CLEO: 2012

Laser Science to Photonic Applications

Technical Conference: 6-11 May 2012

Expo: 6-11 May 2012

Short Courses: 6-8 May 2012

Baltimore Convention Center, Baltimore, Maryland, USA

Applications in ultrafast lasers, nanophotonics, biophotonics, sensing among hot topics

SAN JOSE, May 14—CLEO: 2012,concluded in San Jose last week after six days of technical and business programming highlighting the latest research and developments in the fields of lasers and electro-optics. Attendees heard presentations on ultrafast lasers, OCT, optical sensing, and nanophotonic devices from some of the top scientists, engineers, and business people around the world.

High-Quality Technical Programming

The week kicked off with a special tribute symposium to the late laser pioneer Anthony Siegman, which featured talks on unstable laser cavities, speckle, and Siegman's founding contributions to the field of quantum nonlinear optics. It was one of seven special symposia at the conference, ranging in topics from quantum engineering to space optical systems.

The ubiquity of lasers in research and applications was evident in the more than 1,800 technical presentations in three core areas. The CLEO: Applications & Technology track included a presentation on the development of a small, flexible endoscope fitted with a femtosecond laser "scalpel" that can remove diseased or damaged tissue while leaving healthy cells untouched. Under the CLEO: Science & Innovations program, researchers demonstrated a counterintuitive concept: solar cells should be designed to be more like LEDs, able to emit light as well as absorb it. The CLEO: QELS Fundamental Science track featured research from French and Canadian scientists who developed a new method to study electron motion using isolated, precisely timed, and incredibly fast pulses of light.

Leading Speakers

Plenary session speakers also represented the breadth of the conference topics, with the University of Ottawa's Bob Boyd speaking on nonlinear optics and Steve DenBaars of the University of California Santa Barbara representing the applications side by discussing the state-of-the-art in gallium nitride LEDs. France's Mathias Fink delivered a fascinating presentation on time-reversed waves and subwavelength focusing, while IBM's Yurii Vlasov gave attendees a glimpse into the future of datacenters and supercomputers as it relates to silicon nanophotonics.

Industry Buzz

CLEO: Expo featured 300 participating companies as well as the launch of the new "Technology Playground," where attendees had the opportunity to interact directly with exhibiting company products and view hands-on demos. Market Focus programming on the show floor featured speakers on topics such as materials processing for the auto and heavy machines industry to advances in femtosecond surgery for vision correction. The Technology Transfer Program highlighted entrepreneurs and researchers at start-ups, major universities, businesses and national labs presenting new technologies that are ready and available for commercialization.

The hard work of the CLEO volunteer committees is reflected in the full range of topics covered at CLEO: 2012, providing attendees with exclusive access to a premier set of scientific, business and networking programs in the field of optics and photonics. Mark your calendars for next year as CLEO returns to San Jose for CLEO: 2013, June 9 - 14.

Conference Program

The CLEO: 2012 conference program covers cutting edge topics presented under CLEO: QELS – Fundamental Science and CLEO: Science & Innovations' complete and up-to-date technical curriculum as well as this year's expanded Applications & Technology programming.

Hear breakthrough research during five days of in-depth technical sessions and network at key events like the Plenary Session and more.

Abstracts

- Monday, 7 May (pdf)
- Tuesday, 8 May (pdf)
- Wednesday, 9 May (pdf)
- Thursday, 10 May (pdf)
- Friday, 11 May (pdf)

Agenda of Sessions and Key to Authors and Presiders

- Agenda of sessions (pdf)
- Key to Authors & Presiders (pdf)

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CLEO: 2012 Invited Speakers

CLEO: QELS - Fundamental Science 1: Quantum Optics of Atoms, Molecules and Solids

Tutorial Speaker

Coherent Control of Cold Matter Waves, Ennio Arimondo; *Università di Pisa, Italy*

Invited Speakers

Anderson Metal-insulator Transition with the Atomic Kicked Rotor, Dominique Delande; *Université Pierre et Marie Curie, France*

Cavity QED with Fiber Cavities: From Atoms to Quantum Well Excitons, Jakob Reichel; *Université Pierre et Marie Curie, France*

Optomechanics with Ultracold Atoms and SiN Membranes, Matthew Rakher; *Universität Basel, Switzerland*

CLEO: QELS - Fundamental Science 2: Quantum Science, Engineering and Technology

Tutorial Speaker

Toward Quantum Computing with Oscillators, Olivier Pfister; *Univ. of Virginia, Physics Department, USA*

Invited Speakers

Diamond in Glass, a New Platform for Quantum Photonics, Andrew Greentree; *Univ. of Melbourne, Australia*

Entangling the Motion of Diamonds at Room Temperature, Michael Sprague; *University of Oxford, United Kingdom*

Quantum-Coherent Coupling of a Mechanical Oscillator to an Optical Cavity Mode, Ewold Verhagen; *EPFL, Switzerland*

Single-Photon Switches, Prem Kumar; *Northwestern Univ., USA*

CLEO: QELS - Fundamental Science 3: Metamaterials and Complex Media

Tutorial Speaker

Defining New Optics with Metamaterials, David R. Smith; *Duke Univ., USA*

Invited Speakers

Broadband Birefringent Metainterfaces, Nanfang Yu; *Harvard University, USA*

Nonlocal Optical Phenomena in Metamaterials, Viktor A. Podolskiy; *Univ. of Massachusetts Lowell, USA*

Purcell Effect, Surface Modes and Nonlocality in Hyperbolic Metamaterials, Pavel Belov; *Queen Marry Univ. of London, UK*

Strain-induced Band Gap and Effective Magnetic Field in Photonic Crystals, Mikael Rechtsman; *Technion - Israel Institute of Technology, Israel*

CLEO: QELS - Fundamental Science 4: Optical Interactions with Condensed Matter and Ultrafast Phenomena

Invited Speakers

Direct Photoluminescence Observation of the Negative Bogoliubov Branch in an Exciton-polariton Condensate, Tomoyuki Horikiri; *National Institute of Informatics, Stanford, Japan*

Photoinduced Phase Transitions in Strongly Correlated Electron Systems, Shin-ya Koshihara; *Tokyo Institute of Technology, Japan*

Quantum Coherence Controls the Charge Separation in a Prototypical Artificial Light Harvesting System, Sarah Falke; *University Oldenburg, Germany*

Ultrafast Dynamics and Coherent Control in Graphene, Theodore Norris; *Univ. of Michigan, USA*

CLEO: QELS - Fundamental Science 5: Nonlinear Optics and Novel Phenomena

Tutorial Speaker

Microcavity Polaritons: Quantum Fluid Phenomena and Optoelectronic Applications, Alberto Bramati; *Laboratoire Kastler Brossel, Université Pierre et Marie Curie, Ecole Normale Supérieure et CNRS, Paris, France*

Invited Speakers

Bloch Oscillations, Landau–Zener Tunneling and Fractal Patterns in a Discrete Fiber Network, Alois Regensburger; *University Erlangen-Nuremberg, Max Planck Institute for the Science of Light, Germany*

Demonstration of Temporal Cloaking, Moti Fridman; *Cornell University, United States*

Photon Extrabunching in Twin Beams Beams in the Femtosecond Range Measured by Two-Photon Counting in a Semiconductor, Antoine Godard; *ONERA - the French Aerospace Lab, France*

Quantum Phenomena in Laser-Written Waveguide Arrays, Alex Szameit; *Univ. of Jena, Germany*

Reversal of Photon Scattering Decoherence, Roee Ozeri; *Weizmann, Israel*

Towards Optical Manipulation of Casimir Force using Free-standing Membranes with Engineered Optical and Mechanical Properties, Eiji Iwase; *Harvard University, USA*

CLEO: QELS - Fundamental Science 6: Nano-Optics and Plasmonics

Tutorial Speaker

Surface Plasmon Circuitry in Opto-Electronics, Alain Dereux; *Universite de Bourgogne, France*

Invited Speakers

Coherent Light Emission from Planar Plasmonic Metamaterials, Giorgio Adamo; *University of Southampton, UK*

Infrared Nanophotonics, Rainer Hillenbrand; *CIC nanoGUNE, Spain*

Magnetic Light-Matter Interactions: Quantifying and Exploiting Magnetic Dipole Transitions, Rashid Zia; *Brown Univ., USA*

Parallel Laser Printing of Nanoparticles, Spas Nedev; *LMU Munich, Germany*

Plasmon Induced Transparency with Asymmetric π-Shaped Metamaterials, Arif Cetin; *Boston University, USA*

Strong Field Acceleration of Attosecond Electron Pulses emitted by an Individual Metallic Nanostructure, Doo Jae Park; *University of Oldenburg, Germany*

CLEO:QELS - Fundamental Science 7: High-Field Physics and Attoscience

Tutorial Speaker

High Harmonic Spectroscopy of Attosecond Dynamics, Misha Ivanov; *Imperial College London, UK*

Invited Speakers

Dynamics of Electron Acceleration in Plasmas, Laszlo Veisz; *Max-Planck-Institut fuer Quantenoptik, Germany*

Strong-field Effects in Solids, David Reis; *Stanford PULSE Institute, SLAC National Accelerator Laboratory MS, USA*

CLEO: Science & Innovation 1: Light-matter Interactions and Materials Processing

Tutorial Speaker

Ultrafast Laser Writing in Transparent Materials: From Physics to Applications, Peter Kazansky; *Univ. of Southampton, UK*

Invited Speakers

Energy Conversion Processes in Laser-matter Interactions, Xianfan Xu; *Purdue Univ., USA*

Improved Interband Cascade Lasers for λ = 3-5.6 μm, Jerry Meyer; *Naval Research Laboratory, USA*

Intuitive Analysis of Space-time Focusing with Double-ABCD Calculation, Charles Durfee; *Colorado School of Mines, United States*

Theory of Ultrafast Laser-matter Interactions, Baerbel Rethfield; *Univ. of Kaiserslautern, Germany*

CLEO: Science & Innovation 2: Solid-State, Liquid, Gas, and High-Intensity Lasers

Tutorial Speaker

Key Laser Technologies for Next Generation X-ray Sources, Franz X. Kärtner; *CFEL-DESY, Universität Hamburg, Germany; MIT, USA*

Invited Speakers

Applications and Performance of Epoxy-free Composite Laser Optics, Nick Traggis; *Precision Photonics Corp, USA*

Picosecond Thin-disk Amplifiers with High Average Power for Pumping Optical Parametric Amplifiers, Tom Metzger; *Max-Planck Institute for Quantum Electronics, Germany*

Reliable Laser Technology for Laser Peening Applications, Lloyd Hackel; *Metal Improvement Corp., USA*

Ultrafast Thin Disk Lasers for Intralaser Extreme Nonlinear Optics, Clara Saraceno; *ETH Zurich, Switzerland*

CLEO: Science & Innovation 3: Semiconductor Lasers

Tutorial Speaker

Physics and Applications of Quantum Dot Lasers, Peter Smowton; *Cardiff University, UK*

Invited Speakers

Electrically-pumped UV Nanowire Lasers, Jianlin Liu; *Univ. of California Riverside, USA*

High Power Extraction in (THz) Surface-emitting Lasers using Type-II Photonic Heterostructures, Raffaele Colombelli; *Universite Paris-Sud, France*

Metal-Cavity Quantum-Dot Surface-Emitting Microlaser, Chien-Yao Lu; *University of Illinois at Urbana-Champaign, USA*

Ultra-Low Threshold and High Speed Electrically Driven Photonic Crystal Nanocavity Lasers and LEDs, Jelena Vuckovic; *Stanford Univ., USA*

CLEO: Science & Innovation 4: Nonlinear Optical Technologies

Tutorial Speaker

Light Filaments: An Intricate Case of Light Matter --- Matter-Light Interaction, Jean-Claude Diels; *Univ. of New Mexico, USA*

Invited Speakers

Development of Periodically Oriented Gallium Nitride, Jennifer Hite; *U.S. Naval Research Lab, USA*

Giant Enhancement of Stimulated Brillouin Scattering in the Sub-wavelength Limit, Peter T. Rakich; *Sandia National Lab, USA*

Mid-IR Frequency Comb Based on Subharmonic GaAs OPO, Konstantin Vodopyanov; *Stanford Univ., USA*

Nonlinear Optical Functions of Photonic Crystals for Ultralow-power Photonic Processing, Masaya Notomi; *NTT Basic Research Lab, Japan*

Observation of Brillouin Cooling, Gaurav Bahl; *University of Michigan, USA*

CLEO: Science & Innovation 5: Terahertz Technologies and Applications

Tutorial Speaker

Waveguides for Pulsed Terahertz Radiation, Daniel Mittleman; *Rice Univ., USA*

Invited Speakers

Controlling Superconductivity with Strong Terahertz Fields, Matthias Hoffman; *Univ. of Hamburg – CFEL, Germany*

High Field THz Pulse Generation and Nonlinear THz Dynamics, Frank Hegmann; *Univ. of Alberta, Canada*

Near-Infrared Metal Nanoantennas for Femtosecond Quantum Optics, Rudolf Bratschitsch; *Technical Univ. of Chemnitz, Germany*

CLEO: Science & Innovations 6: Optical Materials, Fabrication and Characterization

Tutorial Speaker

Nonlinear Optics in Crystalline and Amorphous Silicon-on-Insulator, Roel Baets; *Ghent Univ. - IMEC, Belgium*

Invited Speakers

Delayed Fluorescence by Reverse Intersystem Crossing and Applications to Organic Light-Emitting Diodes, Kenichi Goushi; *Kyushu Univ., Japan*

Nonlinear and Quantum Optics in Mesoscopic Photonic Lattices, Chee Wei Wong; *Columbia Univ., USA*

Trapping the Light Fantastic, Diederik Wiersma; *European Lab for Nonlinear Spectroscopy (LENS) and CNR-INO Complex Photonics Group, Italy*

CLEO: Science & Innovation 7: Micro- and Nano-Photonic Devices

Tutorial Speaker

Hybrid III-V Semiconductor/Silicon Nanolaser, Fabrice Raineri; *Laboratoire de Photonique et de Nanostructures-CNRS-Marcoussis, France*

Invited Speakers

Heralded Single Photons from a Silicon Nanophotonic Chip, Jun Rong Ong; *University of California San Diego, USA*

Hollow-core Photonics for Optofluidics and Atom Photonics, Holger Schmidt; *UC Santa Cruz, USA*

Microresonator-based Optical Frequency Combs, Tobias Kippenberg; *Ecole Polytechnique Federale de Lausanne (EPFL) and Max Planck Inst. of Quantum Optics (MPQ), Switzerland*

Optomechanical Crystals for Quantum Photon and Phonon Circuits, Oskar Painter; *California Institute of Technology, USA*

Quantum Electrodynamics with Nanophotonic Devices, Peter Lodahl; *Univ. of Copenhagen, Denmark*

Quantum Optics with Quantum Dots in Photonic Nanowires, Jean-Michel Gerard; *CEA/INAC/SP2M, France*

CLEO: Science & Innovation 8: Ultrafast Optics, Optoelectronics and Applications

Tutorial Speaker

Ultrashort Coherent Light Sources: From Femtosecond to Attosecond, Chang Hee Nam; *KAIST, South Korea*

Invited Speakers

A Laser Front End for Ultra-Intense OPCPA, Jake Bromage; *University of Rochester, USA*

High Repetition Rate Frequency Combs: Ultrafast Optics Starting with Continuous-wave Lasers, Andrew Weiner; *Purdue Univ., USA*

Reliable Carrier-Envelope Phase Control for Current and Future Attosecond Experiments, Fabian Lücking; *Femtolasers Produktions GmbH, Austria*

Soliton Control by Saturable Absorber with Complex Recovery, Oleg Okhotnikov; *Optoelectronics Research Centre, Finland*

CLEO: Science & Innovation 9: Components, Integration, Interconnects and Signal Processing

Tutorial Speaker

Single-chip Integrated Transmitters and Receivers, Larry Coldren; *University of California, Santa Barbara, USA*

Invited Speakers

Silicon Photonic Integrated Circuits, Subal Sahni; *Luxtera Inc., USA*

The Foundry Model for Silicon Photonics – Technology, Challenges, and Opportunities, Patrick (Guo-Qiang) Lo; *Nano Electronics & Photonics, Institute of Microelectronics, AStar, Singapore*


Ultra-fast Photodetectors, Bach Heinz-Gunter; *Henrich Hertz Institute, Fraunhofer Germany*

CLEO: Science & Innovation 10: Biophotonics and Optofluidics

Tutorial Speaker

ePetri: High Resolution Lensless Microscopy Solution for Petri Dish Applications, Changhuei Yang; *Caltech, USA*

Invited Speakers

In Vivo Multi-Harmonic Generation Biopsy of Human Skin and Mucosa, Chi-Kuang Sun; *National Taiwan Univ., Taiwan*

Integrated Lasers for Polymer Lab-on-a-Chip Systems, Timo Mappes; *Karlsruhe Institute of Technology, Germany*

Quantitative Phase Imaging in Biomedicine, Gabriel Popescu; *University of Illinois, Urbana-Champaign, USA*

CLEO: Science & Innovation 11: Fiber, Fiber Amplifiers, Lasers and Devices

Tutorial Speaker

Modelocked Fiber Lasers, Past Present and Future, Martin Fermann; *IMRA America Inc., USA*

Invited Speakers

Low Loss Photonic Crystal Fiber Fabricated by Slurry Casting Method, Tamotsu Yajima; *Kohoku Kogyo Co. Ltd., Japan*

Metamaterials Fabricated by Drawing, Simon Fleming; *Univ. Sydney, Australia*

Modeling and Power Scaling of Carbon-Nanotube Mode-Locked Fiber Lasers, Norihikon Nishizawa; *Nagoya Univ., Japan*

Photonic Microcell: A Revival Tool for Gas Lasers, Fetah Benabid; *Xlim Research Institut, and Univ. of Bath, France*

Stimulated Brillouin Scattering in Specialty Optical Fibers: Importance of Material, Structure and Manufacturing Parameters, Yves Jaouen; *Telecom ParisTech, France*

Ultra-Low-Crosstalk Multi-Core Fiber Realizing Space-Division Multiplexed Ultra-Long-Haul Transmission, Tetsuya Hayashi; *Sumitomo Electric Industries, Ltd., Japan*

CLEO: Science & Innovation 12: Lightwave Communications and Optical Networks

Tutorial Speaker

Modulation and Coding Techniques, and Optical Networking Technologies Enabling Multi Terabit Bandwidth Delivery, Milorad Cvijetic; *Univ. of Arizona, USA*

Invited Speakers

Coherent Reception of 80 GBd QPSK using Integrated Spectral Slice Optical Arbitrary Waveform Measurement, Nicolas Fontaine; *Alcatel-Lucent, University of California, USA*

Design and Modeling of Novel Fibers for Space Division Multiplexing, John Fini; *OFS Labs, USA*

Nyquist Frequency Division Multiplexing for Optical Communications, Rene Schmogrow; *KIT, Germany*

The Age of Optical Coherent Communication, Kuang-Tsan Wu; *Infinera, Canada*

CLEO: Science & Innovation 13: Active Optical Sensing

Tutorial Speaker

Frequency Comb Spectroscopy from Mid-Infrared to Extreme Ultraviolet, Jun Ye; *NIST and Univ. of Colorado, USA*

Invited Speakers

Adaptive Dual-comb Spectroscopy with Free-running Lasers and Resolved Comb Lines, Antonin Poisson; *Université Paris-Sud, Max Planck Institut fur Quantenoptik, France*

Photochemical Microreactors in Photonic Crystal Fibers, Ana Cubillas; *Max Planck Institute for the Science of Light, Germany*

Realization of Nano-Strain-Resolution Fiber Optic Static Strain Sensor for Geo-Science Applications, Zuyuan (Joey) He; *The Univ. of Tokyo, Japan*

CLEO: Science & Innovation 14: Optical Metrology

Tutorial Speaker

Ultra-Stable Cavities, Mark Notcutt; *Stable Lasers Systems, USA*

Invited Speakers

New Determination of the Fine Structure Constant and Test of Quantum Electrodynamics, Rym Bouchendira; *Laboratoire Kastler Brossel, Université Pierre et Marie Curie, Ecole Normale Supérieure et CNRS, France*

Silicon-Based Frequency Combs, Alexander Gaeta; *Cornell Univ., USA*

Toward a Nuclear Optical Clock, Corey Campbell; *Georgia Tech, USA*

CLEO: Science & Innovation 15: LEDS, Photovoltaics and Energy-Efficient ("Green") Photonics

Tutorial Speaker

Tutorial on Solar Energy, Ryne Raffaelle; *Rochester Institute of Technology, USA*

Invited Speakers

GaN Based Nanorod Technology for Solid State Lighting, Andreas Waag; *TU Braunschweig, Germany*

Photonics with Graphene and Carbon Nanotubes, Andrea Ferrari; *University of Cambridge, UK*

CLEO: Applications & Technology 1: Biomedical

Tutorial Speaker

Image-Guided Spectroscopy of Cancer: Translating Optical Technology into Clinical Tools, Brian W. Pogue; *Dartmouth College, USA*

Invited Speakers

Coherence Imaging for Early Cancer Detection, Adam Wax; *Dept of Biomedical Engineering, Duke University, USA*

Full-field Oct: from a Lab Bench to a Valuable Hospital Tool, A. Claude Boccara; *Institut Langevin ESPCI-ParisTech, France*

Molecular Spectroscopy and Imaging: A Multibillion-dollar Industry Reshaping Biotech and Medicine, David Benaron; *Spectros Corporation, USA*

Recent Advances in Translating OCT into GI Endoscopy, Brett Bouma; *Wellman Center for Photomedicine, Massachusetts General Hospital, USA*

CLEO: Applications & Technology 2: Environment/Energy

Invited Speakers

Atmospheric Volatile Organic Compound Sensing with Lasers, Frank Keutsch; *University of Wisconsin, USA*

Green LEDs and Solar Cells based on ZnTe-related Materials, Tooru Tanaka; *Saga University, Japan*

Hydrogen Generation using Nitride Photoelectrodes, Kazuhiro Ohkawa; *Tokyo University of Science, Japan*

III-Nitride Optochemical Nanosensors, Martin Eickhoff; *Physikalisches Institut Justus Liebig University, Giessen, Germany*

CLEO: Applications & Technology 3: Government & National Science, Security & Standards Applications

Tutorial Speaker

Enabling Science at the Advanced Light Source X-Ray Facility, Roger Falcone; *Lawrence Berkeley National Lab (LBNL); USA*

Invited Speakers

Applications of Ultrafast Lasers, Mike Mielke; *Raydiance Inc., USA*

Non Destructive Remote Inspection for Heavy Construction, Masayuki Fujita; *Institute for Laser Technology, Osaka, Japan*

CLEO: Applications & Technology 4: Industrial

Invited Speakers

Inline Coherent Imaging: Measuring and Controlling Depth in Industrial Laser Processes, Paul J. L. Webster; *Queen's University, Canada*

Laser Based Synthesis of Nanomaterials, Alberto Salleo; *Stanford University, USA*

Laser Plasmas for Spectrochemistry, Rick Russo; *Lawrence Berkeley National Lab, USA*

Micromanufacturing and Nano Surface Functionalisation with Ultrashort Pulsed Lasers, Arnold Gillner; *Fraunhofer Institute, Germany*

Special Symposia

50th Anniversary of the Semiconductor Laser

Joint CLEO: QELS-Fundamental Science/ CLEO: Science & Innovations/ CLEO: Applications & Technology

Monday, 7 May 2012, 10:30 - 18:00

Room B2/B3, San Jose Convention Center

Symposium Organizers:

Dan Wasserman, UIUC, USA

Tom Koch, University of Arizona, USA

Seth Bank, Univ. of Texas, USA

In this Special Symposium, we will review the historical development and state-of-the-art of the semiconductor laser, which has become ubiquitous to modern society, yet remains a vibrant area of research. These 50 years have witnessed remarkable progress, with device metrics improving by 4+ orders of magnitude in many cases. We will bring together pioneers at the materials, device, and applications levels to recount the history behind the demonstrations of the first semiconductor lasers, the subsequent major milestones in semiconductor laser technology, and the current state-of-the-art of the field, as well as the future of the semiconductor laser.

Invited Speakers:

Quantum Dot Lasers, Yasuhiko Arakawa; *The University of Tokyo, Japan*

Materials Development for Semiconductor Lasers, Russel Dupuis; *Georgia Institute of Technology, USA*

Quantum Cascade Lasers, Jerome Faist; *ETH Zurich, Switzerland*

Quantum Well Lasers, Charles Henry; *Bell Laboratories, retired, USA*

Vertical Cavity Surface Emitting Lasers (VCSELs), Jack Jewell; Green VCSEL, *USA*

Telecom & DFB Semiconductor Lasers, Thomas Koch; *University of Arizona, USA*

The Double Heterostructure, Herbert Kroemer; *University of California Santa Barbara, USA* ***Nobel Prize in Physics 2000***

Invention of the Semiconductor Laser, Marshall Nathan; *IBM T.J. Watson Research Center and Univ. Minnesota, USA*

High Power Semiconductor Lasers, Don Scifres; *SDL Ventures, LLC, USA*

Semiconductor Photonic Integrated Circuits, David F. Welch; *Infinera Corporation, USA*

Antenna-Coupled Nanolasers and Nano-LEDs, Ming Wu; *University of California Berkeley, USA*

Semiconductor Lasers & OEIC's, Amnon Yariv; *California Institute of Technology, USA*

Space Optical Systems: Opportunities and Challenges

Joint CLEO: Science & Innovations/ CLEO: Applications & Technology

Wednesday, 9 May, 10:30–18:30

Room A3, San Jose Convention Center

Symposium Organizers:

Nan Yu; Jet Propulsion Lab, USA

David Caplan; MIT Lincoln Laboratory, USA

Iain Mckinnie; Lockheed Martin Coherent Technologies, USA

Modern space telescopes have advanced observational astronomy with UV, visible and infrared measurements that impact astrophysics and cosmology in profound and unforeseen ways. Laser light sources on Earth orbiters will enhance Earth gravity field and atmospheric monitoring far beyond RF- based measurements. Space-based optical interferometers will open new windows on the universe as gravity wave detection becomes possible. Nearly all spacecraft rely on solar arrays to power onboard science instruments and avionics, but degrade over time due to photochemical processes in the space environment. Each of these in-space systems requires specialized optical designs for conditions quite different from typical terrestrial environments. Pioneering optical systems have already met the challenges of in-space operation and promise greatly enhanced science measurements and operational capabilities. This symposium will present several examples of robust space optical systems carrying out a diverse range of measurements including solar power generation, high data rate optical communications, large space telescopes, Earth observing optical instruments, and future space based interferometers. Each speaker will be encouraged to focus on optical instrument design challenges unique to space operations.

Invited Speakers:

Laser Interferometry in Space for Gravitational Wave Detection and Geodesy, Karsten Danzmann; *Albert Einstein Institute: Max Planck Institute for Gravitational Physics and Leibniz University, Germany*
Design and Performance of the Herschel Space Telescope, Dominic Doyle, *The European Space Research and Technology Centre (ESTEC), Denmark*
Qualification of Lasers For NASA Space-Based Remote Sensing Missions: Applying Lessons Learned from CALIPSO to ICESat-2, Floyd Hovis; *Fibertek, Inc., USA*
Preparing for Future EO Innovations: the NASA Earth Technology Program, George J. Komar; *NASA ESTO, USA*
Space-Based Lidar Systems, Xiaoli Sun; *NASA Goddard Flight Center, USA*
Space-Based Laser Communication Systems and Future Trends, Morio Toyoshima; *NICT, Japan*

Singular Light: Applications of Vortices, Orbital Angular Momentum, Bessel and Airy Beams

Joint CLEO: QELS-Fundamental Science/ CLEO: Science & Innovations/ CLEO: Applications & Technology

Tuesday, 8 May, 11:00–18:30
Room C3/C4, San Jose Convention Center

Symposium Organizers:
Siddharth Ramachandran; Boston University, USA
Andrei Rode; Australian National University, Australia

Non-Gaussian light beams, variously called structured light beams containing phase or polarization singularities, have become one of the most widely researched topics today. The diffraction-free, and self-healing properties of Bessel beams have impacted microscopy and imaging, while beams with polarization singularities are now applied towards single molecule spectroscopy, the possibilities of nan-focusing, and perhaps even particle acceleration. On the other hand, light beams carrying orbital angular momentum (OAM) possess intriguing properties that themselves have become a field of study, especially considering that they yield a new degree of freedom for encoding information for quantum and classical networks. This symposium will bring together scientists and engineers across an array of disciplines, interested in the physics and applications of such beams. Topics to be considered would include, but not be limited to, fiber, free-space and integrated-optic generation techniques, applications to the study of the physics of light, applications to microscopy, especially bio-imaging, and technological applications such as high-power laser machining and free-space propagation.

Invited Speakers:

Direct Laser Generation and Amplification of Singular Light, Nir Davidson; *Weizmann Institute of Science, Israel*

Measuring Light's Twist, Miles Padgett; *Glasgow University, UK*

The Role Optical Angular Momentum of Light in Optical Micromanipulation, Halina Rubinsztein-Dunlop; *University of Queensland, Australia*

Using OAM Beams for Transmitting Orthogonal Data Streams, Alan Willner; *University of Southern California, USA*

Advances in High-Power Lasers and their Applications

Joint CLEO: Applications & Technology/ CLEO: Science & Innovations

Thursday, 10 May, 08:00–18:30
B2/B3 San Jose Convention Center

Symposium Organizers:

Iain Mckinnie, Lockheed Martin Coherent Technologies, USA
David Richardson, Univ. of Southampton, UK

High power lasers are increasingly emerging from the laboratory and into real applications. This symposium will focus on advances in laser technology for three specific applications areas: materials processing, defense, and national science programs. Perhaps the most mature applications are currently in the area of materials processing and, in that area, advances in the laser technology are leading to ever more precision and to an increasing range of processed materials and applications. High power lasers are also being developed for potential applications in directed energy defense missions. Impressive defense demonstrations have been conducted, and the emphasis is currently on achieving the high power levels required by using compact and highly efficient laser architectures. In the area of large national science programs, high peak and/ or average power lasers are being developed for diverse applications from laser-induced fusion to accelerators and fundamental light-matter interactions.

Invited Speakers:

Development and Application of Lasers for LIFE (Laser Inertial Fusion Energy), Mike Dunne; *Livermore National Laboratory, USA*

Raytheon Planar Waveguide Architecture for the RELI Program, Dave Filgas; *Raytheon Space and Airborne Systems, USA*

Tailored Light for High Precision Manufacturing, Duncan Hand; *Heriot-Watt University, UK*

Priorities in High Power Laser Development for Directed Energy Missions*,* Jason Marshall*; Office of the Assistant Secretary of Defense, Research and Engineering, USA*

Laser-Based Fundamental High Energy Physics, Gerard Mourou; *The Ecole Polytechnique, France*

Advances in Fiber Lasers for the Materials Processing Market, *Tim Webber; IPG Photonics Inc., USA*

Exploring the Quantum Frontiers of Communications

CLEO: QELS- Funadmental Science/CLEO: Science & Innovations

Thursday, 10 May, 08:00–18:30

Room C3/C4, San Jose Convention Center

Symposium Organizers:

Richard Hughes; Los Alamos National Lab, USA

Tom Chapuran; Telcordia, USA

Robert Jopson; Bell Labs, Alcatel-Lucent, USA

Beth Nordholt; Los Alamos National Lab, USA

The ultimate limits to communications imposed by quantum phenomena are now being probed in planned deep-space optical communications demonstrations as well as in optical fiber network test beds. At the same time the new secure communications capabilities that can be enabled by harnessing uniquely quantum phenomena are achieving a higher level of research sophistication. Large-scale optical fiber quantum communications test beds have been demonstrated in several countries, and commercial standards activities are underway. The resulting quantum communications capabilities are opening the door to new ultra-long range tests of fundamental quantum physics such as non-locality. Space-based tests of quantum mechanics and demonstrations of global scale quantum cryptography are now in the advanced planning stage. Theoretical research is leading to the emergence of wholly new cryptographic paradigms and applications, while experimental research into entanglement, teleportation, and other uniquely quantum phenomena is laying critical groundwork for the development of quantum repeaters. The proposed symposium will highlight the latest research results across the broad spectrum of theoretical and experimental quantum communications topics, from fundamental science to applications. It will bring together the optical communications, quantum cryptography, and fundamental quantum physics research communities.

Invited Speakers:

Device-independent Quantum Key Distribution, Marcos Curty; *Univ. of Vigo, Spain*

Quantum Limits in Space-to-Ground Optical Communications, Hamid Hemmati and Samuel Dolinar; *Jet Propulsion Laboratory, USA*

Quantum Random Numbers, Stefano Pironio; *Laboratoire d'Informatique Quantique, Belgium*

Information Capacities for Optical Communications: Conventional Versus Quantum Reception, Jeffrey H. Shapiro; *MIT, USA*

How to Overcome the Distance Barrier in Quantum Communication: Quantum Repeaters and Quantum Memory, Wolfgang Tittel; *University of Calgary, Canada*

Quantum Channel Capacities, Jon Yard; *Los Alamos National Lab, USA*

Quantum Engineering and Architectures

CLEO: QELS-Fundamental Science/CLEO: Science & Innovations

Wednesday, 9 May, 10:30–18:30

Room B2/B3, San Jose Convention Center

Symposium Organizers:

Bill Munro; NTT BRL, Japan

Gerard Milburn; University of Queensland, Australia

Quantum information-based research has reached a stage in which few-qubit devices are being demonstrated experimentally, and there is a growing need to consider practical engineering approaches for larger, more complex systems. From the perspective of abstract theory there have been significant developments in high-threshold error correction codes and scalable architectures, but further work will be required to connect these ideas to realistic hardware implementations. This symposium will bring the leading researchers in these areas together, highlighting key results and providing an overview of where the field needs to go.

Invited Speakers:

Transport of Trapped-Ion Qubits and Scalable Architectures, Brad Blakestad; *JQI/NIST, USA*

The Nitrogen-Vacancy Center: Controlling Quantum Registers in Diamond, Lily Childress; *Bates College, USA*

Implementing the Quantum von Neumann and RezQu Architecture with Superconducting Circuits, John Martinis; *University of California Santa Barbara, USA*

Photonic Quantum Computing, Andrew White; *University of Queensland, Australia*

Plenary Sessions

Tuesday, 8 May 2012

Nonlinear Optics: Past Successes and Future Challenges

CLEO: Science & Innovations

Robert W. Boyd, *University of Ottawa, Canada and University of Rochester, USA*

Dr. Robert W. Boyd has been an internationally recognized leading scientist in nonlinear optics for over 30 years. In 2010, he became Canada Excellence Research Chair in Quantum Nonlinear Optics and Professor of Physics at the University of Ottawa. His research interests include studies of "slow" and "fast" light propagation, quantum imaging techniques, nonlinear optical interactions, studies of the nonlinear optical properties of materials, and the development of photonic devices including photonic biosensors. Professor Boyd holds a PhD in physics from the University of California at Berkeley, and received his bachelor's degree in physics from the Massachusetts Institute of Technology. Dr. Boyd has written two books, co-edited two anthologies, published over 300 research papers, and been awarded eight patents. He is the 2009 recipient of the Willis E. Lamb Award for Laser Science and Quantum Optics. He is a fellow of the American Physical Society (APS) and of the Optical Society of America (OSA). He has also served as an APS representative and chair of the Joint Council on Quantum Electronics (joint among APS, OSA and IEEE/LEOS). Professor Boyd has served as a member of the Board of Editors of Physical Review Letters and is currently a member of the Board of Reviewing Editors of Science Magazine.

Abstract

The field of nonlinear optics is now fifty years old. We present a brief survey of past successes of this field and then analyze the equally exciting current status and future prospects of this field.

Development of nonpolar and semipolar InGaN/GaN light-emitting diodes (LEDs) and Laser Diodes

CLEO: Applications & Technology

Steven Denbaars, *University of California, Santa Barbara, USA*

Dr. Steven P. DenBaars is a Professor of Materials and Co-Director of the Solid-State Lighting and Energy Center at the University of California Santa Barbara. In 2005 he was appointed the Mitsubishi Chemical Chair in Solid State Lighting and Displays. From 1988-1991 Prof. DenBaars was a member of the technical staff at Hewlett-Packard's Optoelectroncis Division involved in the growth and fabrication of visible LEDs. Specific research interests include growth of wide-bandgap semiconductors (GaN based), and their application to Blue LEDs and lasers and high power electronic devices. This research has led to the first US university demonstration of a Blue GaN laser diode. He received a NSF Young Investigator award in 1994 and the IEEE Fellow award in 2005. He has authored or Co-authored over 600 technical publications, 250 conference presentations, and holds over 30 patents.

Steven Denbaars was elected in 2012 to National Academy of Engineering membership, one of the highest professional honors accorded an engineer.

Abstract

LEDs fabricated from gallium nitride have led to the realization of high-efficiency white solid-state lighting; a review of the unique polarization anisotropy in GaN is included for the different crystal orientations. Emphasis on nonpolar LEDs will highlight high-power violet and blue emitters and considers the effects of indium incorporation and substrate miscut. Semipolar GaN materials has enable the development of LEDs in green, and recent achievements of green laser diodes at 520nm.

Wednesday, 9 May 2012

Time-Reversed Waves and Subwavelength Focusing

CLEO: QELS – Fundamental Science

Mathias Fink, *Ecole Supérieure de Physique et de Chimie Industrielles de la Ville de Paris (ESPCI), France*

Mathias Fink is professor at the ESPCI ParisTech and the Director of the Institut Langevin. He is a member of the French Academy of Sciences and holder of the Chair of Technological innovation at the Collège de France. In 1973, he took part in the development of the first real-time medical ultrasound echographs, working in cooperation with General Electric and Philips. He then worked on the analogy existing between sound waves, quantum mechanics and optics. More recently, he has turned his attention to the development of new medical imaging techniques and time-reversal signal processing in complex and disordered propagation media. Since 2009, he has been Director of the Institut Langevin, a re-grouping of the laboratories of Waves and Acoustics and the laboratories of Physical Optics of ESPCI ParisTech.

Abstract

According to time-reversal symmetry, a broadband wave can be focused both in time and space regardless of the complexity of a scattering medium. The broadband nature of time-reversed waves distinguishes them from continuous phase-conjugated waves and allows revisiting the origin of diffraction limits, suggesting new ways to obtained subwavelength focusing for broadband signals in media made of coupled subwavelength resonators. A review of this field in ultrasound, microwaves and light will be presented.

Silicon Integrated Nanophotonics: Road from Scientific Explorations to Practical Applications

CLEO: Science & Innovations

Yurii A. Vlasov, *IBM TJ Watson Research Center, USA*

Dr. Yurii Vlasov is the Manager of Silicon Nanophotonics Department at the IBM TJ Watson Research Center. Prior to IBM, Dr. Vlasov developed semiconductor photonic crystals at the NEC Research Institute in Princeton, and at the Strasbourg IPCMS Institute, France. He also was, for over a decade, a Research Scientist with the Ioffe Institute of

Physics and Technology in St. Petersburg, Russia working on optics of semiconductors and photonic crystals. He received his MS from the University of St.Petersburg (1988) and PhD from the Ioffe Institute (1994), both in physics. Dr. Vlasov has published over 100 highly cited journal papers, filed over 30 US patents, and delivered over 150 invited and plenary talks in the area of nanophotonics. He served on numerous organizing committees of conferences on nanophotonics under OSA, IEEE, LEOS, APS, MRS, etc. Dr. Vlasov was elected a Fellow of both the OSA and the APS, as well as a Senior Member of the IEEE. He was awarded several Outstanding Technical Achievement Awards from IBM and was named a scientist of the year by the Scientific American journal. Dr. Vlasov also served for a few years as an adjunct professor at Columbia University's Department of Electrical Engineering.

Abstract

Silicon Nanophotonics enables single-chip integration of electrical circuits with optical devices scaled down to diffraction limit. Ultra-low power silicon interconnects that link racks, modules, and chips together can enable future large-scale datacenters and Exaflops supercomputers.

Market Focus

The CLEO: Market Focus program focuses on the latest trends in the photonics marketplace. CLEO: Market Focus provides a forum to discuss new products and emerging technologies and markets while also providing a networking opportunity within the high-quality atmosphere of the CLEO Conference. All presentations and discussions will be focused on the latest in photonics products and services that have been playing an important role in the industry and those that potentially hold a future business opportunity. A key feature of this forum will be the survey of market trends and market sector outlook in the selected areas.

Market Focus Chairs

Marcos Dantus; President & CEO, BioPhotonic Solutions, USA

Keshav Kumar; Senior Manager Product Marketing & Engineering, Newport Corporation, USA

BioPhotonics: Femtosecond Lasers and the Future of Vision Correction

Tuesday, 8 May 2012

10:30 - 12:30

Moderator:

Marcos Dantus, *Michigan State Univ., USA*

Professor Dantus received his Ph.D. in Chemistry (1991 Caltech) where he worked on the development of Femtochemistry, and his postdoctoral work on the development of Ultrafast Electron Diffraction under Professor Zewail (1999 Nobel Prize). He is a University Distinguished Professor of Chemistry and Physics at Michigan State University. His interests include ultrafast laser pulse theory, development and control, control of nonlinear laser-matter interactions, and biomedical imaging. Dantus has more than 160 publications, 43 invention disclosures and 28 patents related to the characterization, compression and applications of ultrashort shaped laser pulses in the areas of nonlinear optics, communications, biomedical imaging, and analytical chemistry instruments. Dantus has founded three companies and is presently serving as the President and CEO of BioPhotonic Solutions Inc, and serves on the board of advisors for the Chemical Physics Letters and the Journal of Raman Spectroscopy.

Panel Description:

The introduction of femtosecond lasers to improve vision has revolutionized refractive correction. At first, the laser was only being used to create the flap for LASIK. However, present systems cut the flap and perform the refractive correction. The most exciting development this year is the FDA approval of femtosecond lasers capable in aiding the treatment of cataracts, which requires much deeper incisions. This session will host the pioneers that have made these advances possible, discuss needed technological improvements and provide a sense of future innovations.

Speakers:

All LASER LASIK: From Pico to Femto

Arturo Chayet, MD, *Director, Codet Vision Institute, Mexico*

First surgeon to do all laser lasik, using the picosecond laser, and contributor to the pionneer work on the use of femtosecond laser in refractive surgery. He held the fellowship in Cornea and Refractive Surgery UCSD Dept Ophthtalmology in 1988 and is a Past President Mexican Society of Refractive Surgery.

Noninvasive Vision Correction using High Repetition Rate Femtosecond Lasers: A New Approach

Wayne Knox, *Associate Dean of Education and New Initiatives at the Hajim School of Engineering and Applied Sciences, Univ. of*

Rochester, USA

The use of femtosecond lasers in eye surgery for flap cutting has been a great commercial success, and femtosecond lasers are pushing into new areas of eye surgery at an impressive rate. We describe a completely different approach to vision correction wherein we use femtosecond lasers at high repetition rate to directly write 3D index of refraction corrections in a range of ophthalmic polymers, or directly into cornea or lens tissue. Our approach is to use multi-photon absorption-initiated highly localized phase transitions that occur below the threshold of tissue damage and cutting. This requires the use of high repetition rate femtosecond lasers with specialized scanning protocols to develop 3D gradient index microlens structures. We review recent device and tissue studies and discuss the requirements for OEM femtosecond lasers as well as the potential market implications of this technology.

Wayne H. Knox obtained BS (1979) and PhD degrees (1984) at The Institute of Optics , University of Rochester. He went to Bell Labs in Holmdel NJ in 1984, and in 1997 became Director of the Advanced Photonics Research Department. A Fellow of the OSA and APS, in April 2001 he returned to the Institute of Optics as Professor of Optics and served as Director until June 2011. He is also Associate Dean of Education and New Initiatives at the University of Rochester. He carries out a research program in ultrafast laser technology, and applications.

Femtosecond Technology Comes of Age in Ophthalmology

Shareef Mahdavi, *President, SM2 Strategic, USA*

During the past decade, the femtosecond laser has emerged to become widely used in refractive surgery. This process began with LASIK and now continues with cataract surgery, the two most widely performed surgical procedures (elective surgery and traditional surgery, respectively) in the US and likely worldwide. This talk will review the history of commercialization of this technology.

For 25 years, Shareef Mahdavi has worked with established and start-up device companies and medical practices to create demand for new technologies. After directing VISX's commercial launch of the laser used in LASIK (now the most widely performed elective surgery procedure), he has helped clients including Alcon, Allergan, Bausch & Lomb and Carl Zeiss. A frequent speaker and author of over 100 publications, Shareef was recognized for his work to improve the customer experience for patients as the 2011 EMA Award recipient, given annually by Experience Economy authors Pine and Gilmore. You can follow, friend, link or simply read Shareef's work by visiting www.sm2strategic.com .

Defense: Laser Interrogation for Standoff Detection of Hazardous Materials

Tuesday, 8 May 2012

14:00 - 16:00

Moderator:

Paul Pellegrino, *Team Lead Optical Devices & Sensors, U.S. Army Research Laboratory, USA*

Dr. Paul Pellegrino's officially assigned duties, for the past 11 years, have focused on the detection of hazardous material (Chemical, Biological and Explosive) for increased solider survivability. Techniques applied to these problems have been varied, but maintain an underlying theme of advanced optical transduction techniques including numerous forms of spectroscopy and optical scattering techniques. Detection techniques applied to hazardous material detection include but are not limited to the following: Photoacoustic spectroscopy, Photothermal interferometry, Surfaced Enhanced Raman Scattering, Lanthanide photoluminescence and Ultrafast Laser Spectroscopy. Currently, Dr. Pellegrino leads a 12-person team supporting these mission areas by utilization of advanced optics and materials including biology and biologically-inspired routes to sensor and electronic applications. Dr. Pellegrino is also currently involved in work in support of the CBRNE mission including active research and as a Subject Matter Expert for the Army in several topical areas including laser spectroscopy.

Panel Description:

The current defense climate has required an increase in our ability to combat terrorism in both military and civilian settings. This change in climate has also been accompanied with changes to the battlefield that presents ever-changing asymmetric threats to the modern warfighter. Threats from traditional chemical and biological warfare coupled with new threats from Toxic Industrial Chemicals and Materials (TICs and TIMs) and explosive related materials (ERMs) pose serious injury and harm to the soldier both from a human health and direct, serious injury. This increase has made rapid detection and identification of hazardous materials a priority for Military and Homeland Defense applications. Reliable real-time detection of these threats is complicated by our enemy's use of a diverse range of materials and the desire to detect these materials at safe distances. Therefore the defense community is investigating several spectroscopic techniques (e.g. ultrafast laser spectroscopy) that could be applied to ranged detection of hazardous materials. This session will provide an overview of the use of laser interrogation for these defense applications with focus on soldier and vehicle operation.

Speakers:

**The IR&D Game**

Matt Cox, *Laser Product Director, Raytheon Space and Airborne Systems, USA*

An overview of the internal investment process to mature key enabling technologies - Building the business case to pursue Remote

Sensing (Stand-off Detection) technologies utilizing LiDAR / LADAR modalities for trace residue and aerosol particulate detection projects.

Matt currently supports the Space Systems Mission Area as the Laser Product Director responsible for helping to transition SAS's leading role in passive sensors to active sensors and LADAR. Matt brings 30-years of relevant experience to the position having worked for several of the major aerospace firms, including: Hughes Aircraft; Radar Systems Group, TRW – ESG (before the Northrop Grumman acquisition), Northrop; Electronics Division (before they merged with Grumman), Rockwell International (before they were acquired by Boeing, and the Boeing Company – Lasers and Electro Optical Systems. Matt has extensive experience with COIL based High Energy Laser (HEL) systems, Beam Control Systems (BCS), laser stray radiation analysis and currently works exclusively with solid state laser media which is enabled by Raytheon's investment in Planar Wave Guide (PWG) technology for use on ground, space and airborne platforms. Matt pursued his Mechanical Engineering degree at Cal State Long Beach, and has attended several technology and management development programs at the University of Rochester, University of Madison-Wisconsin, and UCLA. Since joining Raytheon in 2001, he has held Program Management and Line Manager positions and over the last 4-years has helped grow the business by capturing new active sensor/laser programs.

**Small Business Electro-Optics Innovation in the Defense Industry – A Case Study**

Edwin Dottery, *Founder and President, Alaka 'I Defense Systems, Inc., USA*

The rise of Alakai Defense Systems, Inc. as a small business, electro-optical sensing enterprise will be discussed, with an emphasis on lessons learned about how Alakai innovated within a large bureaucracy, partnered within industry and academia, and boot-strapped their way into a research and development company with products and intellectual property without use of venture capital.

Ed Dottery is the founder and President of Alakai Defense Systems, Inc. In that position, he has overseen the company during: rapid growth, multiple state and regional awards including the Governors Entrepreneurial Award in 2008, and Tampa Bay Technology Forum's Emerging Technology company of the year 2010, many publications, patents & patents pending, and three major generations of standoff spectroscopic sensor systems. During his Army career he commanded in the Infantry and Special Forces and served on the physics faculty at West Point. He oversaw defense programs in both the Army Acquisition Corps and also for the Lockheed Martin Corporation. He is a graduate of West Point and Stanford University.

**21st Century Challenges for the Detection of CBRNE Threats**

Augustus W. Fountain III, *Senior Research Scientist - Chemistry, Edgewood Chemical Biological Center, USA*

The detection of chemical, biological, radiological, nuclear, and explosive (CBRNE) materials on surfaces without contact has been an important military concern for nearly half a century. However in today's counter-terrorism environment, new threats as well as new tactics, techniques, and procedures (TTPs) pose new challenges. In response, there has been rapid growth and significant new development in its science and technology. In parallel, there are applications in public health and safety such as detection, monitoring, and response to incidents involving toxic industrial chemicals/materials, and law enforcement applications such as detection of illicit substance manufacturing and distribution. These diverse applications are based on the same fundamentals of the science and technology of standoff chemical and biological sensing. This talk aims to provide a broad technical overview of the needs for hazardous materials detection for a 21st Century environment.

Dr. Augustus Way Fountain III is a member of the Scientific and Professional cadre of the Senior Executive Service and serves as the Senior Research Scientist for Chemistry within the Research and Technology Directorate, Edgewood Chemical Biological Center. He is responsible for planning, leading, and conducting cutting edge research in chemical defense related to the Research and Technology Directorate, Edgewood Chemical Biological Center, Department of Army, and Department of Defense missions. He is an internationally recognized expert in electro-optics as it pertains to chemical, biological, radiological, nuclear and explosives sensing and provides advice to government agencies for developing schedules and milestones for analytical chemistry and nanoscience projects to ensure appropriate emphasis on emerging technologies. Most recently Dr. Fountain deployed to Iraq as a civilian scientist, advising the CEXC labs on the forensic analysis of explosives residues. Additionally, Dr. Fountain serves as an at- large representative of the United States to the NATO Sensors & Electronics Technology Panel advising them on CBRNE detection.

Technology and Market Perspectives

Scott Roberson, *Missiles and Fire Control, Technical Operations and Applied Research Senior Manager, Lockheed Martin, USA*

The development of standoff hazardous materials detection systems for the market will be discussed. Specifically, the main focus will be on past system development and the needs for future systems to bring these systems to market. In addition, the topics of laser interrogation, detection distance, and eye safety will be addressed. A Systems perspective will be discussed in relation to deployable systems and technology needs at different standoff distances to enable hazardous detection of materials via laser interrogation.

Dr. Scott L. Roberson has focused his professional career on work with and for the DoD with leadership positions in Government, Federal Government Support and Large Prime Contractors. From 1997 - 2002, Scott was a civil servant and acted as the Team Lead for the Advanced Fuzing Team at Air Force Research Laboratory, Munitions Directorate, where he led a team of engineers and scientists developing technologies for next generation penetration fuzes. From 2002-2004, Scott worked at the Pentagon for SAF/AQR. From 2004-2008, Scott served as Client Manager SETA Services Division and as Deputy Branch Chief and Senior

Scientist, with Strategic Analysis Inc (SAINC), Arlington, Va., where he supported a new standoff detection program at DARPA-RIEDAR. Since 2008, Scott has worked at Lockheed Martin, Orlando, Fl as a Deputy Director and Senior Manager in Sensor Systems and Technology. While at Lockheed, Scott has developed and managed technical programs while growing the research portfolio in several technology areas.

**Developing Laser-Based Technologies for Detecting Explosive Materials Joint IED Defeat Organization (JIEDDO) Perspective**

Tom Stark, *Lanmark Technologies (Joint IED Defeat Organization), USA*

The Joint IED Defeat Organization (JIEDDO) has a unique role within the U.S. Department of Defense to take mature technologies and to develop them so that they can be quickly fielded. At present there are only a select few technologies that can be used to identify explosive materials at standoff distances, and among these, laser-based methods are the most mature and reliable. This presentation will discuss, JIEDDO's role within the Department of Defense technology development process. It will also discuss, at a high level, the requirements and operational constraints that must be considered in developing and fielding laser-based detection technologies for military field use.

Dr. Tom Stark holds Bachelors, Masters, and Doctor of Philosophy Degrees in Physics. Dr. Stark obtained his Bachelors Degree from Virginia Commonwealth University, and his Masters and Doctor of Philosophy Degrees from the University of North Texas. Dr. Stark's graduate research emphasized development of pulsed laser systems, their use in non-linear optical spectroscopy, and numerical modeling of non-linear optical phenomena in semiconducting materials. With over 15 years of professional experience, Dr. Stark serves as a subject matter expert in a wide range of technologies, including counter- Chemical, -Biological, and -IED technologies, Sensor and Data Fusion, Numerical Modeling of Physics-based phenomena, and Net-Centric Software Development. Dr. Stark currently serves as a Technical Program Manager at JIEDDO, managing two portfolios of counter-IED rapid technology development projects; portfolio emphases are in detecting Vehicle and Person-Borne Suicide Bombs.

Energy/Environment: Development of Cost Competitive Solar Energy

Wednesday, 9 May 2012

10:30 - 12:00

Moderator:

Tyler Morgus, *Strategic Marketing, THORLABS, USA*

Tyler Morgus received his Ph.D in physics from Lehigh University in 2002 under the direction of Dr. Alan Streater. After his graduation Tyler spent three years as a professor teaching physics at East Stroudsburg University. After which he joined Thorlabs' marketing technical marketing department where he currently holds the position of strategic marketing manager.

Panel Description:

Clean renewable energy technologies are becoming increasingly more attractive as fossil fuel costs increase and the effect on the environment from their usage becomes more pronounced. Much of the current research and development in the field of photovoltaics is focused on commercializing this technology by lowering the cost of solar energy while at the same time improving the ease with which photovoltatic solutions can be implemented. Efficiency, material costs, durability, installation requirements, and even aesthetics are all being actively addressed. For example, advances in thin-film photovoltaic cells reduce the manufacturing cost and weight of the solar panels which results in a lower cost panel that is easier to install. In this session, the speakers will present the latest advancements in photovoltaic technologies that affect the commercial viability of solar energy.

Speakers:

CIGS Thin Film PV Technology: Challenges, Potential, and Opportunities

Rommel Noufi, *Principal Scientist*, *National Center for Photovoltaics at NREL, USA*

I will review the state of CIGS technology from the laboratory to industry. I will examine the technical challenges, opportunities, and potential of CIGS solar cells for: (1) increased laboratory cell efficiencies approaching the theoretical limit of 30%, (2) reducing the gap between laboratory cell efficiencies of 20.3% and average commercial module efficiencies of 12%, and (3) reducing cost by continued improvement in deposition processes and alternative window layers.

Dr. Rommel Noufi is a Principle Scientist and Group Manager for Thin Film Photovoltaics at the National Center for Photovoltaics (NCPV), National Renewable Energy Laboratory (NREL). He leads a world-class R&D team that has held record CuInGaSe and CdTe solar cell efficiencies for 16 years. Dr. Noufi is a recognized leader in cooperative research between industry and government, and has a voice in shaping our national program on photovoltaics development. In 2008, he took a two-year leave of *absence from NREL to serve as the VP of R&D for Solopower, a start-up manufacturing flexible CIGS solar panels. Prior to joining NREL, Dr. Noufi received his PhD in Analytical/Physical Chemistry at the University of Texas at Austin and served three years as a senior scientist at Rockwell International Science Center in Thousand Oaks, CA. He is a recipient of the inaugural Distinguished Innovator Award, an Outstanding Achievement Award, and the H.M. Hubbard Award at NREL. Dr. Noufi has over 180 publications in interdisciplinary fields, and is the inventor of 9 patents, of which 6 are licensed to industry. Since 1998, he has the 3rd highest impact citations world-wide in the field of Energy and Fuels.*

Industrial: Next Generation Materials Processing Applications in the Automobile, Heavy Industry and Machine Tool Marketplace

Wednesday, 9 May 2012

14:30 - 16:30

Moderator:

Merrill M. Apter, *Vice President, Marketing and Sales, Telesis Technologies, Inc., USA*

Merrill Apter has been involved in the laser and photonics industry since 1987. He began his career at The Ensign-Bickford Aerospace Company, later working as International Sales Manager at Opto Power Corporation before having management and leadership positions at Coherent Inc., Newport Corporation and Oclaro. He currently is responsible for Sales and Business Development at Telesis Technologies, a global leader in mechanical pin stamp, scribe and laser (fiber, gas and solid state) based Product Identification, Traceability and Process Solutions. Apter earned his Bachelor of Science in Electronic Technology degree from the University of Hartford in 1984 and in 1990 earned his Masters in Business Administration degree from Rensseleaer Polytechnic Institute (RPI). Apter has published many papers in industry conferences, authored many articles for tradeshow seminars and trade magazines and been an invited speaker at several world symposiums.

Panel Description:

In today's evolving marketplace where demands of lighter weight materials and fuel efficient vehicles are now a prerequisite, laser based solutions are becoming the tool of choice for cutting, cladding, marking and engraving. Our panel of speakers will educate us as to why they concur with this, provide some examples where the laser is the optimal tool as well as provide us some insights to the future.

Speakers:

Elevating Diode Laser Technology for Direct Industrial Applications

Wolfgang Gries, *Founder and CEO, DirectPhotonics, GmbH. Germany*

Lasers have revolutionized welding and cutting application. Progress in diode laser technology gains momentum to replace established laser sources for many more applications in industrial machining. In contrast to diode bars today single emitter diodes allow for a much simpler heat-sink temperature control, high-frequency modulation and higher optical brightness. Furthermore, the wavelength variability of the diodes enable optimizing machining processes. DirectPhotonics will lead the way for the implementation of new disruptive diode laser technology for cutting and welding application with multi-kW ultra-high brightness direct diode laser systems with beam parameter products better than 7.5 mm*mrad.

Wolfgang Gries bears more than 20 years of experience in the laser business. He graduated from the Technical University of Berlin in Physics, co-founded LAR GmbH, an analytical equipment company in Berlin and founded Laser Analytical Systems LAS GmbH, which he eventually sold to Spectra-Physics. Wolfgang continued to lead the Spectra-Physics Berlin facility while he served in a strategic marketing role for Newport/Spectra Physics in the industrial manufacturing segment. In 2006 Wolfgang moved to Silicon Valley to lead the Newport/Spectra-Physics fiber laser program as well as the product development group for industrial lasers. Moving to JDSUs laser division in 2009 he was responsible for the laser R&D group developing JDSUs 4kW fiber laser product line. Back in Berlin/Germany in 2011 Wolfgang founded DirectPhotonics Industries GmbH with the objective to bring ultra-high brightness direct diode lasers to market for cutting and welding applications.

The Applications of Lasers in General Motors Direct Part Marking

Steven Jones, *GM Powertrain Laser Safety Officer & Lead Engineer for Lasers and Machine Vision, GM CETC, USA*

Today GM utilizes lasers to create unique datamatrix identification codes on many of the important internal components in GM Powertrains. Traceability strategies have proven to be powerful tools to improve quality and reduce costs.

An engineer at General Motors for more than 30 years, Steve graduated from General Motors Institute (now Kettering University) in 1986 with a degree in Electrical Engineering. Steve is currently the Lead Engineer for Machine Vision at General Motors Powertrain. In this role, Steve provides engineering guidance for traceability applications including aspects of laser marking. In 2010, he became the Laser Safety Officer for Direct Part Marking Applications assuming responsibilities for laser installations in GM Powertrain's North American operations. At the Robot Industry Association Safety Conference in 2009, Steve presented his work *on pioneering applications with safety -rated motion technology. More recently he has presented several GM applications utilizing 3-D vision at the Automated Imaging Association's International Conference for Vision Guided Robotics in 2011.*

Laser Marking for Part Traceability

Mike Kennedy, *Facilities Operations Engineer, Caterpillar, USA*

Caterpillar and its companion companies use lasers marking to give them an advantage to protect from defective parts reaching their customers. In addition laser marking is used to ensure its product work for zero defects.

Laser Marking for Traceability; The Time is NOW

Jeff Thorsen, *Market Development Manager Automotive Sector, Telesis Technologies, Inc., USA*

Individual part traceability is now required on many key components in today's high quality vehicles. These marks need to be machine readable the first time, every time, so that the valuable information can be used for continuous improvement as well as containment/recall issues. Additionally, materials used in today's vehicles are constantly changing to help meet regulations and customer requirements. As a result of laser improvements and choices, laser marking has now become the preferred choice for critical traceability marks as opposed to the last resort.

Jeff Thorsen has been involved in the automotive industry since 1992. He began his career as an application engineer working with PC and PLC controls, vision systems, non-contact gauging and marking systems. Jeff earned his Bachelor of Science in Electrical Engineer degree from the Oakland University in 1990 and in 1993 earned his Masters in Electrical and Computer Engineering. He was actively involved with the Automotive Industry Action Group (AIAG) B-17 2-D Direct Parts Marking Guideline document committee. His current responsible is for Automotive Markets Sales and Development at Telesis Technologies, a global leader in mechanical pin stamp, scribe and laser (fiber, gas and solid state) based Product Identification, Traceability and Process Solutions.

Technology Transfer Program

Thursday, May 10, 2012

The Technology Transfer Program provides a forum for entrepreneurs and researchers from start-ups, major universities, businesses and national laboratories to present exciting new technologies which are ready and available for commercialization. The Program will kick off with a Tutorial for those that want to learn more about the licensing process – funding, entrepreneurship, technology transfer and intellectual property. During the Showcase, attendees will hear from several organizations about their latest license-ready optics and photonics technologies (intellectual property from universities and laboratories) that could lead to new commercial products or improve the efficiency, durability or availability of existing components or systems. In addition, organizations will feature their license ready technologies at tabletop displays in the exhibit hall.

Keynote Presentation: Next Generation Inertial Sensors based on Atom de Broglie Wave Interferometry

Mark Kasevich, Prof. Physics and Applied Physics, Stanford University; Chief Scientist/Consulting, *AOSense, Inc*.

Over the past 20 years, atom de Broglie wave interferometers have matured from laboratory curiosities to tools for geodesy, security, and navigation. This talk will review this evolution, focusing on commercialization and technology transfer challenges.

Speaker Biography

Mark Kasevich is a Professor of Physics and Applied Physics at Stanford University. He received his B.A. degree (1985) in Physics from Dartmouth College, his M.A. (1987) in Physics and Philosophy from Oxford University and his Ph.D. (1992) in Applied Physics from Stanford University. He joined the Stanford Physics Department faculty in 1992. From 1997-2002 he was a member of the Yale Physics Department faculty. He returned to Stanford in 2002. His current research interests are centered on the development of quantum sensors of rotation and acceleration based on cold atoms (quantum metrology), application of these sensors to tests of General Relativity, investigation of many-body quantum effects in Bose condensed vapors (including quantum simulation), and investigation of ultra-fast laser-induced phenomena. Kasevich currently serves as Consulting Chief Scientist at AOSense, Inc. and as a National Security Science and Engineering Faculty Fellow.

Company Profile

AOSense, Inc. was founded in 2004 to develop cold-atom navigation sensors. Located in Sunnyvale, CA with a staff of 34, its core capability is design, fabrication and testing of sensors based on laser cooled atom technologies.

Tutorial: Technology Transfer 101: Technology Licensing and Tech Startups

The University of Arizona's Technology Transfer Methodologies for Licensing the Optics, Photonics, and Laser Industry

**Eugene R. Cochran**, Sr. Licensing Associate and Sector Director Physical Sciences, *University of Arizona*

This discussion delineates the University of Arizona's Office of Technology Transfer methodologies and efforts in transferring Optics, Photonics, and Laser related inventions. The College of Optical Sciences at the University of Arizona is one of, if not the world's premier, optical institute, with outstanding faculty members, an international student body, a challenging curriculum, pioneering research programs and close relationships with the optics industry. Given the applied nature of the program, a majority of invention disclosures and patents filed at the University of Arizona's Office of Technology Transfer relate to optical systems, interferometry, imaging, polarimetry, lasers, fiber optics, photonics, and spectroscopic related technologies. Cochcan will give a brief introduction to the College, the TTO office, the technologies we manage, as well as an overview on commercialization approaches with a specific case study.

Speaker Biography

Eugene Cochran received a B.S. in Optical Engineering from the University of Rochester, and an M.S. and Ph.D. in Optical Sciences from the University of Arizona, in 1987 and 1988 respectively. He also has obtained an M.B.A. from the University of Arizona in 1992. Cochran, an optical engineer by training specializing in optical testing and optical instrument design, has more than eight years of experience designing and developing optical systems. He has been employed on the technical staff at IBM, Perkin-Elmer, GCA/Tropel, and WYKO. Cochran has extensive technology transfer and commercialization skills having worked within the commercialization group at Research Corporation Technologies for over seventeen years. Rising to the position of Director, he was responsible for evaluating and commercializing inventions in the fields of physics, materials, scientific instrumentation, and biomedical devices - successful in licensing patents and starting companies on numerous projects in the both the physical and life sciences. He has expertise in intellectual property, licensing, business valuation, managing technology, and strategic planning for new ventures. Cochran also served in the capacity of the Administrative Director for the Center for Integrated Access Networks an NSF Engineering Research Center. He assisted the Center Director in overall management of the Engineering Research Center developing, recommending, and administering program policies and budgets. Currently, Cochran is Sr. Licensing Associate and Sector Director Physical Sciences in the Office of Technology Transfer at the University of Arizona, wherein he assists OTT professionals in the patenting and licensing of University of Arizona physical science inventions as well as spearheading efforts in biomedical device incubation.

Commercializing University Research – Lessons from the Trenches

Bob Bridge, CEO, *InView Technology Corporation*

Bob Bridge has worked in venture capital funded start-up companies since 1985, primarily in the semiconductor industry. In 2009 Bridge started his first company that had the mission of commercializing university technology. InView has licensed Compressive Sensing IP from Rice University to building high-performance infrared cameras and hyperspectral imagers. In this talk, Bridge will discuss lessons learned in 25 years of entrepreneurship, and highlights the unique aspects of university spin-outs.

Speaker Biography

Bob Bridge is currently founder and CEO of InView Technology Corporation. Bridge has been founding CEO at three technology companies, and has raised over $51M in funding since 2000. Most recently, Bridge took Zilker Labs, a power-management semiconductor start-up, from a marketing concept in 2002 to acquisition by public company Intersil in 2008. Bridge has also served as an entrepreneur-in-residence at Austin Ventures and the University of Texas, as VP of marketing at network processor start-up Agere, and as VP & General Manager at Cirrus Logic. Additionally, Bridge has worked at Motorola, AT&T and Bell Labs. He holds a Ph.D. in Electrical Engineering from the University of Texas at Austin, and a BA in Mathematical Sciences from Rice University.

Working with NASA: You Don't Have to be a Rocket Scientist

Enidia Santiago-Arce, Technology Transfer Manager, *NASA-Goddard Space Flight Center*

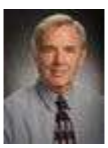
The Innovative Partnerships Office helps leverage NASA developed technologies to form mutually beneficial partnerships with entities such as other NASA centers, other government agencies, private enterprises, universities, and others. These efforts can take many forms. During the presentation Santiago-Arce will describe the partnering and licensing process and mechanisms and share some of NASA's success stories.

Speaker Biography

Enidia Santiago-Arce has worked at NASA Goddard Space Flight Center (GSFC) in Greenbelt, MD for over 10 years. She holds a B.S. in Electrical Engineering from the University of Puerto Rico- Mayaguez Campus and is currently pursuing a M.S. in Technology Commercialization from Northeastern University. Santiago-Arce currently works as a Technology Transfer Manager at the GSFC's Innovative Partnerships Office. Her role requires a background in science and technology coupled with business management skills, and intellectual property knowledge to properly manage the 300+ technologies from a variety of fields, including optical systems and wavefront sensing. In addition to managing NASA GSFC's Intellectual property portfolio, Santiago-Arce is responsible for developing partnerships, licensing technologies, and assisting with analyzing and managing program performance metrics.

Technology Transfer Showcase

Commercial Applications for NASA's 3D Laser Scanner – MILT



Joseph Lavelle, Senior research Engineer/Project Manager, *NASA Ames Research Center 3D Vision Laboratory*

Joseph Lavelle will demonstrate NASA's custom made MILT (Mold Impression Laser Tool) -- winner of NASA's Invention of the Year for 2008. MILT is a small, hand-held instrument used by maintenance crews to scan, detect, and measure Space Shuttle Tile damage. The system produces a complete 3D digital map of the tile surface within a couple of seconds, and then automatically finds and quantifies surface defects. About the size of a teapot, the MILT weighs 2.8 pounds, and wirelessly transmits flaw dimensions and location information to a laptop PC for processing and display. Several commercial companies have shown interest in licensing the MILT for their applications. These applications include inspection of oil and natural gas pipelines, aircraft fuselage surface damage, wood and lumber processing, and many others. NASA is ready to license this technology.

Speaker Biography

Joseph Lavelle is a Senior Research Engineer and Project Manager with over 30 years experience in the design and development of electronic circuits and systems. He has been with NASA Ames Research Center for the past twenty-four years, the last twelve of which have been in leading the development of 3D vision systems for NASA applications. His group has created 3D vision systems for inspection of space shuttle components and materials (including the thermal tiles), for planetary rovers, and for inspection and evaluation of the Crew Exploration

Vehicle/Orion heat shield. Lavelle received his BSEE from UC Berkeley in 1976.

Two-color Ultrashort Pulses

Shai Yefet, Ph.D. Student, Physics Department and BINA Center for Nano-technology, *Bar-Ilan University*

We present a single mode locked oscillator that emits dual-color ultrashort pulses, inherently synchronized in time and in phase. The core of the invention is a novel design of the Ti:sapphire oscillator cavity, allowing flexible control over the gain spectrum, thus steering the mode locked oscillation towards the desired two-lobed (or even multi-lobed) spectrum. With standard techniques of intra-cavity loss shaping, dual color oscillation is hard to obtain in a single oscillator, as it is inherently unstable to mode competition, and previous implementations required either extra-cavity shaping, which is inherently lossy, or synchronization of several independent sources, which is bulky and costly. Our concept of intra-cavity gain shaping offers a simple, power preserving avenue to spectrally shaped ultrashort pulses, as necessary for many applications, such as Raman spectroscopy and microscopy.

Speaker Biography

Shai Yefet received his B.Sc. in Physics from Bar-Ilan University. He received his M.Sc in molecular physics, focusing on thermodynamics and crystallization of thin films. Currently, Yefet is a Ph.D student, at Bar-Ilan University focusing on ultra fast optics and solid-state lasers.

University-technology.com – Scotland's Bright Future

Robert Goodfellow, Technology Transfer Manager, *Heriot-Watt University, Research & Enterprise Services*

University-Technology.com is a Scottish university initiative launched in 2004 as a collaborative effort to market technology licensing opportunities from Scotland's academic research base – it uniquely offers access to the latest technology opportunities from Scotland's universities in one web portal. With over 200 live technology offers, we will showcase a selection of licensable Proof of concept / prototype photonics technologies available from 19 universities, the Scottish Universities Physics Alliance (SUPA) and SU2P (Stanford University / Scottish Universities Partnership). In addition to negotiated licenses the presentation will introduce "Easy Access IP"; a royalty free license scheme currently being piloted across Scotland to increase interaction between companies and university TT offices and encourage technology led business growth.

Speaker Biography

Robert Goodfellow is Technology Transfer Manager at Heriot-Watt University (Edinburgh, Scotland, www.res.hw.ac.uk) and leads the team commercializing the university IP portfolio through licensing and spinout formation. Leading technology transfer activity in the School of Engineering & Physical Sciences and the Institute of Petroleum Engineering he has worked on licensing a diverse IP portfolio including amongst others Laser systems, MEMS/MOEM technologies, RFID, Sonar, Chemicals, Urine fuel cells and Gas Hydrate detectors.

Lensfree On-Chip Microscopy and Cytometry Tools for Telemedicine Applications

Aydogan Ozcan, Associate Professor, *University of California, Los Angeles*

Today there are more than 5 billion cell-phone users in the world, and the majority of these cellphones are being used in the developing parts of the world. This massive volume of wireless phone communication brings an enormous cost-reduction to cellphones despite their sophisticated hardware and software capabilities. Quite importantly, most of these existing cellphones are also already equipped with advanced digital imaging and sensing platforms that can be utilized for various health monitoring applications. This impressive advancement is one of the central building blocks of the emerging fields of “Telemedicine” and “Wireless Health”. The success of these fields will surely increase the quality of health care and reduce the insurance costs in developed countries like the United States, however, their most important and immediate impact will be to provide breakthrough technological solutions to various Global Health Problems including infectious diseases such as HIV, TB or malaria. Specifically, utilizing this advanced state of the art of the cell phone technology towards point-of-care diagnostics and/or microscopic imaging applications can offer numerous opportunities to improve health care especially in the developing world where medical facilities and infrastructure are extremely limited or even do not exist.

Centered on this vision, in this talk Ozcan will introduce fundamentally new imaging and detection architectures that can compensate in the digital domain for the lack of complexity of optical components by use of novel theories and numerical algorithms to address the immediate needs and requirements of Telemedicine for Global Health Problems. Specifically, Ozcan will present an on-chip cytometry and microscopy platform that utilizes cost-effective and compact components to enable digital recognition and 3D microscopic imaging of cells with sub-cellular resolution over a large field of view without the need for any lenses, bulky optical components or coherent sources such as lasers. This incoherent holographic imaging and diagnostic modality has orders of magnitude improved light collection efficiency and is robust to misalignments which eliminates potential imaging artifacts or the need for realignment, making it highly suitable for field use. Applications of this lensfree on-chip microscopy platform to high-throughput imaging and automated counting of whole blood cells, monitoring of HIV+ patients (through CD4 and CD8 T cell counting) and detection of waterborne parasites towards rapid screening of water quality will also be demonstrated. Further, Ozcan will discuss lensfree implementations of various other computational imaging modalities on the same platform such as pixel super-resolution imaging, lensfree on-chip tomography, holographic opto-fluidic microscopy/tomography. Ozcan will also demonstrate lensfree on-chip imaging of fluorescently labeled cells over an ultra wide field of view of >8 cm2, which could be especially important for rare cell analysis (e.g., detection of circulating tumor cells), as well as for high-throughput screening of DNA/protein micro-arrays.

And finally Ozcan will share stories on commercialization of this platform technology through Holomic LLC which was founded in 2011 with a business plan that covers telemedicine, science education and research instrument markets.

Speaker Biography

Aydogan Ozcan received his Ph.D. degree at Stanford University Electrical Engineering Department in 2005. After a short post-doctoral fellowship at Stanford University, he is appointed as a Research Faculty Member at Harvard Medical School, Wellman Center for Photomedicine in 2006. Ozcan joined UCLA in the summer of 2007, where he is currently an Associate Professor leading the Bio- and Nano-Photonics Laboratory at the Electrical Engineering and Bioengineering Departments.

Ozcan holds 18 issued patents and another 12 pending patent applications for his inventions in nanoscopy, wide-field imaging, lensless imaging, nonlinear optics, fiber optics, and optical coherence tomography. Ozcan is also the author of one book and the co-author of more than 220 peer reviewed research articles in major scientific journals and conferences. In addition, Ozcan is the founder and a member of the Board of Directors of Holomic LLC.

Ozcan received several major awards including the 2011 Presidential Early Career Award for Scientists and Engineers (PECASE), which is the highest honor bestowed by the United States government on science and engineering professionals in the early stages of their independent research careers. Ozcan received this prestigious award for developing innovative optical technologies and signal processing approaches that have the potential to make a significant impact in biological science and medicine; addressing public health needs in less developed countries; and service to the optical science community including mentoring and support for underserved minority undergraduate and graduate students. Furthermore, Ozcan also received the 2011 SPIE Early Career Achievement Award, the 2011 Army Research Office (ARO) Young Investigator Award, the 2010 NSF CAREER Award, the 2009 NIH Director’s New Innovator Award, the 2009 Office of Naval Research (ONR) Young Investigator Award, the 2009 IEEE Photonics Society (LEOS) Young Investigator Award and the MIT’s Technology Review TR35 Award for his seminal contributions to near-field and on-chip imaging, and telemedicine based diagnostics.

Ozcan was also selected as one of the top 10 innovators by the U.S. Department of State, USAID, NASA, and NIKE as part of the LAUNCH: Health Forum organized in October 2010.

Ozcan is a Senior Member of IEEE and SPIE, and a member of LEOS, EMBS, OSA, and BMES.

http://innovate.ee.ucla.edu//prof.-ozcan-brief-biosketch.html

Spectrifire: Measure Your Universe

Dominic Murphy, CEO Founder, *Fusion Photonics Ltd.*

Waterford, Ireland is steeped in a long, prestigious and illustrious history of glass fabrication and glass forming. Waterford Crystal is renowned worldwide for its artistic expression of function and form through the working and fusing of glass. Now, researchers at the Waterford Institute of Technology (WIT) are using glass micro- and nano-forming techniques to invent new state-of-the-art technologies. Working on Enterprise Ireland funded technology projects in the Optics Research Group, WIT, Dr. Dominic Murphy and Dr. Kieran O'Mahoney have invented a new *Passive Photonic Engine Technology*, Spectrifire™ (patent pending). Spectrifire™ is a portable interferometer / FT spectrometer technology that provides highest performance across multiple high-value verticals across Process Control, Life Sciences, Medical Diagnostics and Environmental & Structural Health Monitoring market segments. With 10 times the accuracy of competing technologies at 1/10 of the cost, our Passive Photonic Engine Technology adds value to portable and non-portable systems alike. With the smallest footprint and highest cost-performance benefit for measurement and analysis capability Spectrifire™ is the best photonic engine technology for your smart phone.

Speaker Biography

Dominic Murphy, CEO Founder of Fusion Photonics Ltd., has a PhD in optical physics and 15 years Research & Development experience across both commercial and commercially focused academic roles in Ireland, the UK and Australia, including the optical fiber components company, Sumicem Optoelectronics and the spin-out company, BlazePhotonics Ltd, UK. He is an Enterprise Ireland Principal Investigator with 8 patent applications and nearly 40 journal, conference and invited publications, presenting at several international conferences and world-leading research institutions. Murphy was an invited expert panelist at the Photonics West 2012 Blue Ocean Grantee panel in San Francisco. He is a Chartered member of the Institute of Physics, a member of The Optical Society, a reviewer for the OSA, IEEE and AIP and has served on the international conference technical committees.

Short Course Schedule by Time

Sunday 6 May

Time	Code	Title
9:00 AM - 12:00 PM	SC379	**New Course!** Silicon Photonics
9:00 AM - 12:00 PM	SC182	Biomedical Optical Diagnostics and Sensing
9:00 AM - 12:00 PM	SC302	MetaMaterials
9:00 AM - 5:00 PM	SC200	**Cancelled** Laser Remote Sensing
1:00 PM - 5:00 PM	SC149	Foundations of Nonlinear Optics
1:00 PM - 5:00 PM	SC361	Coherent Mid-Infrared Sources and Applications
1:30 PM - 4:30 PM	SC376	**New Course!** Plastmonics

1:30 PM - 4:30 PM	SC221	Nano-Photonics: Physics and Techniques
1:30 PM - 4:30 PM	SC335	Cancelled Super-Resolution Optical Microscopy
1:30 PM - 4:30 PM	SC147	Optical Fiber Communication Systems

Monday 7 May

Time	Code	Title
8:30 AM - 12:00 PM	SC165	Cancelled Laser Diode-Pumped Solid-State Lasers
9:00 AM - 12:00 PM	SC375	New Course! Applications of Mid-Infrared Quantum Cascade Lasers in Health and the Environment
9:00 AM - 12:00 PM	SC153	Quasi-Phasematching for Wavelength Conversion and All-Optical Nonlinear Processing
1:00 PM - 5:00 PM	SC338	Fiber-Based Parametric Devices
1:00 PM - 5:00 PM	SC378	New Course! Introduction to Ultrafast Optics
1:30 PM - 4:30 PM	SC221	Nano-Photonics: Physics and Techniques
1:30 PM - 4:30 PM	SC335	Cancelled Super-Resolution Optical Microscopy

Tuesday 8 May

Time	Code	Title
8:30 AM - 12:30 PM	SC163	Cancelled Optical Parametric Oscillators
9:00 AM - 12:00 PM	SC377	New Course! Fundamentals of Lasers
9:00 AM - 12:00 PM	SC339	A Guide to Building Optical Frequency-comb-based Clocks for Ultralow Noise Signal Generation
9:00 AM - 12:00 PM	SC362	Cavity Optomechanics: Fundamentals and Applications of controlling and measuring nano- and micro-mechanical

		oscillators with laser light
1:00 PM - 5:00 PM	SC270	High Power Fiber Lasers and Amplifiers
1:00 PM - 5:00 PM	SC271	Quantum Information—Technologies and Applications
1:30 PM - 4:30 PM	SC157	Laser Beam Analysis, Propagation and Shaping Techniques
1:30 PM - 4:30 PM	SC352	Ultrafast Laser Shaping and Pulse Compression

Short Courses by Topic

QELS 1. Quantum Optics of Atoms, Molecules and Solids

SC302 MetaMaterials

Vladimir M. Shalaev; *Purdue Univ., USA*

SC339 A Guide to Building Optical Frequency-comb-based Clocks for Ultralow Noise Signal Generation

Scott Diddams, Chris Oates; *NIST, USA.*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

New Course! SC376 Plasmonics

Mark Brongersma; *Univ. of Stanford, USA*

QELS 2. Quantum Science, Engineering and Technology

SC271 Quantum Information—Technologies and Applications

Prem Kumar[1,] Paul Toliver[2]; [1]Northwestern Univ., USA, [2]Telcordia, USA

SC302 MetaMaterials

Vladimir M. Shalaev; *Purdue Univ., USA*

SC339 A Guide to Building Optical Frequency-comb-based Clocks for Ultralow Noise Signal Generation

Scott Diddams, Chris Oates; *NIST, USA.*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

SC362 Cavity Optomechanics: Fundamentals and Applications of controlling and measuring nano- and micro-mechanical oscillators with laser light

Tobia Kippenberg; *Swiss Federal Institute of Technology Lausanne, Switzerland*

New Course! SC376 Plasmonics

Mark Brongersma; *Univ. of Stanford, USA*

QELS 3. Metamaterials and Complex Media

SC302 MetaMaterials

Vladimir M. Shalaev; *Purdue Univ., USA*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

New Course! SC376 Plasmonics

Mark Brongersma; *Univ. of Stanford, USA*

QELS 4. Optical Interactions with Condensed Matter and Ultrafast Phenomena

SC149 Foundations of Nonlinear Optics

Robert Fisher; R.A. Fisher Associates, LLC, USA.

SC182 Biomedical Optical Diagnostics and Sensing

Sebastian Wachsmann-Hogiu; *NSF Center for Biophotonics Science and Technology, Univ. of California Davis, USA*

SC302 MetaMaterials

Vladimir M. Shalaev; *Purdue Univ., USA*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

New Course! SC376 Plasmonics

Mark Brongersma; *Univ. of Stanford, USA*

New Course! SC377 Fundamentals of Lasers

Randy A. Bartels; *Colorado State University, USA*

New Course! SC378 Introduction to Ultrafast Optics

Rick Trebino; *Georgia Institute of Technology, USA*

QELS 5. Nonlinear Optics and Novel Phenomena

Cancelled SC165 Laser Diode-Pumped Solid-State Lasers

Larry Marshall; Southern Cross Venture Partners, USA.

SC302 MetaMaterials

Vladimir M. Shalaev; *Purdue Univ., USA*

SC339 A Guide to Building Optical Frequency-comb-based Clocks for Ultralow Noise Signal Generation

Scott Diddams, Chris Oates; *NIST, USA.*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

SC361 Coherent Mid-Infrared Sources and Applications

Konstantin Vodopyonov; Stanford Univ., USA

New Course! SC376 Plasmonics

Mark Brongersma; *Univ. of Stanford, USA*

New Course! SC379 Silicon Photonics

Michal Lipson; *Cornell Univ., USA*

QELS 6. Nano-Optics and Plasmonics

SC182 Biomedical Optical Diagnostics and Sensing

Sebastian Wachsmann-Hogiu; *NSF Center for Biophotonics Science and Technology, Univ. of California Davis, USA*

SC221 Nano-Photonics: Physics and Techniques

Axel Scherer; *Caltech, USA.*

SC302 MetaMaterials

Vladimir M. Shalaev; *Purdue Univ., USA*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

New Course! **SC376** **Plasmonics**

Mark Brongersma; *Univ. of Stanford, USA*

QELS 7. High-Field Physics and Attosciences

SC352 **Ultrafast Laser Shaping and Pulse Compression**

Marcos Dantus; *Michigan State Univ., USA.*

CLEO 1. Light-matter Interactions and Materials Processing

SC149 **Foundations of Nonlinear Optics**

Robert Fisher; R.A. Fisher Associates, LLC, USA.

SC157 **Laser Beam Analysis, Propagation and Shaping Techniques**

James R. Leger; Univ. of Minnesota, USA.

SC302 **MetaMaterials**

Vladimir M. Shalaev; *Purdue Univ., USA*

SC352 **Ultrafast Laser Shaping and Pulse Compression**

Marcos Dantus; *Michigan State Univ., USA.*

New Course! **SC376** **Plasmonics**

Mark Brongersma; *Univ. of Stanford, USA*

CLEO 2. Solid-State, Liquid, Gas, and High-Intensity Lasers

SC149 **Foundations of Nonlinear Optics**

Robert Fisher; R.A. Fisher Associates, LLC, USA.

SC157 **Laser Beam Analysis, Propagation and Shaping Techniques**

James R. Leger; Univ. of Minnesota, USA.

Cancelled **SC165** **Laser Diode-Pumped Solid-State Lasers**

Larry Marshall; Southern Cross Venture Partners, USA.

SC270 High Power Fiber Lasers and Amplifiers

W. Andrew Clarkson; *Optoelectronics Res. Ctr., Univ. of Southampton, UK*

SC361 Coherent Mid-Infrared Sources and Applications

Konstantin Vodopyonov; Stanford Univ., USA

New Course! SC377 Fundamentals of Lasers

Randy A. Bartels; *Colorado State University, USA*

CLEO 3. Semiconductor Lasers

SC157 Laser Beam Analysis, Propagation and Shaping Techniques

James R. Leger; Univ. of Minnesota, USA.

Cancelled SC165 Laser Diode-Pumped Solid-State Lasers

Larry Marshall; Southern Cross Venture Partners, USA.

SC221 Nano-Photonics: Physics and Techniques

Axel Scherer; *Caltech, USA.*

New Course! SC375 Applications of Mid-Infrared Quantum Cascade Lasers in Health and the Environment

Yamac Dikmelik; *Department of Electrical and Computer Engineering, Johns Hopkins Univ., USA*

New Course! SC376 Plasmonics

Mark Brongersma; *Univ. of Stanford, USA*

CLEO 4. Nonlinear Optical Technologies

SC149 Foundations of Nonlinear Optics

Robert Fisher; R.A. Fisher Associates, LLC, USA.

SC153 Quasi-Phasematching for Wavelength Conversion and All-Optical Nonlinear Processing

Peter G. R. Smith; Univ. of Southampton, UK

Cancelled SC163 Optical Parametric Oscillators

Majid Ebrahim-Zadeh; *ICFO, The Institute of Photonics Science, Spain*

Cancelled SC165 Laser Diode-Pumped Solid-State Lasers

Larry Marshall; Southern Cross Venture Partners, USA.

SC270 High Power Fiber Lasers and Amplifiers

W. Andrew Clarkson; *Optoelectronics Res. Ctr., Univ. of Southampton, UK*

SC302 MetaMaterials

Vladimir M. Shalaev; *Purdue Univ., USA*

Cancelled SC335 Super-Resolution Optical Microscopy

Stephen Lane; *Univ. of California at Davis, USA*

SC339 A Guide to Building Optical Frequency-comb-based Clocks for Ultralow Noise Signal Generation

Scott Diddams, Chris Oates; *NIST, USA.*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

SC361 Coherent Mid-Infrared Sources and Applications

Konstantin Vodopyonov; Stanford Univ., USA

New Course! SC376 Plasmonics

Mark Brongersma; *Univ. of Stanford, USA*

New Course! SC378 Introduction to Ultrafast Optics

Rick Trebino; *Georgia Institute of Technology, USA*

CLEO 5. Terahertz Technologies and Applications

SC149 Foundations of Nonlinear Optics

Robert Fisher; R.A. Fisher Associates, LLC, USA.

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

New Course! SC378 Introduction to Ultrafast Optics

Rick Trebino; *Georgia Institute of Technology, USA*

CLEO 6. Optical Materials, Fabrication and Characterization

SC221 Nano-Photonics: Physics and Techniques

Axel Scherer; *Caltech, USA.*

SC302 MetaMaterials

Vladimir M. Shalaev; *Purdue Univ., USA*

New Course! SC376 Plasmonics

Mark Brongersma; *Univ. of Stanford, USA*

CLEO 7. Micro- and Nano-Photonic Devices

SC157 Laser Beam Analysis, Propagation and Shaping Techniques

James R. Leger; Univ. of Minnesota, USA.

SC182 Biomedical Optical Diagnostics and Sensing

Sebastian Wachsmann-Hogiu; *NSF Center for Biophotonics Science and Technology, Univ. of California Davis, USA*

SC221 Nano-Photonics: Physics and Techniques

Axel Scherer; *Caltech, USA.*

SC302 MetaMaterials

Vladimir M. Shalaev; *Purdue Univ., USA*

SC362 Cavity Optomechanics: Fundamentals and Applications of controlling and measuring nano- and micro-mechanical oscillators with laser light

Tobia Kippenberg; *Swiss Federal Institute of Technology Lausanne, Switzerland*

New Course! SC376 Plasmonics

Mark Brongersma; *Univ. of Stanford, USA*

New Course! SC379 Silicon Photonics

Michal Lipson; *Cornell Univ., USA*

CLEO 8. Ultrafast Optics, Optoelectronics and Applications

SC339 A Guide to Building Optical Frequency-comb-based Clocks for Ultralow Noise Signal Generation

Scott Diddams, Chris Oates; *NIST, USA.*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

New Course! SC376 Plasmonics

Mark Brongersma; *Univ. of Stanford, USA*

New Course! SC377 Fundamentals of Lasers

Randy A. Bartels; *Colorado State University, USA*

New Course! SC378 Introduction to Ultrafast Optics

Rick Trebino; *Georgia Institute of Technology, USA*

CLEO 9. Components, Integration, Interconnects and Signal Processing

SC157 Laser Beam Analysis, Propagation and Shaping Techniques

James R. Leger; Univ. of Minnesota, USA.

New Course! SC376 Plasmonics

Mark Brongersma; *Univ. of Stanford, USA*

New Course! SC379 Silicon Photonics

Michal Lipson; *Cornell Univ., USA*

CLEO 10. Biophotonics and Optofluidics

SC157 Laser Beam Analysis, Propagation and Shaping Techniques

James R. Leger; Univ. of Minnesota, USA.

SC182 Biomedical Optical Diagnostics and Sensing

Sebastian Wachsmann-Hogiu; *NSF Center for Biophotonics Science and Technology, Univ. of California Davis, USA*

SC221 Nano-Photonics: Physics and Techniques

Axel Scherer; *Caltech, USA.*

Cancelled SC335 Super-Resolution Optical Microscopy

Stephen Lane; *Univ. of California at Davis, USA*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

New Course! SC376 Plasmonics

Mark Brongersma; *Univ. of Stanford, USA*

New Course! SC379 Silicon Photonics

Michal Lipson; *Cornell Univ., USA*

CLEO 11. Fiber, Fiber Amplifiers, Lasers and Devices

SC157 Laser Beam Analysis, Propagation and Shaping Techniques

James R. Leger; Univ. of Minnesota, USA.

SC270 High Power Fiber Lasers and Amplifiers

W. Andrew Clarkson; *Optoelectronics Res. Ctr., Univ. of Southampton, UK*

SC338 Fiber-Based Parametric Devices

Colin J. McKinstrie; *Bell Labs, Alcatel-Lucent, USA*.

SC339 A Guide to Building Optical Frequency-comb-based Clocks for Ultralow Noise Signal Generation

Scott Diddams, Chris Oates; *NIST, USA.*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

New Course! SC377 Fundamentals of Lasers

Randy A. Bartels; *Colorado State University, USA*

CLEO 12. Lightwave Communications and Optical Networks

SC147 Optical Fiber Communication Systems

Alan Willner; *Univ. of Southern California, USA*

CLEO 13. Active Optical Sensing

SC182 Biomedical Optical Diagnostics and Sensing

Sebastian Wachsmann-Hogiu; *NSF Center for Biophotonics Science and Technology, Univ. of California Davis, USA*

Cancelled SC200 Laser Remote Sensing

Timothy Carrig and Philip Gatt; *Lockheed Martin, USA*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

SC361 Coherent Mid-Infrared Sources and Applications

Konstantin Vodopyonov; Stanford Univ., USA

New Course! SC375 Applications of Mid-Infrared Quantum Cascade Lasers in Health and the Environment

Yamac Dikmelik; *Department of Electrical and Computer Engineering, Johns Hopkins Univ., USA*

New Course! SC376 Plasmonics

Mark Brongersma; *Univ. of Stanford, USA*

CLEO 14. Optical Metrology

SC157 Laser Beam Analysis, Propagation and Shaping Techniques

James R. Leger; Univ. of Minnesota, USA.

SC339 A Guide to Building Optical Frequency-comb-based Clocks for Ultralow Noise Signal Generation

Scott Diddams, Chris Oates; *NIST, USA.*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

New Course! SC378 Introduction to Ultrafast Optics

Rick Trebino; *Georgia Institute of Technology, USA*

CLEO 15. LEDS, Photovoltaics and Energy-Efficient ("Green") Photonics

New Course! SC376 Plasmonics

Mark Brongersma; *Univ. of Stanford, USA*

A&T 1. Biomedical

SC157 Laser Beam Analysis, Propagation and Shaping Techniques

James R. Leger; Univ. of Minnesota, USA.

SC182 Biomedical Optical Diagnostics and Sensing

Sebastian Wachsmann-Hogiu; *NSF Center for Biophotonics Science and Technology, Univ. of California Davis, USA*

Cancelled SC200 Laser Remote Sensing

Timothy Carrig and Philip Gatt; *Lockheed Martin, USA*

SC221 Nano-Photonics: Physics and Techniques

Axel Scherer; *Caltech, USA.*

Cancelled SC335 Super-Resolution Optical Microscopy

Stephen Lane; *Univ. of California at Davis, USA*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

A&T 2. Environment/Energy

SC157 Laser Beam Analysis, Propagation and Shaping Techniques

James R. Leger; Univ. of Minnesota, USA.

SC182 Biomedical Optical Diagnostics and Sensing

Sebastian Wachsmann-Hogiu; *NSF Center for Biophotonics Science and Technology, Univ. of California Davis, USA*

Cancelled SC200 Laser Remote Sensing

Timothy Carrig and Philip Gatt; *Lockheed Martin, USA*

SC221 Nano-Photonics: Physics and Techniques

Axel Scherer; *Caltech, USA.*

Cancelled SC335 Super-Resolution Optical Microscopy

Stephen Lane; *Univ. of California at Davis, USA*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

A&T 3. Government & National Science, Security & Standards Applications

SC157 Laser Beam Analysis, Propagation and Shaping Techniques

James R. Leger; Univ. of Minnesota, USA.

SC182 Biomedical Optical Diagnostics and Sensing

Sebastian Wachsmann-Hogiu; *NSF Center for Biophotonics Science and Technology, Univ. of California Davis, USA*

Cancelled SC200 Laser Remote Sensing

Timothy Carrig and Philip Gatt; *Lockheed Martin, USA*

SC339 A Guide to Building Optical Frequency-comb-based Clocks for Ultralow Noise Signal Generation

Scott Diddams, Chris Oates; *NIST, USA.*

SC352 Ultrafast Laser Shaping and Pulse Compression

Marcos Dantus; *Michigan State Univ., USA.*

New Course! **SC376** **Plasmonics**

Mark Brongersma; *Univ. of Stanford, USA*

A&T 4. Industrial

Cancelled **SC200** **Laser Remote Sensing**

Timothy Carrig and Philip Gatt; *Lockheed Martin, USA*

SC352 **Ultrafast Laser Shaping and Pulse Compression**

Marcos Dantus; *Michigan State Univ., USA.*

New Course! **SC376** **Plasmonics**

Mark Brongersma; *Univ. of Stanford, USA*

Short Course Descriptions

SC147 Optical Fiber Communication Systems

Monday, May 7, 2012

1:30 PM - 4:30 PM

Instructor: Alan Willner; *Univ. of Southern California, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

The optical fiber, with its low loss and high bandwidth, provides enormous capacity. Furthermore, there has been much excitement involving the simultaneous transmission of several independent channels, each located at a different wavelength. Such wavelength-division-multiplexing (WDM) provides dramatic increases in aggregate system capacity as well as wavelength-dependent network routing. Note that a key enabling technology has been the Erbium-doped fiber amplifier (EDFA), which can provide gain to many channels simultaneously.

This course will be divided into two parts: (1) basic operation of optical fiber communication systems and (2) reconfigurable optical networks. Optical system design, including signal, noise and sensitivity, will be addressed in the context of high-performance transmission. We will describe the device and systems advances in wavelength-division-multiplexing, focusing on the potential gains and probable limitations of future systems. Additional topics include optical amplifiers, multi-channel systems, nonlinear effects and polarization mode dispersion. We will also delve into physical-layer issues associated with dynamic and reconfigurable WDM networks. For instance, as point-to-point links become more sophisticated, systems must dynamically adapt to changing traffic conditions in order to avoid SNR degradation. This scenario erupts into a much greater challenge when channels originate at different locations, as is the case with add/drop multiplexers, reconfigurable cross-connects, circuit-switched networking and, eventually, optical packet switching. We will identify dynamic channel degrading effects that include crosstalk, channel power equalization, tunable management of dispersion and nonlinear effects, nonuniform EDFA gain, switching-related transients and wavelength routing.

Benefits:

This course should enable you to:

1.) Describe the basic components in an optical system.
2.) Explain the operation of optical data generation, transmission, amplification and detection.
3.) Design and analyze a viable optical transmission system.
4.) Evaluate signal-to-noise ratios and system power penalties.
5.) Understand the basic concepts of reconfigurable multi-wavelength optical systems and networks.
6.) Define several degrading effects in high-speed optical fiber transmission.

Audience:

This course is intended for engineers interested in acquiring a working and project-oriented knowledge of an optical communication system, managers and investors wanting a broad overview of the critical technologies and recent directions in optical communication systems, and educators desiring a firm understanding of the fundamental concepts with the goal of teaching a lecture or laboratory course in optical communications.

Instructor Biography:

Alan Willner (Ph.D., Columbia) worked at AT&T Bell Labs and Bellcore, and he is the Sample Chaired Professor of Engineering at USC. He received the Int'l Fellow of U.K. Royal Society of Engineering, NSF Presidential Faculty Fellows Award from White House, Packard Foundation Fellowship, Fulbright Foundation Senior Scholars Award, OSA Forman Eng. Excellence Award, IEEE Photonics Society Eng. Achievement Award and Distinguished Lecturer Award, USC University-Wide Outstanding Teacher Award, and Eddy Best Technical Paper Award from Pennwell. He is an IEEE, OSA, and SPIE Fellow. He was co-chair of National Academies Committee on Harnessing Light II, president of IEEE Photonics Society, OSA Science and Engineering Council co-chair, Optics Letters editor-in-chief, Journal of Lightwave Technology editor-in-chief, IEEE JSTQE editor-in-chief, and CLEO general co-chair.

SC149 Foundations of Nonlinear Optics

Sunday, May 6, 2012

1:00 PM - 5:00 PM

Instructor:

Robert Fisher; R.A. Fisher Associates, LLC, USA.

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

This introductory and intermediate level course provides the basic concepts of nonlinear optics. Although some mathematical formulas are provided, the emphasis is on simple explanations. It is recognized that the beginning practitioner in nonlinear optics is overwhelmed by a constellation of complicated nonlinear optical effects, including second-harmonic generation, optical Kerr effect, self-focusing, self-phase modulation, self-steepening, fiber-optic solitons, chirping, stimulated Raman and Brillouin scattering, and photorefractive phenomena. It is our job in this course to demystify this daunting collection of seemingly unrelated effects by developing simple and clear explanations for how each works, and learning how each effect can be used for the modification, manipulation, or conversion of light pulses. Examples will address the nonlinear optical effects that occur inside optical fibers, and those which occur in liquids, bulk solids, and gases.

Benefits:

This course will enable you to:

- Understand and manipulate the Slowly-Varying Envelope Approximation (SVEA)
- Recognize what nonlinear events come into play in different effects
- Appreciate the intimate relationship between nonlinear events which at first appear quite different
- Understand how a variety of different nonlinear events arise, and how they affect the propagation of light
- Understand how wavematching, phase-matching, and index matching are related
- Understand how self-phase modulation impresses "chirping" on pulses
- Understand basic two-beam interactions in photorefractive materials
- Develop an appreciation for the extremely broad variety of ways in which materials exhibit nonlinear behavior

Audience:

Although we start at the very beginning of each topic, we move quite rapidly in order to grasp a deep understanding of each topic. Therefore both beginners and intermediates will benefit greatly from this course. The material will be of interest to graduate students, to researchers, to members of the legal profession, to experts who are just transferring to this field, to managers, and to anyone else who just wants to learn how nonlinear optics works.

Instructor Biography:

Robert A. Fisher is a private consultant with interests in nonlinear optics, carbon dioxide lasers, molecular spectroscopy, X-Ray lasers, optical phase conjugation and modern optics. He is a fellow of OSA and SPIE, as well as a senior member of the IEEE. He was a member of the Board of Directors of SPIE (2002-2004). He has authored more than 60 publications. Fisher is the editor of the book Optical Phase Conjugation. He is a past associate editor for the journals Applied Optics, and Optics Letters; and he has chaired six SPIE Conferences on Nonlinear Optics. He served a 3-year term on the Board of Directors of SPIE. He was a topical editor for Optics Letters, the chair of OSA's Excellence in Engineering Award Committee, on SPIE's Scholarship Committee, and on the 2003, 2004, 2005, 2006 and 2007 CLEO Program Nonlinear Optics Subcommittees, which he chaired in 2006 and 2007. He was Program CoChair for CLEO 2010 and is General CoChair for CLEO 2012 (now renamed 2012 CLEO: Science and Innovations). He has served the legal community several times as an Expert Witness.

SC153 Quasi-Phasematching for Wavelength Conversion and All-Optical Nonlinear Processing

Monday, May 7, 2012

9:00 AM - 12:00 PM

Instructor: Peter G. R. Smith; Univ. of Southampton, UK

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

This course provides an overview and grounding in the use of quasi-phase matched materials in nonlinear optics. Quasi-phase matching (QPM) is emerging as a dominant technology for nonlinear optical frequency conversion in the visible and near-IR. By offering a large nonlinear susceptibility, non-critical phase matching and a tailored spectral response, it is allowing a wide range of new optical devices to be realized. The course will start by explaining the underlying concepts of QPM and reviewing the available materials, their advantages and disadvantages. Both bulk and waveguide QPM devices will be covered. The course will make use of worked examples of real devices that will be presented to explain their operation. These examples will draw on experiments in harmonic generation, fiber-pumped OPOs, and telecomm wavelength conversion in waveguide PPLN. The commercial and scientific uses of QPM devices will be reviewed. Finally, the market potential of QPM devices will be discussed. The markets and opportunities in telecommunications, infra-red countermeasures, scientific, and displays will be considered.

Benefits:

This course should enable you to:

1.) Describe the basic concepts of phase matching and quasi-phase matching.

2.) Summarize the origins of second order nonlinear processes, such as second harmonic generation, sum and difference frequency mixing, parametric amplification, generation and oscillation.

3.) Gain an overview of existing QPM materials, particularly periodically poled ferroelectrics (PPLN, PPLT, PPKTP) and patterned III-V semiconductors.

4.) Compare, through worked examples, the achievable performance of nonlinear devices.

5.) Develop an appreciation of the uses of QPM devices in IR-countermeasures, visible generation, mid-IR spectroscopy, in quantum communication, etc.

6.) Compare bulk and waveguide applications and define their regions of applicability.

7.) Discuss the applications of QPM materials to all-optical signal processing, particularly for WDM wavelength conversion, TDM (de)multiplexing and signal reconditioning.

8.) Identify the market potential of QPM materials and devices.

Audience:

This course is intended for students, engineers, scientists and managers with a basic knowledge of lasers who wish to familiarize themselves with the practical application of QPM materials in nonlinear optics.

Instructor Biography:

Peter G. R. Smith is a professor at the Optoelectronics Research Centre (ORC), University of Southampton, UK. Following a doctorate from Oxford University and work as a management consultant in London, he moved to Southampton in 1994 to work on nonlinear QPM materials and integrated optics. At the ORC he leads a group that concentrates on the fabrication of periodically poled materials and waveguide devices. He is the author more than 100 journal and conference papers in the area of QPM materials, and is the founder of Stratophase Ltd., a start-up company that is commercializing periodically poled QPM materials.

SC157 Laser Beam Analysis, Propagation and Shaping Techniques

Tuesday, May 8, 2012

1:30 PM - 4:30 PM

Instructor: James R. Leger; Univ. of Minnesota, USA.

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

The propagation and focusing properties of real laser beams are greatly influenced by beam shape, phase distortions, degree of coherence, and aperture truncation effects. The ability to understand, predict, and correct these real-world effects is essential to modern optical engineering. Attendees of this course will learn a variety of techniques for measuring and quantifying the important characteristics of real laser beams, be able to calculate the effects of these characteristics on optical system performance, and explore a variety of beam shaping techniques to optimize specific optical systems.

The course starts with a basic description of Gaussian beam characteristics from an ideal laser. These concepts are extended to non-Gaussian beams (e.g. top-hat shapes) and the relative merits of various beam shapes are discussed. Beam characterization methods such as M2, Strehl ratio, and TDL are reviewed. Simple expressions for estimating the effects of laser aberrations and coherence on beam focusing and propagation are reviewed. Coupling of light into single and multi-mode fibers, as well as far-field light concentration limits are explored as real-world examples. The constant radiance theorem and étendue are employed as engineering tools to optimize optical design. The course ends with a description of internal and external cavity beam shaping techniques using phase and polarization methods.

Benefits:

This course should enable participants to:

1.) Measure the quality of a laser beam using several methods

2.) Interpret the meaning of various laser specifications

3.) Understand Gaussian laser beam properties from an intuitive standpoint

4.) Predict the propagation and focusing properties of non-ideal laser beams

5.) Determine the concentration limits of a light field

6.) Design optimal beam concentration optics

7.) Compare different beam shapes for specific applications

8.) Design beam shaping optics using polarization and phase manipulation

Audience:

This course is designed to provide laser engineers, optical system designers, and technical management professionals with a working knowledge of laser beam characterization, analysis, and modification. Physical explanations of most topics are designed to make the concepts accessible to a wide range of attendees.

Instructor Biography:

James Leger is the Cymer Professor of Electrical and Computer Engineering at the University of Minnesota. His previous work at MIT Lincoln Laboratory and current research concerns diffractive and microoptics applied to lasers and electro-optic systems. Prof. Leger is a fellow of OSA, IEEE, and SPIE, and winner of the 1998 OSA Fraunhofer award. He is also a member of the academy of distinguished teachers, and has won several awards for his teaching. Current and past service include Deputy Editor of Optics Express and membership on the OSA board of directors.

SC163 Optical Parametric Oscillators

This Short Course has been cancelled.

Tuesday, May 8, 2012

8:30 AM - 12:30 PM

Instructor: Majid Ebrahim-Zadeh; *ICFO, The Institute of Photonics Science, Spain*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

This course provides an overview of optical parametric oscillators (OPOs), from basic operation principles to advanced devices. The course will begin with a description of the fundamental concepts in nonlinear optics and frequency conversion, followed by a discussion of OPO devices, an overview of the latest advances in OPO technology, and applications. The discussion will cover OPOs operating in all temporal regimes, from the continuous-wave (cw) to the ultrafast femtosecond time-scales.

Specifically, the course participants will gain knowledge of the basic principles of nonlinear frequency conversion and optical parametric generation; phase-matching, amplification and tuning; OPO design issues, including nonlinear material and pump laser selection criteria; OPO operation in different time-scales, generic device architectures, pumping and resonance configurations; cw OPOs: singly-resonant, pump-enhanced, doubly- and triply-resonant oscillators, pump power threshold and frequency behavior, frequency tuning and control, solid-state, fiber, and semicondcutor disk laser pumping, visible to mid-IR generation, novel device architectures; pulsed OPOs: operating principle, threshold condition, compact all-solid-state oscillators, high- and low-energy devices, single-mode operation, UV to mid-IR and THz generation; synchronously-pumped OPOs: picosecond OPOs: high-repetition-rate cw and pulsed oscillators, solid-state, Ti:sapphire and fiber laser pumping, birefringent and quasi-phase-matched devices, UV to mid-IR generation; femtosecond OPOs: Ti:sapphire, solid-state, and fiber-pumped devices, collinear and noncollinear pumping, birefringent and quasi-phase-matched oscillators, spectral and temporal control, UV to mid-IR generation; applications of OPO devices in spectroscopy, trace gas sensing, imaging, frequency synthesis and comb generation; commercial developments in OPO technology.

Benefits:

This course should enable you to:

1. Understand the basic principles of optical parametric generation and amplification of light
2. Learn the operating principles of optical parametric devices, in particular optical parametric oscillators (OPOs)
3. Obtain an understanding of nonlinear gain, phase-matching, opeartion threshold, device architectures, resonator configurations, tuning, spectral and temporal behavior
4. Identify the critical issues in the design of optical parametric devices, including material and pump laser selection
5. Acquire the reuired skills and apply the necessary procedures in the practical implementation of OPO devices in cw,pulsed, picosecond and femtosecond opeartion
6. Learn the necessary techniques for spatial, spectral, and temporal control of OPO devices in differerent opeating regimes
7. Gain a perspective of current OPO technology, the important recent developments in the field, as well as novel and emerging applications of OPO sources

Audience:

This course is intended for researchers with little or no background in OPOs, as well as those more familiar with the subject area, who wish to enhance their understanding and update their knowledge of the latest developments in OPO device technology. The course will benefit graduate students and other industrial and academic researchers already involved or in early stages in OPO development.

Instructor Biography:

Majid Ebrahim-Zadeh is an ICREA Professor at ICFO, Barcelona, Spain. He has been active in the advancement of OPO technology for over 20 years, with 125 journal publications, 12 book chapters and reviews, and 60 invited talks at major international conferences. He has co-edited 2 books, has been a regular short course instructor at CLEO/USA and CLEO/Europe, is the co-founder and president of Radiantis, a recipient of Berthold Leibinger innovation prize, and an OSA Fellow.

SC165 Laser Diode-Pumped Solid-State Lasers

This Short Course has been cancelled.

Monday, May 7, 2012

8:30 AM - 12:00 PM

Instructor: Larry Marshall; Southern Cross Venture Partners, USA.

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

Advances in Solid state crystals and laser diodes dramatically changed the capabilities of the laser industry, enabling battery powered compact, portable lasers, and a wide range of output wavelengths and pulse formats through nonlinear conversion of diode-pumped solid state lasers. We cover fundamental and advanced design concepts and challenges with solid state lasers and associated nonlinear optical conversion. Underlying theory is presented but emphasis is on solid engineering design concerns and implementation of devices. The course covers, visible, UV, and IR lasers, ultrafast, mode locked, Q-switched, CW devices, and frequency shifting using OPOs, harmonic generation, and novel nonlinear materials. The latter part of the course focuses on commercial opportunities and the ability to be a laser entrepreneur to create value with these unique devices.

Benefits:

This course should enable the participants to:

1.) Design, test and measure diode pumped solid state lasers & their output

2.) Design and compute nonlilnear conversion of diode pumped lasers

3.) Calculate and identify the best solid state materials for lasers and nonlinear optics

Audience:

Audience should be familiar with lasers and aiming to expand their knowledge into the specifics of solid state lasers, diode pumping, and nonlinear conversion using solid state crystals. Budding entrepreneurs will gain additional benefit of understanding the commercial imperatives for laser design, and market drivers, as well as how to start a laser company.

Instructor Biography:

Dr. Larry Marshall developed a unique series of diode pumped solid state lasers using nonlinear conversion to produce the first commercial CW green lasers (used for medical devices), optical parametric oscillators (used for biological sensing), and IR OPOs (used for LIDAR). He also founded 6 successful companies, two of which went public. He is now Managing Director of a VC fund investing in early stage technology startups.

SC182 Biomedical Optical Diagnostics and Sensing

Sunday, May 6, 2012

9:00 AM - 12:00 PM

Instructor: Sebastian Wachsmann-Hogiu; *NSF Center for Biophotonics Science and Technology, Univ. of California Davis, USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

This course provides an introduction to the basics of life sciences, followed by an introduction to the basic properties of photons and the spectroscopic properties of biological materials, i.e. absorbance, reflectance, polarization, fluorescence and light scattering. Modern optical imaging and sensing techniques, based on fluorescence, vibrational and nonlinear concepts and their medical applications will be discussed.

Benefits:

This course should enable the participants to:

1) Describe the interaction of light with tissue in terms of absorption, elastic scattering, fluorescence, and inelastic scattering;

2) Explain the basic principles of microscopy and imaging techniques such as wide-field fluorescence, confocal, two-photon excitation, second harmonic imaging, Raman (coherent and spontaneous), etc.

3) List various ways light can be used for medical diagnostics, including autofluorescence and Raman measurements;

4) Compare methods that use labels with label-free approaches to diagnostics and sensing;

5) Discuss various schemes of sensing, including well established techniques such as ELISA assays and not-yet-established that use plasmonics for detection;

6) Discuss the role of optical fibers in diagnostic and sensing;

7) Identify the advantages and disadvantages of optical diagnostic methods vs non-optical methods.

Instructor Biography:

Sebastian Wachsmann-Hogiu has a background in biophysics, experimental physics, and biomedical optics. He is currently an Associate Professor in the Department of Pathology and Laboratory Medicine, and serves as Facility Director at the NSF Center for Biophtonics Science and Technology, University of California Davis. He previously served as Director of the Advanced Optical Imaging Laboratory within the Minimally Invasive Surgical Technologies Institute at Cedars-Sinai Medical Center in Los Angeles. His interests include optical diagnostics and biosensors, and point of care technologies.

SC200 Laser Remote Sensing

Sunday, May 6, 2012

9:00 AM - 5:00 PM

Instructor: Timothy Carrig and Philip Gatt; *Lockheed Martin, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

This course provides an introduction to laser remote sensing suitable for students with a Bachelor's degree in science or engineering. It provides an overview of key laser remote sensing techniques, focusing on applications, system design, detection techniques, basic theory, performance modeling, and practical hardware considerations. Several system design examples are provided to illustrate key concepts. The course will describe the fundamentals of lidar and ladar systems. Lidar systems discussion will focus on coherent and direct detection Doppler wind lidars, , differential absorption, laser induced fluorescence, and Raman lidar systems. Ladar discussions will focus on 3D imaging, velocity and vibrometry. Coherent and direct detection techniques will be compared and contrasted. Detection statistics and measurement errors will be reviewed. The effects of atmospheric attenuation and turbulence, target reflectivity, and speckle on measurements will be discussed. Laser radar system modeling techniques will be provided, including a description of key laser radar equations, performance metrics, and system efficiency calculations. Hardware discussions will include laser considerations/requirements, transceiver design, platform constraints, system calibration and single-pixel vs. imaging systems. Telescopes, transmit and receive optics, laser sources, detectors, and signal processor requirements and trades will be explained. The goal is to provide the attendee with an understanding of the capabilities of laser based sensing, a framework for system development work, and useful references to aid further study.

Benefits:

This course should enable you to:

1.) Understand the fundamentals of Laser Remote Sensing and Applications

2.) Develop a strawman ladar/lidar desing

3.) Analyze the performance of ladar/lidar sensors.

Audience:

This course is intended for individuals with a bachelor level degree in physics or engineering. Prior knowledge of laser radar is not required but would be useful. Participants should have a basic knowledge of optics and applied mathematics.

Instructor Biography:

Dr. Phil Gatt is a Lockheed Martin Technical Fellow and Modeling & Analysis Team Lead. He earned his Ph.D. in Electrical Engineering from the University of Central Florida. Dr. Gatt specializes in laser radar systems analysis and design, sensor performance modeling, propagation of laser beams through atmospheric turbulence, optical detection theory, Fourier and statistical optics, modeling & simulation. His expertise covers both coherent and direct detection laser radar systems for a variety of applications including imaging, hard-target detection, vibrometry, wind-sensing, aerosol detection, differential absorption lidar, differential scattering lidar, and biological aerosol detection lidar.

Dr. Timothy Carrig is the Director of Research & Technology at Lockheed Martin. He earned his Ph.D. in Applied Physics from Cornell University. Dr. Carrig is a laser physicist by training who has built direct laser sources in the UV, VIS and IR. These include continuous-wave, Q-switched, cavity-dumped, and mode-locked lasers using transition-metal, rare-earth, and color-center gain media. Areas of previous work include diode-pumped solid-state crystal and fiber lasers, tunable lasers, nonlinear optics, stand-off sensors for chemical & biological defense, and hard target ladar using adaptive waveforms.

SC221 Nano-Photonics: Physics and Techniques

Monday, May 7, 2012

1:30 PM - 4:30 PM

Instructor: Axel Scherer; *Caltech, USA.*

Level: Intermediate (prior knowledge of topic is necessary to appreciate course material)

Description:

Students will learn about the applications of printed and integrated optical devices. In particular, optical microcavities and vertical cavity lasers, silicon photonics and plasmonic systems will be introduced and compared. Integrated opto-electronic and opto-fluidic systems for communications and biomedical sensing will be compared.

Benefits:

This course should enable the participants to:

1.) Compare dielectric (total internal reflection and Bragg reflectors) with metallic (surface plasmon) geometries for confining and guiding light

2.) Identify opportunities for using printed optical systems in silicon (silicon photonics)

3.) Describe methods for creating quantum-mechanical systems from optical nanostructures

4.) Design lithographically defined micro- and nanocavities for resonators and lasers

5.) Define applications of printed optics in biochemical sensing

6.) Summarize the evolution of printed optical integrated circuits and devices, such as modulators and switches

7.) Determine the applications of interdisciplinary integration of optics with electronics and fluidics

8.) Describe optical performance of semiconductor structures when these are made with nanoscale dimensions

Audience:

This course is designed for participants with interest in miniaturizing optical devices. Methods of microfabricating dielectric and plasmonic devices will be described, along with examples of their applications and description of future opportunities.

Instructor Biography:

Axel Scherer is the Bernard A. Neches professor of electrical engineering, applied physics and physics at Caltech and the Co-Director of the Kavli Nanoscience Institute. Professor Scherer's research focuses on the development and application of microfabrication and design methods for optical devices. In the past, Professor Scherer pioneered the development of vertical cavity lasers, which have since become a commercial success. His group also developed some of the first silicon photonic circuits, optical nanocavities, and integrated optofluidic devices. Fundamentally new structures, such as photonic bandgap geometries resulted in some of the world's smallest lasers, modulators and waveguides. At the moment, Professor Scherer is also interested in the miniaturization and integration of microfluidic, magnetic and optical devices for applications in nano-biotechnology. His group also explores the limits of lithography at the nanometer scale. Professor Scherer has co-authored over 300 publications and holds over 65 patents in nanofabrication related areas.

SC270 High Power Fiber Lasers and Amplifiers

Tuesday, May 8, 2012

1:00 PM - 5:00 PM

Instructor: W. Andrew Clarkson; *Optoelectronics Res. Ctr., Univ. of Southampton, UK*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

Recent advances in cladding-pumped fiber lasers and amplifiers have been dramatic, leading to unprecedented levels of performance in terms of output power, efficiency, beam quality and wavelength coverage. These achievements have attracted growing interest within the community and have fueled thoughts that fiber-based sources may one day replace conventional "bulk" solid-state lasers in many application areas. The main attractions of cladding-pumped fiber sources are derived directly from their geometry, which simultaneously allows very efficient generation of coherent light and almost complete immunity from the effects of heat generation, which are so detrimental to the performance of other types of lasers.

This course aims to provide an introduction to high power fiber lasers and amplifiers, starting from the basic principles of operation and ending with examples of current state-of-the-art devices and some thoughts on future prospects. The course will cover a range of topics, including basic fiber laser and amplifier theory, spectroscopy of the relevant rare earth ions for high power devices, a discussion of the factors influencing laser and amplifier performance, fiber design and fabrication, pump sources and pump launching schemes, fiber resonator design, master-oscillator and power-amplifier configurations, linewidth control and wavelength selection, transverse mode selection, nonlinear loss processes (SBS and SRS) and their impact on performance, and heat generation and its impact on power scalability. The course will also give an overview of techniques (e.g. coherent and spectral beam combining) for further scaling of output power and provide an introduction to hybrid fiber-bulk laser schemes for scaling pulse energy.

Benefits:

This course should enable you to:
1.) Calculate threshold pump power and slope efficiency, and estimate the maximum output power that can be obtained from a given fiber laser oscillator or amplifier configuration.
2.) Select the optimum pump source for a given rare earth ion transition and fiber design.
3.) Design the pump light collection and coupling scheme and estimate the pump launch efficiency.
4.) Specify the fiber parameters (e.g. cladding design, core size, rare earth ion concentration) required for a particular laser or amplifier configuration.
5.) Design the fiber laser resonator and select the operating wavelength.
6.) Estimate thermally induced damage limit.
7.) Measure fiber laser performance characteristics and relate these to fiber design and resonator parameters.

Audience:
This course is intended for individuals with a basic knowledge of lasers and optics who wish to learn about the basic principles and capabilities of fiber lasers and amplifiers when operating at high power levels. The course will also cover some of the practical issues of operating these devices and provide an update for those wishing to learn about some of the latest developments in this rapidly advancing field.

Instructor Biography:

W. Andrew Clarkson obtained his B.Sc. degree in physics from the University of Manchester (UK) in 1984 and his doctorate from the University of Southampton (UK) in 1991. He currently holds the position of professor at the Optoelectronics Research Centre, University of Southampton, where he leads a research group investigating power-scaling of fiber lasers and solid-state lasers. He has published more than 200 journal and conference papers in this area. He has also served on the program committees of numerous international conferences and as a topical editor for Optics Letters and is a Fellow of The Optical Society (OSA).

SC271 Quantum Information—Technologies and Applications

Tuesday, May 8, 2012

1:00 PM - 5:00 PM

Instructor:

Prem Kumar[1,] Paul Toliver[2]; [1]Northwestern Univ., USA, [2]Telcordia, USA

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

This course will contrast quantum information with classical information and thus introduce the differences between quantum communications and classical communications. The concept of entanglement will be introduced and its essential role in quantum communications will be elucidated by examining the teleportation protocols that have been practically demonstrated. Facts will be delineated from fiction, as implied by the phrase "Beam me up Scotty" in the transporter of Star Trek.

The course will then describe the various technologies that are maturing rapidly for the practical realization of quantum communications. Techniques for generating and distributing entanglement in the near infrared part of the optical spectrum for free-space applications and in the 1500nm wavelength band for applications over the standard optical fiber will be described. Particular emphasis will be placed on the application of quantum communications to quantum cryptography, although a brief overview of the application to quantum computation will also be presented. In the context of quantum cryptography, the objective of key generation/distribution will be differentiated from that of direct data encryption at high speeds. Both single-photon based quantum key distribution approaches and high data- rate quantum data encryption techniques will be described.

Recent progress in demonstrations of the various technologies in real-world scenarios, both fiber based and using free-space optical links, will be presented. The course will also examine commercial activity in quantum cryptography as well as the issues of compatibility with conventional optical networking technologies. It will conclude with an outlook on the possible adoption of the quantum technologies in future optical networks.

Benefits:

This course should enable you to:

1.) Compare and contrast quantum communication versus classical communication.

2.) Understand the concept of entanglement and its role in quantum communication.

3.) Differentiate fact from fiction in the context of upcoming quantum technologies.

4.) Learn techniques for generating entanglement in the various optical bands.

5.) Get up to date on the upcoming practicality of quantum cryptography for free-space, as well as fiber-based, optical networks.

6.) Explore new applications of conventional technologies with knowledge of the current status of research and commercial activities in quantum technologies.

Audience:

The audience may include optical networking and optoelectronic technology researchers with an interest in quantum communications, as well as managers of research groups and engineers who want a glimpse into the new and forward-looking technologies in the optical arena. An undergraduate-level understanding of quantum mechanics would be helpful.

Instructor Biography:

Prem Kumar is the AT&T Professor of Information Technology and director of the Center for Photonic Communication and Computing at Northwestern University. He received a doctorate in physics from SUNY at Buffalo in 1980. His research focuses on developing novel devices for optical and quantum communication networks. He is a Fellow of the OSA, APS and IEEE. In 2006 he received the Walder Research Excellence Award from Northwestern University and in 2004 he received the International Quantum Communication Award from Tamagawa University in Japan. He is the founder of NuCrypt LLC, which commercializes quantum encryption technology for optical networks.

Paul Toliver is the Director of Optical Systems Research at Telcordia. He received his B.S. from the University of Wisconsin and Ph.D. from Princeton University, both in electrical engineering. He leads forward-looking technology research focused on next-generation optical systems including quantum communications, optical physical layer security, optical signal processing, LIDAR, and high-speed communications at 100 Gb/s and beyond.

SC302 MetaMaterials

Sunday, May 6, 2012

9:00 AM - 12:00 PM

Instructor: Vladimir M. Shalaev; *Purdue Univ., USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

Metamaterials (MMs) are expected to open a gateway to unprecedented electromagnetic properties and functionality unattainable from naturally occurring materials. We review this new emerging field and recent progress in demonstrating metamaterials from the microwave to the optical range, including the artificial magnetism and negative-index in MMs. Various approaches for optical cloaking will be analyzed. The feasibility of engineering optical space with metamaterials by using the transformation optics will be discussed. A family of novel meta-devices, ranging from superlens and hyperlens to optical black hole and single-photon gun will be also considered.

Benefits:

This course should enable the participants to:

1.) Specify the new physics behind metamaterials (MMs) and transformation optics (TO)

2.) Identify most exciting applications for MMs and TO devices,

3.) Identify future directions for the development in the field of MMs,

4.) Identify the biggest challenges in the field fo MMs,

5.) Suggest new promising material components for the improved MMs,

6.) Bridge the new physics behind MMs with the recent developments in nanofabication and engineering that can enable the exciting applications of MMs,

7.) Characterize and specify the major physical properties of MMs,

8.) Predict the future impact of the field of MMs and TO on the future nanophotonics industry.

Audience:

The target audience includes R&D representatives from industry, defense and government Lab researchers, and students.

Instructor Biography:

Vladimir (Vlad) M. Shalaev, Scientific Director for Nanophotonics in Birck Nanotechnology Center and Distinguished Professor of Electrical and Computer Engineering at Purdue University, specializes in nanophotonics, plasmonics, and optical metamaterials. Vlad Shalaev received several awards for his research in the field of nanophotonics and metamaterials, including the Max Born Award of the Optical Society of America for his pioneering contributions to the field of optical metamaterials and the Willis E. Lamb Award for Laser Science and Quantum Optics. He is a Fellow of the IEEE, APS, SPIE, and OSA. Prof. Shalaev authored three books, twenty one book chapters and over 300 research publications.

SC335 Super-Resolution Optical Microscopy

This Short Course has been cancelled.

Monday, May 7, 2012

1:30 PM - 4:30 PM

Instructor: Stephen Lane; *Univ. of California at Davis, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

After a brief introduction of historical super-resolution microscopies, primarily near-field approaches, we will review modern far-field approaches that have promise for applications in cell biology and biomedical imaging. These include single molecule localization techniques (PALM, STORM), as well as shaping of the excitation volume (STED, structured illumination). We will introduce the concepts behind these techniques, discuss the latest developments in super-resolution, describe their implementation, hardware and software requirements, image processing, and show some recent applications to bioimaging.

Benefits:

This course should enable the participants to:

1.) Explain the methods discovered in the past few years that started the super-resolution optical microscopy revolution.

2.) Describe the key ideas behind the 3 main approaches to super-resolution microscopy

3.) List the major commercial super-resolution microscope systems.

4.) Summarize the important historical developments in optical microscopy.

5.) Identify several cellular biology applications of super-resolution microscopy.

Audience:

This class is intended for academic, industry, and government participants with a science or engineering background. Past attendees will find the class has been updated with the latest information on the topic.

Instructor Biography:

Dr. Stephen Lane is the Associate Director for Science at the NSF Center for Biophotonics headquartered at the University of California at Davis where he is also Adjunct Professor in the Department of Neurological Surgery. He is also a visiting scientist at Lawrence Livermore National Laboratory. He has been working in the areas of microscopy, imaging, optical sensing, and medical diagnostics for more than 30 years. At the Center for Biophotonics super-resolution microscopy is applied to biological and medical problems.

SC338 Fiber-Based Parametric Devices

Monday, May 7, 2012

1:00 PM - 5:00 PM

Instructor: Colin J. McKinstrie; *Bell Labs, Alcatel-Lucent, USA*.

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

Parametric devices based on four-wave mixing in fibers can amplify, frequency convert and phase conjugate, and buffer (delay), regenerate and sample, optical signals in conventional communication systems. They can also generate and frequency-convert photons in quantum communication experiments. This course will provide a tutorial overview of the classical and quantum physics of fiber-based parametric devices, and their recent applications in communication systems and experiments.

1. Brief introduction to optical communications.

2.Basic physics of parametric devices.Dispersion and nonlinearity; degenerate and nondegenerate four-wave mixing;wave-number matching; polarization effects; practical difficulties.

3.Selected applications of parametric devices.Amplitude regeneration by gain saturation; buffering by wavelength conversion and dispersion; distant wavelength conversion; impairment reduction by phase conjugation; phase-regeneration by phase-sensitive amplification; stroboscopic and real-time sampling; tunable low-noise wavelength conversion.

4. Quantum physics and applications of parametric devices. Transition from classical to quantum mechanics; noise figures and information efficiencies of attenuators, frequency convertors, and phase-insensitive and phase-sensitive amplifiers; squeezed and entangled states produced by parametric amplifiers; recent photon-generation and frequency-conversion experiments.

Benefits:

This course should allow the attendee to

1. Understand the basic physics of fiber-based parametric devices
2. Be familiar with several current applications of these devices
3. Be familiar with their performance characteristics and limitations
4. Follow the progress of future research.

Audience:

Anyone in academia or industry who would like a basic understanding of the classical and quantum physics of fiber-based parametric devices, and a basic knowledge of their applications in optical communication systems and experiments.

Instructor Biography:

Colin J. McKinstrie received a PhD degree from the University of Rochester in 1986. From 1995 to 1998 he was a Postdoctoral Fellow of Los Alamos National Laboratory. In 1988 Dr McKinstrie returned to the University of Rochester as a Professor of Mechanical Engineering and a Scientist in the Laboratory for Laser Energetics. While there, his main research interests were laser fusion and nonlinear optics. Since 2001 Dr McKinstrie has been a Member of the Technical Staff at Bell Labs, Alcatel-Lucent, where his research concerns the amplification and transmission of optical pulses in communication systems, and applications of parametric devices in quantum information science. He has served on technical committees for CLEO, FiO, LEOS, OFC and SPIE, was a LEOS Distinguished Lecturer and is an OSA Traveling Lecturer.

SC339 A Guide to Building Optical Frequency-comb-based Clocks for Ultralow Noise Signal Generation

Tuesday, May 8, 2012

9:00 AM - 12:00 PM

Instructor: Scott Diddams, Chris Oates; *NIST, USA.*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

In the past decade the field of optical frequency metrology has been advanced by exciting developments in femtosecond laser optical frequency combs and their stabilization to ultra-narrow linewidth CW lasers and laser-cooled atoms and ions. Today, techniques based on optically-stabilized lasers and frequency combs provide a new generation of clocks and frequency and phase noise metrology capabilities that are many orders of magnitude better than those based on microwave technology. Initially, this research was limited to a few advanced metrology labs; however, optical clock technology has matured to the point where it is now becoming accessible to a much wider range of users and commercial and military applications. The goal of this short course is to teach the students how to design and construct their own systems using this revolutionary technology. In the process, we will focus on the unique synthesis properties available with optical frequency combs and describe how they can be stabilized relative to optical and microwave oscillators as well as atomic references. Students will be shown how to match and adapt clock technology to a wide range of applications, while taking into account the trade-offs that exist between stability, accuracy, transportability, complexity and cost.

Benefits:

This course should enable the participants to:

1. Identify the three basic building blocks of an optical clock
2. List and assemble the components required to construct each of these building blocks
3. Diagram and explain the basic stabilization techniques of femtosecond laser frequency combs
4. Design an optical clock that can meet the requirements of a given application
5. Evaluate the trade-offs between stability, accuracy, transportability, complexity and cost
6. Design a system that generates low noise microwaves from a stable optical frequency
7. Characterize the stability and/or phase noise of their optical clock systems
8. Identify emerging applications where optical clock technology can have an impact

Audience:

This course is intended for physicists, chemists and engineers desiring practical knowledge related to the design and construction of optical clocks. Instruction will be at a level appropriate for beginning graduate students, and will assume some basic knowledge of laser and atomic physics.

Instructor Biography:

Scott Diddams received a B.A. in Physics from Bethel College (St. Paul, MN) in 1989 and the Ph.D. degree in Optical Science from the University of New Mexico in 1996. Between 1996 and 2000, he did postdoctoral work at JILA (a joint institute of the National Institute of Standards and Technology and the University of Colorado) where he was supported in part by a National Research Council fellowship. Currently he works as a staff physicist in the Time and Frequency Division of NIST in Boulder, where he enjoys research in nonlinear optics, ultrafast lasers, frequency combs, and optical frequency metrology.

Chris Oates received a B.S. in Physics from Stanford University in 1984 and the Ph.D. degree in Physics from the University of Colorado in 1995. Between 1995 and 1998, he did postdoctoral work at the National Institute of Standards and Technology, where he was supported by a National Research Council fellowship. Since
1998 he has been a staff physicist in the Time and Frequency Division of NIST in Boulder, and currently he leads the

Optical Frequency Measurements Group. His research focuses on precision spectroscopy of laser-cooled atoms, with an emphasis on the development of optical clocks based on cold neutral atoms.

SC352 Ultrafast Laser Shaping and Pulse Compression

Tuesday, May 8, 2012

1:30 PM - 4:30 PM

Instructor: Marcos Dantus; *Michigan State Univ., USA.*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

Ultrafast lasers have already enabled two Nobel Prizes and more can be expected. Ultrafast lasers permit time-resolved studies on timescales faster than atomic motion and are the gateway to numerous nonlinear optical processes. Ultrafast lasers enable attosecond pulse generation and can be converted essentially to any frequency from terahertz to X-rays. However, working with these lasers can be difficult. This course will introduce the pulse shaper as a versatile tool for controlling ultrafast laser pulses and ensure that they are as short as possible. The course will make emphasis on applications of pulse shapers that greatly enhance the capabilities of femtosecond laser sources for (a) pulse characterization, (b) pulse compression, (c) creation of two or more pulse replicas, and (d) control of nonlinear optical processes such as selective two-photon excitation and selective vibrational mode excitation. Each participant will receive a pulse shaping simulation program to explore the exciting opportunities opened by pulse shaping.

Benefits:

This course should enable participants to

1.) Design and build a pulse shaper based on a particular set of goals.
2.) Compare among different pulse shaper designs and to determine which one is best suited for a current or future research project.
3.) Simulate the output pulse from a pulse shaper given a particular phase and amplitude modulation.
4.) Define key concepts in pulse shaper design such as optical resolution and focal length.
5.) Describe the effect caused by introducing a simple phase such as a linear, quadratic or cubic function on a transform-limited pulse.
6.) Explain two different approaches to creating pulse replica that can be independently controlled in the time domain using the pulse shaper.
7.) Measure the spectral phase of laser pulses using the pulse shaper itself as the measurement tool, and eliminating phase distortions to compress the output pulses.
8.) Summarize the advantages of having an adaptive pulse shaper for controlling the output of ultrafast lasers.

Audience:

This course is intended for any individual from industry or academia, student or professor, interested in learning how pulse shapers can greatly enhance the performance and utility of ultrafast (femtosecond) laser sources. No prior knowledge about pulse shaping is required.

Instructor Biography:

Professor Dantus received his Ph.D. in Chemistry (1991 Caltech) where he worked on the development of Femtochemistry, and his postdoctoral work on the development of Ultrafast Electron Diffraction under Professor Zewail (1999 Nobel Prize). He is a University Distinguished Professor of Chemistry and Physics at Michigan State University. His interests include ultrafast laser pulse theory, development and control, control of nonlinear laser-matter interactions, and biomedical imaging. Dantus has more than 160 publications, 43 invention disclosures and 28 patents related to the characterization, compression and applications of ultrashort shaped laser pulses in the areas of nonlinear optics, communications, biomedical imaging, and analytical chemistry instruments. Dantus has founded three companies and is presently serving as the President and CEO of BioPhotonic Solutions Inc, and serves on the board of advisors for the Chemical Physics Letters and the Journal of Raman Spectroscopy.

SC361 Coherent Mid-Infrared Sources and Applications

Sunday, May 6, 2012

1:00 PM - 5:00 PM

Instructor: Konstantin Vodopyonov; Stanford Univ., USA

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

The course covers fundamental principles of mid-IR generation and considers different approaches for producing coherent light in this important yet challenging spectral region. These techniques represent diverse areas of photonics and include rare earth and transition metal solid-state lasers, fiber lasers, semiconductor lasers (including intra- and intersubband cascade lasers), and laser sources based on nonlinear optical frequency conversion. The course reviews several emerging technologies such as supercontinuum generation in highly nonlinear fibers as well as frequency combs generation. We will discuss several important mid-IR applications including trace molecular sensing and standoff detection, coherent spectroscopy using frequency combs, infrared countermeasures, and medical applications.

Benefits:

This course will enable you to:

1.) Identify direct mid-IR laser sources including rare earth and transition metal solid-state lasers, fiber lasers, semiconductor heterojunction and quantum cascade lasers

2.) Identify laser sources based on nonlinear-optical techniques including optical parametric oscillators and amplifiers, and get the idea of emerging nonlinear materials such as quasi-phase-matched zinc-blende crystals

3.) Distinguish between different temporal formats of existing mid-IR laser sources, from continuous-wave to ultrafast

4.) Understand what are frequency combs and how they can be used for advanced mid-IR spectroscopic detection

Audience:

Students, academics, researchers and engineers in various disciplines who require a broad introduction to the subject and would like to learn more about the state-of-the-art and upcoming trends in mid-infrared coherent source development and applications. Undergraduate training in engineering or science is assumed.

Instructor Biography:

Konstantin L. Vodopyanov is a world expert in mid-IR solid state lasers, nonlinear optics and laser spectroscopy. He is a co-author of a book on the subject: I.T. Sorokina, K.L. Vodopyanov, “Solid-State Mid-Infrared Laser Sources”, Springer, 2003 and has both industrial and academic experience. Now he teaches and does scientific research at Stanford University, CA. Dr. Vodopyanov earned his Ph.D. in Physics at Lebedev Physical Inst. in Moscow. He is a Fellow of SPIE, OSA, American Physical Society (APS), the UK Institute of Physics (IOP), and is a Senior Member of IEEE. He serves on program committees for major laser conferences, including CLEO and Photonics West where he is a conference chair. Dr. K.L. Vodopyanov delivered numerous invited talks and tutorials at scientific conferences on the subject of mid-IR technology.

SC362 Cavity Optomechanics: Fundamentals and Applications of controlling and measuring nano- and micro-mechanical oscillators with laser light

Tuesday, May 8, 2012

9:00 AM - 12:00 PM

Instructor: Tobia Kippenberg; *Swiss Federal Institute of Technology Lausanne, Switzerland*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

Radiation pressure denotes the force that optical fields exert and which have wide ranging applications in both fundamental science and applications such as Laser cooling or optical tweezers. Radiation pressure can however also have a profound influence on micro- and nanophotonic devices, due to the fact that radiation pressure can couple optical and mechanical modes. This optomechanical coupling gives rise to a host of new phenomena and applications in force, displacement and mass sensing. This course is intended to give an introduction of the Physics and Applications of cavity optomechanics and highlight the rapid developments in this emerging field. Optomechanical coupling can be used to both cool and amplify mechanical motion and thereby allow new light driven photon clocks. Optomechanical refridgeration of mechanical modes gives insights into the quantum limits of mechanical motion. In addition radiation pressure coupling enables new way of processing light all optically enabling optical mixers, delay lines or storage elements. Moreover, the basic limitations of optomechanical displacement measurements, due to quantum noise and practical laser phase noise limitations will be reviewed, relevant across a wide range of sensing experiments.

The course will make contact to practical applications of optomechanics in Metrology (force sensors, mass sensors and light driven optical clocks) and review fundamental design principles of optomechanical coupling and the design of high Q mechanical oscillators. The use of finite element simulations will be covered.

Benefits:

This course should enable you to:

1.) Understand gradient and scattering light forces in microcavities and micromechanical systems

2.) Design high –Q nano-and micro- mechanical oscillators (finite element modeling, FEM)

3.) Understand the fundamental limits of mechanical Q in NEMS/MEMS

4.) Understanding of the fundamental and practical limits of displacement sensors

5.) Applications of optomechanics in mass and force sensing

6.) Understand the basic optomechanical phenomena (amplification, cooling)

7.) Understand the standard quantum limit (SQL)

8.) Characterize radiation pressure driven oscillations in terms of fundamental oscillator metrics

9.) Phase and frequency noise of oscillators

10) Influence of phase and amplitude noise of a wide variety of laser systems (fiber lasers, TiSa, diode lasers) in optomechanical systems

Audience:

This course is intended for physicists and optical and electrical engineers desiring both focused fundamental knowledge of cavity optomechanical coupling (i.e radiation pressure coupling of light and NEMS/MEMS) but also a view of emerging applications of this new technology. The instruction will be at a level appropriate for graduate students and will assume some basic knowledge of laser.

Instructor Biography:

Tobias J. Kippenberg is Associate Professor of Physics and Electrical Engineering at EPFL and leads the Laboratory of Photonics and Quantum Measurement. He obtained his BA at the RWTH Aachen, and MA and PhD at the California Institute of Technology (Caltech in Pasadena, USA). From 2005- 2009 he lead an Independent Research Group at the MPI of Quantum Optics and obtained his Habilitation from the LMU with T.W. Haensch. His research area are the Physics and Application of ultra high Q resonators in Metrology and Quantum Measurements of mechanical motion (cavity optomechanics). Tobias Kippenberg is alumni of the "Studienstiftung des Deutschen Volkes" and winner of the 8th EU Contest for Young Scientists (1996) for his invention of an "Infrared-microwave radiation ice condition sensor for cars. For his invention of "chip-scale frequency combs" he is co-recipient of the Helmholtz Price for Metrology (2009). Moreover he is recipient of the EFTF Young Investigator Award (2010) and the EPS Fresnel Prize (2009).

SC375 Applications of Mid-Infrared Quantum Cascade Lasers in Health and the Environment

New Course!

Monday, May 7, 2012

9:00 AM - 12:00 PM

Instructor: Yamac Dikmelik; *Department of Electrical and Computer Engineering, Johns Hopkins Univ., USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

Mid-infrared quantum cascade lasers (QCLs) have a unique advantage in their wavelength flexibility and are an enabling technology for trace gas sensing applications. Starting with the fundamental aspects of QCL operation, this short course will cover QCL based sensor systems and their spectroscopic applications. The course will first introduce the underlying physical concept of intersubband transitions in quantum wells, and will make the connection between the structure of QCLs and their electrical and spectral characteristics. The course will then present QCL based systems for spectroscopic sensing of trace gas species, and will provide application examples in environmental monitoring and medical diagnostics.

Benefits:

This course should enable the participants to:

1.) Understand the connections between the structure of mid-infrared QCLs and their electrical, optical, and temperature characteristics

2.) Compare various spectroscopic techniques and systems that use QCLs for trace gas sensing

3.) Learn about recent applications of QCL based systems in medical diagnostics and environmental monitoring

Audience:

The intended audience of this course includes scientists and engineers with an interest in laser based technologies for trace gas sensing applications.

Instructor Biography:

Yamac Dikmelik is an Assistant Research Scientist in the Department of Electrical and Computer Engineering at Johns Hopkins University (JHU). He received his Ph.D. degree in electrical engineering from JHU, and was subsequently a Postdoctoral Fellow in the Department of Materials Science and Engineering at JHU. He is also currently serving MIRTHE (Mid-InfraRed Technologies for Health and the Environment – an NSF Engineering Research Center) as a Research and Teaching Fellow.

SC376 Plasmonics

Sunday, May 6, 2012

1:30 PM - 4:30 PM

Instructor: Mark Brongersma; *Univ. of Stanford, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

Plasmonics is an exciting new field of science and technology that aims to exploit the unique optical properties of metallic nanostructures to enable routing and active manipulation of light at the nanoscale. Nanometallic objects derive these properties from their ability to support collective electron excitations, known as surface plasmons (SPs). Presently we are witnessing an explosive growth in both the number and range of plasmonics applications; it is becoming eminently clear that both new fundamental science and device technologies are being enabled by the current plasmonics revolution. The intention of this tutorial is to give the participants a fundamental background and working knowledge of the main physical ideas used in plasmonics, as well as an overview of modern trends in research and applications.

The tutorial will begin with a general overview of the field of plasmonics. This will be followed by an introduction to the basic concepts that enable one to understand and design a range of plasmonic functionalities. This part will be followed by an in-depth discussion of a range of active and passive plasmonic devices that have recently emerged. Particular attention will be given to nanometallic structures in which surface plasmons can be generated, routed, switched, amplified, and detected. It will be shown that the intrinsically small size of plasmonic devices directly results in higher operating speeds and facilitates an improved synergy between optical and electronic components. The field of plasmonics is rapidly growing and has started to provide a whole range of exciting new research and development opportunities that go well beyond chipscale components. A number of such developments will be investigated, including new types of optical sensors, solar cells, quantum plasmonic components, non-linear, and ultrafast devices. At the end of the tutorial, a critical assessment of the entire field is given and some of the truly exciting new opportunities for plasmonics are identified.

Benefits:

This course should enable the participants to:

1.) Obtain a working knowledge of the key physical concepts used in Plasmonics that enable light manipulation at ultra small length- and time-scales.

2.) Understand choices of different metal types, shapes, and sizes to accomplish different plasmonic functionalities.

3.) Find out about common electromagnetic computational tools to design plasmonic structures and devices.

4.) Get a feel for the current state of the field in terms of fundamental understanding as well as device applications.

5.) Learn about the most recent trends and developments in research and applications.

Audience:

Optical engineers and scientists who are interested in learning about the rapidly emerging field of plasmonics and its potential impact. A basic knowledge of electromagnetism will be very helpful.

Instructor Biography:

Mark Brongersma is an Associate Professor and Keck Faculty Scholar in the Department of Materials Science and Engineering at Stanford University. He leads a research team of eight students and three postdocs. Their research is directed towards the development and physical analysis of new materials and structures that find use in nanoscale electronic and photonic devices. His most recent work has focused on Si-based light-emitting materials, light sources, modulators, detectors, and metallic nanostructures that can manipulate and actively control the flow of light at the nanoscale. Brongersma has given over 50 invited presentations in the last 5 years on the topic of nanophotonics and plasmonics. He has also presented 3 tutorials at International conferences on these topics. He has authored\co-authored over 85 publications, including papers in Science, Nature Photonics, Nature Materials, and Nature Nanotechnology. He also holds a number of patents in the area of Si microphotonics and plasmonics. He received a National Science Foundation Career Award, the Walter J. Gores Award for Excellence in Teaching, the International Raymond and Beverly Sackler Prize in the Physical Sciences (Physics) for his work on plasmonics, and is a Fellow of the Optical Society of America, the American Physical Society, and the SPIE. Dr. Brongersma received his PhD in Materials Science from the FOM Institute in Amsterdam, The Netherlands, in 1998. From 1998-2001 he was a postdoctoral research fellow at the California Institute of Technology.

SC377 Fundamentals of Lasers

New Course!

Tuesday, May 8, 2012

9:00 AM - 12:00 PM

Instructor: Randy A. Bartels; *Colorado State University, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

This course provides a review of the fundamentals of lasers, spanning from basic design principles, laser dynamics and stability, and an introduction to mode-locked laser operation. The course will begin with a description of the fundamental concepts of optical gain and Gaussian beam propagation. Application of these concepts to the design of both continuous-wave (cw) and modelocked ultrafast lasers will be discussed. Stability and noise performance of will also be covered in this course. The course participants will gain knowledge of the basic principles for laser design and operation; conditions for stable operation of cw and pulsed modelocked lasers; solid-state diode pumped laser design considerations; fiber laser design considerations; laser stability and noise; and power scaling.

Benefits:

This course should enable the participants to:

1.) Describe the fundamental principles of single frequency (cw) lasers and modelocked lasers.

2.) Determine sources of deviation of laser performance from theoretical optima and understand approaches to mitigating these problems.

3.) Design stable laser cavities for complex laser geometries.

4.) Describe the fundamental operating principles for producing short laser pulses, and methods used to produce shorter pulses.

5.) Explain the conditions for stable laser operation and limitations that destabilize single-frequency and modelocked lasers.

6.) Summarize the various types and classes of laser pumping scenarios and gain media types.

7.) Identify the unique capabilities and properties of laser light sources.

8.) List the applications of lasers in a diverse set of fields and applications.

Audience:

This course is designed for participants with interest in understanding the fundamental operational principles, design challenges, and practical issues of single frequency and modelocked lasers sources.

Instructor Biography:

Randy A. Bartels received his Ph.D. from the University of Michigan 2002. His Ph.D. work was performed at JILA in Boulder, CO, where he worked on ultrafast laser development, coherent control of quantum systems, and the study of extreme nonlinear optical processes. Randy is currently an Associate Professor of Electrical and Computer Engineering, with joint appointments in the Department of Chemistry and in the School of Biomedical Engineering at Colorado State University (CSU). Prof. Bartels has been awarded the Adolph Lomb Medal from the Optical Society of America, a National Science Foundation CAREER award, a Sloan Research Fellow in physics, a gold medal for the Human Competitive award for work in evolutionary computation, an Office of Naval Research Young Investigator Award, a Beckman Young Investigator Award, an IEEE-LEOS (now Photonics Society) Young Investigator Award, and was named a Kavli Fellow of the National Academy of Sciences. Prof. Bartels was awarded a Presidential Early Career Award for Science and Engineering (PECASE. His current research involves the control and ultra-sensitive detection of molecular coherences for novel spectroscopy and microscopy applications, the development of VUV laser sources and optical systems, the development of ultrafast fiber lasers, as well as the development of stable optical combs sources in the mid infrared spectral region. Recently, Randy received a grant from the W. M. Keck Medical Research program. He is a Fellow of the Optical Society of America, a senior member of the IEEE, and a member of the APS. He also serves as Associate Editor for the IEEE Journal of Quantum Electronics.

SC378 Introduction to Ultrafast Optics

New Course!

Monday, May 7, 2012

1:00 PM - 5:00 PM

Instructor: Rick Trebino; *Georgia Institute of Technology, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

Ultrafast Optics—the science and technology of ultrashort laser pulses—is one of the most exciting and dynamic fields of science. While ultrashort laser pulses seem quite exotic (they're the shortest events ever created!), their applications are many, ranging from the study of ultrafast fundamental events to telecommunications to micromachining to biomedical imaging, to name a few. Interestingly, these lasers are readily available, and they are easy to understand. But their use requires some sophistication. This course is a basic introduction to the nature of these lasers and the pulses they generate. It will discuss the principles of their generation and amplification and describe their most common distortions in space and time and how to avoid them—or take advantage of them. In addition, it will cover the nonlinear optics of ultrashort pulses for converting pulses to almost any color, as well as the additional interesting and potentially deleterious effects nonlinear optical processes can cause. Finally, it will cover techniques for ultrashort-pulse measurement.

Benefits:

This course should enable the participants to:

1.) Understand how ultrashort-pulse lasers and amplifiers work.

2.) Understand and describe ultrashort pulses and their many distortions.

3.) Use nonlinear optics to an convert ultrashort laser pulse to virtually any wavelength.

4.) Take advantage of—or avoid—nonlinear-optical high-intensity effects.

5.) Meaningfully measure ultrashort pulses.

Audience:

Any scientist or engineer interested in the science and technology of the shortest events ever created, especially those new to it.

Instructor Biography:

Rick Trebino is the Georgia Research Alliance-Eminent Scholar Chair of Ultrafast Optical Physics at the School of Physics at the Georgia Institute of Technology. His research focuses on the use and measurement of ultrashort laser pulses. He is best known for his invention and development of Frequency-Resolved Optical Gating (FROG), the first general method for measuring the intensity and phase evolution of an ultrashort laser pulse, and which is rapidly becoming the standard technique for measuring such pulses. He has also invented techniques for measuring ultraweak ultrashort pulses, ultracomplex pulses, ultrafast polarization variation, and the complete spatio-temporal measurement of ultrashort pulses. He has also developed pulse compressors and a general theory of spatio-temporal distortions of ultrashort pulses.

SC379 Silicon Photonics

New Course!

Sunday, May 6, 2012

9:00 AM - 12:00 PM

Instructor: Michal Lipson; *Cornell Univ., USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

Silicon Photonics enables a platform for monolithic integration of optics and microelectronics for applications of optical interconnects where high data streams are required in a small footprint. The course will begin with an overview of optical communications and charts the birth of on-chip photonics from the meeting of the fiber optics and integrated circuit industries. This will be followed by an introduction to the basic concepts that enable one to understand and design a range of photonic functionalities. The fundamental physics of light confinement, carrier generation and transmission will be reviewed, and followed by a detailed review of key passive and active devices. The course will describe the state of art and research challenges of silicon photonic integration with microelectronics for interconnect applications. Silicon is evolving as a versatile photonic platform with multiple functionalities that can be seamlessly integrated. The tool box is rich starting from the ability to guide and amplify multiple wavelength sources at GHz bandwidths, to optomechanical MEMS and opto-fluidics devices. The course will describe these new research directions and novel applications.

Benefits:

This course should enable the participants to:

1. Explain the key physical concepts used in silicon photonics that enable light manipulation at ultra small length- and time- scales.
2. Explain choices of different materials, shapes, and sizes to accomplish different photonic functionalities.
3. Summarize the current state of the field in terms of device applications.
4. Describe the most recent trends and developments in research and applications.

Audience:

The course is intended for researchers or early graduate students with little or no background in silicon photonics or integrated optics. Those familiar with the subject area will experience a review of basic concepts and main applications, but will also learn about the most recent developments in the field.

Instructor Biography:

Michal Lipson is an Associate Professor at the School of Electrical and Computer Engineering at Cornell University, Ithaca NY. Her research focuses on novel on-chip Nanophotonics devices. She has pioneered several of the critical building blocks for silicon photonics including the GHz silicon modulators. Professor Lipson's honors and awards include MacArthur fellow, NYAS Blavatnik award, OSA Fellow, IBM Faculty Award, and NSF Early Career Award. More information on Professor Lipson can be found at nanophotonics.ece.cornell.edu