CLEO:2011

Laser Science to Photonic Applications

Technical Conference: 1-6 May 2011

Expo: 3-5 May 2011

Short Courses: 1-3 May 2011

Baltimore Convention Center, Baltimore, Maryland, USA

CLEO: 2011 concluded in Baltimore this week and once again provided a must-attend venue for the latest research and business developments coming out of the lasers and electro optics field. Featured technical presentations covered developments from research teams around the world in the areas of nonlinear optics, biophotonics, ultrafast lasers, quantum optics and more.

Attendees heard technical presentations at CLEO: 2011 that also made a big impact in the pressâ€”from ceramic microlasers for multi-point ignition to 3-D invisibility cloaks, the science and media worlds alike are buzzing with news of laser applications and technology.

The first of two CLEO Plenary Sessions reflected the full range of content in research and technology with presentations from two luminaries in the field. Don Keck (retired, Corning) gave an insightful historical perspective on the development of the first low-loss optical fiber, while Jim Fujimoto (MIT) provided a captivating look into the world of medical imaging with Optical Coherence Tomography.

Held Tuesday through Thursday, CLEO: Expo showcased the latest in laser systems, optoelectronic components, imaging and sensing equipment, infrared detectors, test & measurement equipment and more from 300 participating companies.

The new products and demos were complemented by show floor programming highlighting technology transfer and four hot topic areas as part of CLEO: Market Focus - biophotonics, energy, industrial lasers and defense/security.

The Technology Transfer Program featured speakers from universities and U.S. government labs discussing ways to take laboratory R&D into the marketplace with presentations such as "Creating Infrastructure to Transition Early Stage Technologies to Commercial Use" and "Technology Transfer Opportunities at Stanford University."

The second CLEO Plenary Session focused on the hot topic research areas of nonlinear optics and photonic crystals, with keynote presentations from Moti Segev (Technion Institute of Technology, Israel) covering Anderson Localization of Light and Susumu Noda (Kyoto University, Japan) discussing recent progress and new trends in photonic crystals.

The more than 1,700 presentations at CLEO: 2011 were spread across three program areas this year:

- CLEO: Science & Innovations, or the "classic" CLEO program, covers applied research and innovations in lasers, optical materials, and photonic devices.
- CLEO: QELS - Fundamental Science continues to be the premier venue for discussion of fundamental research in optical and laser physics-related areas.
- CLEO: Applications & Technology is a new program area exploring the intersection of academic research with product commercialization.

Featured research in the CLEO: Science & Innovations program included a paper from the Institute for Molecular Science in Japan demonstrating a ceramic micro-laser with two-beam output for multi-point ignition, which may one day lead to traditional spark plugs being replaced with a fuel-efficient laser-based system.

Appearing in CLEO: QELS - Fundamental Science category was a paper demonstrating a full 3-D invisibility cloak in visible light by a research team from the Karlsruhe Institute of Technology in Germany.

Featured research in the CLEO: Applications & Technology program included a presentation from Lawrence Livermore National Lab on several applications of MEGa-rays, including mobile MEGa-ray technology for bomb detection, nuclear waste assessment and drug tracking.

The hard work of the CLEO volunteer committees is reflected in the full range of topics covered at the conference. General co-chairs of CLEO: 2011 included: Hal Metcalf, SUNY Stony Brook, USA and Vladimir Shalaev, Purdue Univ., CLEO: QELS - Fundamental Science co-chairs; Kaoru Minoshima, Natl. Inst. of Advanced Industrial Science and Technology, Japan (pictured), CLEO: Science & Innovations co-chair; and Timothy Carrig, Lockheed Martin, USA, CLEO: Science & Innovations co-chair and CLEO: Applications & Technology chair.

CLEO: 2011 provided 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 we head to San Jose for CLEO: 2012, May 6 - 11.

Conference Program

The CLEO: 2011 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, 2 May 2011

Tuesday, 3 May 2011

Wednesday, 4 May 2011

Thursday, 5 May 2011

Friday, 6 May 2011

CLEO: 2011 Postdeadline Paper Abstracts

Agenda of Sessions and Key to Authors and Presiders

Agenda of Sessions

Key to Authors and Presiders

CLEO: 2011 Postdeadline Paper Key to Authors and Presiders

CLEO: 2011 Committees

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2011 CLEO:QELS – Fundamental Science 2: Quantum Science, Engineering and Technology

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2011 CLEO:QELS – Fundamental Science 4: Optical Interactions with Condensed Matter and Ultrafast Phenomena

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2011 CLEO:QELS – Fundamental Science 5: Nonlinear Optics and Novel Phenomena

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2011 CLEO: Science & Innovations 9: Components, Integration, Interconnects and Signal Processing

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Optical Society of America
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Steven Cundiff, *NIST, USA*
Prem Kumar, *Northwestern Univ., USA*

APS/Division of Laser Science
Nicholas Bigelow, *Univ. of Rochester, USA*
Wendell T. Hill, *Univ. of Maryland at College Park, USA*
Hailin Wang, *Univ. of Oregon, USA*

IEEE/Photonics Society
Alexander L. Gaeta, *Cornell Univ., USA*
David Hutchings, *Univ. of Glasgow, UK*
Andrew Weiner, *Purdue Univ., USA*

CLEO: 2011 Invited Speakers

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

Tutorial Speaker

Wednesday, 4 May
QWB1, **Ultracold Molecules: Production Techniques and Scientific Applications**, D. DeMille, *Physics Dept., Yale Univ., USA*

Invited Speakers

Tuesday, 3 May
QTuJ3, **Quantum Sensors, Computing, Metrology, and Imaging**, J.P. Dowling, *Louisiana State Univ., USA*
QTuO5, **Spin Self–Rephasing and Very Long Coherence Times in Trapped Atomic Ensembles**, P. Rosenbusch, *LNE–SYRTE, Observatoire de Paris, CNRS, France*

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

Invited Speakers

Thursday, 5 May
QThO5, **Quasiprobability Representations of Quantumness**, W. Vogel, T. Kiesel, J. Sperling, *Univ. Rostock, Germany*
QThT1, **Continuous Variable Quantum Communication and Computation**, U.L. Andersen, R. Dong, M. Jezek, A. Laghaout, M. Lassen, L. Madsen, A. Tipsmark, *Technical Univ. of Denmark, Denmark*

Friday, 6 May
QFH3, **Experimental Repetitive Quantum Error Correction with Trapped Ions**, M. Hennrich[1], P. Schindler[1], J.T. Barreiro[1], T. Monz[1], D. Nigg[1], M. Chwalla[1], R. Blatt[1], V. Nebendahl[2]; *[1]Institut fuer Quantenoptik und Quanteninformation, Osterreichische Akademie der Wissenschaften, Austria, [2] Institut fuer Theoretische Physik, Univ. Innsbruck, Austria*

CLEO: QELS Fundamental Science 3: Metamaterials and Complex Media

Tutorial Speaker

Tuesday, 3 May
QTuM1, **Optical Metatronics**, N. Engheta, *Univ. of Pennsylvania, USA*

Invited Speakers

Tuesday, 3 May
QTuG5, **Three–dimensional Invisibility Carpet Cloak at 700nm Wavelength**, T. Ergin, J.

Fischer, M. Wegener, *Inst. for Applied Physics, DFG–Center for Functional Nanostructures (CFN), and Inst. für Nanotechnologie, Karlsruhe Inst. of Technology, Germany*

Friday, 6 May
QFA5, **Plasmonic Oligomers: The Role of Individual Particles in Collective Behavior**, M. Hentschel[1,2], D. Dregely[1], H. Giessen[1], N. Liu[3]; *[1] 4th Physics Inst. and Research Center SCoPE, Univ. of Stuttgart, Germany, [2]Max–Planck–Inst. for Solid State Res., Germany; [3]Dept. of Chemistry, Univ. of California at Berkeley and Materials Science Division, Lawrence Berkeley Natl. Lab, USA*
QFE1, **Intraband Optical Transitions in Graphene**, F. Wang, *Univ. of California at Berkeley, USA*

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

Tutorial Speaker

Monday, 2 May
QME1, **Coherent Processes in the Ultrafast Magnetization Dynamics**, J. Bigot; *Univ. of Strasbourg – CNRS, France*

Invited Speakers

Monday, 2 May
QMH3, **Persistent Spin Helix in GaAs Quantum Wells**, J. Orenstein; *Univ. of California at Berkeley, USA*
QMK1, **Ultrafast Optical Entanglement Control between two Quantum Dot Spins**, S.G. Carter, D. Kim, A. Greilich, A.S. Bracker, D. Gammon; *NRL, USA*

Wednesday, 4 May
QWD5, **Terahertz Frequency Magnetoelectric Phenomena in Condensed Matter**, R. Shimano; *Univ. of Tokyo, Japan*

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

Tutorial Speaker

Wednesday, 4 May
QWE1, **Cavity Optomechanics**, P. Meystre; *Univ. of Arizona, USA*

Invited Speakers

Monday, 2 May
QMA1, **Electron Laguerre–Gaussian Beams**, B. McMorran[1], A. Agrawal[1,2], H. Lezec[1], J.J. McClelland[1], J. Unguris[1], I.M. Anderson[1], A.A. Herzing[1]; *[1]NIST, USA, [2]Univ. of Maryland, USA*
QMD5, **Observation of Nonlinear Light Bullets in Waveguide Arrays**, F. Eilenberger[1], S. Minardi[1], E. Pshenay–Severin[1], S. Nolte[1], A. Tünnermann[1], T. Pertsch[1], Y. Kartashov[2], L. Torner[2], A. Szameit[3], U. Roepke[4], J. Kobelke[4], K. Schuster[4], F. Lederer[5]; *[1]Inst. of Applied Physics, Friedrich Schiller Univ., Germany, [2]ICFO – Inst. de Ciences Fotoniques, and Univ. Politecnica de Catalunya, Spain, [3]Solid State Inst. and Physics Dept., Technion, Israel, [4]Inst. of Photonic Technology, Germany, 5Inst. of Condensed Matter Theory and Solid State Optics, Friedrich Schiller Univ., Germany*

Wednesday, 4 May
QWI3, **An Optically Pumped Phonon Laser in a Silicon Micromechanical Oscillator**, M.W. Pruessner[1], J.B. Khurgin[2],T. Stievater[1], W.S. Rabinovich[1]; *[1]NRL, USA, [2]Johns Hopkins Univ., USA*

Thursday, 5 May
QThN1, **NOON States**; Y. Silberberg, *Weizmann Inst. of Science, Israel*

Friday, 6 May
QFB1, **Optical Antennas for Enhanced Light Absorption and Emission**, L. Novotny; *Univ. of Rochester, USA*

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

Tutorial Speaker

Tuesday, 3 May
QTuA1, **Solar Energy Applications of Plasmonics**, H. Atwater, *Caltech, USA*

Invited Speakers

Tuesday, 3 May
QTuE1, **Optical Trapping at the Ultimate Nanoscale in the Near–field of Plasmonic Antennas**, O.J. Martin; *Nanophotonics & Metrology Lab, Swiss Fed. Inst. Technology, Switzerland*

Wednesday, 4 May
QWC1, **Unidirectional Emission of a Quantum Dot Coupled to an Optical Nanoantenna**, N.F. van Hulst, *ICFO – Inst. of Photonic Sciences, Spain*
QWG2, **Nanoparticle Manipulation Using a Plasmonic Nano–tweezer with an Integrated Heat Sink**, K. Wang[1], K.B. Crozier[1], E. Schonbrun[1], P. Steinvurzel[2]; *[1]Harvard Univ., USA,*

[2]*Boston Univ., USA*
QWG1, **Optical Bonding And Antibonding Forces In Asymmetric Geometries For Casimir Force Detection**, D.N. Woolf[1], P. Hui[1], E. Iwase[1], A. Rodriguez[1], I. Lovchinsky[1], M. Khan[1], M. Loncar[1], F. Capasso[1], A. Rodriguez[2], A. McCauley[2], S.G. Johnson[2]; [1]*Harvard Univ., USA*, [2]*MIT, USA*

Thursday, 5 May
QThQ1, **Off–axis and Multi–directional Plasmonic Lenses**, R. Blanchard[1], J. Tetienne[1], N. Yu[1], P. Genevet[1], A. Kats[1], J. Fan[1], F. Capasso[1], T. Edamura[2], S. Furuta[2], M. Yamanishi[2]; [1]*Harvard Univ., USA*, [2]*Hamamatsu Photonics, Japan*

Friday, 6 May
QFC1, **Octave–wide Photonic Band Gap in Three–Dimensional Plasmonic Bragg Structures**, R. Taubert, H. Giessen; *4th Physics Inst. and Research Center SCoPE, Univ. of Stuttgart, Germany*

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

Tutorial Speaker

Monday, 2 May
QMG1, **Resolving Attosecond Processes via High Harmonic Generation**, N. Dudovich; *Weizmann Inst. of Science, Israel*

Invited Speakers

Monday, 2 May
QMF3, **Ultraintense X–Ray Induced Multiple Ionization and Double Core–Hole Production in Molecules**, N. Berrah, *Western Michigan Univ., USA*

Tuesday, 3 May
QTuC5, **Powerful Attosecond Pulses from Relativistic Mirrors**, M. Zepf, *Queen's Univ. Belfast, UK*

CLEO: Science & Innovations 1: Laser Processing of Materials: Fundamentals and Applications

Tutorial Speaker

Wednesday, 4 May
CWE3, **Laser Fabrication of 3–D Microenvironments for Small Cellular Populations**, J.B.

Shear[1,2], E.T. Ritschdorff[1], J.L. Connell[1], E. Spivey[1]; *[1]Univ. of Texas at Austin, USA, [2]Rice Univ., USA*

Invited Speakers

Tuesday, 3 May
CTuAA5, **Hybrid Optoelectronics**, P. Lagoudakis, *Univ. of Southampton, UK*
(Joint with CLEO: Applications & Technology 4)

JTuH3, **Printing Thin Films by Laser Decal Transfer**, A. Pique; *NRL, USA*

Wednesday, 4 May
CWO1, **Synthesis of Materials by Ultrafast Microexplosion**, A. Vailionis[1,2], V. Mizeikis[3], W. Yang[4], E. Gamaly[5], A. Rode[5], S. Juodkazis[6]; *[1]Geballe Lab for Advanced Materials, Stanford Univ., USA, [2]Stanford Inst. for Materials and Energy Sciences, SLAC National Accelerator Lab, USA, [3]Division of Global Res. Leaders, Shizuoka Univ., Japan, [4]HPSynC – Carnegie Institution of Washington, Argonne Natl. Lab, USA, [5]Laser Physics Centre, The Australian National Univ., Australia, [6]Centre for Micro–Photonics, Swinburne Univ. of Technology, Australia*

CLEO: Science & Innovations 2: Solid–State, Liquid, Gas, and High–Intensity Lasers

Tutorial Speaker

Monday, 2 May
CMH1, **Laser Beam Quality Control with Nonlinear Interactions and Adaptive Optics**, A. Brignon; *Thales Research & Technology, France*

Invited Speakers

Monday, 2 May
CMP3, **ALADIN TxA – a Spaceborne UV Laser**, M. Endemann; *European Space Agency, Netherlands*

Tuesday, 3 May
CTuJ1, **The Vulcan 10 PW OPCPA Project**, John Collier, *Rutherford Appleton Lab, UK*

Wednesday, 4 May
CWG5, **Extreme Ultraviolet Free Electron Laser Seeded by High–Order Harmonic**, T. Togashi[1], [2], T. Sato[1], T. Hara[1], N. Kumagai[1], S. Matsubara[1], [2], M. Nagasono[1], T. Ohshima[1], [2], Y. Otake[1], [2], T. Shintake[1], H. Tanaka[1], [2], T. Tanaka[1], [2], K. Togawa[1], H. Tomizawa[1], [2], M. Yabashi[1], T. Ishikawa[1], T. Watanabe[2], E. Takahashi[3], K. Midorikawa[3], M. Aoyama[4], H. Yamakawa[4], T. Sato5, A. Iwasaki5, S. Owada5, T. Okino5, K. Yamanouchi5, M.E. Couprie6; *[1]XFEL Project Head Office, RIKEN, Japan, [2]Japan Synchrotron Radiation Research Inst., Japan, [3]Advanced*

Science Inst., RIKEN, Japan, [4] Quantum Beam Science Directorate, Japan Atomic Energy Agency, Japan, 5The Univ. of Tokyo, Japan, 6Synchrotron SOLEIL, France

CLEO: Science & Innovations 3: Semiconductor Lasers

Tutorial Speaker

Tuesday, 3 May
CTuG1, **Nanoscale Lasers: How Small Can they Go?** S.L. Chuang, *Univ. of Illinois at Urbana–Champaign, USA*

Invited Speakers

Monday, 2 May
CMF3 , **Monolithically Integrated Solid–State Terahertz Transceivers**, M. Wanke[1], C. Nordquist[1], M. Cich[1], C.T. Fuller[1], J. Reno[1], M. Lee[2], A.D. Grine[3]; *[1]Sandia National Labs, USA, [2]Univ. of Texas at Dallas, USA, [3]LMATA Government Services, USA*
CMQ5 , **Nonlinear Dynamics, Phase Coherence, and Mode Locking in Quantum Cascade Lasers**, A. Belyanin[1], A. Wojcik[1], N. Yu[2], L. Diehl[2], F. Capasso[2]; *[1]Texas A&M Univ., USA, [2]Harvard Univ., USA*

Tuesday, 3 May
CTuG2, **Room Temperature CW Operation of Metal–Semiconductor Plasmonic Nanolasers with Subwavelength Cavity**, Z. Liu[1], K. Ding[1], L. Yin[1], M. Hill[2], M.J. Marell[2], R.J. van Veldhoven[2], R. Noetzel[2], C. Ning[2]; *[1]Arizona State Univ., USA, [2]COBRA Research Inst., Technische Univ. Eindhoven, Netherlands*

Thursday, 5 May
CThG3, **Femtosecond Semiconductor Lasers**, A. Tropper, *Univ. of Southampton, UK*

Friday, 6 May
CFL3, **A Germanium–on–Silicon Laser for On–chip Applications**, J. Michel[1], L. Kimerling[1], R. Camacho–Aguilera[1], J. Bessette[1], Y. Cai[1], J. Liu[2]; *[1]MIT, USA, [2]Dartmouth College, USA*

CLEO: Science & Innovations 4: Applications of Nonlinear Optics

Tutorial Speaker

Thursday, 5 May
CThR1, **Slow Light, Fast Light, and their Applications**, R.W. Boyd[1,2]; *[1]Univ. of Ottawa, Canada, [2]Inst. of Optics, USA*

Invited Speakers

Monday, 2 May
CMR1, **Spatiotemporal Quasi Phase Matching**, A. Bahabad, *Tel Aviv Univ., Israel*

Tuesday, 3 May
CTuD5, **Doubly Resonant Optical Parametric Oscillator: A Generic Transmitter Architecture for DIAL**, M. Raybaut, A. Godard, A.K. Mohamed, M. Lefebvre; *DMPH/SLM, Onera, The French Aerospace Lab, France*
CTuQ1, **Liquid Crystals Nonlinear Optics – CW to Femtoseconds All–Optical Signal Processing**, I. Khoo, *Pennsylvania State Univ., USA*

Thursday, 5 May
CThR2, **Large Two–Photon Absorption Enhancement with Extremely Nondegenerate Photons**, E. Van Stryland[1], D. Fishman[1], S. Webster[1], D.J. Hagan[1], C. Cirloganu[2], L. Padilha[3]; [1]*CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA,* [2]*Georgia Inst. of Technology, USA,* [3]*Los Alamos Natl. Lab, USA*

CLEO: Science & Innovations 5: Terahertz Technologies and Applications

Tutorial Speaker

Wednesday, 4 May
CWK1, **Terahertz Metamaterials: Recent Developments and New Opportunities**, R.D. Averitt, *Boston Univ., USA*

Invited Speakers

Monday, 2 May
CMM3, **Amplified Stimulated Terahertz Emission from Optically Pumped Graphene**, T. Otsuji[1], S. Boubanga Tombet[1], A. Satou[1], V. Ryzhii[2]; [1]*RIEC, Tohoku Univ., Japan,* [2]*CNEL, Univ. of Aizu, Japan*
CMFF3, **Semiconductor Laser Based THz Technology**, C. Brenner, M.R. Hofmann; *Photonics and Terahertz Technology, Ruhr Univ. Bochum, Germany*

Wednesday, 4 May
CWA5, **Three–dimensional Terahertz Cloak**, F. Zhou[1], Y. Bao[1], W. Cao[2], C. T. Stuart[1], J. Gu[2], W. Zhang[2], C. Sun[1]; [1]*Northwestern Univ., USA,* [2]*Oklahoma State Univ., USA*

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

Tutorial Speaker

Tuesday, 3 May
CTuR1, **Advanced in Quantum Dot Lasers: Classical Lasers and Single Artificial Atom Lasers with a Nanocavity**, Y. Arakawa; *Univ. of Tokyo, Japan*

Invited Speakers

Monday, 2 May
CMV5, **Nanoplasmonics for Guiding, Focusing and Detection Applications**, U. Levy, Y. Zuta, B. Desiatov, I. Goykhman; *Hebrew Univ., Israel*

Tuesday, 3 May
CTuR2, **Recent Progress and Future Prospects in Quantum Cascade Lasers**, C. Gmachl; *Princeton Univ., USA*
CTuY1, **Melt–grown Molecular Mono–crystals: Morphology, Optical Properties, Role of the Substrate**, S. Tavazzi, S. Mora, P. Spearman; *Univ. of Milano, Italy*

CLEO: Science & Innovations 7: Micro– and Nano–Photonic Devices

Tutorial Speaker

Monday, 2 May
CMO1, **Nanophotonics for Information Systems Integration**, Y. Fainman; *Univ. of California at San Diego, USA*

Invited Speakers

Monday, 2 May
CMX3, **Coupled Nanocavity–Grating Resonances: Large Plasmonic Enhancement of Nonlinear Optical Phenomena**, F. Capasso[1,2], P. Genevet[1,2], J. Tetienne[1], R. Blanchard[1], A. Kats[1], M.O. Scully[2,3], E. Gatzogiannis[4]; *[1]Harvard Univ., USA, [2]Texas A&M Univ., USA, [3]Princeton Univ., USA, [4]Center for Nanoscale System, USA*

Tuesday, 3 May
CTuN5, **40GHz Zero Chirp Single–ended EO Polymer Modulators with Low Half–wave Voltage**, G. Yu, J. Mallari, H. Shen, E. Miller, C. Wei, V. Shofman, D. Jin, B. Chen, H. Chen, R. Dinu; *GigOptix Inc., USA*

Wednesday, 4 May
CWC3, **From Analog to Digital Conversion to Blood Screening; Evolution of Photonic Time Stretch**, B. Jalali[1,3], K. Goda[1,2], A. Fard[1,2], S. Kim[1]; *[1]Electrical Engineering, Univ. of California at Los Angeles, USA, [2]California NanoSystems Inst., Univ. of California at Los Angeles, USA,*

[3]*Department of Surgery, Univ. of California at Los Angeles, USA*
CWM1, **Fabless Nanophotonics**, M. Hochberg; *Univ. of Washington, USA*

Thursday, 5 May
CThA5, **Ultra–fast Optical Signal Processing using Optical Time Lenses and Highly Nonlinear Silicon Nanowires**, L. K. Oxenlowe; *DTU Fotonik, Denmark*

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

Tutorial Speaker

Tuesday, 3 May
CTuT1, **Few-Cycle Optical Parametric Chirped-Pulse Amplification**, A. Baltuska; *Technical Univ. of Vienna, Austria*

Invited Speakers

Monday, 2 May
CMD5, **Sub–40 fs Er:fiber Laser**, Z. Zhang, W. Zong, C. Li, D. Ma, C. Zhou, A. Wang; *Peking Univ., China*

Tuesday, 3 May
CTuH3, **Sub–30nm Spatial Resolution Imaging Using a Tabletop 13nm High Harmonic Source**, M.D. Seaberg[1], D.E. Adams[1], M. Murnane[1], H.C. Kapteyn[1], W.F. Schlotter[2], Y. Liu[3], C. Menoni[4]; [1]*Univ. of Colorado at Boulder, USA,* [2]*SLAC National Lab, USA,* [3]*Center for X–Ray Optics, Lawrence Berkeley Natl. Lab, USA,* [4]*Colorado State Univ., USA*
CTuO1, **Characterizing Ultrashort Pulses One Photon at a Time**, O. Schwartz, O. Raz, O. Katz, N. Dudovich, D. Oron; *Weizmann Inst. of Science, Israel*

Wednesday, 4 May
CWI1, **High–fidelity Frontend Based on XPW Filter for High–contrast Few–cycle OPCPAs**, A. Jullien[1], A. Ricci[1,2], X. Chen[1,3], J. Rousseau[1], R. Lopez–Martens[1], D. Papadopoulos[3,4], A. Pellegrina[3,4], L.P. Ramirez[4], P. Georges[4], F. Druon[4]; [1]*ENSTA–CNRS–Ecole Polytechnique, Laboratoire d'Optique Appliqué, France,* [2]*Thales Optronique SA, France,* [3]*Inst. de la Lumiére Extréme, France,* [4]*Lab Charles Fabry de l'Insitut d'Optique, France*

Thursday, 5 May
CThAA1, **Carbon Nanotube Saturable Absorbers for Bulk Solid–State Laser Mode–Locking**, F. Rotermund; *Division of Energy Systems Res., Ajou Univ., Republic of Korea*

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

Tutorial Speaker

Friday, 6 May
CFB1, **Lasers on Silicon**, J. Bowers; *Univ. of California at Santa Barbara, USA*

Invited Speakers

Thursday, 5 May
CThI1, **Demonstration of a 10 GHz CMOS–Compatible Integrated Photonic Analog–to–Digital Converter**, M.E. Grein[1], S. Spector[1], J. Wang[1], M.W. Geis[1], M.M. Willis[1], D.M. Lennon[1], T. Lyszczarz[1], A. Khilo[2], A.H. Najadmalayeri[2], M.Y. Sander[2], M. Peng[2], C.M. Sorace[2], E.P. Ippen[2], F.X. Kaertner[2]; *[1]MIT Lincoln Lab, USA, [2]MIT, USA*
CThP5, **A 4x12.5 Gbps CWDM Si Photonics Link using Integrated Hybrid Silicon Lasers**, B.R. Koch[1], A. Alduino[1], L. Liao[1], R. Jones[1], M. Morse[1], B. Kim[1], W. Lo[1], J. Basak[1], H. Liu[1], H. Rong[1], M. Sysak[1], C. Krause[1], A. Liu[1], K. Sullivan[1], O. Dosunmu[1], N. Na[1], T. Yin[1], F. Haubensack[1], I. Hsieh[1], J. Heck[1], R. Beatty[1], J. Bovington[1], M.J. Paniccia[1], R. Saba[2], D. Lazar[2], L. Horwitz[2], R. Bar[2], S. Litski[2]; *[1]Photonics Technology Lab, Intel, USA, [2]Intel, Israel*

Friday, 6 May
CFJ1, **Integration of Semiconductor Mach–Zehnder Modulator with Tunable–wavelength Laser Diode**, Y. Shibata; *NTT Photonics Labs, Japan*

CLEO: Science & Innovations 10: Biophotonics and Optofluidics

Tutorial Speaker

Tuesday, 3 May
(Joint with CLEO: Applications & Technology 1) JTuG1, **Photoacoustic Imaging in Biomedicine**, R.J. Zemp; *Univ. of Alberta, Canada*

Invited Speakers

Monday, 2 May
CMDD1, **Optical Techniques For Tracking Cells in vivo**, C. Lin, MGH Wellman Ctr. for Photomedicine, *Harvard Medical School, USA*

Tuesday, 3 May
CTuF5, **Single Exposure Fabrication and Manipulation of 3–D Hydrogel Cell Microcarriers**, S. Kwon[1,2], L.N. Kim[1,2], S. Choi[1,2], J. Kim[1,2], H. Kim[1,2]; *[1]Seoul National Univ., Republic of Korea; [2]Inter–Univ. Semiconductor Center, Republic of Korea*

Wednesday, 4 May
CWL3, **Cell–Based Assays Using Photonic Crystal Biosensors**, B.T. Cunningham; *Univ. of Illinois, USA*

Thursday, 5 May
(Joint with CLEO: Applications & Technology 1) JThA1, **Fiber–optic Two–photon Fluorescence and Second Harmonic Generation Endomicroscopy**, Y. Zhang[1], K. Murari[1], J. Xi[1], Y. Chen[1], X. Li[1], M. Arkin[2], M. Mahendroo[2], S. Kakkad[3], Z. Bhujwalla[3] , K. Glunde[3], K. Luby–Phelps[4], S. Li5, M. Li5; *[1]Johns Hopkins Univ., USA, [2]Obstetric and Gynecology, UT Southwestern Medical Ctr., USA, [3]Radiology, Johns Hopkins Univ., USA, [4]Cell Biology, UT Southwestern Medical Ctr., USA, 5Science & Technology Division, Corning Incorporated, USA*
CThW3, **Fluorescence Nanoscopy: Eluding the Diffraction Limit by Switching Markers**, A. Schoenle, S.W. Hell; *NanoBiophotonics, MPI for Biophysical Chemistry, Germany*

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

Tutorial Speaker

Monday, 2 May
CMBB1, **Optical Comb and Pulse Generation from CW Light**, T. Sakamoto; *Natl. Inst. of Information and Communications Technology, Japan*

Invited Speakers

Tuesday, 3 May
CTuB3, **Plasmonic Photonic Crystal Fiber**, M. A. Schmidt, H. W. Lee, H. Y. Tyagi, P. Uebel, P. St. J. Russell; *Max Planck Inst. for the Science of Light, Germany*

Thursday, 5 May
CThD1, **Mid–IR Fiber Lasers Based on Molecular Gas–filled Hollow–Core Photonic Crystal Fiber**, A.M. Jones[1], R. Kadel[1], W. Hageman[1], K.L. Corwin[1], B.R. Washburn[1]; A.V.V. Nampoothiri[2], T. Fiedler[2], W. Rudolph[2], N.V. Wheeler[3], F. Couny[3], F. Benabid[3]; *[1]Kansas State Univ., USA, [2]Univ. of New Mexico, USA, [3]Univ. of Bath, UK*
CThD4, **Direct Visible Lasers by Rare Earth Doped Waterproof Fluoro–aluminate Fibers**, Y. Fujimoto; *Inst. of Laser Engineering, Osaka Univ., Japan*
CThM5, Semiconductor Core Optical Fiber, *J. Ballato[1], T. Hawkins[1], P. Foy[1], S. Morris[1], R. Stolen[1], C. McMillen[2], J. Fan[3], L. Zhu[3], R. Rice[4], [1]School of Materials Science and Engineering, Clemson Univ., USA, [2]Dept. of Chemistry, Clemson Univ., USA, [3]Dept. of Electrical and Computer Engineering, Clemson Univ., USA, [4]DreamCatchers Consulting, USA*

Friday, 6 May
CFE3, **Coherent Beam Combining of Fiber Amplifiers in a kW Regime**, A. Flores; *Air Force Res. Lab, USA*

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

Tutorial Speaker

Wednesday, 4 May
CWJ1, **Advances in Modulation Formats for Fiber–Optic Transmission Systems**, S.L. Jansen, D. van den Borne, M. Kuschnerov; *Nokia Siemens Networks, Germany*

Invited Speakers

Thursday, 5 May
CThO1, **All–optical Real–time OFDM Transmitter and Receiver**, W. Freude[1], D. Hillerkuss[1], T. Schellinger[1], R. Schmogrow[1], M. Winter[1], T. Vallaitis[1], R. Bonk[1], A. Marculescu[1], J. Li[1], C. Koos[1], J. Leuthold[1], M. Dreschmann[2], J. Meyer[2], M. Huebner[2], J. Becker[2], S. Ben Ezra[3], M. Caspi[3], B. Nebendahl[4], F. Parmigiani[5], P. Petropoulos[5], B. Resan[6], A.H. Oehler[6], K. Weingarten[6], T. Ellermeyer[7], J. Lutz[7], M. Moeller[7]; *[1]Inst. of Photonics and Quantum Electronics (IPQ), Karlsruhe Inst. of Technology (KIT), Germany, [2]Inst. of Information Processing Technology (ITIV), Karlsruhe Inst. of Technology (KIT), Germany, [3]Finisar Corp., Israel, [4]Agilent Technologies, Germany, [5]Optoelectronics Res.Ctr., UK, [6]Time–Bandwidth Products, Switzerland, [7]Micram Microelectronic GmbH, Germany*
CThX5, **Demonstration of 10–40–Gbaud Baud–Rate–Tunable Optical Generation of 16–QAM from a QPSK Signal Using a Variable DGD Element**, Z. Bakhtiari, J. Wang, X. Wu, J. Yang, S. R. Nuccio, R. Hellwarth, A.E. Willner, *Univ. of Southern California, USA*
CThGG3, **Ultrafast and High–Spectral–Density Optical Communications Systems**, M. Nakazawa, *Res. Inst. of Electrical Communication, Tohoku Univ., Japan*

Friday, 6 May
CFP3, **Automatic Higher–order Dispersion Measurement and Compensation of a 1.28 Tbaud Signal**, Y. Paquot[1], J. Schroeder[1], J. Van Erps[1,2], T.D. Vo[1], M.D. Pelusi[1], B.J. Eggleton[1], S.J. Madden[3], D. Choi[3], D.A. Bulla[3], B. Luther–Davies[3]; *[1]Ctr. for Ultrahigh–bandwidth Devices for Optical Systems (CUDOS), The Univ. of Sydney, Australia, [2] Vrije Univ. Brussel, Belgium, [3]CUDOS, Laser Physics Ctr., Australian National Univ., Australia*

CLEO: Science & Innovations 13. Active Optical Sensing

Tutorial Speaker

Monday, 2 May
CMN4, **Nonlinear Microspectroscopy for Biomedical Applications**, J. Popp[1,2], M. Schmitt[1], B. Dietzek[1,2], P. Rösch[1], R. Möller[2], C. Krafft[2]; *[1]Inst. of Physical Chemistry, Friedrich–Schiller Univ. Jena , Germany, [2]Inst. of Photonic Technology, Germany*

Invited Speakers

Monday, 2 May
CMG5, **Hyperspectral Imaging Technology and Systems, Exemplified by Airborne Real–time Target Detection**, T. Skauli , T.V. Haavardsholm, I. Kåsen, T.O. Opsahl, A. Skaugen, A. Kavara; *Norwegian Defence Res. Establishment (FFI), Norway*

(Joint with CLEO: Applications & Technology 3) JMC3, **IR Reflectance Detection of Explosives Using Pseudo Random Code Generator Driven QCLs**, John Haas, *ARA, USA*

Thursday, 5 May
CThT1, **Low Cost Absorption Sensors for Networked Applications**, M.G. Allen; *Physical Sciences Inc., USA*
CThCC1, **Laser Induced Fluorescence for Quantitative Temperature and Concentration Measurements in Internal Combustion Engines**, F. Beyrau; *Imperial College London, UK*

Friday, 6 May
CFF3, **Broadband Coherent Anti–Stokes Raman Microspectroscopy With Shaped Femtosecond Pulses**, J. Rehbinder, C. Pohling, A. Wipfler, T. Buckup, M. Motzkus, *Physikalisch–Chemisches Inst., Univ. Heidelberg, Germany*

CLEO: Science & Innovations 14: Optical Metrology

Tutorial Speaker

Friday, 6 May
CFK1, **Science and Technology with Optical Frequency Combs**, S. Diddams; *NIST, USA*

Invited Speakers

Wednesday, 4 May
CWQ5, **Dual–Comb Based Measurement of Frequency Agile Lasers**, I. Coddington, F. Giorgetta, E. Baumann, W. Swann, N. Newbury; *NIST, USA*

Thursday, 5 May
CThB3, **Frequency Comb Metrology in the Extreme Ultraviolet**, D.Z. Kandula[1], C. Gohle[1], T.J. Pinkert[1], J. Morgenweg[1], I. Barmes[1], W. Ubachs[1], K.S. Eikema[1], D.Z. Kandula[2], C. Gohle[3]; *[1]LaserLaB, FEW, VU Univ., Netherlands, [2]Max Born Inst., Germany, [3]Ludwig–Maximilians–Univ., Germany*

CLEO: Science & Innovations 15: LEDS, Photovoltaics and Energy–Efficient ('Green') Photonics

Tutorial Speaker

Monday, 2 May
CMA1, **Light Extraction Methods in Light–Emitting Diodes**, J.J. Wierer; *Sandia Natl. Labs, USA*
CMU5, **Nitride–based Nanocolumns and Applications**, K. Kishino[1,2], K. Yamano[1], S. Ishizawa[1], K. Nagashima[1], M. Goto[1], R. Araki[1], A. Kikuchi[1,2], T. Kouno[1]; *[1]Sophia Univ., Japan, [2]Sophia Nanotechnology Res. Ctr., Sophia Univ., Japan*

Invited Speakers

Monday, 2 May
CMT5, **Present and Future of High Efficiency Multi–Junction Solar Cells**, M. Yamaguchi[1], N. Kojima[1], Y. Ohshita[1], T. Takamoto[2], K. Araki[3], M. Imaizumi[4]; *[1]Toyota Technological Inst., Japan, [2]Sharp Co., Japan, [3]Daido Co., Japan, [4]JAXA, Japan*

Wednesday, 4 May
CWF1, **Highly efficient InGaN/GaN blue LED grown on Si (111) substrate**, J. Kim[1,3], Y. Tak[1], J. Lee[1], H. Hong[1], S. Chae[1], H. Choi[1], B. Min[1], Y. Park[1], M. Kim[2], S. Lee[2], N. Cha[2], Y. Shin[2], J. Shim[4]; *[1]Samsung Electronic Company, Republic of Korea, [2]R&D [2]Team, Samsung LED, Republic of Korea, [3]Sejong Univ., Republic of Korea; [4]Hanyang Univ., Republic of Korea*

CLEO: Applications & Technology 1: Biomedical

Tutorial Speaker

Monday, 2 May
AME1, **Therapeutic applications of light: PDT – the killer; LLLT – the healer**, M.R. Hamblin[1,2]; *[1]Wellman Center for Photomedicine, Massachusetts General Hospital, USA, [2]Harvard Medical School, USA*

Tuesday, 3 May
(Joint with CLEO: Science & Innovations 10) JTuG1, **Photoacoustic Imaging in Biomedicine**, R.J. Zemp; *Univ. of Alberta, Canada*

Invited Speakers

Monday, 2 May
AMF1, **Assessing Human Skin with Light**, N. Kollias; *Johnson & Johnson, USA*
AMF2, **Near–infrared Fluorescence Imaging in Humans: New Discoveries from a New Modality**, E. Sevick; *Univ. of Texas Health Science Ctr., USA*

Tuesday, 3 May
ATuB1, **Quantitative, Wide–field Characterization of Tissue Optical Properties and Chromophores with Spatial Frequency Domain Imaging (SFDI)**, D. Cuccia; *Modulated Imaging, Inc., USA*
ATuB4, **Diffuse Spectroscopy with Very High Collection Efficiency**, M.B. van der Mark, A. Desjardins; *Minimally Invasive Healthcare, Philips Res., Netherlands*
ATuC5, **Biomedical Applications of Enhanced Backscattering Spectroscopy**, J. Rogers, N. Mutyal, A. Radosevich, V. Turzhitsky, H. Roy, V. Backman; *Northwestern Univ., USA*

Thursday, 5 May
(Joint with CLEO: Science & Innovations 10) JThA1, **Fiber–optic Two–photon Fluorescence**

and Second Harmonic Generation Endomicroscopy, Y. Zhang[1], K. Murari[1], J. Xi[1], Y. Chen[1], X. Li[1], M. Arkin[2], M. Mahendroo[2], S. Kakkad[3], Z. Bhujwalla[3] , K. Glunde[3], K. Luby-Phelps[4], S. Li[5], M. Li[5]; [1]*Johns Hopkins Univ., USA,* [2]*Obstetric and Gynecology, UT Southwestern Medical Ctr., USA,* [3]*Radiology, Johns Hopkins Univ., USA,* [4]*Cell Biology, UT Southwestern Medical Ctr., USA,* [5]*Science & Technology Division, Corning Incorporated, USA*

CLEO: Applications & Technology 2: Environment-Energy

Tutorial Speaker

Tuesday, 3 May
ATuD1, **Water and Air Treatment Using Ultraviolet Light Sources**, G. Knight; *Trojan Technologies, Canada*

Invited Speakers

Monday, 2 May
AMC1, **High Efficiency Photovoltaics: Recent Progress and Long Term Goals**, N.J. Ekins–Daukes; I*mperial College, London, UK*
AMC4, **New Concepts and Materials for Solar Power Conversion Devices**, W. Walukiewicz; *Lawrence Berkeley Natl. Lab, USA*

Tuesday, 3 May
ATuD2, **Applications of Robust, Radiation Hard AlGaN Optoelectronic Devices in Space Exploration and High Energy Density Physics**, K. Sun[1,2]; [1]*Hansen Experimental Physics Lab, Stanford Univ., USA,* [2]*National Security Technologies, USA*

Wednesday, 4 May
AWA1, **High–power LED Technology and Solid State Lighting**, W. Goetz; *Philips Lumileds Lighting Co., USA*
AWA4, **True Bulk GaN Substrates for High Efficiency Devices**, D.F. Bliss[1]; B. Wang[2], M. Mann[2]; [1]*US Air Force Res. Lab, USA,* [2]*Solid State Scientific Corp., USA*

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

Tutorial Speaker

Tuesday, 3 May
ATuA1, **Upcoming NASA Earth Science Decadal Missions: ICESat II and DESDynI**, M. McGill, T. Markus; *NASA Goddard Space Flight Ctr., USA*

Invited Speakers

Monday, 2 May
(Joint with CLEO: Science & Innovations 13) JMC3, **IR Reflectance Detection of Explosives Using Pseudo Random Code Generator Driven QCLs**, J. Haas, *ARA, USA*

Tuesday, 3 May
ATuE5, **Terahertz Spectral Imaging for Drug inspection**, K. Kawase[1,2], T. Shibuya[1,2], A. Iwasaki[2]; [1]*RIKEN, Japan,* [2]*Nagoya Univ., Japan*
ATuF1, **Lasers in Electronic Warfare**, G. Manke; *Naval Surface Warfare Ctr., USA*
ATuF2, **Mono–Energetic Gamma–rays (MEGa–rays) and the Dawn of Nuclear Photonics**, C. Barty; *Lawrence Livermore Natl. Lab, USA*
ATuF3, **The Intelligence Advanced Research Projects Activity – Its BEST and Beyond**, M. King; *IARPA, USA*

CLEO: Applications & Technology 4: Industrial

Tutorial Speaker

Monday, 2 May
AMB1, **Industrial Applications of Laser Materials Processing**, M. Jones; *GE Global Res. Ctr., USA*

Invited Speakers

Monday, 2 May
AMA1, **Use of Fundamental Laser Material Interaction Parameters in Laser Welding**, S.W. Williams, W. Suder, *Welding Engineering Res. Ctr., Cranfield Univ., UK*
AMD1, **Ultrafast Laser Processing of Semiconductor Devices**, J. Carey, M. Pralle, C. Vineis, J. McKee, S. Alie, J. Sickler, X. Li, J. Jiang, D. Miller, C. Palsule, H. Haddad; *SiONyx Inc., USA*
AMD4, **Laser Microstructuring and Processing in Printing Industry**, G. Hennig[1], S. Bruening[2], B. Neuenschwander[3]; [1]*Daetwyler Graphics AG, Switzerland,* [2]*Schepers GmbH, Germany,* [3]*BFH Burgdorf, Switzerland*

Tuesday, 3 May
(Joint with CLEO: Science & Innovations 1) JTuH3, **Laser Induced Forward Transfer for Industrial Applications**, A. Pique; *NRL, USA*

Special Symposia

Contributions were considered for select Symposiums.

Symposium on Nano-Bio-Photonics

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

Symposium Organizer:
Jin U. Kang, *Johns Hopkins Univ., USA*

Modern radiological diagnostic and therapeutic technologies—such as MRI, CAT, PET, and radiation therapy—are invaluable technologies that are integral parts of today's state–of–the–art medical care. Nevertheless, the technological complexity of installing, maintaining, and operating these technologically advanced systems, along with their high cost, have contributed to ever–rising health care costs and, most important, have contributed to an uneven level of health care across different regions of the world. Advances in nano-biophotonics—especially in the areas of nano-particles and functionalized nano–particles—provide hope that their applications in medicine can revolutionize the future of medical diagnostics and therapeutics toward cost–effective and readily-accessible medical care. We have gathered world-renowned experts in nano–biophotonics to discuss the advances in nano–biophotonics, their technical limitations, and future directions. We will hear from these experts the advances in nano–biophotonic technologies that could be used to provide very early cancer diagnostics, ultra–high resolution diagnostic imaging, and functionalized nano–particle based cancer therapy.

Invited Speakers:

Monday, 2 May

JMB1, **Magnetomotive Molecular Nanoprobes for Optical Biomedical Imaging and Diagnostics**, S.A. Boppart; Beckman Inst., *Univ. of Illinois at Urbana-Champaign, USA*

JMB2, **Beyond Diffraction Limited Imaging and Sensing in Nanobiophotonics**, I. Ilev; *US FDA, USA*

JMB3, **Combined OCT and Fluorescence Imaging for Cancer Detection and Therapeutic Monitoring**, Y. Chen[1], J. Wierwille[1], C. Roney[2], R.M. Summers[2], B. Xu[3], G.L. Griffiths[3]; [1]*Univ. of Maryland, College Park, USA,* [2]*Radiology and Imaging Sciences, Natl. Institutes of Health, USA;* [3]*Imaging Probe Development Ctr., Natl. Institutes of Health, USA*

JME1, **Functional Fluorescent Nanocapsules for Molecular Imaging and Potential Targeted Therapy**, Y. Chen, T. Jabbour, X. Li; *Johns Hopkins Univ., USA*

JME2, **Nanoshells for Two-Photon-Induced Photoluminescence Imaging of Tumors**, J. Tunnell; *Univ. of Texas at Austin, USA*

JME3, **Magnetic Nanoparticles for Contrast Enhanced Infrared Thermal Imaging**, I. Gannot; *Tel-Aviv Univ., Israel*

Symposium on Broadband Spectroscopy: New Techniques and Sources

CLEO: Science & Innovations

Symposium Organizers:
Nathan R. Newbury, *NIST, USA*
Scott Sanders, *Univ. of Wisconsin-Madison, USA*

Spectroscopic instruments that monitor broad portions of the electromagnetic spectrum continue to advance with improvements in optical sources and detection techniques. For example, in recent years researchers have explored the application of stable broadband frequency comb sources to spectroscopy in a number of different approaches. This symposium will collect invited and contributed talks covering new sources and methods suitable for broad-spectral-coverage instrumentation. Dual comb Fourier transform spectroscopy, broadband Mid-IR/NIR/VIS/UV sources, incorporation of novel broadband sources into conventional FTS systems, cavity-enhanced laser supercontinuum techniques, and related developments and analyses are all of interest. Submissions of contributed papers to CLEO S&I 13: Active Optical Sensing, S&I 14: Optical Metrology and S&I 4: Applications of Nonlinear Optics were strongly encouraged to be considered for inclusion in this symposium.

- CLEO: Science & Innovations 13: Active Optical Sensing
- CLEO: Science & Innovations 14: Optical Metrology
- CLEO Science & Innovations 4: Applications of Nonlinear Optics

Invited Speakers:

Thursday, 5 May

CThK1, **Optically Referenced Double Comb Interferometry: Applications and Technological Needs**, J. Genest, J. Deschênes, C. Perilla, S. Potvin, S. Boudreau; *Univ. Laval, Canada*

CThK4, **Molecular Spectroscopy with Laser Frequency Combs**, T.W. Hänsch[1,2], N. Picqué[1,2]; *[1]Max Planck Institut für Quantenoptik, Germany, [2]Ludwig-Maximilians-Univ., Germany*

CThS1, **Broadband Direct Frequency Comb Spectroscopy in the Mid-Infrared**, P. Maslowski, A. Foltynowicz, F. Adler, K.C. Cossel, T. Briles, T. Ban, J. Ye, *JILA, NIST, Univ. of Colorado, Boulder, USA*

CThS2, **Probing Sensitivity Limits by Comb-Based Spectroscopic Techniques**, P. De Natale[1,2], I. Galli[1,2], D. Mazzotti[1,2], G. Giusfredi[1,2], P. Cancio[1,2], G. Gagliardi[1,2], P. Maddaloni[1,2], *[1]INO, CNR, Italy, [2]LENS, Italy*

CThS3, **Molecular Sensing with Supercontinuum Radiation**, C. Kaminski[1,2], S. Kiwanuka[1], T. Laurila[1], *[1]Univ. of Cambridge, UK, [2]SAOT School of Advanced and Optical Technologies, Univ. of Erlangen-Nuremberg, Germany*

CThBB1, **Frequency Divide-and-Conquer Approach to Producing Ultra-broadband Mid-IR Combs**, K. Vodopyanov; *Stanford Univ., USA*

Symposium on Quantum Communications

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

Symposium Organizers:
Thomas Chapuran, *Telcordia Technologies, Inc., USA*
Richard Hughes, *Los Alamos Natl. Lab, USA*
Norbert Lütkenhaus, *Univ. of Waterloo, Canada*
Iain McKinnie, *Lockheed Martin Coherent Technologies, USA*

Quantum communications is a rich interdisciplinary field encompassing fundamental science, innovative technologies, and a broad range of potential applications to computing, cryptography, and networking. Since the first experiments two decades ago, the transmission of quantum states has been extended to ranges of hundreds of kilometers, in optical fiber and in free space. Novel optical networking techniques have been developed to enable scalable communications among large numbers of users. Investigations of entanglement, teleportation, and other uniquely quantum phenomena have provided fundamental insights into the quantum world, while also laying critical groundwork for the development of quantum repeaters. Theoretical research has led to the emergence of wholly new cryptographic paradigms and applications, such as quantum key distribution, quantum secure identification and quantum secret sharing, whose security assurances are rooted in the laws of physics. Large-scale quantum communications testbeds have been demonstrated in recent years in several countries, and commercial standards activities are underway. The symposium will highlight the latest research results across the broad spectrum of quantum communications topics from fundamental science to practical applications. It will provide an overview of quantum communications in optical fiber networks and free-space, including the underlying science, components and technology impacting systems, networks, and field trials, with invited presentations from leading research groups around the world.

Both invited and contributed talks will be presented. Submissions to one of the following subcommittees were considered for this symposium:

- CLEO:QELS–Fundamental Science 2: Quantum Science, Engineering and Technology
- CLEO: Science & Innovations 12: Lightwave Communications and Optical Networks
- CLEO: Applications & Technology 3: Government & National Science, Security & Standards Applications

Invited Speakers:

JTuA1, **Overview of Quantum Communications**, H. Weinfurter; *Ludwig Maximilian Univ., Germany*

JTuA2, **Superconducting Nanowire Single-Photon Detectors**, K. Berggren[1], V. Anant1, X. Hu[1], F. Marsili[1], F. Najafi[1], F. Wong[1], T. Zhong[1], E. Dauler[2], A. Kerman[2], R. Molnar[2], B. Baek[3], R.P. Mirin[3], S. Nam[3], M. Stevens[3]; *[1]MIT, USA, [2]MIT Lincoln Lab, USA, [3]NIST, USA*

JTuC1, **Tokyo QKD Network and the evolution to Secure Photonic Network**, M. Sasaki, *Quantum ICT Group, Natl. Inst. of Information and Communications Technology, Japan*

JTuC2, **Full Eavesdropping on a Practical QKD System**, C. Kurtsiefer; *Natl. Univ. of Singapore, Singapore*

JTuF1, **Recent Progress in Quantum Teleportation Experiments**, J. Pan; *Hefei Natl. Lab for Physical Science at The Microscale and Dept. of Modern Physics, Univ. of Science and Technology of China, China*

JTuF2, **Triple Photons and Triple Slits – a New Frontier in Quantum Mechanics Tests**, Thomas Jennewein[1], H. Hubel[1], D. Hamel[1], A. Fedrizzi[2], S. Ramelov[3], K. Resch[1], U. Sinha[1], C. Couteau[4], R. Laflamme[1], Gregor Weihs[6]; *[1]Univ. of Waterloo, Canada, [2]Dept. of Physics and Centre for Quantum Computer Technology, Univ. of Brisbane, Australia, [3]Inst. for Quantum Optics and Quantum Information, Austrian Acad. of Sciences, Austria, [4]Lab de Nanotechnologie et d'Instrumentation Optique, Univ. de Technologie de Troyes, France, [5]Perimeter Inst. for Theoretical Physics, Canada, [6]Inst. für Experimentalphysik, Univ. Innsbruck, Austria*

Symposium on Fiber Parametric Devices and Applications

CLEO: Science & Innovations

Symposium Organizers:
Jay Sharping, *Univ. California at Merced, USA*
Shu Namiki, *AIST, Japan*

There has been a dramatic increase recently in the breadth of application of guided-wave optical parametric processes. The recent developments in practical phase-sensitive amplifiers and advanced multi-level coherent modulation formats promise to address a looming bandwidth shortage in optical fiber communications. In particular, fiber-based devices have been shown to have many promising features in that they are low-noise, ultrafast, broadband, and, transparent to most signal modulation formats. Fiber-based devices promise to figure heavily in future applications.

The utility of fiber parametric schemes extends well beyond traditional communications. Non-silica fiber platforms such as soft glasses continue to evolve. They are being used as optical sources and signal processing platforms for wavelengths extending well into the infrared. Frequency conversion of signals between visible, near and far infrared bands foretells an explosion of wavelength transparent applications. The ultrafast electronic nonlinearity makes possible the generation and/or processing of short pulses in compact and robust fiber-based systems. Finally, the need to enhance and understand device performance has fueled fundamental theoretical and material studies.

This symposium addresses the recent and future advances in optical parametric processes in fiber and their applications to and beyond optical communications. Presentations will range from theoretical foundations, to material platforms and device implementations. Key topics in communications include low-noise phase-sensitive amplifiers, wavelength conversion techniques, format conversion, and all-optical regeneration for phase-amplitude modulated signals. Key non-communications topics include ultrafast sources, and highly nonlinear and non-silica fibers.

Submissions to one of the following subcommittees were considered for this symposium:

- CLEO: Science & Innovations Subcommittee 11: Fiber Amplifiers, Lasers and Devices
- CLEO: Science & Innovations Subcommittee 12: Lightwave Communications and Optical Networks

Invited Speakers:

Wednesday, 4 May

CWD1, **Progress in Phase-Sensitive Fiber-Optic Parametric Amplifiers and Their Applications**, P. Andrekson[1,2], [1]*Chalmers Univ. of Technology, Sweden,* [2]*EXFO Sweden AB, Sweden*

CWD2, **All-optical Regeneration Based on Phase Sensitive Amplification**, R. Slavik, J. Kakande, F. Parmigiani, D.J. Richardson; *Univ. of Southampton, UK*

CWD3, **Optical Parametric Regeneration for Phase-Modulated Signals**, M. Matsumoto; *Osaka Univ., Japan*

CWN1, **Recent Advances in Fiber Optic Parametric Amplifiers**, J.D. Harvey, S.G. Murdoch, Y. Q. Xu, R. Leonhardt; *Univ. of Auckland, New Zealand*

CWN5, **Parametric Replication and Sampling of Optical Fields**, S. Radic, *Univ. of Southampton, UK*

Symposium on Hybrid Quantum Nanoplasmonic Systems – Towards Active Nanoplasmonics

Joint CLEO: QELS – Fundamental Science, CLEO: Science & Innovations

Symposium Organizers:
Kartik Srinivasan, *NIST, USA*
Harald Giessen, *Univ. of Stuttgart, Germany*
Gennady Shvets, *Univ. of Texas at Austin, USA*
Seth Bank, *Univ. of Texas at Austin, USA*

The symposium covers new and exciting developments in nanophotonics. In particular, hybrid systems where quantum systems such as semiconductor quantum dots or defect centers are coupled to plasmonic nanostructures and nanoantennas are of high interest. Recent exciting developments in the field such as directed emission of photons and net gain will be included. Submissions of contributed papers to CLEO: QELS–Fundamental Science 3: Metamaterials and Complex Media, CLEO:QELS–Fundamental Science 6: Nano-optics and Plasmonics, CLEO Science & Innovations 3: Semiconductor Lasers and CLEO Science & Innovations 7: Micro- and Nano-Photonic Devices were strongly encouraged to be considered for inclusion in this symposium.

- CLEO: QELS–Fundamental Science 3: Metamaterials and Complex Media
- CLEO:QELS–Fundamental Science 6: Nano-optics and Plasmonics
- CLEO Science & Innovations 3: Semiconductor Lasers
- CLEO Science & Innovations 7: Micro- and Nano-Photonic Devices

Invited Speakers:

Monday, 2 May

JMA1, **Lasing and Spontaneous Emission in Gap-plasmon Mode Bragg Grating Waveguides**, M.J. Marell, M. Hill; *Technische Univ. Eindhoven, Netherlands*

JMA2, **Lasers Beyond the Diffraction Limit**, R.F. Oulton[1,2], V.J. Sorger[2], R. Ma[2], T. Zentgraf[2], G. Bartal[2], X. Zhang[2]; [1]*Imperial College London, UK,* [2]*NSF Nanoscale Science and Engineering Ctr., Univ. of California at Berkeley, USA*

JMD1, **Active and Passive Composite Metal-Dielectric Nanophotonic Devices**, Y. Fainman; *Univ. of California at San Diego, USA*

JMD2, **Amplification of Surface Plasmons: Theory and Experiment**, P. Berini, I. De Leon; *Univ. of Ottawa, Canada*

JMF1, **Launching Single Photons into Plasmonic Structure**, J. Wrachtrup, F. Jelezko, B. Grotz, I. Gerhardt, M. Becker, H. Fedder; *Univ. of Stuttgart, Germany*

JMF4, **Plasmonic Modes of Strongly-Coupled Single-Crystalline Gold Nanoparticle Dimmers**, B. Hecht[1], J. Kern[1], J. Prangsma[1], P. Geisler[1], P. Weinmann[2], M. Kamp[2], A. Forchel[2], J. Huang[3], P. Biagioni[4]; [1]*Univ. Würzburg – Nano-Optics & Biophotonics Group, Experimentelle Physik 5, Physikalisches Inst., Röntgen Res. Ctr. for Complex Material Systems, Germany,* [2]*Univ. Würzburg-Technische Physik, Physikalisches Inst., Röntgen Res. Ctr. for Complex Material Systems, Germany,* [3]*Natl. Tsing Hua Univ., Taiwan,* [4]*CNISM – Politecnico di Milano, Italy*

Symposium on Semiconductor Ultraviolet LEDs and Lasers

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

Symposium Organizers:
Michael Wraback, *ARL, USA*
Leo Schowalter, *Crystal IS Inc., USA*
Motoaki Iwaya, *Meijo Univ., Japan*

LEDs and laser diodes offer the possibility of compact, low-cost, energy efficient ultraviolet sources for a myriad of applications addressing health, environment, and safety, including water purification and remediation, hospital sterilization, chemical and biological detection, UV curing, food preservation, and many others. This symposium will bring together leading researchers in semiconductor ultraviolet sources to address fundamental issues affecting the realization of robust UV LEDs and lasers for these applications.

Submissions to one of the following subcommittees were considered for this symposium:

- CLEO: Science and Innovations 3: Semiconductor Lasers
- CLEO: Science and Innovations 15: LEDs Photo-Voltaics and Energy Efficient ("Green") Photonics
- CLEO: Applications and Technology 2: Environment/Energy

Invited Speakers:

Tuesday, 3 May

JTuB1, **AlGaN-based Ultraviolet Lasers – Applications and Materials Challenges**, M.A. Kneissl[1,2], T. Kolbe[1], J. Schlegel[1], J. Stellmach[1], A. Knauer[2], V. Kueller[2], M. Weyers[2], C.L. Chua[3], Z. Yang[3], N. Johnson[3]; *[1]Inst. of Solid State Physics, Technische Univ. Berlin, Germany, [2]Ferdinand-Braun-Inst., Germany, [3]Palo Alto Res. Ctr., USA*

JTuB4, **Near-UV LEDs on Sapphire Using Single Crystal AlN-Buffer**, Y. Ohba; *Toshiba Corp., Japan*

JTuD1, **High Power III-Nitride UV Emitters**, M. Shatalov[1], J. Yang[1], Y. Bilenko[1], R. Gaska[1], M. Shur[2]; *[1]Sensor Electronic Technology, Inc., USA , [2]Rensselaer Polytechnic Inst., USA*

JTuD2, **IQE and EQE of the nitride-based UV/DUV LEDs**, H. Amano[1], G.J. Park[1], T. Tanikawa[1], Y. Honda[1], M. Yamaguchi[1], K. Ban[2], K. Nagata[2], K. Nonaka[2], K. Takeda[2], M. Iwaya[2], T. Takeuchi[2], S. Kamiyama[2], I. Akasaki[2]; *[1]Nagoya Univ., Japan, [2]Meijo Univ., Japan*

Symposium on The Zeno Effect in Optoelectronics and Quantum Optics

CLEO: QELS–Fundamental Science

Symposium Organizers:
Joe Altepeter, *Northwestern Univ., USA*
Jim Franson, *Univ. of Maryland Baltimore County, USA*
Prem Kumar, *Northwestern Univ., USA*

The Zeno effect is the use of repeated measurement to either inhibit or induce unitary evolution. Vaidman described this paradoxical phenomenon by noting that the old adage "a watched pot never boils" can be literally true in the quantum regime. First used to inhibit photon emission in atomic systems, active research on the Zeno effect includes applications in classical and quantum optics, optoelectronics, and quantum information. Topics include Zeno-based quantum logic gates, the Zeno effect as a method for preventing or reversing decoherence, and the use of optically controlled absorption to create novel opto-electronic devices (e.g., fast, low-energy-dissipation classical optical switches). This Symposium will provide a review of the Zeno effect in quantum optics, quantum information, and classical opto-electronics, in addition to presenting invited talks from leading research groups from around the world.

Both invited and contributed talks will be presented. Submissions to one of the following subcommittees were considered for this symposium:

- CLEO:QELS – Fundamental Science 1: Quantum Optics of Atoms, Molecules and Solids
- CLEO:QELS–Fundamental Science 2: Quantum Science, Engineering and Technology
- CLEO:QELS–Fundamental Science 5: Nonlinear Optics and Novel Phenomena
- CLEO: Science & Innovations 12: Lightwave Communications and Optical Networks

Invited Speakers:

Thursday, 5 May

QThB1, **Zeno or Anti-Zeno : which is more useful?** G. Kurizki; *Weizmann Inst., Israel*

QThB4, **Organic Materials for Zeno-Based Optical Switching**, J. Hales[1], J.D. Matichak[1], H. Lin[1], Y. Shi[1], J. Campo[1], N. Makarov[1], H. Kim[1], S.R. Marder[1], J.W. Perry[1], S. Jang[2], A. Jen[2]; *[1]Georgia Inst. of Technology, USA , [2]Univ. of Washington, USA*

QThG3, **Nonlinear Optics near the Single Photon Level with Quantum Dots**, E. Waks[1], D. Sridharan[1], R. Bose[1], H. Kim[1], G. Solomon[2]; *[1]Univ. of Maryland, College Park, USA, [2]NIST, USA*

Plenary Sessions

Rooms III-IV, Baltimore Convention Center

Monday, 2 May 2011
18.00 – 20.30

Donald Keck, *Retired Vice President, Corning, USA*
CLEO: Science & Innovations
Presentation: Communications Revolution: Through a Glass Brightly: Making the First Low-Loss Optical Fibers

Forty years ago a Corning Incorporated team invented the first low-loss optical fiber usable for telecommunications. This critical component launched a global effort that resulted in the Information Age in which we live. Some of the stories of that invention will be shared together with broader perspectives on technological revolutions.

Biography
Dr. Keck retired in 2002 as Vice President, Research Director for Corning Incorporated. He had served there in a number of technical and management positions for 34 years. Most recently he served as a consultant for the Infotonics Technology Center that he helped start in upstate New York, He was a key member of the Corning (Keck, Maurer and Schultz) team that invented low-loss optical fiber in 1970. This work created the optical fiber telecommunications revolution and enabled the Internet. He has authored more than 150 papers and holds 36 patents.

Dr. Keck received his physics degrees from Michigan State University. He is a Distinguished Alumnus and currently serves on the College of Natural Science Advisory Board. He received an honorary doctorate from Rensselaer Polytechnic Institute.

Dr. Keck is an inductee of the National Inventors Hall of Fame. He is a member of the National Academy of Engineering and has served on several NRC Panels. He is a Fellow of the Optical Society of America and the IEEE. Among his awards are the Department of Commerce American Innovator Award and the President's National Medal of Technology.

Presently he is serving as vice-chair, National Inventors Hall of Fame Board of Directors. He is a past member of the oversight board for the National Institute of Standards and Technology (NIST). He is a past Board Chairman of the Optoelectronics Industry Development Association (OIDA) and Past President of the National Inventor's Hall of Fame Foundation. Formerly he served on the boards of directors of PCO, Inc., a joint venture of Corning, Inc. and IBM, and the Optical Society of America. Locally he serves on the American Red Cross, the Community Foundation, and the Science Center Boards.

James Fujimoto, *MIT, USA*
CLEO: Applications & Technology
Presentation: Medical Imaging Using Optical Coherence Tomography

Optical coherence tomography (OCT) uses echoes of light to perform 3D micron scale, real time imaging of tissue pathology in situ. We describe the development of OCT and its application in research, ophthalmology and cardiology.

Biography
James G. Fujimoto obtained his bachelors, masters, and doctorate from the Massachusetts Institute of Technology and has been on the faculty of the Department of Electrical Engineering and Computer Science since 1985. His research interests include femtosecond optics and biomedical optical imaging. Dr. Fujimoto's research group and collaborators were responsible for the invention and development of optical coherence tomography (OCT). He was co-chair of CLEO, the OSA Biomedical Optics and Ultrafast Phenomena Conferences and is current co-chair of the Biomedical Optics conference (BIOS) at Photonics West. Dr. Fujimoto is a Fellow of the OSA, APS, and IEEE. He was co-recipient of the Rank Prize in Optoelectronics in 2002. Dr. Fujimoto is in the National Academy of Engineering, the American Academy of Arts and

Sciences and the National Academy of Sciences. He was co-founder of Advanced Ophthalmic Devices, the company that transferred OCT technology to Carl Zeiss for ophthalmic imaging and co-founder of LightLabs Imaging, a joint venture with Carl Zeiss in cardiovascular imaging that was recently acquired by St. Jude Medical in 2010.

Wednesday, 4 May 2011
8.00 – 10.30

Mordechai (Moti) Segev, *Technion-Israel Inst. of Technology, Israel*
CLEO: QELS – Fundamental Science
Presentation: Anderson Localization of Light

Anderson localization is one of the most fundamental processes in solid-state physics, but optics offers the direct avenue to observe it. I will describe experiments on transport of light in disordered media, and various new ideas ranging from delocalization in quasicrystals to hyper-transport of light, where a light beam expands faster than ballistic.

Biography
Mordechai (Moti) Segev is a Distinguished University Professor and the Trudy and Norman Louis Professor of Physics, at the Technion - Israel Institute of Technology, Haifa, Israel. He has received his B.Sc. and D.Sc. from the Technion, Israel, in 1985 and 1990, respectively. Moti Segev has spent one year at Caltech as a post-doctoral fellow and two more years as a Senior Research Fellow. He joined Princeton in September of 1994 as an Assistant Professor, becoming an Associate Professor in 1997, and a Professor in 1999. In the summer of 1998, Moti Segev went back to his home country, Israel, and joined the Technion, eventually resigning from Princeton in 2000.

Moti Segev has contributed to a wide range of topics in nonlinear optics, and some of his discoveries have opened new areas. For his achievements, he has won several international awards, among them the 2007 Quantum Electronics Prize of the EPS , and the 2009 Max Born Award of the OSA. However, beyond his personal achievements, Moti Segev takes pride in the success of the graduate students and post-doctoral fellows who have worked with him over the years. Among those are currently 12 university professors, in the US, Taiwan, Germany, Italy, Croatia and Israel.

Susumu Noda, *Kyoto University, Japan*
CLEO: Science & Innovations: ***Manipulation of Photons by Photonic Crystals: Recent Progress and New Trends***

Presentation video and slides coming soon!

Photonic crystals, in which the refractive index changes periodically, provide an exciting tool for the manipulation of photons. In this presentation, I will review recent progresses and new trends in photonic-crystal researches.

Biography
Professor Susumu Noda received B.S., M.S., and Ph.D. degrees from Kyoto University, Kyoto,Japan, in 1982, 1984,and 1991, respectively, all in electronics. In 2006, he has received an honorary degree from Gent University, Gent, Belgium. From 1984 to 1988, he was with the Mitsubishi Electric Corporation, and he joined Kyoto University in 1988. Currently he is a Professor with the Department of Electronic Science and Engineering and a director of Photonics and Electronics Science and Engineering Center (PESEC), Kyoto University.

His research interest covers physics and applications of photonic and quantum nanostructures including photonic crystals and quantum nanostructures. He received various awards including the IBM Science Award (2000), the Japan Society of Applied Physics Achievement Award on Quantum Electronics (2005), and OSA Joseph Fraunhofer Award/Robert M. Burley Prize (2006), IEEE Fellow (2008), and IEEE Nanotechnology Pioneering Award (2009). From 2003 to 2005, he served as IEEE/LEOS Distinguished Lecturer.

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.

Defense
Tuesday, 3 May, 10.30-12.30

Sensors & Lasers for Defense and Security
John Koroshetz, Manager, Product Technology and Applications, *Northrop Grumman Laser Systems, USA*, **Moderator**

Sensors and lasers continue to play a broad and vital role in the rapidly evolving environments of the defense and security marketplace. Critical to transitioning emerging technologies is an understanding of the capability gaps, platform requirements, and maturation process of individual component technologies to fulfill the needs of the warfighter. This session will provide an overview of the state of the marketplace across defense applications including soldier, vehicle, airborne, and space-based sensor and laser systems.

John Koroshetz is the Manager of Product Technology and Applications at Northrop Grumman Laser Systems. He has served in a variety of roles at NGLS over the past six years, including Chief Engineer for Laser Components and Subsystems and Manager of the Laser Design group. John has focused on the design, development, production, and support of electro-optic systems for a variety of defense applications including man-portable, vehicle, and airborne target locators, rangefinders, and designators; infrared countermeasures, and non-lethal systems. Prior to joining NGLS, he was active in research and development across the commercial, DoD, and scientific application space including high power fiber and waveguide based lasers for remote sensing and directed energy, commercial solid-state lasers for medical and materials processing, polarization based sensors for astrophysics, and EUV & X-ray sources for lithographic applications. John received a BS in Physics from the University of Central Florida and has authored more than 25 publications and patents in the field of lasers and electro-optics.

Speakers include:

Title to Be Announced
Joshua Culp; NSWC Dahlgren, Tech Direction Agent PM-FSS, USA.

Joshua Culp graduated from the United States Naval Academy in Annapolis, MD with a B.S. in Mechanical Engineering in 1999, and was commissioned as an Officer in the United States Marine Corps. He was qualified as an Air Traffic Control Officer and a Weapons and Tactics Instructor. He served overseas in direct support of Operations Enduring and Iraqi Freedom while assigned to the 22nd Marine Expeditionary Unit (Special Operations Capable), the Combined Joint Task Force - Horn of Africa, and the Current Operations Cell of the Joint Operations Center in Baghdad, Iraq.

Mr. Culp resigned his Commission in the U.S. Marine Corps after 7 years of honorable service and is now a civilian government employee of the Naval Sea Systems Command aboard Naval Surface Warfare Center, Dahlgren, VA. He currently serves as a Technical Direction Agent for the Fire Support Systems Program Manager (PM FSS), Marine Corps Systems Command in Quantico, VA. PM FSS is responsible for the research, development, acquisition, fielding, training and sustainment of the Marine Corps' Laser Target Designators and GPS Target Location Devices.

Infrared Imaging in the Military: Status and Challenges
Craig Hoffman, Associate Superintendent, Optical Sciences Division, *NRL, USA*

Dr. Hoffman is currently Associate Superintendent of the Optical Sciences Division at the U.S. Naval Research Laboratory. In this position he aids the superintendent in guiding the research of ~200 government and contract scientists in myriad areas of optical science including infrared optical materials, organic opto-electronics, semiconductor diode lasers, quantum dot optics, bio-chemical sensing, hyperspectral imaging, infrared focal plane arrays, infrared countermeasures, imaging reconnaissance systems, optical fiber research and fiber optic sensing.

Dr. Hoffman's own research has included the physics of narrow gap semiconductors and superlattices and the susceptibility and hardening of infrared detectors and focal plane arrays to laser radiation. He has published over 200 scientific papers in the open and classified literature. In addition, he represents NRL and the Navy on a variety of Navy and DoD scientific panels

Dr. Hoffman came to NRL as a National Research Council post-doctoral fellow in 1979 after receiving his M.S. (1975) and Ph.D. (1979) degrees in physics from Brown University. He received his B.S. degree in physics from Purdue University (1973). After his fellowship, he joined NRL as a staff scientist in 1981. He became a section head in the Optical Physics branch in 1995 and was appointed Associate Superintendent in 1998. Dr. Hoffman is a member of OSA, IEEE, Sigma Xi and Phi Beta Kappa.

Manufacturing Quality EO Systems for Defense
Jon McGuire, Consulting Engineer, nLIGHT Photonics, USA.

Jon McGuire is a Sr Product Engineer with nLIGHT Photonics, joining the team in 2011 to help grow their portfolio of integrated laser systems for DoD markets. From 2005 - 2011, Jon was a Sr Systems Engineer with Northrop Grumman involved in the design, development, integration, test, and rate production of advanced laser systems for Infrared Countermeasures (IRCM) applications. During that time he also served on the ANSI Optics and Electro-Optics Standards Council from 2007 - 2009 where he helped develop new functional standards for the specification of optical component quality, most notably of surface imperfections. Jon has a BS in Optical Engineering from University of California at Davis’s Dept. of Applied Science and a MS in Optics from the University of Central Florida (CREOL).

Title to Be Announced
Pete Vallianos; Co- Founder, VP Bus. Dev. & Technology Applications, N2 Imaging Systems, USA.

Pete Vallianos has over 40 years experience in EO sensor and system development and management within the US DoD and NATO marketplace starting with GE in 1968 and later moving to the West Coast to work with McDonnell Douglas, Ford Aerospace, Rockwell, and Hughes Aircraft. He became a Technical Consultant and Entrepreneur in 1988 working on combining new imaging sensor, stabilization, and image processing technologies, before focusing on the new generation of uncooled IR systems including the formation of Nytech Imaging Systems. Nytech's success in small IR imagers and development programs for thermal weapon sights and driver's viewers led to the acquisition of Nytech and Pete by DRS Technologies in 2002. N2 Imaging Systems is the new name of the former Nytech Imaging Systems development operation after its spin out from DRS in 2007.

In his current role at N2 imaging Systems, Pete is responsible for the system design of low SWaP, high performance, uncooled IR and multi-sensor imaging systems for soldier, vehicle, and small UAV applications, and development of business and technical strategies to meet the product performance and affordability to allow proliferation of this capability to maintain historic night vision and targeting superiority of US Forces.

Biophotonics
Tuesday, 3 May, 14.00-16.00

Meeting Clinical Needs with Photonics
Christopher Myatt, Founder and CEO, *Precision Photonics Corporation (PPC) and MBio Diagnostics, USA*, **Moderator**

Biophotonics continues to be an exciting field, where advances in lasers and detection technology drive new applications. Photonics technologies play a critical role in imaging (both in traditional microscopy and in newer applications such as OCT and multi-photon microscopy), detection and sensing, and sequencing. While there is a wealth of new techniques in photonics, the key to adoption is in meeting a clinical need that will improve the outcomes of a patient. This panel will review a diverse cross section of topics in biophotonics, with an emphasis on matching new photonic capabilities with clinical needs.

Dr. Myatt founded Precision Photonics Corporation in 2000 to pursue applications of high precision opto-electronics. He has built it into a world-wide supplier of key photonic components, and recently has formed a second company, MBio Diagnostics, focused on applications of ultra-sensitive photonics technology to medical diagnostics. Dr. Myatt received BA (math) and BS (physics) degrees from Southern Methodist University (1991), and a Ph.D. in atomic physics from the University of Colorado (1997). He was a student of Professor Carl Wieman (2001 Nobel Laureate) and created the first Bose-Einstein condensates in Dr. Wieman's laboratory. Prior to founding the company, Dr. Myatt was an NRC Postdoctoral Fellow at NIST, working on single atomic ions and quantum computation.

Speakers Include:

Michael Hamblin, Wellman Center for Photomedicine, *Massachusetts General Hospital, USA and Harvard Medical School, USA*

Dr. Hamblin is a Principal Investigator at the Wellman Center for Photomedicine at Massachusetts General Hospital and an Associate Professor of Dermatology at Harvard Medical School. He received his PhD from Trent University in England in synthetic organic chemistry. His research interests lie in the areas of photodynamic therapy for infections, cancer, and heart disease and in low-level light therapy for wound healing, arthritis, traumatic brain injury and hair regrowth. His research program is supported by NIH, CDMRP and CIMIT among others. He has published over 125 peer-reviewed articles, over 120 conference proceedings, book chapters and international abstracts and holds 8 patents.

Optical Biosensors and Systems Integration for On-site Applications
Frances S. Ligler, Senior Scientist for Biosensors & Biomaterials, *Center for Bio/Molecular Science & Engineering, Naval Research Laboratory, USA*

New concepts for molecular recognition, integration of microfluidics and optics, simplified fabrication technologies, and improved approaches to biosensor system integration are producing smaller, faster, cheaper biosensors with capacity to provide effective and actionable information. We have combined microfluidic mixers, Dean-based separation systems, magnetic field control, and hydrodynamic focusing methods to move target molecules and cells into a variety of interrogation devices. These approaches achieve improved target delivery to sensors and reduced clogging. Most importantly, we have focused on issues critical for effective systems integration, including the interactivity of the choices for sampling technology, biochemistry, optics, fluidics, and electronics. The overall sensing geometry, size, power, and data readout must address the sensing needs and the user requirements—in a final format that is as simple, robust, and inexpensive as possible.

Frances S. Ligler is the Navy's Senior Scientist for Biosensors and Biomaterials and current chair of the Bioengineering Section of the National Academy of Engineering. She earned a B.S. from Furman University and both a D.Phil. and a D.Sc. from Oxford University. She has >350 full-length publications/patents. She has won the National Drug Control Policy Technology Transfer Award, the Chemical Society Hillebrand Award, 3 NRL Awards for Patent of the Year, and the Women in Science and Engineering (WISE) Outstanding Achievement in Science. She serves as an Associate Editor of Analytical Chemistry, as an SPIE Fellow, on the organizing committee for the World Biosensors Congress and on the steering committee for Europt(r)odes, the European Conference on Optical Sensors. In 2003, she was awarded the Homeland Security Award (Biological, Radiological, Nuclear Field) by the Christopher Columbus Foundation and the Presidential Rank of Distinguished Senior Professional by President Bush.

Clinical Relevance of Diffuse Spectroscopy,, Martin B. van der Mark, Principal Scientist, *Philips Research Eindhoven, Netherlands*

In 1990, Martin van der Mark received his PhD from the University of Amsterdam on a thesis about coherence in strongly diffusive scattering of light. In that same year he joined Philips Research in Eindhoven, working on several subjects, mostly related to optics, acoustics and high bit rate signals. From 1995, he worked on Optical Mammography for early breast cancer detection and built a clinical prototype imaging system for multi-wavelength diffuse optical tomography. He conducted a pilot clinical trial involving 327 patients at Leiden University Medical Center, with encouraging results. From 2001 he worked on 4th generation optical recording techniques. Then, in 2005, in collaboration between Bayer Schering, Royal Philips Electronics and Utrecht University Medical Centre he pursued fluorescence assisted diffuse optical tomography for breast cancer detection. Clinical trials showed significant improvements but for reasons of business perspective the project was frozen in 2008. During a short leave at Canterbury University in Christchurch he studied Clifford algebra's and electromagnetism. On return, from New Zealand, a number of assignments were taken up, mostly related to the use of optics in healthcare. Martin is a principal scientist at Philips Research Eindhoven in the group "Minimally Invasive Healthcare". He holds of a number of US and world patents. Presently he is improving nebulizers for the treatment respiratory diseases and he is working on shape sensing and guiding techniques for minimally invasive surgery.

Energy
Wednesday, 4 May, 11.30-13.30

Photonics: A Promising Technology for the Green Energy Value Chain
Keshav Kumar, Newport Corp., USA, **Moderator**

According to World Energy Outlook 2010 report, Global Energy demand increases by 36% between 2008 and 2035, or 1.2% per year on average. This brings extra challenges for well known problems like reduction of greenhouse-gas emissions. To overcome this consumer's need encouragement for energy savings and switching to low carbon energy sources and overall industry needs to look for energy production from green energy sources.

Market Focus Energy session will bring experts to address the existing and new opportunities for photonics products and solutions in energy sector. The discussion will be across the energy value chain which has strong correlation with photonics industry. This session will primarily focus on the usage of photonics components and devices which has accelerated the adoption of more efficient and economical energy sources like LEDs and green energy production sources like solar cells. Speakers will address the challenges and opportunities in LED market where usage of lasers and other suitable photonics components has helped the efficiency and packaging of LEDs from handheld devices to new LED TVs, lighting systems etc. The other part of the program will highlight the challenges and current developments of new processes involving photonics solutions that have helped to improve the efficiency and production of solar cells.

Speakers include:

A Laser System Overview for Laser Inertial Fusion Energy (LIFE) Production
Andy Bayramian, *LLNL, USA*

We will present a design for laser drivers to be used for Laser Inertial Fusion Energy (LIFE) power plants based on the anticipated success of the National Ignition Facility. Modest extensions of existing laser technology ensure near-term feasibility. Simulated performance meets or exceeds plant requirements: 2.2 MJ pulse energy produced by 384 beamlines at 16-Hz, with 18% wall-plug efficiency. High reliability and maintainability are achieved by mounting components in compact, line-replaceable units that can be removed and replaced rapidly during plant operations. Statistical modeling predicts that laser availability can be 99%, which meets power plant availability specifications.

Andy Bayramian received his bachelors from Montana State University, Bozeman, in 1995, and his Ph.D. in Applied Science at Lawrence Livermore National Laboratory from University of California, Davis in 2000. Following graduation, Andy accepted a position as the chief laser scientist responsible for the design, implementation and operation of the Mercury/E23 laser system at Lawrence Livermore National Laboratory (LLNL), a high average power diode pumped solid state laser testbed for fusion driver technology. He is currently the lead scientist designing the laser driver for the Laser Inertial Fusion Energy (LIFE) effort at LLNL. Dr.

Bayramian's interests include applied research in laser optical materials, diode pumped solid state lasers, and LIFE research and technologies. Dr. Bayramian is a subject matter expert in laser physics, spectroscopy, and optical design with over 15 years experience in the design, engineering, and operations of high efficiency diode pumped laser systems. He has three R&D 100 awards for the technical development of innovative solid state laser components.

Electricity - a precious commodity for the future of energy, Jan-Gustav Werthen, Senior Director Photovoltaics, *JDSU, USA*

Photovoltaic conversion of sunlight is becoming an efficient way to generate electricity. Large-scale solar power plants, which operate with minimal environmental impact, are likely to replace conventional energy production in the future.

Dr. Jan-Gustav Werthen brings more than 26 years of technology experience in the optoelectronic and photovoltaic industry to JDSU. As senior director of Photovoltaics, Werthen drives overall business and product development that includes power-over-fiber products and solar CPV cells. He joined JDSU in 2005 as part of the acquisition of company that he founded called Photonic Power Systems, Inc. At Photonic Power Systems, Werthen served as CEO from 2002-2005. During this time, he built a semiconductor device and subsystems organization from the ground up and grew sales to over $1 million annually worldwide. Prior to running his own company, Werthen held management positions at companies such as VS Corporation, an early player in the fiber-to-the-home market, Varian Associates, and Xerox. Werthen received his Ph.D. and M.S. in Materials Science and Engineering from Stanford University.

Industrial

Wednesday, 4 May, 14.30-16.30

Challenges of Laser Products and Markets
Daniel J. Kane, CEO and Founder, *Mesa Photonics, LLC, USA*, **Moderator**

Lasers are complex systems, yet they have become highly reliable, turn-key commercial products used in applications that span research laboratories to the most inhospitable deserts. Each market has its own set of constraints and needs as well as its own challenges and technological requirements. In this session, we explore the challenges and trade-offs required to adapt laser technology into products spanning military to commercial markets. How customer needs drive chosen laser technologies and designs will also be discussed.

Dr. Daniel J. Kane is the CEO and Founder of Mesa Photonics, LLC, which provides advanced pulse measurement solutions for ultrafast laser systems and applications, and conducts research in spectroscopy and ultrafast laser pulse measurement. Before Mesa Photonics, Dr. Kane was a Principal Research Scientist at Southwest Sciences, Inc. Dr. Kane received his Ph.D. and M.S. in Physics from the University of Illinois at Urbana-Champaign, and his B.S. in Physics from Montana State University. His interests include ultrafast laser pulse measurement, nonlinear optics, and spectroscopy, and he is the co-inventor of Frequency Resolved Optical Gating

(FROG) for ultrafast laser pulse measurement. He is a Fellow of The Optical Society.

Speakers Include:

High Power Ultrafast Lasers
Sterling Backus, Vice President of Research and Development, *Kapteyn-Murnane Labs, USA and Research Faculty, Electrical and Computer Engineering, Colorado State Univ., USA*

Since joining KMLabs full-time in 2003, Dr. Sterling Backus has led the development of new high-power amplifier systems funded by external research contracts and IR&D. His career began with six years in the U.S. Army Infantry and Washington Army National Guard before he attended Washington State University, graduating with a B.S. and M.S. Degrees in Physics. After working on SDI-related programs for a small business in Seattle, Washington, Dr. Backus returned to WSU to conduct his Ph.D. research in the Murnane-Kapteyn Group on ultrafast kHz amplifier systems, and UV / VUV generation and characterization. He remained with Murnane-Kapteyn, for Post-Doctoral work at the University of Michigan and University of Colorado (JILA), pushing performance to >20W and <15fs, and working on high harmonic generation (HHG). His current research involves new ultrafast materials, fiber lasers, and MHz ultrafast amplifiers. Currently he is the VP of R&D of KMLabs, and Research Faculty at Colorado State University.

Choosing, Developing & Delivering a Successful Product
John MacKay, CEO, Founder, *Lighthouse Photonics Inc., USA*

Many factors can affect the success of a product in today's photonics market. Even before any product development cycle can start, a market opportunity must be clearly identified and defined. The chosen application and market will also define many of the design aspects of the product - these aspects will include physical size, performance specifications, reliability and cost. Once the decision has been made to push ahead with product development then timelines, project "gates" and costs must be carefully managed in order that the product be positioned for commercial success. Some of the generally-accepted rules in product marketing and engineering development will be discussed, together with some real life examples of failure and success in the photonics market.

Dr. John MacKay is CEO and Founder of Lighthouse Photonics Inc. in Sunnyvale, California, a small company focused on developing & manufacturing advanced diode-pumped solid-state lasers. With more than 20 years experience in the laser industry, he previously was General Manager of the Research Laser Systems division at Coherent Inc. In that role he successfully spearheaded a strategic overhaul of the entire product line resulting in more than a dozen new ultrafast laser products in a four year period. Prior to Coherent, he was Vice President at PowerNetix Inc - a venture-capital funded, semiconductor laser packaging company that he cofounded. Born and raised in Scotland, Dr. MacKay holds a PhD in Laser Physics from Heriot-Watt University.

The Unique Challenges of Military Laser Products

Dr. David Shannon, PhD, V.P. of Engineering and New Product Development, *B.E. Meyers & Co., Inc., USA*

The military marketplace, like other markets, places some very unique and challenging requirements on the design, manufacture, and sales of optoelectronic products - specifically laser based systems. Although B.E. Meyers produces a variety of military and law enforcement products, this presentation will concentrate on our core competency in fielding portable (hand-held) military laser systems.

The basic guidelines of hand-held military laser systems are; simple & intuitive, small, lightweight, inexpensive, very rugged & durable, and multi-use. The ultimate environment of our products is often very harsh (temperature, shock, water, salt, mud) and the eventual customer is oftentimes a soldier operating in a state of extreme stress. Successful military laser product designs require extensive systems engineering so that these conflicting performance features and environmental constraints are aligned effectively. A few counter-intuitive aspects of the military marketplace will also be presented.

Dave Shannon received his Bachelors of Science in Nuclear Engineering, 1981, Masters of Science in Nuclear Engineering, 1984, and PhD in Electrical Engineering, 1989 from the University of Illinois at Champaign, Urbana. His graduate studies focused on spectroscopy of the rare gas dimers, specifically Ar2, but the design and assembly of the needed experimental equipment revealed a passion for creating products. Dave began his career at Lightwave Electronics from 1989 to 1997 as a Project Lead designing a variety of DPSS laser systems for industrial markets. Accomplishment: a 3W green ophthalmic laser system. In 1997, he moved to Washington state as the Director of Product Development at Aculight Corporation through 2004. Accomplishment: a 1W 209 nm PRK laser system. In 2004, Dave moved to B.E. Meyers & Co., Inc. as the V. P. of Engineering, where he is presently employed. Accomplishment: Building a 1st class Engineering department & the Glare MOUT family of non-lethal laser products. In off-hours, Dave has been making, and fueling his automobile with, his own Biodiesel for the past 4 years.

Technology Transfer Showcase

Thursday, 5 May 2011; 10.00–15.00 GMT (10:00 a.m.–3:00 p.m. EDT)
Exhibit Hall F (end of 1100 aisle)

Attend this session to find out about the latest license-ready optics and photonics technologies coming out of universities and government labs that could lead to new commercial products or improve the efficiency, durability or availability of existing components or systems. The session will also include case study speakers who will talk about how they successfully licensed technology from a university and transferred that research into a commercial product offered by their company. The Technology Transfer Showcase will include a morning panel discussion and a day long tabletop session.

Technology Transfer Panel Discussion

Speakers

Moderator: Mark Tolbert, President, Toptica Photonics Inc.

Sandia National Laboratories Optics Licensing Opportunities: Fiber Saturable Absorber and More
Dan Allen, Licensing Executive, IP Management, Alliances and Licensing Department, *Sandia National Laboratories*

Sandia has demonstrated an all-fiber amplitude discriminator (4FAD) that functions like a power-dependent waveplate or saturable absorber. 4FAD has applications for reducing cost and improving fiber laser performance, including bi-directional isolation of amplifier ASE, wavelength stability, passive modelocking, power-limiting, and pulse compression/cleanup. Sandia researchers received two recent R&D 100 awards for a successful 6 year R&D effort that produced multifunctional optical and infrared coatings (e.g. AR, HR, dichroic) without vacuum deposition. The polymer-nanocrystal composite hydrophobic coatings employ self-organization to produce single or multiple layers in a drying polymer applied in a single spray or dip coating step. The process is potentially scalable for large area or irregularly shaped surfaces. Other licensable optics technologies include a compact multifunctional trace/greenhouse gas detection spectrometer, stable Silicon photonics modulators, and a spin-on silica microsphere layer for reduced defect density and easy liftoff of GaN. Contact Sandia for current licensing availability.

Speaker Profile
Dan Allen is an IP manager and licensing executive at Sandia National Laboratories overseeing several hundred patents in optics, microelectronics, and nanoscience. He has a Ph.D. in physics from UC Santa Barbara and research experience in terahertz quantum cascade lasers, quantum computing, and semiconductor nanoscience, as well as industry experience in optomechanics design. He has contributed several inventions offered in major optical component supplier catalogs.

About Sandia National Laboratories Technology Transfer
Sandia National Laboratories has about 8000 employees at sites in New Mexico and California and performs tens of millions of dollars in commercially-funded R&D every year, in addition to nearly two billion dollars in federal R&D and mission-related work. Sandia's technology transfer effort enhances US competitiveness through collaborative R&D and licensing of cutting-edge innovations to small and large companies. Commercial licenses require substantial manufacture of licensed product in the US, or a net benefit to the US. Successful products based on Sandia technology range from lead-free solder to breakthrough supercomputing architectures, from industrial process monitoring to business data and risk analysis software, and pioneering VCSEL and MEMS technologies. Visit http://sandia.gov or contact partnerships@sandia.gov. (Sandia National Laboratories is a multiprogram laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94AL85000.)

Encouraging Innovation and Facilitating Technology Transfer at Stanford University
Tom Baer, Executive Director, Stanford Photonics Research Center, *Stanford University*

The presenter will describe the history, policy and practices of the Stanford University Office of Technology Licensing (OTL).

Speaker Profile
Dr. Baer is currently the executive director of the Stanford Photonics Research Center and a member of the Applied Physics Department at Stanford University. His research is focused on developing imaging and analysis technology for exploring the molecular basis of developmental biology and neuroscience. From 1996 to 2005 Dr. Baer was the CEO, chairman, and founder of Arcturus Bioscience, a biotechnology company located in Mountain View, CA, which he established in 1996. Prior to Arcturus, Dr. Baer was vice president of research at Biometric Imaging, where he led an interdisciplinary group developing products with applications in the areas of AIDS monitoring, bone marrow transplant therapy, and blood supply quality control. From 1981 to 1992 Dr. Baer was at Spectra-Physics, Inc., where he held positions as vice-president of research and Spectra-Physics Fellow. Dr. Baer has made major contributions in the areas of biotechnology, quantum electronics, and laser applications, and is listed as an inventor on 60 patents and is a co-author on many peer reviewed publications in a number of different scientific fields. His commercial products have received many industry awards for design innovation. Co-founder of four companies in Silicon Valley, he was named entrepreneur of the year for emerging companies in Silicon Valley in 2000, by the Silicon Valley Business Journal. Dr. Baer graduated with a BA degree in Physics Magna Cum Laude from Lawrence University and received his MS and Ph.D. degrees in Atomic Physics from the University of Chicago. He is also an alumnus of Harvard Business School and in 1994 he received the Distinguished Alumni Award from Lawrence University. He has been elected to the status of Fellow in two

international scientific societies, the American Association for the Advancement of Science and The Optical Society of America (OSA) and served as the President of OSA in 2009.

About Office of Technology Licensing, Stanford University

The Office of Technology Licensing at Stanford University is responsible for managing the intellectual property assets of Stanford University. Scientific insights and academic breakthroughs draw interest and enthusiasm from the research community when they are presented at a scientific meeting or published in a journal. However, without a company willing to invest in bringing the invention to marketplace, many potential benefits of these breakthroughs are likely to end on the page. At OTL our charter is to help turn scientific progress into tangible products, while returning income to the inventor and to the University to support further research. OTL receives invention disclosures from Stanford faculty, staff and students. We evaluate these disclosures for their commercial possibilities, and when possible license them to industry. If the inventions are successfully licensed, cash royalties collected by OTL provide funding to the inventors' departments and schools, as well as personal shares for the inventors themselves.

We typically begin the licensing process by reviewing an invention with the inventors to learn about potential applications. We then develop a licensing strategy, consider the technical and market risks, and decide whether to patent the invention. Together with the inventors, we try to find companies that might be interested in the invention and seek a product champion within a company before negotiating a licensing agreement.

Technology Transfer at the NRL Optical Sciences Division

Craig Hoffman, Associate Superintendent, Optical Sciences Division, *Naval Research Lab*

The Optical Sciences Division of the Naval Research Laboratory performs a wide range of basic and applied research on many areas of optics that are of current or potential future interest to the Navy and the Department of Defense. This includes materials, devices, and techniques for generation, transmission and detection of electromagnetic radiation from the X-ray through the terahertz regime. Specifically, we will present advances in optical ceramics for windows (i.e. spinel {$MgAl_2O_4$} and calcium lanthanum sulfide), ceramic laser hosts (Y_2O_3, Lu_2O_3), active and passive infrared transmitting fiber, bioconjugated quantum dots for chemical/biological sensing, type II superlattice infrared detectors and lasers, nanostructured polymer optics, ionizing radiation detectors, MEMS and MOEMS chemical sensors, free space optical communications, fiber optic acoustic/seismic sensors, structural health monitoring, and photonics solutions for RF processing.

Speaker Profile

Craig Hoffman is associate superintendent of the Optical Sciences Division at the U.S. Naval Research Laboratory. In this position he aids the superintendent in guiding the research of ~200 government and contract scientists in myriad areas of optical science including infrared optical materials, organic opto-electronics, semiconductor diode lasers, quantum dot optics, bio-chemical sensing, hyperspectral imaging, infrared focal plane arrays, infrared countermeasures, imaging reconnaissance systems, optical fiber research and fiber optic sensing. Dr. Hoffman's own research has included the physics of narrow gap semiconductors and superlattices and the susceptibility and hardening of infrared detectors and focal plane arrays to laser radiation. He has published over 200 scientific papers in the open and classified literature. In addition, he represents NRL and the Navy on a variety of Navy and DoD scientific and technical panels. Dr. Hoffman came to NRL as a National Research Council post-doctoral fellow after receiving his M.S. and Ph.D. degrees in physics from Brown University. He received his B.S. degree in physics from Purdue University. After his fellowship, he joined NRL as a staff scientist. He became a section head in the Optical Physics branch and was then appointed associate superintendent. Dr. Hoffman is a member of OSA, IEEE, Sigma Xi and Phi Beta Kappa.

MIRTHE Investment Focus Group: Creating Infrastructure to Transition Early Stage Technologies to Commercial Use

Joseph X. Montemarano, MIRTHE Executive Director, PRISM Director for Industrial Enterprise, *Princeton University*

For universities conducting pioneering and even transformation research, one finds that early stage technologies need to be transitioned into a business context that the investment community can understand and evaluate. MIRTHE established an Investment Focus Group at Princeton University, which is comprised of Venture Capital and Angel investors, State Government Economic Development, among other key skill sets to mentor entrepreneurs from within academia as well as collaborating small technology companies. The purpose is to help inform the investment community of key opportunities, as well as to access investor experience and mentorship. The Investment Focus Group also brings in large companies that are looking for suppliers of new products as well as potential acquisition relationships.

Speaker Profile

Joseph X. Montemarano has been involved in state-of-the-art research and commercialization efforts related to health-care, defense and homeland security, advanced materials, computer science and photonic applications throughout his career. Mr. Montemarano has helped large and small companies, and government researchers access emerging technologies, faculty and other university resources resulting in a significant increase in sponsored research, the launch of several spin-off companies, and successful technology commercialization and fielded applications. He joined Princeton University in July 1994, and currently serves as Executive Director for the NSF-Engineering Research Center on Mid-InfraRed Technologies for Health and Environment (MIRTHE) led by Princeton University, and Director for Industrial Enterprise for the Princeton Institute for Science and Technology of Materials (PRISM). Prior to joining Princeton University, Mr. Montemarano served as Associate Director for Science, Technology, and New Business Ventures with the New Jersey Commission on Science and Technology. His State government service spanned three NJ Governors (Hon. Kean-R, Florio-D and Whitman-R). He helped formulate effective state economic development policy, and managed diverse science, engineering and business programs totaling over $250 million. Prior experience includes business and technology management and R&D programs at PA Consulting Services, Inc., Allied-Signal/Bendix Advanced Technology Center, University of Maryland Medical School, and The Johns Hopkins University. He received his B.A. in Biology, and his M.S. in Computer Science, both from The Johns Hopkins University.

Michael Pavia, President and Co-Founder, *Sydor Instruments, LLC*

Speaker Profile
Michael Pavia is the president and co-founder of Sydor Instruments, LLC. Sydor Instruments manufactures precision diagnostic imaging systems for US and European government agencies. He started the company 8 years ago with a technology licensed from the University of Rochester and has grown it to become one of the Inc 5000 fastest growing companies in America. The company is also a recipient of the UNYTECH award for most innovative business model of technology transfer.

Mr. Pavia's earlier work includes a variety of technical and leadership positions in electro-optics, semiconductor systems, aerospace/defense, and imaging. Prior to starting Sydor Instruments, he built a successful track record in advanced product commercialization for Eastman Kodak Company, launching products on a global basis as the worldwide marketing manager of a $1.5B strategic product group.

He currently serves as an instructor in entrepreneurship and technology fellow for the office of technology transfer at the University of Rochester. He holds a B.S. in Optics from the University of Rochester.

Short Course Schedule by Time

Sunday, 1 May 2011

09.00–18.00

SC200 **Laser Remote Sensing,** *Timothy Carrig, Phillip Gatt; Lockheed Martin, USA*

10.00–13.00

SC189 **Quantum-Enhanced Technologies,** *Ian Walmsley; Univ. of Oxford, UK*
NEW! SC362 **Cavity Optomechanics: Fundamentals and Applications,** *Tobias Kippenberg, Max-Planck-Institut fur Quantenoptik, Germany*

14.00–18.00

SC164 **THz Technology**, *Matthew T. Reiten; Oklahoma State Univ., USA*
SC198 **Packaging of Optoelectronic Components**, *Andreas Rose; Photonics Res. Corp., USA*
CANCELLED SC336 **Green Photonics**, *S. J. Ben Yoo; Univ. of California at Davis, USA*

Monday, 2 May 2011

08.30–12.30

SC300 **Silicon Photonics**, *Bahram Jalali; Univ. of California at Los Angeles, USA*

09.00–12.00

SC302 **MetaMaterials**, *Vladimir M. Shalaev; Purdue Univ., USA*

13.30–17.30

SC149 **Foundations of Nonlinear Optics**, *Robert Fisher; R. A. Fisher Associates, USA*
SC182 **Biomedical Optical Diagnostics and Sensing**, *Sebastian Wachsmann-Hogiu; Univ. of California at Davis, USA*
CANCELLED SC316 **Organic Photonic Devices**, *Marc Baldo, Vladimir Bulovic; MIT, USA*
NEW! SC361 **Coherent Mid-Infrared Sources and Applications**, *Konstantin Vodopyanov, Stanford Univ., USA*

Tuesday, 3 May 2011

08.30–12.30

CANCELLED SC154 **Quantum Well Devices for Optics and Optoelectronics**, *David A. B. Miller; Stanford Univ., USA*
SC157 **Laser Beam Analysis, Propagation and Shaping Techniques**, *James R. Leger; Univ. of Minnesota, USA*
SC221 **Nano-Photonics: Physics and Techniques**, *Axel Scherer; Caltech, USA*
SC270 **High Power Fiber Lasers and Amplifiers**, *W. Andrew Clarkson; Optoelectronics Res. Ctr., Univ. of Southampton, UK*
CANCELLED SC334 **The Art of Modeling Optical Systems**, *Curtis Menyuk; Univ. of Maryland, Baltimore County, USA*

13.30–18.30

CANCELLED SC123 **Erbium-Doped Fiber Amplifiers and Raman Fiber Amplifiers**, *John Zyskind; Oclaro, Inc., USA*
CANCELLED SC155 **Ultrashort Laser Pulse Measurement**, *Rick Trebino, Swamp Optics LLC, USA*
SC301 **Quantum Cascade Lasers: From Band Structure Engineering to Commercialization**, *Federico Capasso; Harvard Univ., USA*
SC335 **Super-Resolution Optical Microscopy**, *Stephen Lane[1,2], [1]Lawrence Livermore Natl. Lab, USA, [2]Univ. of California at Davis, USA*
SC353 **An Overview of R&D Program Management**, *Michael T. Dehring; Lockheed Martin, USA*

Short Course Schedule by Topic Category

CLEO:QELS – Fundamental Science

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

CLEO:QELS – Fundamental Science 2: Quantum Science, Engineering and Technology
CANCELLED SC154 Quantum Well Devices for Optics and Optoelectronics, *David A. B. Miller; Stanford Univ., USA*
SC189 Quantum-Enhanced Technologies, Ian Walmsley; *Univ. of Oxford, UK*
SC221 Nano-Photonics: Physics and Techniques, *Axel Scherer; Caltech, USA*
SC301 Quantum Cascade Lasers: From Band Structure Engineering to Commercialization, *Federico Capasso; Harvard Univ., USA*

CLEO:QELS – Fundamental Science 3: Metamaterials and Complex Media
SC221 Nano-Photonics: Physics and Techniques, *Axel Scherer; Caltech, USA*
SC302 MetaMaterials, *Vladimir M. Shalaev; Purdue Univ., USA*

CLEO:QELS – Fundamental Science 4: Optical Interactions with Condensed Matter and Ultrafast Phenomena
SC149 Foundations of Nonlinear Optics, *Robert Fisher; R. A. Fisher Associates, USA*
CANCELLED SC154 Quantum Well Devices for Optics and Optoelectronics, *David A. B. Miller; Stanford Univ., USA*
SC182 Biomedical Optical Diagnostics and Sensing, *Sebastian Wachsmann-Hogiu; Univ. of California at Davis, USA*
SC300 Silicon Photonics, *Bahram Jalali; Univ. of California at Los Angeles, USA*

CLEO:QELS – Fundamental Science 5: Nonlinear Optics and Novel Phenomena
SC149 Foundations of Nonlinear Optics, *Robert Fisher; R. A. Fisher Associates, USA*
SC301 Quantum Cascade Lasers: From Band Structure Engineering to Commercialization,

Federico Capasso; Harvard Univ., USA
SC302 MetaMaterials, *Vladimir M. Shalaev; Purdue Univ., USA*
NEW! SC361 Mid IR to Coherent Mid-Infrared Sources and Applications, *Konstantin Vodopyanov, Stanford Univ., USA*

CLEO:QELS – Fundamental Science 6: Nano-Optics and Plasmonics
SC182 Biomedical Optical Diagnostics and Sensing, *Sebastian Wachsmann-Hogiu; Univ. of California at Davis, USA*
SC221 Nano-Photonics: Physics and Techniques, *Axel Scherer; Caltech, USA*
SC300 Silicon Photonics, *Bahram Jalali; Univ. of California at Los Angeles, USA*
SC301 Quantum Cascade Lasers: From Band Structure Engineering to Commercialization, *Federico Capasso; Harvard Univ., USA*
SC302 MetaMaterials, *Vladimir M. Shalaev; Purdue Univ., USA*
NEW! SC362 Cavity Optomechanics: Fundamentals and Applications, *Tobias Kippenberg, Max-Planck-Institut fur Quantenoptik, Germany*

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

CLEO:QELS – Fundamental Science 8: Other Topics in Quantum Electronics and Laser Science

CLEO: Science & Innovations

CLEO: Science & Innovations 1: Laser Processing of Materials: Fundamentals and Applications
SC149 Foundations of Nonlinear Optics, *Robert Fisher; R. A. Fisher Associates, USA*
SC157 Laser Beam Analysis, Propagation and Shaping Techniques, *James R. Leger; Univ. of Minnesota, USA*

CLEO: Science & Innovations 2: Solid-State, Liquid, Gas, and High-Intensity Lasers
SC149 Foundations of Nonlinear Optics, *Robert Fisher; R. A. Fisher Associates, USA*
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*
NEW! SC361 Mid IR to Coherent Mid-Infrared Sources and Applications, *Konstantin Vodopyanov, Stanford Univ., USA*

CLEO: Science & Innovations 3: Semiconductor Lasers
CANCELLED SC154 Quantum Well Devices for Optics and Optoelectronics, *David A. B. Miller; Stanford Univ., USA*
SC157 Laser Beam Analysis, Propagation and Shaping Techniques, *James R. Leger; Univ. of Minnesota, USA*
SC221 Nano-Photonics: Physics and Techniques, *Axel Scherer; Caltech, USA*

SC300 Silicon Photonics, *Bahram Jalali; Univ. of California at Los Angeles, USA*
SC301 Quantum Cascade Lasers: From Band Structure Engineering to Commercialization, *Federico Capasso; Harvard Univ., USA*

CLEO: Science & Innovations 4: Applications of Nonlinear Optics
SC149 Foundations of Nonlinear Optics, *Robert Fisher; R. A. Fisher Associates, USA*
CANCELLED SC154 Quantum Well Devices for Optics and Optoelectronics, *David A. B. Miller; Stanford Univ., USA*
SC221 Nano-Photonics: Physics and Techniques, *Axel Scherer; Caltech, USA*
SC300 Silicon Photonics, *Bahram Jalali; Univ. of California at Los Angeles, USA*
NEW! SC361 Mid IR to Coherent Mid-Infrared Sources and Applications, *Konstantin Vodopyanov, Stanford Univ., USA*

CLEO: Science & Innovations 5: Terahertz Technologies and Applications
SC149 Foundations of Nonlinear Optics, *Robert Fisher; R. A. Fisher Associates, USA*
SC164 THz Technology, *Matthew T. Reiten; Oklahoma State Univ., USA*
SC301 Quantum Cascade Lasers: From Band Structure Engineering to Commercialization, *Federico Capasso; Harvard Univ., USA*

CLEO: Science & Innovations 6: Optical Materials, Fabrication and Characterization
CANCELLED SC154 Quantum Well Devices for Optics and Optoelectronics, *David A. B. Miller; Stanford Univ., USA*
SC221 Nano-Photonics: Physics and Techniques, *Axel Scherer; Caltech, USA*
SC302 MetaMaterials, *Vladimir M. Shalaev; Purdue Univ., USA*

CLEO: Science & Innovations 7: Micro- and Nano-Photonic Devices
CANCELLED SC154 Quantum Well Devices for Optics and Optoelectronics, *David A. B. Miller; Stanford Univ., USA*
SC157 Laser Beam Analysis, Propagation and Shaping Techniques, *James R. Leger; Univ. of Minnesota, USA*
SC182 Biomedical Optical Diagnostics and Sensing, *Sebastian Wachsmann-Hogiu; Univ. of California at Davis, USA*
SC221 Nano-Photonics: Physics and Techniques, *Axel Scherer; Caltech, USA*
SC302 MetaMaterials, *Vladimir M. Shalaev; Purdue Univ., USA*

CLEO: Science & Innovations 8: Ultrafast Optics, Optoelectronics and Applications
SC149 Foundations of Nonlinear Optics, *Robert Fisher; R. A. Fisher Associates, USA*
CANCELLED SC154 Quantum Well Devices for Optics and Optoelectronics, *David A. B. Miller; Stanford Univ., USA*
SC221 Nano-Photonics: Physics and Techniques, *Axel Scherer; Caltech, USA*
SC300 Silicon Photonics, *Bahram Jalali; Univ. of California at Los Angeles, USA*
CANCELLED SC155 Ultrashort Laser Pulse Measurement, *Rick Trebino, Swamp Optics LLC, USA*

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

CANCELLED SC154 Quantum Well Devices for Optics and Optoelectronics, *David A. B. Miller; Stanford Univ., USA*
SC157 Laser Beam Analysis, Propagation and Shaping Techniques, *James R. Leger; Univ. of Minnesota, USA*
SC198 Packaging of Optoelectronic Components, *Andreas Rose; Photonics Res. Corp., USA*
SC300 Silicon Photonics, *Bahram Jalali; Univ. of California at Los Angeles, USA*

CLEO: Science & Innovations 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; Univ. of California at Davis, USA*
SC221 Nano-Photonics: Physics and Techniques, *Axel Scherer; Caltech, USA*
SC335 Super-Resolution Optical Microscopy, *Stephen Lane[1,2], [1]Lawrence Livermore Natl. Lab, USA, [2]Univ. of California at Davis, USA*

CLEO: Science & Innovations 11: Fiber Amplifiers, Lasers and Devices
CANCELLED SC123 Erbium-Doped Fiber Amplifiers and Raman Fiber Amplifiers, *John Zyskind; Oclaro, Inc., USA*
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*

CLEO: Science & Innovations 12: Lightwave Communications and Optical Networks
CANCELLED SC123 Erbium-Doped Fiber Amplifiers and Raman Fiber Amplifiers, *John Zyskind; Oclaro, Inc., USA*
SC198 Packaging of Optoelectronic Components, *Andreas Rose; Photonics Res. Corp., USA*
SC300 Silicon Photonics, *Bahram Jalali; Univ. of California at Los Angeles, USA*

CLEO: Science & Innovations 13. Active Optical Sensing
SC182 Biomedical Optical Diagnostics and Sensing, *Sebastian Wachsmann-Hogiu; Univ. of California at Davis, USA*
SC200 Laser Remote Sensing, Timothy Carrig, *Phillip Gatt; Lockheed Martin, USA*
SC300 Silicon Photonics, *Bahram Jalali; Univ. of California at Los Angeles, USA*
NEW! SC361 Mid IR to Coherent Mid-Infrared Sources and Applications, *Konstantin Vodopyanov, Stanford Univ., USA*

CLEO: Science & Innovations 14: Optical Metrology
SC157 Laser Beam Analysis, Propagation and Shaping Techniques, *James R. Leger; Univ. of Minnesota, USA*
SC200 Laser Remote Sensing, *Timothy Carrig, Phillip Gatt; Lockheed Martin, USA*

CLEO: Science & Innovations 15: LEDS, Photovoltaics and Energy-Efficient ("Green") Photonics
SC221 Nano-Photonics: Physics and Techniques, *Axel Scherer; Caltech, USA*

SC300 Silicon Photonics, *Bahram Jalali; Univ. of California at Los Angeles, USA*
CANCELLED SC316 Organic Photonic Devices, Marc Baldo, Vladimir Bulovic; *MIT, USA*
CANCELLED SC336 Green Photonics, *S. J. Ben Yoo; Univ. of California at Davis, USA*

CLEO: Applications & Technology

CLEO: Applications & Technology 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; Univ. of California at Davis, USA*
SC221 Nano-Photonics: Physics and Techniques, *Axel Scherer; Caltech, USA*
SC335 Super-Resolution Optical Microscopy, *Stephen Lane[1,2], [1]Lawrence Livermore Natl. Lab, USA, [2]Univ. of California at Davis, USA*
SC353 An Overview of R&D Program Management, *Michael T. Dehring; Lockheed Martin, USA*

CLEO: Applications & Technology 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; Univ. of California at Davis, USA*
SC200 Laser Remote Sensing, *Timothy Carrig, Phillip Gatt; Lockheed Martin, USA*
SC301 Quantum Cascade Lasers: From Band Structure Engineering to Commercialization, *Federico Capasso; Harvard Univ., USA*
CANCELLED SC336 Green Photonics, *S. J. Ben Yoo; Univ. of California at Davis, USA*
SC353 An Overview of R&D Program Management, *Michael T. Dehring; Lockheed Martin, USA*

CLEO: Applications & Technology 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; Univ. of California at Davis, USA*
SC200 Laser Remote Sensing, *Timothy Carrig, Phillip Gatt; Lockheed Martin, USA*
SC301 Quantum Cascade Lasers: From Band Structure Engineering to Commercialization, *Federico Capasso; Harvard Univ., USA*

CLEO: Applications & Technology 4: Industrial
SC157 Laser Beam Analysis, Propagation and Shaping Techniques, *James R. Leger; Univ. of Minnesota, USA*
SC300 Silicon Photonics, *Bahram Jalali; Univ. of California at Los Angeles, USA*

SC301 Quantum Cascade Lasers: From Band Structure Engineering to Commercialization, *Federico Capasso; Harvard Univ., USA*

Fundamental Optical Science and Technologies

CANCELLED SC334 The Art of Modeling Optical Systems, Curtis Menyuk; *Univ. of Maryland, Baltimore County, USA*

Short Course Descriptions

SC200 Laser Remote Sensing

Sunday 1 May 2011
09.00–18.00
Timothy Carrig, Phillip Gatt; Lockheed Martin, USA
Level: TBA

Course 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 and Learning Objectives

This course should enable you to:

- Understand the differences between the various types of laser radar systems
- Understand laser radar fundamentals with emphasis on back–of–the–envelope equations and physical interpretation
- Understand key differences between direct and coherent detection
- Understand the differences between hard and soft targets and their corresponding laser radar signatures
- Conduct first–order systems level trade studies
- Develop component–level laser radar system designs
- Have knowledge of key references and texts for further investigation

Intended 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.

Biography

Phillip 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.

Timothy 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.

SC189 Quantum Enhanced Technologies

Sunday 1 May 2011
10.00–13.00
Ian Walmsley; Lockheed Martin, USA
Level: TBA

Course Description

This course will provide a tutorial overview of the sorts of enhancements that quantum physics can provide for technology, and a short survey of applications and potential applications. These will include quantum interferometry and metrology, microscopy, communications, cryptography, frequency standards and clock synchronization, as well as computation and information processing. The rudiments of quantum mechanics needed to understand the technology will be covered, focusing particularly on quantum interference and entanglement, as well as laboratory measurement methods. The ideas concerning the application of these principles to the enhancement of important technologies will then be discussed. One of the critical issues in this area is how to design schemes that are robust with respect to unavoidable environmental noise. The critical practical issues that confront real-world implementation of these concepts are many, and important performance parameters that might limit the utility of quantum-enhanced technologies will also be examined.

Intended Audience

The course is intended for those would like to gain a basic understanding of the ways and means by which quantum mechanics can be used to enhance technologies that are critical to the modern world. Some knowledge (a college course at an intermediate level) of quantum mechanical concepts and optics is recommended.

Biography

Ian A. Walmsley is the Hooke Professor of Experimental Physics at the University of Oxford, and is head of atomic and laser physics. He was educated at Imperial College, University of London, and the Institute of Optics, University of Rochester. His research is in the area of quantum optics and quantum control, using the tools of ultrafast optics.

SC 362 Cavity Optomechanics: Fundamentals and Applications

Sunday, 1 May 2011
10.00–13.00
Tobias Kippenberg; EPFL Switzerland
Level: Beginner (no background or minimal training is necessary to understand course material)

Course 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 and Learning Objectives

This course should enable you to:

- Understand gradient and scattering light forces and their applications
- Design high–Q nano- and micro- mechanical oscillators (finite element modeling, FEM)
- Understand the fundamental limits of mechanical Q in NEMS/MEMS
- Understanding of the fundamental and practical limits of displacement sensors
- Applications of optomechanics in mass and force sensing
- Understand the basic optomechanical phenomena (amplification, cooling)
- Understand the standard quantum limit (SQL)
- Characterize radiation pressure driven oscillations in terms of fundamental oscillator metrics
- Influence of phase and amplitude noise of a wide variety of laser systems (fiber lasers, TiSa, diode lasers) in optomechanical systems

Intended 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.

Biography

Tobias J. Kippenberg obtained his BA in EE and Physics at the RWTH Aachen Germany and his PhD from Caltech in 2004 working with K.J. Vahala. From 2005-2009 he worked as independent group leader at the Max Planck Institute of Quantum Optics (Garching, Germany) in the Division of T.W. Haensch. In 2010 he was appointed associate Professor at the Swiss Federal Institute of Technology Lausanne (EPFL). His research is focused on the use of ultra-high Q micro-resonators in optical frequency Metrology and their exploration in cavity quantum Optomechanics.

SC164 THz Technology

Sunday 1 May 2011
14.00–18.00
Matthew T. Reiten, Oklahoma State Univ., USA
Level: TBA

Course Description

Pulsed terahertz (THz = $1x10^{12}$ Hz) waves with a frequency range from < 0.1 THz to 10 THz (sometimes called T-Rays) have found unique applications in both scientific and industrial settings for medical imaging, fundamental research and material characterization. THz radiation spans the portion of the electromagnetic spectrum between the infrared and microwave bands. However, compared to the relatively well-developed technology at microwave, optical and X-ray frequencies, advanced technology development in the THz band is still in relatively early stages. Just as one can use visible light to create a photograph, radio waves to transmit music and speech, or X-rays to reveal broken bones, this course will cover how to use THz pulses for similar applications in the far infrared. Participants will leave with an understanding of the fundamentals of free-space THz optoelectronics, including how to generate and detect THz pulses. A variety of different techniques will be discussed, including photoconductive antennas or electro-optic crystals to achieve diffraction-limited spatial resolution, femtosecond temporal resolution, ultra-wide spectral bandwidth and high sensitivity.

Benefits and Learning Objectives

This course should enable you to:

- Learn what type of optical source is required to drive a pulsed THz system.
- Choose between photoconductive and electro-optic THz detectors.
- Design an optimal beam coupling system between a THz source and a detector.
- Characterize a THz system and optimize its spatial and temporal resolutions, bandwidth and dynamic range.
- Construct several types of THz imaging systems.
- Extract the complex refractive index, permittivity or conductivity from a THz measurement.
- Specify (mostly) off-the-shelf components to build your own THz system.

Intended Audience

This course is designed for graduate students and researchers in academia and industry who are interested in the fundamental concepts of far-infrared pulsed THz radiation.

Biography

Matthew T. Reiten earned his B.S.E.E. and B.S. Physics from the University of North Dakota (Grand Forks, North Dakota) and his Masters in applied physics from Rice University (Houston, Texas). After a stint in the armed forces, he returned to graduate school and earned his Ph.D. in electrical engineering at Oklahoma State University (Stillwater, Oklahoma). While at OSU he investigated broadband terahertz propagation and imaging with special interest in claims of superluminal propagation through optical tunneling barriers. After graduating in 2006, he joined a small research firm, GMA Industries of Annapolis Maryland, where he worked on optical techniques for non-destructive evaluation for the electronics and aviation industries and developed a prototype time domain terahertz ellipsometer. In mid-2009, he accepted a postdoctoral fellowship with Los Alamos National Laboratory to develop a novel room temperature narrow band THz emitter based on metamaterial elements.

SC198 Packaging of Optoelectronic Components

Sunday 1 May 2011
14.00–18.00
Andreas Rose, Photonics Research Corporation, USA
Level: Beginner (No background or minimal training is necessary to understand course material)

Course Description

Optoelectronic packaging has become increasingly important due to the requirements of high-speed, large-capacity transmissions of information, especially in long-haul and metro-optical networking. Economical, cost-oriented packaging of simple or complex active and passive components is one of the major issues in optical networking. Cost-effective robust optoelectronical packages interfacing solid-state components, functional optical circuitry, and optical fibers are increasingly needed to facilitate deployment of high capacity optical communication systems. The course will describe the basic principles of optoelectronic packaging of passive and active components, and will guide attendees through modern packaging and related testing procedures. We will emphasize reliability issues, and give an overview of future packaging methods, such as "siliconization" of photonics devices.

Benefits and Learning Objectives

This course should enable you to:

- Explain where and why optoelectronic packaging is being deployed
- Discuss related topics, such as mechanical support, environmental protection, thermal control, electrical connection and optical connection
- Describe different packaging techniques, e.g, hermetic and non-hermetic sealed packages
- Identify different coupling schemes by means of fiber to fiber, source to fiber, fiber to detector, fiber to planar waveguide circuit, fiber to linear/nonlinear optical component, free space beam processing, fiber to MEMS devices, etc.
- Evaluate and compare critical issues of different joint techniques, such as adhesive bonding, laser welding and soldering
- Describe characteristics of package design, mechanical structures and electronic design.

- Discuss issues such as cost effectiveness and the reliability of the packaging process, with regard to process integration and automation.
- Discuss future-oriented packaging, such as integrated optics and siliconization of devices.

Intended Audience

Beginner (No background or minimal training is necessary to understand course material) The course is intended for those interested in understanding how modern optoelectronic packaging works, the range of applications and the potential for novel and improved devices. The course is relatively self-contained. It meets the needs of engineers, system designers, scientists, students and managers, especially those who need a picture of state-of-the-art photonic packaging technology and the difficulties in cost-effective development and manufacturing.

Biography

Andreas Rose is general manager of Photonics Research Corp. He has gained his experience as head of research and development, vice president of engineering, vice president of research and development, and as an independent contractor in Europe, the United States and Japan for several market leaders in laser and fiber optics technology in telecom, datacom, medical, sensor and industrial applications. He is well known as an expert in the scientific and industrial field of fiber optics and lasers.

SC336 Green Photonics

CANCELLED

Sunday 1 May 2011
14.00–18.00
S. J. Ben Yoo, Professor, University of California at Davis, USA
Level: Beginner (No background or minimal training is necessary to understand course material)

Course Description

This course reviews green photonic technologies and their impacts on the environment and energy–efficiency. The course will cover the following five main topics.

1. Overview of green phonics and benchmarking its impact on energy–efficiency and environments.
2. Energy-efficient lighting and solar cell technologies.
    - Quantum dot, nanostructure, and organic based lighting and solar cell technologies
    - Internal and external designs to improve energy–efficiency
3. Green photonics in smart buildings, smart grids, and manufacturing systems.
    - Combining intelligent management to enhance energy–efficiency

    - System approaches applied to energy-efficient buildings, energy grids, and manufacturing systems.
4. Green photonics in data centers, computing systems, routers, and optical networks.
    - The role of optical interconnects in data centers and computing systems
    - Optical switches, optical routers in communication networks
5. Future prospects of Green photonics

Benefits and Learning Objectives

- This course should enable participants to understand green photonics to bring energy–efficiency and environmental benefits.
- Identify benchmarking to evaluate the effectiveness of green photonics in light of life cycle analysis of the positive impact.
- Review various green photonics technologies and understand their positive impacts on energy–efficiency and environment.
- Realize the combination of 'smart designs' and 'green photonic technologies' to enable smart buildings, smart grids, and energy–efficient manufacturing systems.
- Distinguish green photonic technologies from conventional technologies.
- Understand the impact of photonic interconnects in data centers and computing systems.
- Understand the impact of optical switches and all–optical technologies in energyvefficient networks.
- Discuss the future of green photonics.

Intended Audience

Beginner (No background or minimal training is necessary to understand course material)

Biography

S. J. Ben Yoo is Director of Center for Information Technology Research in the Interest of Society (CITRIS) and Professor at UC Davis. As CITRIS Director at UC Davis, he has been pursuing energy efficiency in systems by applying advanced photonic technologies and information technologies. His research at UC Davis includes future Internet architectures, high–performance optical switching systems, optically–interconnected computing systems, nano photonic–electronic systems integration for next generation networking and computing systems. His recent demonstrations included optical label switching routers scalable to 42 Petabit/sec capacity with more than 1000 times improvement in performance/power efficiency over conventional electronic routers. Prior to joining UC Davis in 1999, he was a Senior Research Scientist at Bellcore, leading technical efforts in optical networking research and systems integration for DARPA sponsored MONET and NGI projects.

SC300 Silicon Photonics

Monday 2 May 2011
08.30 - 12.30
Bahram Jalali, Univ. of California at Los Angeles, USA
Level: Beginner (No background or minimal training is necessary to understand course material)

Course Description

The bricks and mortar of the internet have always been built with silicon, but now this wonder material is playing an increasing role in the world of optics. This revolutionary change of paradigm was brought about by a realization that for computing power to maintain its extraordinary pace of progress, as expressed by proverbial Moore's law, future systems much rely ever more on multi-core architectures. Implied is the fact that, going forward, progress will be driven by interconnects that unit these cores into powerful computing and communication machines. Closer to home for most consumers is the need for affordable multi-gigabit per second cabling in internet data centers and personal computers to keep up with the evolution of the internet from a traditional computer network to a media delivery and telecommunication network. Propelled by its promise of sharing the same manufacturing machines and foundries that produce complex yet inexpensive electronics chips, Silicon photonics is now a thriving community and a blossoming business.

The aim of this course is to provide an in depth understanding of the silicon photonics technology, its unique features and its anticipated impact. It discusses passive devices such as waveguides and wavelength filters, photodetectors, modulators, amplifiers, lasers and wavelength converters. The course will highlight the state of the art in each device category and outline challenges that must be overcome before large-scale commercialization can take place. In particular, for realization of integration with CMOS VLSI, silicon photonics must be compatible with the economics of silicon manufacturing and must operate within thermal constraints of VLSI chips. The impact of silicon photonics may reach beyond optical communication - its traditionally anticipated application. Silicon has excellent linear and nonlinear optical properties in the mid-wave infrared spectrum. These properties, along with silicon's excellent thermal conductivity and optical damage threshold, open up the possibility for a new class of mid-infrared photonic devices.

Benefits and Learning Objectives

This course should enable you to:

- Understand unique attributes of the silicon photonics technology
- Compare properties of silicon photonics with other integrated optics technologies
- Identify main technical challenges that remain on the path to wide scale commercialization
- Justify investment in silicon photonics
- Define the most promising applications of silicon photonics

Intended Audience

The intended audience is engineers, engineering managers, graduate students and private equity investors who are interested in research and commercialization of silicon photonics.

Biography

Bahram Jalali is a professor of electrical engineering at the UCLA. He is a Fellow of IEEE and OSA. His research interests include silicon photonics and time-wavelength signal processing. He has published more than 350 scientific papers and holds six U.S. patents. He is the 2007 recipient of OSA's R.W. Wood Prize and was chosen by Scientific American as one of the "50 Leaders Shaping the Future of Technology" in 2005. Jalali serves on the Board of Trustees of the California Science Center. He has received the BridgGate 20 Award for his contributions to the Southern California economy.

SC302 Metamaterials and Transformation Optics

Monday 2 May 2011
09.00 - 12.00
Vladimir M. Shalaev, Purdue Univ., USA
Level: Beginner (No background or minimal training is necessary to understand course material)

Course 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 and Learning Objectives

This course should enable you to:

- Understand the fundamentals of metamaterials and learn about new emerging areas
- Learn more about optical magnetism
- Learn more about applications of negative-index metamaterials (NIMs)
- Understand the nature of a negative refractive index
- Learn approaches for scaling NIMs to the optical range

- Explore novel applications in nanophotonic
- Discuss novel optical materials

Intended Audience

Beginner (No background or minimal training is necessary to understand course material)

Biography

Vladimir (Vlad) M. Shalaev, the Robert and Anne Burnett Professor of Electrical and Computer Engineering and Professor of Biomedical 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.

SC149 Foundations of Nonlinear Optics

Monday 2 May 2011
13.30–17.30
Robert A. Fisher, R. A. Fisher Associates, USA
Level: TBA

Course Description

This introductory and intermediate level course provides the basic concepts of bulk media 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 parametric oscillation, optical Kerr effect, self-focusing, self-phase modulation, self-steepening, fiber-optic solitons, chirping, stimulated Raman and Brillouin scattering, two-photon absorption, 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. Where possible, examples will address the nonlinear optical effects that occur inside optical fibers. Also covered are examples in liquids, bulk solids, and gases.

Benefits and Learning Objectives

This course should 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

Intended 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.

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 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 is Program Chair for CLEO 2010 and General Chair for CLEO 2012.

SC182 Biomedical Optical Diagnostics and Sensing

Tuesday, 2 May 2011
13.30 - 17.30
Sebastian Wachsmann-Hogiu, Univ. of California at Davis, USA
Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Course 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 and Learning Objectives

This course should enable you to:

- Describe the interaction of light with tissue in terms of absorption, elastic scattering, fluorescence, and inelastic scattering
- 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)
- List various ways light can be used for medical diagnostics, including autofluorescence and Raman measurements
- Compare methods that use labels with label-free approaches to diagnostics and sensing
- Discuss various schemes of sensing, including well established techniques such as ELISA assays and not-yet-Established that use plasmonics for detection
- Discuss the role of optical fibers in diagnostic and sensing
- Identify the advantages and disadvantages of optical diagnostic methods vs non-optical methods

Intended Audience

Advanced Beginner (Basic understanding of topic is necessary to follow course material)

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.

SC316 Organic Photonic Devices

CANCELLED

Monday, 2 May 2011
13.30–17.30
Marc Baldo, Vladimir Bulovic; MIT, USA
Level: Beginner

Benefits and Learning Objectives

This course should enable you to:

- Define the basic concepts underlying the design and fabrication of organic light emitting devices and organic photovoltaic cells.
- Summarize the differences between organic semiconductors and conventional semiconductors, in particular the consequences of van der Waals bonding.
- Examine the state of the art of organic electronics technology.
- Differentiate the fundamental benefits and limitations of the organic materials.
- Investigate new manufacturing paradigms enabled through use of organic materials.
- Compare some successful start-up companies and their brief lessons.

Intended Audience

The course is suitable for a general audience. No specific knowledge of chemistry is required.

SC 361 Coherent Mid-Infrared Sources and Applications

Monday 2 May 2011
13.30–17.30
Konstantin L. Vodopyanov, Stanford Univ., USA
Level: Advanced Beginner to Intermediate

Course Description

This course will cover fundamental principles of mid-IR generation and will regard different approaches for generating coherent light in this important spectral region, based on solid state lasers, fiber lasers, semiconductor lasers (including quantum cascade lasers), as well nonlinear optical frequency conversion techniques. The course will discuss several applications of mid-IR technologies which include: molecular spectroscopy, sub-wavelength (nano IR) spectroscopy, trace molecular detection, stand-off sensing, and advanced coherent spectroscopic detection techniques based on frequency combs.

Benefits and Learning Objectives

This course should enable you to:

- Define what is the "molecular fingerprint" region
- Identify existing direct laser sources of mid-IR coherent radiation, including solid state lasers, fiber lasers, semiconductor heterojunction and quantum cascade lasers
- Identify laser sources based on nonlinear optical methods, including difference frequency generators and optical parametric oscillators and generators
- Describe the principles of trace gas sensing and standoff detection
- Explain what are frequency combs and how they can be used for advanced spectroscopic detection

Intended Audience

Advanced Beginner to Intermediate. 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.

Biography

Konstantin Vodopyanov is a world expert in mid-IR solid state lasers, nonlinear optics and laser spectroscopy. He has published 300 technical publications and is a co-author of a book on the subject: I.T. Sorokina, K.L. Vodopyanov, "Solid-State Mid-Infrared Laser Sources", Springer, 2003. He has both industrial and academic experience and now he teaches and does scientific research at Stanford University, CA. Dr. Vodopyanov is a Fellow of the OSA, SPIE, 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 (General Chair, 2010) 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.

SC154 Quantum Well Devices for Optics and Optoelectronics

CANCELLED

Tuesday 3 May 2011
08.30–12.30
David A. B. Miller; Stanford Univ., USA
Level: Beginner (No background or minimal training is necessary to understand course material)

Course Description

Physics, device principles, and major applications of thin layered quantum well structures in optoelectronics.

Benefits and Learning Objectives

This course should enable you to:

- Describe the basic physics of very thin layered "quantum well" and other quantum-confined semiconductor structures
- Calculate elementary properties of such structures, including in particular how the thickness of the layers affects their behavior
- Describe the principles of devices enabled by such structures, such as quantum well lasers (both edge-emitting and surface emitting), quantum well intersubband detectors, quantum cascade lasers, saturable absorbers for laser mode-locking, and quantum well modulators
- Specify the materials for constructing such devices, such as III-V (e.g., GaAs, InGaAs) and group IV (e.g., Ge) materials
- Describe the various application areas of the major devices, such as telecommunications, optical interconnects, and silicon photonics

Intended Audience

Beginner (No background or minimal training is necessary to understand course material)

Biography

David A. B. Miller received a bachelor's degree from St. Andrews University and a doctorate from Heriot-Watt University. He is a professor of Electrical Engineering at Stanford University with research interests including quantum-well optoelectronic and nanophotonic physics and devices. He has published more than 250 papers and a quantum mechanics textbook, and holds 69 patents. He received several awards for his research. He is a Fellow of the Royal Societies of London and Edinburgh, OSA, APS and IEEE, and is a member of the National Academies of Sciences and of Engineering.

SC157 Laser Beam Analysis, Propagation and Shaping Techniques

Tuesday 3 May 2011
08.30–12.30
James R. Leger, Univ. of Minnesota, USA
Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Course 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 Ã©tendue 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 and Learning Objectives

This course should enable you to:

- Measure the quality of a laser beam using several methods
- Interpret the meaning of various laser specifications
- Understand Gaussian laser beam properties from an intuitive standpoint
- Predict the propagation and focusing properties of non-ideal laser beams
- Determine the concentration limits of a light field
- Design optimal beam concentration optics
- Compare different beam shapes for specific applications
- Design beam shaping optics using polarization and phase manipulation

Intended 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.

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.

SC221 Sub-Wavelength Photonics

Tuesday 3 May 2011
08.30 -12.30
Axel Scherer, Caltech, USA
Level: Beginner (No background or minimal training is necessary to understand course material)

Course Description

In this short course, students will learn about the design and application of printed and integrated optical devices with dimensions at or below the scale of the wavelength of light. In particular, optical microcavities for efficient light emitters and spectroscopic systems will be reviewed.

Benefits and Learning Objectives

This course should enable you to:

- Compare dielectric (total internal reflection and Bragg reflector) with metallic (surface plasmon) geometries for confining and guiding light
- Identify opportunities for using printed optical systems in silicon (silicon photonics)
- Describe methods for creating quantum-mechanical systems from optical nanodevices
- Design lithographically defined micro- and nanocavities and nanocavity lasers
- Explain applications of printed optics for biological and chemical sensing
- Discuss the next generation of nonlinear optics for high-speed modulators and switches
- Summarize the evolution of printed optics integrated circuits
- Determine applications of interdisciplinary integration of photonics with electronics and fluidics

Intended Audience

Advanced Beginner (Basic understanding of topic is necessary to follow course material)

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 3 May 2011
08.30 -12.30
W. Andrew Clarkson, *Optoelectronics Res. Ctr., Univ. of Southampton, UK*

Course Description

Recent advances in cladding-pumped fiber lasers and amplifiers have been dramatic, leading to a range of fiber-based devices with unrivalled performance in terms of output power, beam quality, overall efficiency and flexibility in operating wavelength. The success of fiber technology in the high power arena is largely due to the fiber's geometry, which provides immunity from effects of heat generation in the core whilst at the same time facilitating efficient conversion from relatively low brightness diode pump radiation to high brightness laser output. The pace of progress in scaling output power from fiber-based source has been very rapid, attracting much interest and fuelling thoughts that they may one day replace conventional "bulk" solid-state lasers in many application areas.

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 and Learning Objectives

This course should enable you to:

- Compare dielectric (total internal reflection and Bragg reflector) with metallic (surface plasmon) geometries for confining and guiding light.
- 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.
- Select the optimum pump source for a given rare earth ion transition and fiber design.
- Design the pump light collection and coupling scheme and estimate the pump launch efficiency.
- Specify the fiber parameters (e.g. cladding design, core size, rare earth ion concentration) required for a particular laser or amplifier configuration.
- Design the fiber laser resonator and select the operating wavelength.
- Estimate thermally-induced damage limit and nonlinear limits.
- Measure fiber laser performance characteristics and relate these to fiber design and resonator parameters.

Intended 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 the latest developments in this rapidly advancing field.

Biography

W. Andrew Clarkson obtained his BSc 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.

SC334 The Art of Modeling Optical Systems

CANCELLED

Tuesday 3 May 2011
08.30 - 12.30
Curtis Menyuk, Univ. of Maryland, Baltimore County, USA
Level: Beginner (No background or minimal training is necessary to understand course material)

Course Description

This course will describe effective procedures for formulating and solving mathematical models of optical systems. A first step is to decide on the purpose of the model and the required accuracy: Design of a commercial system and prediction of a new phenomenon are typical applications, and the former requires more accuracy. You should then determine the basic equations and find analytical solutions when possible to serve as a baseline. You can then find computational solutions.

In obtaining a computational solution, you must first decide the problem's character. Is it a propagation problem, such as the nonlinear propagation of light in an optical fiber? Or is it a static problem, such as finding the modes of a semiconductor waveguide? Does it have a random component that requires Monte Carlo simulations? Once that is determined, you must choose between a number of different algorithms and determine what computer and what software to use. Whether using commercial or home-grown software, it should be validated in the parameter regime where it will be used. That can be done by comparison to analytical solutions when possible and by comparison to other simulation codes that solve the same problem. Verification by comparison to experiments is also important, but it is not the same as validation.

All these steps are not present in every modeling problem, but many of them typically are. In this course, the instructor will draw from his own experience in carrying out these tasks in modeling a variety of different optical systems to show how to do them.

Benefits and Learning Objectives

This course should enable you to:

- Set up and test an optical system model
- Decide which software to use
- Analyze the time and space scales in an optical system
- Understand the different types of computational problems and how to solve them

Intended Audience

Beginner (No background or minimal training is necessary to understand course material)

Biography

Curtis Menyuk received a doctorate from the University of California at Los Angeles in 1981, and he has worked at the University of Maryland College Park and SAIC. He is currently a professor of computer science and electrical engineering at the University of Maryland, Baltimore County. He has previously co-directed a program in optical networking for the Department of Defense (1999-2001) and been chief scientist at PhotonEx Corp. (2001-2002). He specializes in modeling optical fiber and laser systems, and he is a Fellow of the OSA and the IEEE.

SC123 Erbium–Doped Fiber Amplifiers and Raman Fiber Amplifiers

CANCELLED

Tuesday 3 May 2011
13.30–18.30
John Zyskind, Oclaro, Inc., USA
Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Course Description

This course will introduce Erbium-doped fiber amplifiers and Raman amplifiers. By enabling the extensive deployment of commercial Dense Wavelength Division Multiplexing (DWDM) systems, the Erbium-doped fiber amplifier (EDFA) is the key driver for the explosive growth in the capacity and reach of optical networks. We will use the EDFA and its principles of operation as the vehicle to present the key functional characteristics of optical amplifiers, such as gain, output power, optical noise, gain flatness, polarization dependence and dynamic response. These ideas will be applied to understand the design principles of EDFAs, the revolutionary impact of optical amplifiers on optical network architectures, most notably high-capacity DWDM networks for terrestrial and undersea applications, and system engineering considerations, particularly OSNR engineering, in designing such networks. Raman fiber amplifiers, which have superior noise characteristics and spectral flexibility, are now also becoming more widely deployed to enhance performance and reduce system cost. To understand the design principles of Raman amplifiers and their applications in optical networks, we will discuss their principles of operation and key characteristics, such as pump requirements, spectral dependence and polarization dependence, with particular attention to their superior noise performance and effective noise figure. Impairments which limit the design and applications of Raman amplification, such as nonlinear pump interactions and RIN transfer will also be discussed. Finally, alternative technologies such as semiconductor optical amplifiers and doped waveguide amplifiers will be compared to the dominant optical amplifier technologies.

Benefits and Learning Objectives

This course should enable you to:

- Define and describe optical amplifier performance metrics and their impact on WDM system applications
- Explain the principles of Erbium-doped fiber amplifier operation, architecture and design
- Explain the principles of Raman amplifier operation, architecture and design
- List the advantages and drawbacks of various optical amplifier technologies for different system applications

- Describe system applications enabled by EDFAs including high-capacity DWDM networks
- Compute optical signal to noise ratios and link budgets for optically amplified systems
- Design optical amplifiers for high performance and low cost
- Design optical communications systems which rely on optical

Intended Audience

This course is intended for engineers who design or specify optical amplifiers and/or optical networks which employ optical amplifiers. It will also be valuable for managers and others who seek an overview of the DWDM/optical amplifier revolution and a guide to the optical network architectures and technology choices it makes possible. Previous knowledge of optical amplifiers is not required.

Biography

John Zyskind received his doctorate from the California Institute of Technology, where he was a Fannie and John Hertz Fellow. At Bell Labs, where he pioneered optical amplifiers for DWDM systems and led optical amplifier research for the MONET optical networking program, he was named Distinguished Member of Technical Staff and received the President's Gold Award. From 1999 to 2002 he was at Sycamore Networks, where he led the development of ultralong haul optical network products. More recently, as senior director of engineering at Optovia, he led development of optically amplified line systems for hut skipping applications. He is currently at Oclaro, Inc. Transport Systems Solutions Division where he is Director of System Engineering. Zyskind is an OSA Fellow and has served as 2001 Technical Co-Chair and 2002 General Co-Chair of the Topical Meeting on Optical Amplifiers and Their Applications.

SC 155 Ultrashort Laser Pulse Measurement

CANCELLED

Tuesday 3 May 2011
13.30 - 18.30
Rick Trebino, Swamp Optics LLC, USA

Course Description

Arguably no field in science and technology is beset by more confusion and misconceptions than that of the measurement of ultrashort laser pulses. There are several reasons: the events involved are unimaginably short; most measurement techniques yield results that can't easily be confirmed; and competition is fierce to sell lasers or claim world records for generating the shortest pulses. Worse, obsolete techniques introduced decades ago continue to find common use, despite their uninformative and often misleading nature. In addition, new techniques are introduced frequently, and most only work for a small range of pulses.

Interestingly, most ultrashort-pulse measurement problems have now been solved, and the techniques are accurate, reliable, convincing and easy to work with. This course is designed for anyone who would like to learn how to (reliably!) measure ultrashort laser pulses. It will begin by describing the basics of ultrashort laser pulses and answer the question: what characteristics of them do we need to measure? It will then describe earlier methods (autocorrelation) and why they are now obsolete. It will cover a combination of spectrographic and interferometric methods for measuring almost any pulse that can be generated, from few-femtosecond, near-single-cycle pulses to noisy trains of the most complex pulses ever generated.

Benefits and Learning Objectives

This course should enable you to:

- Discuss how to determine which technique is right for your application
- Measure the complete spatio-temporal electric field of an unfocused ultrashort pulse on a single shot using only two optical elements
- Measure the complete spatio-temporal electric field of a focused pulse
- Measure ultrafast polarization variation
- Verify that your measurement is correct
- Measure almost any ultrashort pulse
- Explain the fundamental mathematics and physics behind these methods

Intended Audience

Anyone using ultrashort pulses for any reason will find this course useful. Anyone interested in why as seemingly obscure a mathematical fact as the failure of the Fundamental Theorem of Algebra for polynomials of two variables can be responsible for a wide range of successful techniques for measuring ultrashort pulses will also enjoy the course.

Biography

Over the past 10 years, Mr. Dehring has served as a program manager on ground-based, airborne, and near-space technology demonstration programs that ranged in size from $50k study contracts to $20M development contracts. He is currently a program manager with Lockheed Martin (LM). Prior to joining LM, Mr. Dehring was a program and business unit manager at a small aerospace company, Michigan Aerospace Corporation. In addition to running programs for LM, he works with other PMs within the organization on improving processes and tools for effective program management and performance on Research & Development contracts.

SC 301 Quantum Cascade Lasers: High Performance Mid–infrared and THz Light Sources and Applications

Tuesday 3 May 2011
13.30–18.30
Federico Capasso, Harvard Univ., USA
Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Course Description

Focus is on unipolar semiconductor lasers, known as Quantum Cascade Lasers (QCLs), which are fundamentally different from diode lasers. Their wavelength can be designed over a wide range by simple tailoring the active region layer thicknesses; widely tunable and broad band lasing can be achieved. These features have revolutionized spectroscopy and chemical sensing in the mid-infrared region of the spectrum, where molecules have their absorption fingerprints.

The physics and design principles of QCLs will be discussed along with their electronic, transport and iptical properties. State-of-the-art performance in the mid-ir and Terahertz will be reviewed. A broad range of applications and their ongoing commercial development will be presented. Recent important developments which utilize plasmonics to greatly improve the functionality of QCLs will be presented.

Benefits and Learning Objectives

This course should enable you to:

- Understand the underlying QC laser physics, operating principles and fundamental differences between standard semiconductor lasers and QC lasers
- Learn the basics of quantum design of the key types of QC lasers used in real world applications, and of how their quantum mechanical properties can be tailored to optimize performance in the mid-infrared and THz region.
- Describe, discuss and quantify device characterization and performance, including design constraints and trade-offs, and comparison with theory.
- Understand the basics of QC laser device technology such as fabrication process and materials growth options
- Acquire in depth information on the current research frontier of QC lasers including physics, design, performance and applications
- Learn the basics of spectroscopic techniques for chemical sensing; discuss applications of state-of the-art mid-infrared QC lasers to sensing
- Understand the status of QC laser commercialization

Biography

Federico Capasso is the Robert Wallace Professor of Applied Physics at Harvard University, which he joined in 2003 after a 27 years career at Bell Labs where he did research, became Bell Labs Fellow and held several management positions including Vice President for Physical Research. His research has spanned a broad range of topics from applications to basic science in the areas of electronics, photonics, nanoscale science and technology including plasmonics and the Casimir effect. He is a co-inventor of the quantum cascade laser. He has lectured widely including many short courses and tutorials. He is a member of the National Academy of Sciences, the National Academy of Engineering, a fellow of the American Academy of Arts and Sciences; his most recent awards include the King Faisal Prize, the Berthold Leibinger Future Prize, the Julius Springer Prize for Applied Physics, the APS Arthur Schawlow Prize and the IEEE Edison Medal.

SC335 Super-Resolution Optical Microscopy

Tuesday 3 May 2011
13.30–18.30
Stephen Lane, University of California at Davis, USA
Level: TBA

Course 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.

Biography

Stephen Lane is the Associate Director for Science at the NSF Center for Biophotonics 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.

SC 353 Overview of R&D Program Management

Tuesday 3 May 2011
13.30 - 18.30
Michael T. Dehring; Lockheed Martin, USA

Course Description

This class provides an overview of Program Management, and is intended for new and aspiring program managers in Research & Development (R&D). The course covers the principles of program management as applied to R&D programs under $20M for government & commercial contracts. Program management expectations and needs will be explored from contract start-up through close-out. The initial focus of the course will be on the essential elements of program start-up and planning, which are key factors in creating & maintaining a high performing program. The objective will be to develop a program plan that encompasses a Work Breakdown Structure (WBS), task scheduling, cost planning, resource allocation, risk/ opportunity management, and program performance metrics. The final section of the course will focus on Program Performance Management (PPM) and close-out. PPM is critical throughout the execution phase of a program. This section of the course will provide students with practical experience on assessment and control of program performance, including managing cost, schedule, financial report interpretation, and risks. Earned Value Management concepts will be introduced in the course as a tool to aid in measuring program performance. Emphasis will be placed on practical and cost effective application of EVM methods to R&D programs.

Benefits and Learning Objectives

This course should enable you to:

- The expectations and principles of program management
- All phases of a program life cycle and where & how program management plays a role
- The elements of a basic program plan
- Steps involved in risk assessment and management
- The basics of Earned Value Management
- Essentials of monitoring & assessing performance

Biography

Over the past 10 years, Mr. Dehring has served as a program manager on ground-based, airborne, and near-space technology demonstration programs that ranged in size from $50k study contracts to $20M development contracts. He is currently a program manager with Lockheed Martin (LM). Prior to joining LM, Mr. Dehring was a program and business unit manager at a small aerospace company, Michigan Aerospace Corporation. In addition to running programs for

LM, he works with other PMs within the organization on improving processes and tools for effective program management and performance on Research & Development contracts.