; [1]*Physics, Oregon State University, USA;* [2]*Laboratory of Atomic and Solid-State Physics, Cornell University, USA;* [3]*Kavli Institute at Cornell for Nanoscale Science, Cornell University, USA.* We study graphene/dielectric interfaces using THz imaging and spectroscopy. Non-contacting, non-destructive THz probing reveals the local sheet conductivity of single-layer graphene deposited on a Si substrate and covered by a thin PMMA layer.

CTu3B.2 • 16:45
Imaging of Local Photo-excited Current in Solar Cell Using a Laser Terahertz Emission Microscope, Hidetoshi Nakanishi[1], Shogo Fijiwara[2], Kazuhisa Takayama[2], Iwao Kawayama[2], Hironaru Murakami[2], Masayoshi Tonouchi[2]; [1]*Image Processing Technology, DAINIPPON SCREEN MFG,, Japan;* [2]*Institute of Laser Engineering, Osaka University, Japan.* We have succeeded in detecting the terahertz waves generated from the solar cell under the irradiation of femtosecond laser pulses. This technique has enabled to visualize instantaneous power generation in the solar cell.

CTu3B.3 • 17:00
A Noninvasive Terahertz Assessment of 2nd and 3rd Degree Burn Wounds, M. Hassan Arbab[1], Dale Winebrenner[1], Trevor C. Dickey[1], Matthew B. Klein[2], Antao Chen[1], Pierre D. Mourad[1,3]; [1]*Applied Physics Laboratory, University of Washington, USA;* [2]*Burn Center and Division of Plastic Surgery, Department of Surgery, University of Washington, USA;* [3]*Department of Bioengineering, University of Washington, USA.* We demonstrate the application of THz-TDS in characterizing the severity of burn injuries in a live animal model. 2nd and 3rd degree burns were studied immediately and 72 hours post-burn. A new diagnosis criterion was verified against histopathology.

Room A3

16:30–18:30
CTu3C • Ultra-intense Laser Technology for Next-Generation Sources
Constantin Haefner, Lawrence Livermore National Laboratory, USA, *Presider*

CTu3C.1 • 16:30 Tutorial
Key laser technologies for next generation x-ray sources, Franz X. Kärtner[1,2]; [1]*CFEL-DESY, Universität Hamburg, Germany;* [2]*MIT, USA.* Advances in femtosecond lasers and ultrafast optical techniques may lead to the construction of fully coherent soft and hard x-ray sources with unprecedented coherence, peak brightness and temporal control. Key laser technologies enabling this progress are reviewed.

Franz X. Kärtner received his Diploma and Ph.D. degree in Electrical Engineering from Technische Universität München. He heads the Ultrafast Optics and X-rays Division at the Center for Free-Electron Laser Science (CFEL) at DESY Hamburg and Professor of Physics at University of Hamburg, and Adjunct Professor of Electrical Engineering at Massachusetts Institute of Technology (MIT). His research interests include few-cycle and ultralow jitter femtosecond lasers and its use in attosecond photonics such as precision timing distribution in advanced accelerators and light sources. He has published more than 230 papers and holds 22 patents. He is a fellow of the OSA and IEEE.

Room A4

CLEO: QELS-Fundamental Science

16:30–18:30
QTu3D • Cavity QED in Solid-State Systems
Andreas Muller, University of South Florida, USA, *Presider*

QTu3D.1 • 16:30 Invited
Cavity QED with Fiber Cavities: From Atoms to Quantum Well Excitons, Jakob Reichel[1]; [1]*Laboratoire Kastler Brossel, ENS/UPMC/CNRS, France.* We have developed laser-machined ultralow-roughness mirrors with curvatures below 100um yielding stable fiber Fabry-Perot cavities with measured finesse above F=100000 and microscopic volumes. This has enabled exceptional coupling strength in atomic CQED and solid-state CQED with tunable cavities.

QTu3D.2 • 17:00
A Tunable Microcavity, Russell Barbour[1,2], Paul Dalgarno[2], Arran Curran[2], Kris Nowak[2], Howard Baker[2], Denis Hall[2], Nick Stoltz[3], Pierre Petroff[3], Richard Warburton[4,2]; [1]*Physics and Astronomy, University of Washington, USA;* [2]*School of Engineering and Physical Sciences, Heriot-Watt University, United Kingdom;* [3]*Materials Department, University of California, USA;* [4]*Department of Physics, University of Basel, Switzerland.* We present a miniaturized Fabry-Pérot microcavity for cavity experiments on optically active nanostructures. Spectral and spatial tuning of the Purcell effect (weak coupling regime) on a single InGaAs quantum dot is demonstrated.

Room A5 | Room A6 | Room A7

CLEO: QELS-Fundamental Science

16:30–18:30
QTu3E • Detectors II
Christian Mueller, Max Planck Institute for the Science of Light, Germany, *Presider*

QTu3E.1 • 16:30
Transition edge sensors with low timing jitter at 1550 nm, Antia Lamas-Linares[1], Thomas Gerrits[1], Nathan A. Tomlin[1], Adriana Lita[1], Brice Calkins[1], Joern Beyer[2], Richard Mirin[1], Sae Woo Nam[1]; *[1]NIST, USA; [2]PTB, Germany.* Transition edge sensors have near unity detection efficiency and can resolve photon number. However, they are slow, with common timing jitter values around 100ns (best around 20ns). We report measured jitter times below 5ns for a tungsten TES.

QTu3E.2 • 16:45
Extending Single-Photon Optimized Superconducting Transition Edge Sensors beyond the single-photon counting regime, Thomas Gerrits[1], Brice Calkins[1], Adriana E. Lita[1], Alan Migdall[2,3], Richard Mirin[1], Sae Woo Nam[1]; *[1]National Institute of Standards and Technology, USA; [2]National Institute of Standards and Technology, USA; [3]Joint Quantum Institute, University of Maryland, USA.* We illuminate a photon-number-resolving transition edge sensor with strong pulses of light containing up to 6.7 million photons. We show that the sensor operates from the single-photon-counting regime to picowatt levels of light.

QTu3E.3 • 17:00
Cavity-Integrated Ultra-Narrow Superconducting Nanowire Single-Photon Detector Based on a Thick Niobium Nitride Film, Francesco Marsili[1], Faraz Najafi[1], Eric Dauler[2], Hasan Korre[1], Vikas Anant[3], Kristen Sunter[1], Karl K. Berggren[1]; *[1]Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, USA;[2]Lincoln Laboratory, Massachusetts Institute of Technology, USA; [3]Photon Spot, Inc., USA.* We propose a design for cavity-integrated Superconducting Nanowire Single-Photon Detectors based on 20-nm-wide 10-nm-thick nanowires. Our simulations show that these detectors can potentially reach ~90% device detection efficiency.

16:30–18:30
QTu3F • Terahertz Metamaterials
Presider TBD

QTu3F.1 • 16:30
Broadening of fundamental resonance via nested resonators in terahertz metamaterial, Dibakar Roy Chowdhury[1]; *[1]center for Integrated NanoTechnologies, Los Alamos National Laboratory, USA.* We demonstrate broadening of fundamental resonance by successive insertion of rings inside of a split ring resonator (SRR) in a nested fashion. With the maximum inner rings, the resonance linewidth broadens by factor of four.

QTu3F.2 • 16:45
Spatial dispersion management in three-dimensional drawn magnetic metamaterials, Alessandro Tuniz[1], Benjamin Pope[1], Alexander Argyros[1], Simon Fleming[1], Anna Wang[1], Maryanne Large[1], Elise Pogson[2], Roger A. Lewis[2], Avi Bendavid[3], Boris T. Kuhlmey[1]; *[1]School of Physics, Institute of Photonics and Optical Science, Australia; [2]School of Engineering Physics, University of Wollongon, Australia; [3]Materials Science and Engineering, Commonwealth Scientific and Industrial Research Organization, Australia.* We characterize resonances of 3D fiber metamaterials under transmittance at oblique incidence. The resonance frequency of longitudinally invariant resonators increases with the incident angle, while the resonance of disconnected resonators does not.

QTu3F.3 • 17:00
Ultrafast Optical Tuning of Superconducting Terahertz Metamaterials, Ranjan Singh[1], Abul Azad[1], Stuart A. Trugman[1], Quanxi Jia[1], A. J. Taylor[1], Hou-Tong Chen[1]; *[1]CINT, LANL, USA.* We demonstrate the ultrafast switching and tuning of the resonance in high temperature superconducting YBCO metamaterial excited by near infrared femtosecond laser pulses. The photons break the Cooper pairs thus destroys the metamaterial resonance

CLEO: Science & Innovations

16:30–18:30
CTu3G • Broadband Pulse Synthesis
Presider TBD

CTu3G.1 • 16:30
Coherent Synthesis of 3.7 fs Pulses with Independent, Ultrafast Lasers for Single-cycle Pulse Generation, Jonathan A. Cox[1], William P. Putnam[1], Alexander Sell[1], Alfred Leitenstorfer[3], Franz X. Kaertner[1,2]; *[1]Electrical Engineering and Computer Science, Massachusetts Institute of Technology, USA; [2]CFEL Ultrafast Optics and X-Rays Division, Deutsches Elektronen-Synchrotron, Germany; [3]Department of Physics and Center for Applied Photonics, University of Konstanz, Germany.* We report the synthesis of a 3.7 fs, ultrafast optical pulse train centered at 1000 nm and 78 MHz repetition rate, through active synchronization of independent ultrafast lasers, for single-cycle pulse generation.

CTu3G.2 • 16:45
Octave-spanning spectrum generation with a 503MHz repetition rate femtosecond Yb:fiber ring laser, Aimin Wang[1], Hongyu Yang[1], Chen Li[1], Zhigang Zhang[1]; *[1]School of Electronics Engineering and Computer Science, Peking University, China.* We demonstrate octave-spanning spectrum generation in tapered silica and tellurite photonic crystal fibers pumped by a compact 503 MHz repetition rate mode-locked Yb:fiber ring oscillator and amplifier system.

CTu3G.3 • 17:00
On-Chip High Repetition Rate Femtosecond Source, Kasturi Saha[1], Yoshitomo Okawachi[1], Bonggu Shim[1], Jacob S. Levy[2], Mark A. Foster[1], Michal Lipson[2,3], Alexander Gaeta[1,3]; *[1]School of Applied & Engineering Physics, Cornell University, USA; [2]School of Electrical and Computer Engineering, Cornell University, USA; [3]Kavli Institute at Cornell for Nanoscale Science, Cornell University, USA.* We show that a parametric frequency comb generated in a silicon-nitride resonator on-chip can be passively mode-locked to produce sub-200-fs pulses at a 99-GHz repetition rate.

Room A8

CLEO: QELS-Fundamental Science

16:30–18:30
QTu3H • XUV and X-Ray Attosecond Sources and Applications
Tenio Popmintchev, JILA, University of Colorado at Boulder, USA, *Presider*

QTu3H.1 • 16:30
Synthesis of sub-optical-cycle transients of light, Mohammed T. Hassan[1], Adrian Wirth[1], Ivanka Grguraš[1], Justin Gagnon[1], Antoine Moulet[1], Tran Trung Luu[1], Olga Razskazovskaya[2], Stefan Pabst[3], Robin Santra[3,4], Zeyad Alahmed[5], Abdallah Azzeer[5], Vladislav Yakovlev[1,2], Vladimir Pervak[2], Ferenc Krausz[1,2], Eleftherios Goulielmakis[1]; [1]*Max-Planck-Institute for Quantum Optics, Germany; [2]Department für Physik, Ludwig-Maximilians-Universität, Germany; [3]Center for Free-Electron Laser Science, DESY, Germany; [4]Department of Physics, University of Hamburg, Germany; [5]Physics and Astronomy Department, King Saud University, Saudi Arabia.* We report the synthesis, sampling and tailoring of ultrafast optical transients of light spanning over 1.5 octaves and their first application in attosecond experiments. Extension of the synthesizer to the deep ultraviolet is being demonstrated.

QTu3H.2 • 16:45
Attosecond Lighthouses, Henri Vincenti[1], Jonathan Wheeler[2], Sylvain Monchocé[1], Antonin Borot[2], Arnaud Malvache[2], Rodrigo Lopez-Martens[2], Fabien Quéré[1]; [1]*Service des Photons Atomes et Molécules, CEA, France; [2]Laboratoire d'Optique Appliquée, France.* We show how to use spatio-temporally coupled light fields to generate isolated attosecond pulses. This general effect provides an ideal scheme for attosecond pump-probe experiments, and constitutes a powerful new tool for ultrafast metrology.

QTu3H.3 • 17:00
Toward "Perfect-Wave" HHG Driving With a Multicolor OPA, Stefan Haessler[1], Tadas Balciunas[1], Giedrius Andriukaitis[1], Audrius Pugzlys[1], Andrius Baltuska[1], Amelle Zaïr[2], Richard Squibb[2], Luke Chipperfield[2], Leszek Frasinski[2], John Tisch[2], Jon P. Marangos[2]; [1]*TU Wien, Photonics Institute, Austria; [2]Imperial College London, United Kingdom.* We realize a multicolor, multi-cycle combination of commonly CEP-locked three waves from a single femtosecond OPA driven by a CEP -stable 7-mJ kHz Yb laser system and report HHG driving with individual and combined colors.

Room B2 & B3 / Room C1 & C2

CLEO: Science & Innovations

16:30–18:30
CTu3I • Silicon Photonics III
Wolfgang Freude, Karlsruher Institut of Technologie, Germany, *Presider*

CTu3I.1 • 16:30
27-Meter-Long Ultra-Low-Loss Optical Delay Line on a Silicon Chip, Tong Chen[1], Hansuek Lee[1], Jiang Li[1], Oskar Painter[1], Kerry J. Vahala[1]; [1]*Applied Physics, California Institute of Technology, USA.* Using a wet etch process, 27 meter long waveguides having optical loss of less than 0.1dB/m are demonstrated. Resonator measurements show that this loss value can be reduced to 0.037 dB/m.

CTu3I.2 • 16:45
Silicon Nanophotonic Mid-IR Optical Modulator, Mackenzie A. Van Camp[1], Solomon Assefa[1], Douglas M. Gill[1], Tymon Barwicz[1], Steven M. Shank[2], Yurii A. Vlasov[1], William M. Green[1]; [1]*IBM T. J. Watson Research Center, USA; [2]IBM Systems & Technology Group, Microelectronics Division, USA.* We demonstrate the first mid-IR silicon nanophotonic modulator, with a bitrate of 3Gbps. Our results show that similar design methodologies can be applied to silicon mid-IR active devices as for telecom devices.

CTu3I.3 • 17:00
Demonstration of Reconfigurable Directed Logic in Silicon Photonic Integrated Circuits, Ciyuan Qiu[1], Richard Soref[2], Qianfan Xu[1]; [1]*ECE, Rice University, USA; [2]Department of Physics, University of Massachusetts, USA.* We show a scalable and reconfigurable optical logic architecture based on a regular array of integrated optical switches. We present a proof-of-principle demonstration with a 2×2 switch array that can perform arbitrary two-input logic functions.

16:30–18:30
CTu3J • Advanced Microscopy
Chulmin Joo, Yonsei University, Republic of Korea, *Presider*

CTu3J.1 • 16:30
Towards Giga-pixel Microscopy, Guoan Zheng[1], Xiaoze Ou[1], Changhuei Yang[1]; [1]*Electrical Engineering, Caltech, USA.* We report a wide field-of-view (FOV) microscopy imaging system that is capable to capture a 10 mm * 7.5 mm FOV image with submicron resolution, resulting in 0.54 giga-pixels across the entire image.

CTu3J.2 • 16:45
High Throughput Microscopy With a Microlens Array, Antony Orth[1], Kenneth B. Crozier[1]; [1]*School of Engineering and Applied Sciences, Harvard University, USA.* We demonstrate large field-of-view (FOV) (30 mm2) fluorescence microscopy with submicron resolution using a microlens array. The large area of the array decreases image acquisition time over large FOVs by avoiding long-range mechanical scanning.

CTu3J.3 • 17:00
Simultaneous acquisition of multiple focal planes for real time 3-D microscopy using ultra-high speed adaptive optics, Marti Duocastella[1], Sun Bo[1], Howard A. Stone[1], Craig Arnold[1]; [1]*Mechanical and Aerospace Engineering, Princeton University, USA.* An ultra-high speed adaptive element is used to provide simultaneous real-time imaging of multiple and selectable focal planes in a specimen. This novel approach offers promising perspectives in areas including microfluidics and biomedical imaging.

Room C3 & C4

JOINT

16:30–18:30
JTu3K • Symposium on Singular Light: Applications of Vortices, Orbital Angular Momentum, Bessel and Airy Beams III: Light with Singularities: Properties and Applications
Andrei Rode, Australian National University, *Presider*

JTu3K.1 • 16:30 Invited
Measuring Light's Twist, Martin Lavery[1], Johannes Courtial[1], David Robertson[2], Gordon Love[2], Gregorius Berkhout[3], Miles Padgett[1]; [1]*School of Physics and Astronomy, Glasgow University, United Kingdom; [2]Department of Physics, Durham University, United Kingdom; [3]Huygens Laboratory, Leiden University, Netherlands.* Whereas the spin angular momentum (polarization) has only two orthogonal states, the orbital angular momentum has any number. To use this extra information we present a multi-way beam splitter to efficiently separate individual photons.

JTu3K.2 • 17:00
A Practical Orbital Angular Momentum Spectrometer using Time Mapping, Paul Bierdz[1], Hui Deng[1]; [1]*University of Michigan, USA.* We demonstrate a compact and practical orbital angular momentum spectrometer for arbitrary input states, based on an optical delay loop. Extinction ratios of 44-8.7 were measured, mainly limited by the available input states.

Tuesday, 8 May

Marriott San Jose
Salon I & II

CLEO: Applications & Technology

16:30–18:30
ATu3L • Laser Micro Processing
Robert Hainsey, Electro Scientific Industries Inc., USA, *Presider*

ATu3L.1 • 16:30 Invited
Micromanufacturing and nano surface functionalisation with ultrashort pulsed lasers, Arnold Gillner[1]; [1]*Fraunhofer Institute, Germany.* Ultra short pulsed lasers in the picosecond and even in the femtosecond range offer new possibilities for micro machining and surface functionalisation. With this new tool, micro molds for enhanced light guiding can be generated as well as surface with low friction and enhanced wear resistance. Using high power ultrashort pulsed lasers with powers up to 500 W, this technology will enter industrial applications even for large part machining.

ATu3L.2 • 17:00
Picosecond laser machining in the bulk of transparent dielectrics: critical comparison with fs-laser direct writing, Costantino Corbari1, Audrey Champion2, Mindaugas Gecevičius1, Martynas Beresna1, Matthieu Lancry3, Bertrand Poumellec3, Yves Bellouard2, Peter G. Kazansky1; 1Optoelectronics Research Centre, University of Southampton, United Kingdom; 2Mechanical Engineering Department, Eindhoven University of Technology, Netherlands; 3Institut de Chimie Moléculaire et des Matériaux d'Orsay, Université de Paris Sud, France. Picosecond lasers for bulk machining of transparent dielectrics are assessed as an alternative to fs-lasers. Nanogratings and micro-channels by selective etching are demonstrated. Scattering and inhomogeneous etching are challenges yet to be solved.

Marriott San Jose
Salon III

CLEO: Science & Innovations

16:30–18:30
CTu3M • Pulsed and Ultrafast Lasers
Emmanuel Hugonnot, Commissariat a l'Energie Atomique, France, *Presider*

CTu3M.1 • 16:30
Widely-Tunable UV-Visible Source Using Gas-Filled Hollow-Core PCF, Ka Fai Mak[1], John C. Travers[1], Philipp Hoelzer[1], Johannes Nold[1], Wonkeun Chang[1], Francesco Tani[1], Frederick Vinzent[2], Nicolas Joly[2,1], Philip S. Russell[1,2]; [1]*Division Russell, Max Planck Institute for the Science of Light, Germany;* [2]*Physics, University of Erlangen-Nuremberg, Germany.* An efficient and tunable 200-600 nm source based on resonant radiation from ultrafast solitons in gas-filled hollow-core PCF is demonstrated. The influence of axially varying dispersion, controlled with a pressure gradient, is also explored.

CTu3M.2 • 16:45
Fiber Front End for an OMEGA EP Demonstration of Beam-Smoothing Techniques for NIF Polar-Drive Ignition, Christophe Dorrer[1], Andrey Okishev[1], Rick Roides[1], Robert Cuffney[1], Wade Bittle[1], Jonathan D. Zuegel[1]; [1]*Laboratory for Laser Energetics, USA.* A fiber front end delivering shaped optical waveforms with various radio-frequency modulations has been developed to demonstrate beam-smoothing concepts on OMEGA EP with applications to polar-drive ignition at the National Ignition Facility.

CTu3M.3 • 17:00
Frequency conversion in the visible and UV regions of a high average power and high peak power ultrafast fiber amplifier, Yoann Zaouter[1], Marc Hanna[2], Franck Morin[1], Mario Tonin[1], Rysvan Maleck[1], Clemens Hönninger[1], Patrick Georges[2], Eric Mottay[1]; [1]*Amplitude Systemes, France;* [2]*Laboratoire Charles Fabry de l'Institut d'Optique, France.* We report the highly efficient generation from a 250uJ FCPA into 150uJ, 90uJ, 35uJ respectively at 515nm, 343nm and 258nm through harmonic generation in non-linear crystals. Alternatively, 50W at 515nm and 25W at 343nm will also be shown.

Marriott San Jose
Salon IV

16:30–18:30
CTu3N • Spectral, Temporal & Modal Control of Semiconductor Lasers
Peter Smowton, Cardiff University, UK, *Presider*

CTu3N.1 • 16:30
Singlemode 50nm Tunable Surface Micro-Machined MEMS-VCSEL Operating at 1.95µm, Karolina Zogal[1], Tobias Gründl[2], Christian Gierl[1], Christian Grasse[2], Hooman Davani[1], Gerhard Böhm[2], Peter Meissner[1], Franko Küppers[1], Markus C. Amann[2]; [1]*Institute for Microwaveengineering and Photonics, Technische Universität Darmstadt, Germany;* [2]*Walter Schottky Institut, Germany.* We demonstrate for the first time a surface micro-machined micro-electro-mechanical tunable VCSEL operating at 1.95 µm with 50 nm tuning range, 1 mW output power and 2.5 mA threshold current, capable for absorption spectroscopy.

CTu3N.2 • 16:45
Linewidth of surface micro-machined MEMS tunable VCSELs at 1.5µm, Christian Gierl[1], Tobias Gründl[2], Karolina Zogal[1], Christian Grasse[2], Hooman Davani[1], Gerhard Böhm[2], Franko Küppers[1], Peter Meissner[1], Markus C. Amann[2]; [1]*Institute for Microwaveengineering and Photonics, Technische Universität Darmstadt, Germany;* [2]*Walter Schottky Institut, Germany.* We demonstrate the linewidth characteristics of a micro-electro-mechanical system (MEMS) widely tunable VCSEL based on a newly developed surface micro-machining technology. The minimal linewidth is 98MHz at thermal rollover.

CTu3N.3 • 17:00
ASE-Free Continuously Tunable Diode Laser with a Novel Configuration, Kiyofumi Muro[1], Tomohisa Endo[1], Akira Terayama[1], Yuji Wakabayashi[1], Ken KItahara[1], Yasutaka Shimada[1], Daisike Fukuoka[1]; [1]*Graduate School of Science, Chiba University, Japan.* ASE-free tunable laser is constructed in a novel design, where output beam is extracted through fixed half-mirror and the unit composed of laser diode, lens and grating is rotatable around the pivot axis of Littman configuration.

Room A1	Room A2	Room A3	Room A4

CLEO: Science & Innovations

CLEO: QELS-Fundamental Science

CTu3A • Microwave Photonics: Systems—Continued

CTu3A.4 • 17:15
Ultra-Wideband Gain in Microwave Photonic Links using Four-Wave Mixing, Walter S. Wall[1], Mark A. Foster[1]; [1]*Johns Hopkins University, USA.* Partially-degenerate four-wave mixing is proposed as an efficient and ultrahigh-bandwidth method for improving the microwave gain of analog fiber optic links. A flat 9-dB gain is experimentally demonstrated over an ultra-wideband of 14GHz.

CTu3A.5 • 17:30
Impact of Semiconductor Optical Amplifiers in Coherent Down-Conversion Microwave Photonic Links, Siva Yegnanarayanan[1], Leonard Johnson[1], Reuel Swint[1], Jason Plant[1], Paul W. Juodawlkis[1]; [1]*MIT Lincoln Laboratory, USA.* We compare the impact of conventional semiconductor optical amplifiers (SOAs) and high-linearity slab-coupled optical waveguide amplifiers (SCOWAs) on the SFDR of carrier-suppressed coherent down-conversion microwave photonic links.

CTu3A.6 • 17:45
RF-Amplifier-Free Coupled Optoelectronic Oscillator (COEO), William Loh[1,2], Siva Yegnanarayanan[1], Jason Plant[1], Frederick J. O'Donnell[1], Matthew Grein[1], Jonathan Klamkin[1], Shannon Madison[1], Rajeev Ram[2], Paul W. Juodawlkis[1]; [1]*MIT Lincoln Laboratory, USA;* [2]*Massachusetts Institute of Technology, USA.* We report the first demonstration of a RF-amplifier-free 10 GHz coupled optoelectronic oscillator (COEO) through use of high-power slab-coupled optical waveguide (SCOW) amplifier and photodiode components.

CTu3B • Terahertz Imaging & Sensing—Continued

CTu3B.4 • 17:15
Sub-surface Terahertz Imaging through Uneven Surfaces: Visualizing Neolithic Wall Paintings in Çatalhöyük, Gillian C. Walker[1], John W. Bowen[1], J-Bianca Jackson[2], Julien Labaune[2], Gerard Mourou[2], Michel Menu[4], Wendy Matthews[3], Ian Hodder[5]; [1]*School of Systems Engineering, University of Reading, United Kingdom;* [2]*ILE, École Polytechnique, France;* [3]*School of Human and Environmental Sciences, Department of Archaeology, University of Reading, United Kingdom;* [4]*C2RMF, Palais du Louvre, France;* [5]*Department of Archaeology, Stanford University, USA.* Neolithic paintings at Çatalhöyük, Turkey, are hidden under uneven layers of plaster. Terahertz imaging in conjunction with a novel image processing technique using Gaussian beam-mode coupling, visualizes the obscured painting.

CTu3B.5 • 17:30
Ultrafast imaging of terahertz pulse generation by tilted optical pulse front in LiNbO3, Zhenyou Wang[1], Ayesheshim Ayesheshim[1], Fuhai Su[1,2], Frank Hegmann[1]; [1]*Department of Physics, University of Alberta, Canada;* [2]*Institute of Solid State Physics, CAS, China.* We directly image terahertz waves generated by optical rectification of tilted-pulse-front optical pulses in LiNbO3. The terahertz generation efficiency is highest when the pump-pulse tilt angle is equal to the THz cherenkov angle.

CTu3B.6 • 17:45
Label-free bacteria detection using evanescent mode of a suspended core terahertz fiber, Anna Mazhorova[1], Andrey Markov[1], Andy Ng[2], Raja Chinnappan[2], Mohammed Zourob[2], Maksim Skorobogatiy[1]; [1]*Genie Physique, Ecole Polytechnique de Montreal, Canada;* [2]*Institut National de la Recherche Scientifique, Canada.* For the first time we demonstrate the possibility of using suspended core polyethylene fibers for the sensing of E. coli. Diameter of our fiber is 5.1 mm, it has 150 µm suspended core which is strongly isolated from the environment.

CTu3C • Ultra-intense Laser Technology for Next-Generation Sources —Continued

CTu3C.2 • 17:30
Table-top Short Pulse Driver for sub-10 nm soft X-ray lasers, Brad Luther[1], David Alessi[1], Yong Wang[1], Liang Yin[1], Dale Martz[1], Mark Woolston[1], Jorge Rocca[1]; [1]*CSU, USA.* We demonstrate a Ti:Sa driver for pumping sub-10 nm table-top soft X-ray lasers. Output energies of 13.5 J have been obtained pre-compression, allowing gain-saturated lasing in sub-10 laser lines at 1 Hz repetition rate.

CTu3C.3 • 17:45
High repetition rate PetaWatt level Titanium Sapphire laser system for laser wakefield acceleration, François Lureau[1], Sébastien Laux[1], Olivier Casagrande[1], Christophe Radier[1], Olivier Chalus[1], Frédéric Caradec[1], Christophe Simon-Boisson[1]; [1]*Thales Optronique SA, France.* We describe design and performance of a PetaWatt laser based on Titanium Sapphire and working at an unprecedented repetition rate of 1 Hz. Preliminary results indicate an energy of 22 J before the final amplifier.

QTu3D • Cavity QED in Solid-State Systems—Continued

QTu3D.3 • 17:15
Spontaneous Coherence of Indirect Excitons in a Trap, Alexander A. High[1], Jason R. Leonard[1], Mikas Remeika[1], Leonid V. Butov[1], Micah Hanson[2], Arthur C. Gossard[2]; [1]*Physics, University of California, San Diego, USA;* [2]*Materials, University of California, Santa Barbara, USA.* We report on the emergence of spontaneous coherence of indirect excitons in a trap. At low temperatures, coherence extends over the entire exciton cloud indicating condensation of excitons in the trap.

QTu3D.4 • 17:30
Coherent Injection of Microcavities Polaritron Through tow Photon Excitations, Godefroy Leménager[1], Ferruccio Pisanello[2,3], Alberto Amo[1,5], Isabelle Sagnes[5], Rémy Braive[5], Elisabeth Galopin[5], Aristide Lemaître[5], Pascale Sanellart[5], Massimo De Vittorio[4], Jacqueline Bloch[5], Elisabeth Giacobino[1], Alberto Bramati[1]; [1]*ENS, UPMC, CNRS, Laboratoire Kastler Brossel, France;* [2]*Center for Bio-Molecular Nanotechnology, Istituto Italiano di Tecnologia (IIT), Italy;* [3]*Center for Neuroscience and Cognitive Systems @UNITN, Istituto Italiano di Tecnologia, Italy;* [4]*CNR-Nano, Università del Salento, Dipartimento Ingegneria dell'innovazione, National Nanotechnology Laboratory, Italy;* [5]*CNRS, Laboratoire de Photonique et Nanostructures, France.* We present a technique based on a two-photon absorption process. We coherently inject polaritons in planar or pillar microcavities, being in resonance and with a well defined in plane wavevector (k) and show polariton laser.

QTu3D.5 • 17:45
Nanocavity-enhanced Optical Stark Shift in a Single Quantum Dot under Extremely Low Excitation Power, Hiroyuki Takagi[1,2], Yasutomo Ota[2], Naoto Kumagai[2], Satomi Ishida[1], Satoshi Iwamoto[1,2], Yasuhiko Arakawa[1,2]; [1]*IIS, The University of Tokyo, Japan;* [2]*NanoQuine, The University of Tokyo, Japan.* An enhanced optical Stark shift in a single quantum dot is demonstrated using a newly-designed H1-type photonic crystal nanocavity. A 70µeV shift is observed at 450nW; 110-times lower than excitation powers reported in the literature.

Room A5 | Room A6 | Room A7

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

QTu3E • Detectors II—Continued

QTu3E.4 • 17:15
Direct measurement of the dependence of the photon-number distribution on the number of modes in parametric down-conversion, Liat Dovrat[1], Michael Bakstein[1], Daniel Istrati[1], Assaf Shaham[1], Hagai S. Eisenberg[1]; [1]*Racah Institute of Physics, The Hebrew University of Jerusalem, Israel.* The dependence of the photon-number distribution from parametric down-conversion on the number of collected modes is directly measured using Silicon photomultiplier number-resolving detectors. Measurements are analyzed using a novel crosstalk model.

QTu3E.5 • 17:30
High-stability Time-domain Balanced Homodyne Detector for Ultrafast Optical Pulse Applications, Merlin F. Cooper[1], Christoph Soeller[1], Brian J. Smith[1]; [1]*Department of Physics, University of Oxford, United Kingdom.* We present a broadband high-efficiency balanced homodyne detector exhibiting unparalleled stability and signal-to-noise characteristics. Quantum state tomography of a weak coherent state demonstrates the detector capability in the quantum regime.

QTu3E.6 • 17:45
Improving a lossy photon detector with an imperfect CNOT gate, Katherine L. Brown[1], Moochan B. Kim[1], Christopher D. Richardson[1], Jonathan P. Dowling[1]; [1]*Physics & Astronomy, Louisiana State University, USA.* We improve a lossy detector by using a CNOT gate to copy the classical information from the state into an ancilla qubit. This scheme works even when the CNOT gate introduces errors into the circuit.

QTu3F • Terahertz Metamaterials—Continued

QTu3F.4 • 17:15
Strong Terahertz Light-Matter Coupling Between Metamaterials and Intersubband Transitions, Daniel Dietze[1], Alexander Benz[1], Gottfried Strasser[2], Karl Unterrainer[1,2], Juraj Darmo[1]; [1]*Institute for Photonics, Vienna University of Technology, Austria;* [2]*Center for Micro- & Nanostructures, Vienna University of Technology, Austria.* The interaction of metamaterials and terahertz intersubband transitions is investigated in the strong coupling regime. We demonstrate that the resonant frequency of the metamaterial can be tuned by etching without destroying the strong interaction.

QTu3F.5 • 17:30
Electromagnetically induced transparency in an individual Fano resonator metamaterial, Ranjan Singh[1,2], Ibraheem Al-Naib[3], Yuping Yang[2], Dibakar Roy Chowdhury[1], Wei Cao[2], Carsten Rockstuhl[4], Tsuneyuki Ozaki[3], Roberto Morandotti[3], Weili Zhang[2]; [1]*CINT, LANL, USA;* [2]*School of Electrical and Computer Engineering, Oklahoma State University, USA;* [3]*INRS-EMT, Université du Québec, Canada;* [4]*Institute of Condensed Matter Theory and Solid State Optics, Friedrich-Schiller-Universität Jena, Germany.* We observe metamaterial induced transparency in a single Fano resonator array. In a perfect symmetric configuration, a broad dipolar resonance is excited whereas a high Q transparency window opens as the structural symmetry is broken.

QTu3F.6 • 17:45
Terahertz wave control enabled by nano objects embedded in slot antennas, Hyeong-Ryeol Park[1], Young-Mi Bahk[1], Kwang Jun Ahn[1], Q-Han Park[2], Dai-Sik Kim[1], Luis Martín-Moreno[3], Francisco J. García-Vidal[4], Jorge Bravo-Abad[4]; [1]*Department of physics and astronomy, Seoul National University, Republic of Korea;* [2]*Department of Physics, Korea University, Republic of Korea;* [3]*Departamento de Física de la Materia Condensada, CSIC-Universidad de Zaragoza, Spain;* [4]*Departamento de Física Te orica de la Materia Condensada, Universidad Autonoma de Madrid, Spain.* We show that sub-skin depth nano metallic objects embedded in terahertz slot antennas strongly modulate their resonance features. Our findings have fundamental implications for sensitive nanoparticle detections using millimeter wavelength light.

CTu3G • Broadband Pulse Synthesis—Continued

CTu3G.4 • 17:15
On-Chip Sub-Cycle Pulse Generation via a Two-Octave Supercontinuum from Visible to Mid-Infrared Wavelengths, Lin Zhang[1], Qiang Lin[2], A. Agarwal[1], Lionel Kimerling[1], Jurgen Michel[1]; [1]*Massachusetts Institute of Technology, USA;* [2]*University of Rochester, USA.* Using dispersion flattening technique, a two-octave-wide nearly symmetric supercontinuum can be generated from visible to mid-IR wavelengths on a chip, which is accompanied by pulse compression from 120 to 4 fs (0.76 optical cycles).

CTu3G.5 • 17:30 Invited
High Repetition Rate Frequency Combs: Ultrafast Optics Starting with Continuous-wave Lasers, Andrew Weiner[1]; [1]*Purdue Univ., USA.* High repetition rate frequency combs and pulse trains are generated from continuous-wave lasers by nonlinear wave mixing in microresonators or by strong electro-optic modulation. Applications to arbitrary waveform generation and RF photonic filtering are discussed.

Room A8

CLEO: QELS-Fundamental Science

QTu3H • XUV and X-Ray Attosecond Sources and Applications—Continued

QTu3H.4 • 17:15

Role of Self-focusing in Bright Coherent X-Ray Generation by Mid-Infrared Driving Lasers, Bonggu Shim[1], Samuel E. Schrauth[1], Tenio Popmintchev[2], Ming-Chang Chen[2], Dimitar Popmintchev[2], Skirmantas Ališauskas[3], Audrius Pugzlys[3], Andrius Baltuška[3], Margaret M. Murnane[2], Henry C. Kapteyn[2], Alexander Gaeta[1]; *[1]School of Applied and Engineering Physics, Cornell University, USA; [2]JILA, University of Colorado, USA; [3]Photonics Institute, Vienna University of Technology, Austria.* We theoretically investigate the role of self-focusing in high harmonic generation in high pressure waveguides. Self-focusing can stabilize phase matching at higher pressures than predicted for full phase matching, further enhancing the flux.

QTu3H.5 • 17:30

Temporal structure of ultra high-order harmonic generation in the keV regime driven by mid-infrared lasers, Carlos Hernandez-Garcia[1], Tenio Popmintchev[2], Margaret M. Murnane[2], Henry C. Kapteyn[2], Agnieszka Jaron-Becker[2], Andreas Becker[2], Luis Plaja[1]; *[1]Física Aplicada, Universidad de Salamanca, Spain; [2]JILA and Department of Physics, University of Colorado at Boulder, USA.* We present predictions based on numerical calculations for the temporal structure of bright, phase matched, ultra high-order keV harmonic X-rays driven by 3.9 μm laser fields.

QTu3H.6 • 17:45

Demonstration of an 8.85 nm Gain-Saturated Table-Top Soft X-Ray Laser and Lasing down to 7.4 nm, Yong Wang[1,2], David Alessi[1,2], Brad Luther[1,2], Liang Yin[1,2], Dale Martz[1,2], Mark Berrill[1,2], Jorge Rocca[1,2]; *[1]National Science Foundation ERC, Colorado State University, USA; [2]Electrical and Computer Engineering, Colorado State University, USA.* We report the efficient generation of a gain-saturated 8.85 nm wavelength table-top soft x-ray laser operating at 1 Hz repetition rate and the observation of lasing at wavelengths as short as 7.36 nm in lanthanide ions.

Room B2 & B3

CLEO: Science & Innovations

CTu3I • Silicon Photonics III—Continued

CTu3I.4 • 17:15

Super-Ring Resonators: Taking Advantage of Resonance Variability, Jaime Cardenas[1], Paul A. Morton[2], Jacob B. Khurgin[3], Carl B. Poitras[1], Michal Lipson[1,4]; *[1]Cornell University, USA; [2]Morton Photonics, USA; [3]Johns Hopkins University, USA; [4]Kavli Institute at Cornell, USA.* We show that 20 microresonators collectively behave as one resonance and are controllable with one voltage signal, thereby exploiting the inherent variability of microresonators enabling multi-ring Balanced SCISSOR devices with two drive signals.

CTu3I.5 • 17:30

Self-aligned Silicon Fins in Metallic Slits as a Platform for Planar Tunable Nanoscale Resonant Photodetectors, Krishna Coimbatore Balram[1], David A.B. Miller[1]; *[1]Edward L. Ginzton Laboratory, Stanford University, USA.* We demonstrate self-aligned fabrication of etched silicon fins in metallic slits and show that this structure supports both dielectric and plasmonic resonances and photodetection that can be tuned by varying the width of the fin.

CTu3I.6 • 17:45

Complementary Apodized Grating Waveguides for Tunable Photonic Delay Lines, Saeed Khan[2], Sasan Fathpour[1,2]; *[1]CREOL - The College of Optics & Photonics, University of Central Florida, USA; [2]Department of Electrical Engineering and Computer Science, University of Central Florida, USA.* A novel class of tunable integrated photonic delay lines that compromises between loss and size is proposed. The devices comprise cascaded apodized grating waveguides with complementary (positively and negatively modulated) refractive index profiles.

Room C1 & C2

CTu3J • Advanced Microscopy—Continued

CTu3J.4 • 17:15

Pixel super-resolution in serial time-encoded amplified microscopy (STEAM), Terence T. W. Wong[1], Antony Chan[1], Kenneth K. Y. Wong[1], Kevin K Tsia[1]; *[1]The University of Hong Kong, Hong Kong.* We propose pixel super-resolution serial time-encoded amplified microscopy (STEAM) for achieves high speed and high-resolution imaging - relaxing the stringent requirement on the digitizer bandwidth while preserving the ultrahigh frame-rate (>MHz).

CTu3J.5 • 17:30 Invited

Quantitative Phase Imaging in Biomedicine, Gabriel Popescu[1]; *[1]Department of Electrical and Computer Engineering & Bioengineering, University of Illinois at Urbana-ChampaignUniversity of Illinois at Urbana-ChampaignUniversity of Illinois at Urbana-Champaign, USA.* Quantitative phase imaging, i.e., measuring the map of pathlength shifts due to the specimen of interest, has been developing rapidly over the past decade. The main methods and exciting applications to biomedicine will be reviewed.

Room C3 & C4

JOINT

JTu3K • Symposium on Singular Light: Applications of Vortices, Orbital Angular Momentum, Bessel and Airy Beams III: Light with Singularities: Properties and Applications—Continued

JTu3K.3 • 17:15

Laser Induced Macroscopic Vortices in a Gas, Uri Steinitz[1], Yehiam Prior[1], Ilya S. Averbukh[1]; *[1]Department of Chemical Physics, Weizmann institute, Israel.* Laser induced unidirectional molecular rotation is shown to give rise to macroscopic flow and rotational vortices which last orders of magnitude longer than the collision time or the laser pulse duration.

JTu3K.4 • 17:30

Grating-Induced Vortices in Photonic Crystal Fiber: a pathway to ultra-high temperature sensing, Jeffrey Demas[1], Michael D. Grogan[1], Thomas Alkeskjold[2], Siddharth Ramachandran[1]; *[1]Electrical and Computer Engineering, Boston University, USA; [2]NKT Photonics, Denmark.* We demonstrate vortex generation in a PCF, enabled by a micro-bend grating produced by structural deformations alone. The grating-resonance is stable at temperatures exceeding 1000 C, yielding a platform for realizing ultra-high-temperature sensors.

JTu3K.5 • 17:45

Accelerating femtosecond pulses along highly non-paraxial circular trajectories, Amaury Mathis[1], Francois Courvoisier[1], Luc Froehly[1], Luca Furfaro[1], Remo Giust[1], Maxime Jacquot[1], Pierre-Ambroise Lacourt[1], John M. Dudley[1]; *[1]FEMTO-ST Institute, University of Franche-Comte, France.* We report experimental acceleration of 100 fs pulses along 60° arc circular trajectories, the highest degree of beam acceleration reported to date. We show that temporal pulse shape is preserved along the main intensity lobe.

Marriott San Jose Salon I & II

CLEO: Applications & Technology

ATu3L • Laser Micro Processing—Continued

ATu3L.3 • 17:15

Femtoprint: A femtosecond laser printer for micro- and nano-scale systems, Yves Bellouard[1]; [1]*Eindhoven University of Technology, Netherlands.* The Femtoprint project develop a printer for micro-/nano- scale systems. Femtoprint provides users with the capability of producing their own micro-systems, in a rapid-manner without the need for expensive infrastructures and specific expertise.

ATu3L.4 • 17:30

Laser Fabrication of Non-Tapered Deep Micro Holes: Strategies and Working Tools, David Ashkenasi[1], Norbert Mueller[1], Andreas Lemke[1], Tristan Kaszemeikat[1], Matthias Schmidt[1], Daniel Jahns[1], Hans Joachim Eichler[1,2]; [1]*LMTB GmbH, Germany;* [2]*Technische Universität Berlin, Germany.* The implementation of laser processing strategies and working tools for micro cylindrical drilling at high aspect ratio is demonstrated for glasses, ceramics and metals. Laser parameters vary in wavelength, pulse width and pulse energy.

ATu3L.5 • 17:45 Invited

Inline Coherent Imaging: Measuring and Controlling Depth in Industrial Laser Processes, Paul J. Webster[1], Joe X. Yu[1], Kevin D. Mortimer[1], Nathan P. Hoffman[1], James M. Fraser[1]; [1]*Department of Physics, Engineering Physics and Astronomy, Queen's University, Canada.* Controlling depth aspects during practical laser materials processing has remained a challenge for many years. Inline Coherent Imaging is an emerging technique that may hold important answers to "deep" questions for industry and basic science.

Marriott San Jose Salon III

CLEO: Science & Innovations

CTu3M • Pulsed and Ultrafast Lasers—Continued

CTu3M.4 • 17:15

10-GHz Flat-topped Optical Frequency Comb with Ultra-broad Bandwidth, Rui Wu[1], Victor Torres-Company[1], Daniel Leaird[1], Andrew Weiner[1]; [1]*Purdue University, USA.* We present 10-GHz ultra-broadband flat-topped optical frequency comb (> 3.64-THz within 3.5-dB power variation) based on seeding a highly nonlinear fiber with transform-limited Gaussian-shaped pulse from directly generated Gaussian-shaped comb.

CTu3M.5 • 17:30

Pulsed Fiber Laser with Cross-Modulation of Laser Cavities, Vladislav V. Dvoyrin[1]; [1]*Department of Physics Faculty of Natural Sciences and Technology Norwegian University of Science and Technology (NTNU), Norway.* A novel principle of pulsed lasers is demonstrated. All-fiber low-jitter pulsed Yb-doped fiber lasers emitting pulses of 60-125 ns duration with pulse energy up to 0.55 mJ and peak power up to 3 kW are realized.

CTu3M.6 • 17:45

High-energy Fiber Lasers at Non-traditional Colours, via Intermodal Nonlinearities, Lars Rishøj[2,1], Yuhao Chen[1], Paul Steinvurzel[1], Karsten Rottwitt[2], Siddharth Ramachandran[1]; [1]*Electrical and Computer Engineering, Boston University, USA;* [2]*DTU Fotonik - Department of Photonics Engineering, Technical University of Denmark, Denmark.* We propose exploiting intermodal four-wave mixing for energy-scalable tuneable fiber lasers, hitherto restricted to low powers, constrained by dispersion-tailoring limitations in PCFs. Conversion over an octave, at mJ-energy-levels, appears feasible.

Marriott San Jose Salon IV

CTu3N • Spectral, Temporal & Modal Control of Semiconductor Lasers—Continued

CTu3N.4 • 17:15

High-yield Two-Section Single Mode Lasers Based on a 37th Order Surface Grating, Qiaoyin Lu[1], Weihua Guo[2], Azat Azat Abdullaev[1], Marta Marta Nawrocka[1], James O'Callaghan[3], Michael Lynch[1], Vincent Weldon[1], John F. Donegan[1]; [1]*School of Physics, Trinity College Dublin, Ireland;* [2]*Department of Electrical & Computer Engineering, University of California Santa Barbara, USA;* [3]*Tyndall National Institute, Ireland.* A high-yield two-section single-mode laser based on a 37th-order surface-grating is presented. By tuning the back section current, the laser exhibits a side-mode-suppression-ratio of upto 47dB over a temperature range from 15°C to 65°C.

CTu3N.5 • 17:30

Temporal dynamics of the two-color emission in vertical-external-cavity surface-emitting lasers, Alexej Chernikov[1], Matthias Wichmann[1], Mohammad K. Shakfa[1], Stephan W. Koch[1], Maik Scheller[2], Jerome V. Moloney[2], Martin Koch[1]; [1]*Department of Physics, Philipps-Universität Marburg, Germany;* [2]*College of Optical Sciences, The University of Arizona, USA.* We study the temporal stability of two-color emission in vertical-external-cavity surface-emitting lasers via streak-camera measurements. Dynamically stable and unstable regions are found and the dependence on the pump conditions is analyzed.

CTu3N.6 • 17:45

An All-diode Ultralow Noise 10 GHz Frequency Comb and MOPA System with 0.39 W Output Power Based on Slab-Coupled Optical Waveguide Amplifiers, Josue Davila-Rodriguez[1], Marcus Bagnell[1], Charles Williams[1], Peter Delfyett[1], Jason Plant[2], Paul W. Juodawlkis[2]; [1]*CREOL, The College of Optics and Photonics, USA;* [2]*Lincoln Laboratory, MIT, USA.* A 0.39 W, 10 GHz MOPA system based on Slab-Coupled Optical Waveguide Amplifiers (SCOWAs) is presented. The output pulse-train timing jitter (~6 fs), amplitude noise (~0.03%) and spectral bandwidth exhibit no visible degradation.

Room A1 | Room A2 | Room A3 | Room A4

CLEO: Science & Innovations

CLEO: QELS-Fundamental Science

CTu3A • Microwave Photonics: Systems—Continued

CTu3A.7 • 18:00
Characterization of parametric RF channelized receiver through time domain monitoring, Camille Bres[1], Andreas O. Wiberg[2], Sanja Zlatanovic[2], Stojan Radic[2]; [1]*EPFL, Switzerland;* [2]*UCSD, USA.* We present the characterization of a parametric RF channelized receiver with 1GHz resolution. Instantaneous analysis is demonstrated and operating margins are studied from simultaneous monitoring of five sub-channels using real-time oscilloscope.

CTu3A.8 • 18:15
Multiple Microwave Frequencies Acquiring by Photonics-Assisted Compressive Sampling, Li Yan[1], Yitang Dai[1], Kun Xu[1], Jian Wu[1], Yan Li[1], Jintong Lin[1]; [1]*State Key Laboratory of Information Photonics and Optical Communications (Beijing University of Posts and Telecommunications), China.* Multiple microwave frequencies sensing ranging from 15 to 20 GHz is reported based on compressive sampling. A maximum detection error of 150 kHz is achieved using a single ADC with analog bandwidth of 826.75 MHz.

CTu3B • Terahertz Imaging & Sensing—Continued

CTu3B.7 • 18:00
Terahertz profilometer by time-domain polarimetry, Naoya Yasumatsu[1], Shinichi Watanabe[1]; [1]*Department of Physics, Faculty of Science and Technology, Keio University, Japan.* We experimentally show that continuously changing polarity of an elliptically-polarized terahertz electric-field can be used to image a height profile of semiconductors, metals, and their hybrid samples with a depth resolution of ~1 μm.

CTu3B.8 • 18:15
THz Metrological Traceability and Suitable Detectors, Ralf Müller[1], Werner Bohmeyer[2], Karsten Lange[2], Andreas Steiger[1]; [1]*Physikalisch-Technische Bundesanstalt (PTB), Germany;* [2]*Sensor- und Lasertechnik (SLT), Germany.* PTB, the metrology institute of Germany, operates the worldwide first and still unique THz detector calibration facility traceable to SI. A project in cooperation with SLT company is dedicated to develop suitable pyroelectric THz detectors.

CTu3C • Ultra-intense Laser Technology for Next-Generation Sources —Continued

CTu3C.4 • 18:00
Temporal Contrast Degradation at the Focus of Ultrashort Pulses from High-Frequency Spectral Phase Modulation, Jake Bromage[1], Christophe Dorrer[1], Robert K. Jungquist[1]; [1]*University of Rochester, LLE, USA.*Expressions are derived for the low-intensity temporal pedestal produced by optical surface roughness within stretchers and compressors. Phase noise in the near field of a spectrally dispersed beam produces space-time coupling in the focal plane.

CTu3C.5 • 18:15
Amplification of High-Power Picosecond 10-um Pulses in Atmospheric CO2 laser, Sergei Tochitsky[1], Jeremy Pigeon[1], Dan Haberberger[1], Chan Joshi[1]; [1]Electrical Engineering, UCLA, USA**.** 3 ps pulses are amplified to >10 GW peak power in a TEA CO2 laser using ac Stark broadening. Demonstration of such broadband amplification opens opportunities for a powerful mid-IR source at a high-repetition rate.

QTu3D • Cavity QED in Solid-State Systems—Continued

QTu3D.6 • 18:00
A composite cavity QED system deepening the strong coupling regime, Yong-Chun Liu[1], Qihuang Gong[1], Yun-Feng Xiao[1]; [1]*Peking University, China.* We propose a composite cavity quantum electrodynamics system in which the resonant structure consists of a metal nanoparticle and a whispering-gallery microcavity. The system enables more than 100-fold enhancement of the cooperativity parameter.

QTu3D.7 • 18:15
Single Quantum Dot coupling to evanescently coupled Photonic Crystal Microcavities, Ranojoy Bose[1], Tao Cai[1], Glenn S. Solomon[2], Edo Waks[1,2]; [1]*Electrical Engineering, University of Maryland, College Park, USA;* [2]*Joint Quantum Institute, University of Maryland, USA.* We experimentally realize a photonic crystal microcavity-quantum dot system where a quantum dot is simultaneously coupled to evanescently coupled optical cavities with modes spectrally separated by 2.4 nm.

20:30–21:30 OSA Student Happy Hour, *Firehouse No. 1, 69 N. San Pedro Street, San Jose, CA 95110*

NOTES

Room A5 | Room A6 | Room A7

CLEO: QELS-Fundamental Science

QTu3E • Detectors II—Continued

QTu3E.7 • 18:00
Experimental Demonstration of Adaptive Tomography and Self-Calibrating Tomography, Dylan Mahler[1,2], Lee Rozema[1,2], Ardavan Darabi[1,2], Agata M. Branczyk[1,2], Joshua Combes[3], Christopher Ferrie[4], Robin Blume-Kohout[5,6], Daniel F. V. James[1,2], Aephraim Steinberg[1,2]; [1]*for Quantum Information & Quantum Control and Institute for Optical Sciences, University of Toronto, Canada;* [2]*Physics, University of Toronto, Canada;* [3]*Physics and Astronomy, University of New Mexico, USA;* [4]*Applied Mathematics, University of Waterloo, Canada;* [5]*CQuIC, University of New Mexico, USA;* [6]*Theoretical Division, Los Alamos National Lab, USA.* We experimentally demonstrate two new quantum tomography protocols, one of which provides a quadratic speedup using adaptation and the other of which enables tomography to be done even with uncalibrated measurement devices.

QTu3E.8 • 18:15
Increased Maximum Count Rates in Single-photon Avalanche Diodes with Ultrafast Active Quenching, Michael Wayne[2,1], Paul G. Kwiat[2], Joshua Bienfang[1], Alessandro Restelli[1]; [1]*National Institute of Standards and Technology, USA;* [2]*Physics, University of Illinois at Urbana Champaign, USA.* We demonstrate ultrafast active-quenching techniques in a silicon single-photon avalanche diode, and observe an order of magnitude reduction in afterpulsing, a factor of 1.8 reduction in diode recovery time, and increased maximum count rates.

QTu3F • Terahertz Metamaterials—Continued

QTu3F.7 • 18:00
Sub-diffraction-limit resonators operating on the fundamental monopolar resonance: application to THz polaritons, Elodie Strupiechonski[1], Gangyi Xu[1], Aaron M. Andrews[2], Yanko Todorov[3], Carlo Sirtori[2], Gottfried Strasser[2], Aloyse Degiron[1], Raffaele Colombelli[1]; [1]*Photonique, Institut d'Electronique Fondamentale, France;* [2]*Institute for Photonics, Technical University of Vienna, Austria;* [3]*Laboratoire "Materiaux et Phenomenes Quantiques", Université Diderot-Paris 7, France.* We demonstrate resonators operating on the fundamental monopolar resonance with a size considerably below the optical diffraction limit in all 3 dimensions. Maximum confinement is obtained for 13micron diameter resonator at 272 micron wavelength.

QTu3F.8 • 18:15
Radiation Modeling of Terahertz Transmission-Line Metamaterials, Philip Hon[1], Amir Tavallaee[1,2], Zhijun Liu[1,2], Benjamin Williams[1,2], Tatsuo Itoh[1]; [1]*Department of Electrical Engineering, UCLA, USA;* [2]*California Nanosystems Institute, UCLA, USA.* The cavity antenna model is applied to THz composite right/left-handed transmission-line metamaterials based upon metal-insulator-metal waveguides to predict their far-field polarization and is verified with angle-resolved reflectivity spectroscopy.

CLEO: Science & Innovations

CTu3G • Broadband Pulse Synthesis—Continued

CTu3G.6 • 18:00
Nearly-octave, sub-two-cycle, CEP-locked, intense IR pulses from BIBO OPCPA using 810-nm pump pulses, Nobuhisa Ishii[1], Kenta Kitano[1], Keisuke Kaneshima[1], Teruto Kanai[1], Shuntaro Watanabe[2], Jiro Itatani[1]; [1]*Institute for Solid State Physics, University of Tokyo, Japan;* [2]*Research Institute for Science and Technology, Tokyo University of Science, Japan.* We report on the generation of 8.2-fs, CEP-stabilized, 0.52-mJ pulses at 1 kHz with a nearly octave spectrum around 1500 nm based on optical parametric chirped-pulse amplification using BiB_3O_6 and 810-nm pump.

CTu3G.7 • 18:15
Toward complete space-time reconstruction of light pulses., Eugene Frumker[1,2], Gerhard Paulus[2], Hiromichi Niikura[3], Andrei Naumov[3], David M. Villeneuve[3], Paul B. Corkum[3]; [1]*Max-Plank Institute of Quantum Optics, Germany;* [2]*Texas A&M University, USA;* [3]*JASLab, Canada.* We introduce generic approach for complete space-time characterization of the light pulses. Measured spectrally resolved wavefront across one plane and knowledge of temporal profile at one point allow complete space-time reconstruction of the pulse.

20:30–21:30 OSA Student Happy Hour, *Firehouse No. 1, 69 N. San Pedro Street, San Jose, CA 95110*

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Room A8

CLEO: QELS-Fundamental Science

QTu3H • XUV and X-Ray Attosecond Sources and Applications—Continued

QTu3H.7 • 18:00
Sub-cycle AC Stark Shift, Michael Chini[1], Baozhen Zhao[2], He Wang[2], Yan Cheng[2], Suxing Hu[3], Zenghu Chang[1]; *[1]University of Central Florida, USA; [2]Kansas State University, USA; [3]University of Rochester, USA.* By probing the optical Stark shifts induced by a few-cycle laser field using isolated attosecond pulses in a transient absorption scheme, we uncover a sub-cycle-laser-induced AC Stark shift in excited states of the helium atom.

QTu3H.8 • 18:15
Carrier Envelope Phase effects in strong field ionization of Xe with few-cycle 1.8µm laser pulses, Bruno E. Schmidt[1], Max Sayler[3], Max Möller[3], Andrew D. Shiner[2], Giulio Vampa[2], David M. Villeneuve[2], François Légaré[1], Gerhard Paulus[3], Paul B. Corkum[2]; *[1]ALLS - INRS, Canada; [2]NRC - Joint Laboratory for Atto-Second Science, University of Ottawa, Canada; [3]Institut für Optik und Quantenelektronik, Germany.* Stereo above threshold ionization in xenon was studied with CEP stable few-cycle IR laser pulses. Strong CEP dependence was revealed both for directly ionized and rescattered electrons from pulse durations of 2 to 5 cycles.

Room B2 & B3 / Room C1 & C2

CLEO: Science & Innovations

CTu3I • Silicon Photonics III—Continued

CTu3I.7 • 18:00
Wavelength-Tunable on-Chip True Time Delay Lines Based on Photonic Crystal Waveguides for X-Band Phased Array Antenna Applications, Che-Yun Lin[1], Amir Hosseini[1], Harish Subbaraman[2], Zheng Xue[1], Alan Wang[3], Ray T. Chen[1]; *[1]Electrical and Computer Engineering, University of Texas at Austin, USA; [2]Omega Optics, Inc, USA; [3]Electrical Engineering and Computer Science, Oregon State University, USA.* We demonstrate on-chip tunable true-time-delay (TTD) lines based on photonics crystal waveguides. Measurement results show a maximum time delay of 260pS with a 3mm PCW.

CTu3I.8 • 18:15
Energy efficient all-optical signal processing: a comparison of slow-light photonic crystals and nanowires, Chad Husko[1], Benjamin J. Eggleton[1]; *[1]CUDOS - University of Sydney, Australia.* We compare the energy performance of nanowires to slow-light photonic crystals in nonlinear optical processes. We outline the regimes where each is energy efficient suggesting a route towards energy efficient silicon integrated photonics.

CTu3J • Advanced Microscopy—Continued

CTu3J.6 • 18:00
Label-free second harmonic generation holographic imaging of biological specimens at speeds up to 1000 volumes per second, David Smith[1], David G. Winters[1], Randy Bartels[1]; *[1]Colorado State University, USA.* High-speed 3D images of biological tissues are captured with a label-free second harmonic generation holographic microscope. Speeds of up to 1000 image volumes per second are achieved and 3D particle tracking is demonstrated.

CTu3J.7 • 18:15
Measuring Photon Statistics with Live Photoreceptor Cells, Leonid Krivitskiy[1], Dmitri Bessarab[2], Michael Jones[2], Nigel Sim[1]; *[1]Data Storage Institute, Singapore; [2]Institute of Medical Biology, Singapore.* We study the response of an isolated rod photoreceptor under stimulation by well characterized coherent and pseudo-thermal light sources. The results reveal a crucial effect of the cell photobleaching on the statistics of its response.

Room C3 & C4

JOINT

JTu3K • Symposium on Singular Light: Applications of Vortices, Orbital Angular Momentum, Bessel and Airy Beams III: Light with Singularities: Properties and Applications—Continued

JTu3K.6 • 18:00
Accelerating and diffractionless beams in optical lattices, Konstantinos Makris[1,2], Ramy El-Ganainy[3], Xinyuan Qi[4,5], Zhigang Chen[4,6], Demetrios N. Christodoulides[7]; *[1]Materials Science and Technology Department, University of Crete, Greece; [2]Institute for Theoretical Physics, Vienna University of Technology, Austria; [3]Physics Department, University of Toronto, Canada; [4]Physics and Astronomy Department, San Francisco State University, USA; [5]Physics Department, Northwest University, China; [6]TEDA Applied Physics School, Nankai University, China; [7]College of Optics and Photonics, University of Central Florida, USA.* We show that only in a unique class of z-dependent lattices a true accelerating and diffractionless beam (different from Airy) can exist. Such beams are also possible under nonlinear conditions as exact traveling lattice solitons.

JTu3K.7 • 18:15
Transfer of Topological Charges in an Electromagnetically Induced Transparency Solid, Zhaohui Zhai[1], Jingjun Xu[1], Guoquan Zhang[1]; *[1]The MOE Key Laboratory of Weak Light Nonlinear Photonics, School of Physics and TEDA Applied Physics School, Nankai University, China.* Transfer of topological charges associated with optical vortices was experimentally demonstrated in a Pr3+:Y2SiO5 crystal through light pulse storage and retrieval technique based on electromagnetically induced transparency effect.

20:30–21:30 OSA Student Happy Hour, *Firehouse No. 1, 69 N. San Pedro Street, San Jose, CA 95110*

NOTES

Tuesday, 8 May

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

CLEO: Applications & Technology

CLEO: Science & Innovations

ATu3L • Laser Micro Processing—Continued

CTu3M • Pulsed and Ultrafast Lasers—Continued

CTu3N • Spectral, Temporal & Modal Control of Semiconductor Lasers—Continued

CTu3M.7 • 18:00
All-fiber 10-GHz Picosecond-Pulse Generation at 1.9 µm without Mode-locking, James van Howe[1]; [1]*Physics and Astronomy, Augustana College, USA.* I generate 3.6 ps 10-GHz pulses at 1877 nm in an all-fiber package without mode-locking. To the best of my knowledge, this shows the highest repetition rate for all-fiber ultrafast pulse generation near 2.0 µm.

CTu3N.7 • 18:00
Phase Locking Large Arrays of Lasers, Nir Davidson[1], Micha Nixon[1], Eitan Ronen[1], Moti Fridman[1], Asher Friesem[1]; [1]*Weizmann Institute of Science, Israel.* Experimental realization for phase-locking large arrays of lasers arranged in a variety of 2D geometries is presented. Using our degenerate-cavity coupling between lasers is easily controlled giving rise to a variety of intriguing phase structures.

ATu3L.6 • 18:15
Comparative ultrafast laser source study for advanced materials processing, Martin Delaigue[1], Clemens Hönninger[1], Remi Torres[2], Anne Lidolff[2], John Lopez[2,3], Charly Loumena[2], Rainer Kling[2], Eric Mottay[1], Antoine Courjaud[1]; [1]*Amplitude Systèmes, France;* [2]*Alphanov, France;* [3]*Celia, France.* We have realized high-power mJ-range Yb:YAG-based thin-disk regenerative amplifiers of different pulse duration from 850fs to 30ps. These sources have been used for a comparative study of material ablation and the various results are presented.

CTu3M.8 • 18:15
An Active Feedback Pulse Shaping Technique with Spectral Phase and Intensity Modulation to Generate Transform Limited, Parabolic Pulses for CPA systems, Dat Nguyen[1], Mohammad Umar Piracha[1], Kyungbum Kim[2], Mathew Hamamoto[2], Michael M. Mielke[2], Peter Delfyett[1]; [1]*College of Optics and Photonics, USA;* [2]*Raydiance Inc, USA.* A first demonstration of fiber based CPA system with an active feedback loop utilizing spectral phase and intensity modulation to generate clean, high contrast, 10 dB pedestals suppression, transform limited pulse with parabolic intensity profile.

CTu3N.8 • 18:15
On-chip coherent combining of angled-grating broad-area diode lasers, Yunsong Zhao[1,2], Lin Zhu[1,2]; [1]*Department of Electrical and Computer Engineering, Clemson University, USA;* [2]*Center for Optical Materials Science and Engineering Technologies, Clemson University, USA.* Simultaneous modal control and on-chip coherent combining of broad-area diode lasers have been demonstrated in a novel laser structure which can be extended to a monolithic coherently combined laser array for high-power high-brightness applications.

20:30–21:30 OSA Student Happy Hour, *Firehouse No. 1, 69 N. San Pedro Street, San Jose, CA 95110*

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