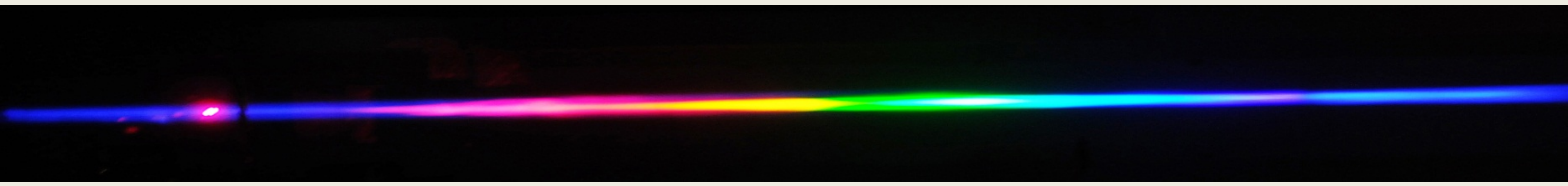
CREOL @25

March 15-16, 2012

Symposium and Industrial Affiliates Program



Celebrating 25 Years of Excellence in Optics and Photonics

UCF

CREOL, The College of Optics and Photonics

CREOL@25

Inaugural Session

8:30	Welcome and Introduction of Special Guests	**Bahaa Saleh**	Dean & Director, CREOL, UCF
8:35	Welcoming Remarks	**Tony Waldrop**	UCF Provost and Vice President
8:45	Industry Partnerships- A Foundational Element of CREOL From the First Day	**Jim Pearson**	Special Consultant, CREOL & Early Affiliates Member
8:55	CREOL Industry Partnership- What it Has Meant to my Company, Florida, the Nation, and the World	**CREOL Industrial Partners**	NGC Laser Systems, Ocean Optics, Analog Modules

Technical Symposium

9:30	Five Decades of Lasers, Six Decades of Progress, and a Proposed Space Experiment to Test Einstein's Assumptions	**John Hall**	NIST, JILA, 2005 Nobel Prize in Physics
10:00	Break & Exhibits		

Session I: Ultrafast Optics

10:30	Photonic Generation of Ultra-Stable Microwaves: Optics Beats Electronics, Again	**Scott Diddams**	NIST
11:00	Ultrafast Coherent X-Rays from Tabletop Lasers – A New Tool For Science and Technology	**Henry Kapteyn**	University of Colorado; JILA
11:20	Ultrafast Optical Signal Processing	**Peter Delfyett**	CREOL, UCF
11:50	Broadband Isolated Attosecond Pulses	**Zenghu Chang**	CREOL, UCF
12:10	Lunch Served & Exhibits		

Session II: High Power Lasers

1:00	Townes@5 – Status and Future of the Townes Laser Institute	**Martin Richardson**	CREOL, UCF Director, Townes Laser Institute
1:20	Fifty Years of Laser and Nonlinear Optics	**Robert Byer**	Stanford University
1:50	High Power Lasers in Additive Manufacturing	**Richard Martukanitz**	Pennsylvania State University
2:20	New Glass Gave Birth To A new Type of Optical Elements and New Enterprise	**Leon Glebov**	CREOL, UCF
2:40	Optical Ceramics: Past, Present and Future	**Romain Gaume**	CREOL, UCF
3:00	Break & Exhibits		

Session III: Imaging and Display

3:30	Biological Tissue Imaging: Breaking the Barriers	**Claude Boccara**	Institut Langevin, ESPCI
4:00	Organic Solar Cells – Prospects and Challenges	**Ching Tang**	University Rochester; NAE Member
4:30	3D Display and Interactive Technologies	**Bounds Huang**	National Chiao Tung University, Cornell University
5:00	Novel Display Possibilities Using Upconversion	**Mike Bass**	CREOL, UCF
5:20	End of Session		
5:30	Cash Bar In UCF Arena Lobby		
6:30	Reception and Awards Banquet Banquet Speaker: MJ Soileau, VP for Research, UCF & Founding Director, CREOL *History of CREOL- Opportunities and Challenges of the Early Days*		UCF Arena (across from UCF Alumni center)

8:00	Continental Breakfast and Walk-in Registrations		Alumni Center
8:30	CREOL's Next 25 Years: The Future of Optics and Photonics	**Bahaa Saleh**	Dean & Director, CREOL, UCF
9:00	The Origin of Nonlinear Optics	**Nicolaas Bloembergen**	University of Arizona; 1981 Nobel Prize in Physics

Session IV: Nonlinear Optics

9:30	Novel Nonlinear Photonic Devices	**Alex Gaeta**	Cornell University
9:55	Single Photons to Multiple Octaves: NLO in Microstructured Media	**Martin Fejer**	Stanford University
10:20	Break & Exhibits		
10:45	Detecting IR with Wide-Gap Semiconductors	**David Hagan**	CREOL, UCF
11:05	Linear and Nonlinear Dynamics of Optical Airy Beams	**Demetri Christodoulides**	CREOL, UCF

Session V: Semiconductor Lasers

11:25	Strong Coupling Effects and Polariton Lasers	**Pallab Bhattacharya**	University of Michigan
11:50	Quantum Dot Laser Diodes and Mode-Locking	**Luke Lester**	University of New Mexico
12:15	Nano-Vertical-Cavity Surface- Emmiting Lasers and Other Novel Photonic Devices	**Dennis Deppe**	CREOL, UCF
12:25	Lunch served; Exhibits	Alumni Center	

Friday, 16 March, Afternoon Session- UCF Alumni Center

Presentations – Alumni Center

Posters, Tours & Reception – CREOL Building

Session VI: Fiber Optics

1:20	Optical Fibre Technology and the Global Internet – Where to Next?	**David Payne**	University of Southampton; CBE, FRS, FREng
1:50	Optical Fibre Sensors – Principles, Achievements and Prospects	**Brian Culshaw**	University of Strathclyde
2:20	A 40 Year Perspective on Fiber Innovation	**Alan Evans**	Corning
2:50	Optical Communication Beyond the Fundamental Capacity Limit of Single-Mode Fibers	**Guifang Li**	CREOL, UCF
3:10	Walk to CREOL		
3:30	Poster Session; Lab Tours; and Reception	CREOL Rooms 102 & 103; Tours start from lobby	
5:00	Poster Award Presentations		

Plenary Talk

Five Decades of Lasers, Six Decades of Progress, and a Proposed Space Experiment to Test Einstein's Assumptions

John L. Hall, University of Colorado and NIST

Abstract: Even though this is the 51st year of the Laser, progress in its control and application in precision measurements is still accelerating. The Optical Frequency Comb technology exploded in 1999-2000 from the synthesis of advances in independent fields of Laser Stabilization, UltraFast Lasers, and NonLinear Optical Fibers, enabling a thousand-fold advance in optical frequency measurement, and searches (in the 16th digit) for time-variation of physical "constants". Current advances in ultra-precise locking are making possible stable optical frequencies defined by length and the speed of light, as well as by locking lasers to the resonant frequency of atoms. These two "clocks" represent our current prototypes of the clocks postulated by Einstein in 1905 in formulating the theory of Special Relativity, which can now be tested into the 18th decimal in a proposed Space-based experiment now being planned by our Space-Time Asymmetry Research collaboration (STAR).

Dr. John L Hall was raised in Colorado and earned his PhD in 1961 at Carnegie Tech (Pittsburgh PA). Hall pioneered the use of stabilized lasers to accomplish measurements of unprecedented accuracy and intrinsic physical interest. He introduced the methane/HeNe stabilized laser and, with his NBS team, used it to measure accurately the speed of light. In collaboration with other National Metrology Institutes, the SI Meter was re-defined in 1983. His group has stabilized various tunable lasers (even diode lasers) to sub-Hz linewidths. He showed how fiber noise could be actively suppressed to deliver phase-stable light at a distant site. His group pioneered the "Optical Comb" techniques which allow simple and direct measurement of optical frequencies. For these works he was awarded the 2005 Nobel Prize in Physics, jointly with Prof. Hänsch of Munich and Prof. Glauber of Harvard. He has received numerous other peer-generated awards, has more than 235 refereed publications, and holds 11 US patents. He has been thesis sponsor for 15 PhD students, co-advisor for 50 more, and his laboratory has hosted more than 150 Postdoctoral, Professional, and Visiting Faculty colleagues from all over the world.

Photonic Generation of Ultra-Stable Microwaves: Optics Beats Electronics, Again

Scott Diddams, NIST

Abstract: The use and manipulation of optical fields provides novel means to address challenging problems that have traditionally been approached with microwave electronics. Some examples that benefit from the low transmission loss, agile modulation and large bandwidths accessible with coherent optical systems include signal distribution, arbitrary waveform generation, and novel imaging. We extend these advantages to demonstrate a microwave generator based on a high-quality factor (Q) optical resonator and a frequency comb functioning as an optical-to-microwave divider. This provides a 10 GHz electrical signal with fractional frequency instability ≤8e-16 at 1 s and close-to-carrier phase noise power that is 10 orders of magnitude below the carrier. These low noise microwaves are more stable than those provided by any room-temperature electronic device. Such sources will benefit radar systems, improve the bandwidth and resolution of communications and digital sampling systems, and be valuable for large baseline interferometry, precision spectroscopy and the realization of atomic time.

Scott Diddams received the Ph.D. degree in Optical Science from the University of New Mexico, Albuquerque in 1996. From 1996 through 2000, he did postdoctroral work at JILA, University of Colorado. In 1998 Dr. Diddams was awarded a National Research Council fellowship to work with Dr. John Hall on the development and use of optical frequency combs. Together with colleagues at JILA, he built the first self-referenced, octave-spanning optical frequency comb and used it to demonstrate carrier-envelope phase stabilized pulses, as well as carry out direct optical to microwave measurements. Since 2000, Dr. Diddams has been a staff member and project leader at the National Institute of Standards and Technology (NIST). With his group and colleagues at NIST, he has continued the development and control of frequency combs and explored their use in optical clocks, tests of fundamental physics, novel spectroscopy, and ultralow noise frequency synthesis. In recent years, special attention has been given to high repetition rate and extremely broadband frequency comb lasers which are being explored for applications in waveform synthesis and astronomy. This work has led to the demonstra- tion of self-referenced laser frequency combs with repetition rates in the range of 10-20 GHz. Dr. Diddams was a co-recipient of a Department of Commerce gold medal for "revolutionizing the way frequency is measured" and was additionally the recipient of the Presidential Early Career Award in Science and Engineering (PECASE) for his work on optical frequency combs. He is a Fellow of the OSA and APS and a member of IEEE.

Ultrafast Coherent X-Rays from Tabletop Lasers—A New Tool For Science and Technology

Henry Kapteyn, University of Colorado; JILA

Abstract: The discovery of x-rays made possible not-only new medical technologies, but also allowed man to "see" for the first time at the atomic scale, revolutionizing our understanding of matter. Efforts to bring x-ray techniques to femtosecond time-scales—the fundamental "atomic" time scale— have been ongoing for the past ~¼ century, and are now providing new insight into the behavior of matter. Key to this work has been to understand the coherent high-order harmonic generation (HHG) upconversion process. Ultrafast HHG sources allow us to probe, using a tabletop setup, the fastest charge, spin and energy transport processes. The capabilities of these sources have increased dramatically with our recent demonstration of bright sources with photon energy >1 keV.[1-4] Recent applications include probing the dynamics of the quantum exchange interaction fundamental to magnetic materials;[5-7] the use of coherent HHG light for tabletop nano-imaging with record resolution;[9] and studies of the physical limits of energy flow at the nanoscale.

Dr. Henry C. Kapteyn has been a Professor at the Department of Physics, and a Fellow of JILA, at the University of Colorado since 1999. Previously, he and his spouse and long-time collaborator Prof. Margaret Murnane were Associate Professors of EECS at the University of Michigan, and Assistant and then Associate Professors of Physics at Washington State University. Henry received his Ph.D. in Physics from the University of California at Berkeley in 1989, in the field of x-ray and short-wavelength laser physics. His work at WSU resulted in the development of a new generation of lasers that make it straightforward to produce light pulses less than ten femtoseconds duration. His current research thrust is in demonstrating novel techniques for generating coherent light in the ultraviolet-to-x-ray region of the spectrum. This work opens up a new region of the electromagnetic spectrum to fundamental studies, and his group is applying these sources to studies of dynamic processes in atomic, molecular, and materials systems, as well as for technological applications such as nanoscale imaging. This work has resulted in a number of advances in fundamental science, including the first demonstration of coherent manipulation of atoms on the attosecond time scales, and the first studies of "radiation femtochemistry" where the dynamics of a molecule exposed to ionizing radiation were followed in real-time. Prof. Kapteyn has received a number of awards including the National Science Foundation Young Investigator award in 1992, the Optical Society of America's Adolph Lomb Medal in 1993, and as co-recipient with Prof. Margaret Murnane of the 2009 Ahmed Zewail Award in Ultrafast Science and Technology of the American Chemical Society, the 2010 R.W. Wood Prize of the Optical Society of America, the 2010 Arthur L Schawlow Prize in Laser Science of the American Physical Society, and the 2012 Willis E. Lamb Medal. Prof. Kapteyn is a Fellow of the Optical Society of America (OSA), the American Physical Society (APS), and the American Association for the Advancement of Science (AAAS).

Peter Delfyett, UCF

Abstract: The development of high speed communications, interconnects and signal processing are critical for an information based economy. Lightwave technologies offer the promise of high bandwidth connectivity from component development that is manufacturable, cost effective, and electrically efficient. The concept of optical frequency/wavelength division multiplexing has revolutionized methods of optical communications, however the development of optical systems using 100's of wavelengths present challenges for network planners. The development of compact, efficient optical sources capable of generating a multiplicity of optical frequencies/wavelength channels from a single device could potentially simplify the operation and management of high capacity optical interconnects and links. Over the years, we have been developing mode-locked semiconductor lasers to emit ultrashort optical pulses at high pulse repetition frequencies for a wide variety of applications, but geared toward optical communications using time division multiplexed optical links. The periodic nature of optical pulse generation from mode-locked semiconductor diode lasers also make these devices ideal candidates for the generation of high quality optical frequency combs, or multiple wavelengths, in addition to the temporally stable, high peak intensity optical pulses that one is accustomed to. The optical frequency combs enables a variety of optical communication and signal processing applications that can exploit the large bandwidth and speed that femtosecond pulse generation implies, however the aggregate speed and bandwidth can be achieved by spectrally channelizing the bandwidth, and utilize lower speed electronics for control of the individual spectral components of the mode-locked laser. This presentation will highlight our recent results in the generation of stabilized frequency combs, and in developing approaches for filtering, modulating and detecting individual comb components. We then show how these technologies can be applied in signal processing applications such as arbitrary waveform generation, arbitrary waveform measurement, laser radar and matched filtering for pattern recognition.

Peter J. Delfyett is the University Of Central Florida Trustee Chair Professor of Optics, EE & Physics at The College of Optics & Photonics, and the Center for Research and Education in Optics and Lasers (CREOL) at the University of Central Florida. Prior to this, he was a Member of the Technical Staff at Bell Communications Research from 1988-1993. Dr. Delfyett served as the Editor-in-Chief of the IEEE Journal of Selected Topics in Quantum Electronics (2001-2006), and served on the Board of Directors of the Optical Society of America. He served as an Associate Editor of IEEE Photonics Technology Letters, and was Executive Editor of IEEE LEOS Newsletter (1995-2000). He is a Fellow of the Optical Society of America, Fellow of IEEE Photonics Society, and Fellow of the American Physical Society. He was also a member of the Board of Governors of IEEE-LEOS (2000-2002) and a member of the Board of Directors of the Optical Society of America (2004-2008). In addition, Dr. Delfyett has been awarded the National Science Foundation's Presidential Faculty Fellow Early Career Award for Scientists and Engineers, which is awarded to the Nation's top 20 young scientists. Dr. Delfyett has published over 600 articles in refereed journals and conference proceedings, has been awarded 34 United States Patents. He was awarded the University of Central Florida's 2001 Pegasus Professor Award which is the highest honor awarded by the University. Dr. Delfyett has also endeavored to transfer technology to the private sector, and helped to found "Raydiance, Inc." which is a spin-off company developing high power, ultrafast laser systems, based on Dr. Delfyett's research, for applications in medicine, defense, material processing, biotech and other key technological markets. Most recently, he was awarded the APS Edward Bouchet Award for his significant scientific contributions in the area of ultrafast optical device physics and semiconductor diode based ultrafast lasers, and for his exemplary and continuing efforts in the career development of underrepresented minorities in science and engineering.

Broadband Isolated Attosecond Pulses

Zenghu Chang, UCF

Isolated attosecond pulses with continuous spectra extending from 20 to 500 eV have been generated with Double Optical Gating. For application of such XUV/soft x-ray pulses, robust characterization of the pulse duration is needed. In the past, the FROG-CRAB technique was developed. However, it requires that the bandwidth of the photoelectron spectrum to be much smaller than its central energy, known as the central momentum approximation. This approximation restricts the applicability of FROG-CRAB to relatively narrow-band attosecond pulses with high photon energies. For this reason, we developed the PROOF (Phase Retrieval by One-Omega Filtering) technique, which does not rely on the central momentum approximation. The new method has been successfully applied to characterize pulses shorter than 100 attoseconds.

Zenghu Chang is a Distinguished Professor of Physics and Optics at the University of Central Florida. He is a fellow of the American Physical Society and the leader of the Attoscience technique group in the Optical Society of America. He directs the Florida Attosecond Science and Technology laboratory. Chang graduated from Xi'an Jiaotong University in 1982 with a bachelor's degree in Electrical Engineering. He then earned an MSc degree and a doctorate in Optics at the Xi'an Institute of Optics and Precision Mechanics, Chinese Academy of Sciences, in 1988. From 1991 to 1993, Dr. Chang visited the Rutherford Appleton Laboratory sponsored by the Royal Society. After returning China, He was appointed as the associate director of basic research at the Xi'an Institute of Optics and Precision Mechanics. Chang moved to the US in 1995. He worked at the University of Michigan as a research scientist. Then joined the physics faculty at Kansas State University in 2001 as an associate professor. In 2007, Chang spent six months at the University of Frankfurt sponsored by the DFG Mercator professorship. He was promoted to the Ernest & Lillian Chapin Professor in 2009. Dr. Chang has published 140 papers. His notable contributions include inventing the double optical gating for the generation of single isolated attosecond pulses. He is the recipient of the Hubert Schardin gold model from the German physical society in 1996. Chang was the co-chair of the second international conference on attosecond physics held in 2009. He is the author of the book "Fundamentals of Attosecond Optics."

Martin Richardson, UCF; Director, Townes Laser Institute

Abstract: The Townes Laser Institute was dedicated nearly 5 years ago. Since then it has grown in stature and impact in areas of high power lasers, laser development and the applications of lasers. New investments have been made in optical fiber technology, ceramic laser materials and attosecond lasers. This talk will summarize these developments, outline new initiatives underway and the vision for the future.

Martin Richardson graduated from Imperial College, London, in Physics and obtained his Ph.D in Photon Physics from London University in 1967. As part of one of the pioneering groups investigating lasers and plasmas at NRC-Canada, he was the first to create plasmas in gases by amplified single ultrashort laser pulses. His work on laser development resulted in patents on the discharge-pumped CO_2 laser that launched the Lumonics corporation, and he spearheaded the creation of the first Canadian team focused on laser fusion. Collaborations with the Lebedev Institute in the former Soviet Union resulted in the development of the picosecond streak camera. After joining the University of Rochester in 1980, Richardson led laser fusion experiments for the then-new 24-beam OMEGA laser system, was involved in x-ray laser and laser-plasma x-ray spectroscopy investigations and held an adjunct faculty in the Institute of Optics. In 1990, Richardson established the Laser Plasma Laboratory with William Silfvast at CREOL in UCF in 1990, growing one of the largest university programs in high power laser development and laser applications in the nation. He was appointed the Northrop Grumman Professor of X-ray Photonics in 2003 as part of major $24M donation to UCF. He was made a Trustee Chair of the University in 2006, and appointed the founding director of the Townes Laser Institute in 2007.

Throughout his career, Richardson has taken a keen interest in education. In Canada, he introduced schemes allowing students from Canadian universities to study for their Ph.D's at NRC-Canada. He directs an NSF International REU program, and initiated an Atlantis program between UCF and the universities of Bordeaux, Jena and Clemson awarding international MS degrees, and some co-tutelle Ph.D degrees. He is particularly interested in advancing science in under-developed countries, and in enabling equal rights for women through science.

Professor Richardson has held visiting scientific positions at a number of foreign institutions, including several in Germany (Max Born Institute, MPQ, Fraunhofer Institute ILT and Friedrich Schiller University, Jena), in France (Bordeaux), Japan (Osaka University), Qatar and Australia. He has published over 400 scientific articles in professional scientific journals, and has presented numerous invited and plenary talks and holds approximately 20 patents. He has chaired many international conferences including IQEC, ICHSP, and several SPIE meetings, is a former Associate Editor of JQE, a recipient of the Schardin Medal, and a Fellow of OSA.

Fifty Years of Laser and Nonlinear Optics

Robert Byer, Stanford University

Abstract: A look back at the early days of the laser and nonlinear interactions will be contrasted to the recent breakthroughs in solid state lasers and the applications to fundamental science, laser acceleration and x-ray generation, and laser inertial fusion energy.

Robert L. Byer is the current President of The American Physical Society and has served as President of OSA and of IEEE LEOS. He has served as Vice Provost and Dean of Research at Stanford. He has been Chair of the Department of Applied Physics, Director of the Edward L. Ginzton Laboratory and Director of the Hansen Experimental Physics Laboratory. He is a founding member of the California Council on Science and Technology and served as Chair from 1995-1999. He was a member of the Air Force Scientific Advisory Board from 2002-2006 and has been a member of the National Ignition Facility since 2000. Robert L. Byer has conducted research and taught classes in lasers and nonlinear optics at Stanford University since 1969. He has made extraordinary contributions to laser science and technology including the demonstration of the first tunable visible parametric oscillator, the development of the Q-switched unstable resonator Nd:YAG laser, remote sensing using tunable infrared sources and precision spectroscopy using Coherent Anti Stokes Raman Scattering (CARS).

High Power Lasers in Additive Manufacturing

Peter R.P. Martunkanitz, Pennsylvania State University

Abstract: Although lasers have been utilized for processing of materials for many years, the application of multi-kilowatt, fiber delivered lasers is playing a prominent role in advancing additive manufacturing. Laser additive manufacturing, as applied to metals, is a deposition technique utilized in a wide range of applications, ranging from the repair of damaged parts to the direct digital manufacturing (DDM) of solid metal components from CAD designs. This presentation will include recent research directed at advancing the understanding and application of laser deposition processes for critical components relevant to industry and the Department of Defense. Several ongoing additive manufacturing innovations will be discussed, including: development of portable processes for automated field repair of large valves; development and design of high deposition tools for repair of propulsion shafts; and repair technology for critical aerospace components. Recent advances in direct digital manufacturing will also be discussed and will include: modeling in conjunction with thermographic imaging of the DDM process for ensuring process consistency; assessing the effect of recycled powder on deposition quality; and exploring the potential for utilizing advanced materials in DDM. The newly formed Center for Innovative Metal Processing through Direct Digital Deposition (CIMP-3D) will also be introduced, along with its mission and roles as a DARPA Manufacturing Demonstration Facility in DDM technology.

Dr. Martukanitz is currently Head of the Laser Processing Division, as well as Assistant Director of the Applied Research Laboratory, Pennsylvania State University. He has spent the last 22 years involved in the development and application of laser processing technology. He is the founder and Director of the Laser Processing Consortium, an organization that has included over 50 commercial companies over the past ten years, as well as the current Director of the Center for Innovative Metal Processing through Direct Digital Deposition. Dr. Martukanitz also holds an adjunct faculty position with the Industrial and Manufacturing Engineering Department of the Pennsylvania State University and lectures on laser processing technology. Dr. Martukanitz' research interests include the interaction of laser energy with metallic systems, additive manufacturing, and rapid kinetics associated with beam processing. Prior to joining the Applied Research Laboratory at Penn State in 1990, Dr. Martukanitz was a member of the Product Engineering Division of Alcoa Technical Center, Alcoa Center, PA.

New Glass Gave Birth To A New Type of Optical Elements And New Enterprise

Leonid B. Glebov, UCF

Abstract: Thirteen years ago CREOL first time reported on creation of a new efficient photosensitive material for volume hologram recording. Twelve years ago CREOL spun off a company (OptiGrate) for commercialization of this technology. Now this new material produces revolutionary changes in lasers and spectroscopy. The Company is booming providing optical community with unique holographic optical elements and lasers.

Leon Glebov got his Ph.D. in Physics (major in Optics) from State Optical Institute, Leningrad, Russia (1976). He has been affiliated with that institute up to 1995 holding different positions in research and scientific management. Since 1995 Dr. Glebov has been at CREOL/ The College of Optics and Photonics, University of Central Florida as a Research Professor. He has published a book and more than 300 papers in scientific journals and holds 15+ Russian patents, and 9 awarded and 3 pending US patents. He is a member of Organizing and Program Committees for a number of International Conferences. Dr. Glebov is a fellow of the major societies in optics and photonics; he is a recipient of SPIE Denis Gabor award in holography. The main directions of his research are optical properties of glasses, holographic optical elements, and semiconductor, solid state and fiber lasers controlled by volume Bragg gratings. Leon Glebov is a founder and VP for R&D of OptiGrate Corporation which develops and fabricates holographic optical elements (volume Bragg gratings) for multiple applications in lasers and photonics.

Optical Ceramics: Past, Present, and Future

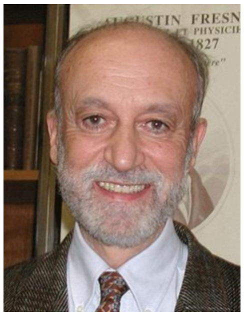
Romain Gaume, UCF

Abstract: Since their first development in the 1960's, optical ceramics have solved recognized and important technological problems in lighting, defense and medical applications. Their unique physical properties combined with the scalability of their fabrication process have offered new pathways for the design of large, complex and novel optical components for transparent armors, compact optics, high-power lasers and nuclear detectors. This talk will review some of the historical developments of the field, present recent achievements and discuss the challenges and opportunities for the future.

Romain Gaume is an assistant professor at CREOL and at the NanoScience Technology Center (NSTC) since November 2011. He earned his Ph.D. degree in Materials Science from Paris VI University in 2002 where he designed novel crystalline materials for high-power and ultra-short laser applications. He then joined Prof. R.L. Byer's group at the Applied Physics department at Stanford University as a postdoctoral researcher, and later as a staff scientist, to work on transparent ceramics. The research activities of his group at CREOL primarily focus on the development of transparent polycrystalline materials for lasers and nuclear detection.

Claude Boccara, Institut Langevin, ESPCI

Abstract: We will briefly summarize the main approaches (Optical Coherence Tomography, Diffuse Tomography, acousto-optics, photoacoustics etc.) that are used to image through scattering media such as biological tissue and discuss their limits in term of resolution, depth and signal to noise ratio. We know that wavefront engineering has been very helpful to correct aberrations induced by atmosphere turbulence. In the same spirit we will point the progresses that have been achieved these last years in term of wavefront control in the space domain or in the time domain and the perspective that they open to image through scattering media.Finally we would like discussing how these wavefront controls could help to revisit the field of optical tomography.



A. Claude Boccara was Dean of Research at ESPCI-ParisTech up to January 2009. He has been involved in light matter interactions and introduced shot noise limited instruments. Polarisation based approaches have been developed and the associated instrumentation (dichrometers and polarimeters) is still produced by industrial partners. Then he introduced a full range of photothermal approaches (“Mirage”, Photothermal Microscope, Interferometers, IR Microscope…). New kinds of microscopies have been developed to increase depth and lateral resolution much below subwavelength limits so, understanding the physics of small objects has been one of his goals. Recently, optical approaches to ultimate measurements have found new fields of application going from optical detection of gravitational waves to 3-D imaging though like biological tissues. A.C. Boccara has published more than 300 scientific articles in international journals.

Organic Solar Cells- Prospects and Challenges

Ching W. Tang, University of Rochester

Abstract: Since the report of the organic photovoltaic cell with a heterojunction structure in 1986 and the more efficient organic bulk-heterojunction structures nearly a decade later, the power conversion efficiency of organic photovoltaic cells is rapidly approaching the threshold of 10% and the prospect for practical applications becomes increasingly more attractive. In this talk, the challenges of developing organic photovoltaic cells as a robust and low-cost solar cell technology will be discussed with particular reference to the development of the organic light emitting diode (OLED) – a companion technology that has been successfully commercialized for display applications.

Dr. Ching W. Tang is Doris and Johns Cherry Professor of Chemical Engineering at University of Rochester. His recent research interests include Organic Electronics; Thin-Film Devices; Display Technology; Organic Light Emitting Diodes; Organic Solar Cells; II-VI Semiconductors; CdTe Solar Cells; Thin-Film Deposition and Characterization. Dr. Tang received his Ph.D. in Chemistry from Cornell University. He has received numerous national and international recognitions, including Wolf Prize in Chemistry (2011), Lifetime Achievement Award, University of Rochester (2010), IEEE Daniel E. Noble Award (2007), Humboldt Research Award (Germany, 2005), SID Jan Rajchman Prize (2001), and ACS Carothers Award (2001), just to name a few. He is a fellow of the SID and APS, and a member of the U.S. National Academy of Engineering.

Yi-Pai Bounds Huang, Cornell University

Abstract: What is the perfect naked eye 3D Display? People may say "wide-viewing angle, FHD on 2D/3D mode, acommodation-convergence match, intractability, etc." For achieving this target, several key components must be realized. In this talk, the adaptive liquid-crystal lens will be first introduced. An array of such lenses can be used for 3D display and 3D capturing. Good 3D imaging quality is assured and a 3D interactive system was further developed, with the user "virtually touching" the popped out images. This system could be a general model for the 3D flat panel of the future.

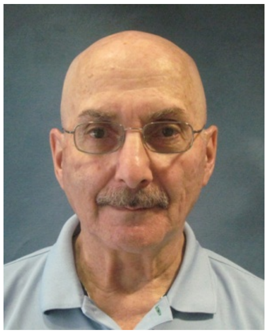
Yi-Pai Bounds Huang received his BS degree from National Cheng Kung University in 1999 and earned a Ph.D. degree in Electro-Optical Engineering at the National Chiao Tung University in Hsinchu, Taiwan. He was a short-term visiting scholar at CREOL, University of Central Florida from 2001 to 2002. In 2004, he was a project leader in the technology center of AU Optronics (AUO) Corp. He is currently a visiting associate professor in Cornell University, and a full-time associate professor in the Department of Photonics and Display Institute at National Chiao Tung University. His expertise includes 3D Display and Interactive Technologies, Display Optics and Color science, and Micro-optics. In the above-mentioned research, He have so far published more than 110 International Journal and conference papers(including the 50 SID Conference Papers and 10 invited talks), and have obtained 35 granted patents, with another 52 patents currently publicly available. In addition, He had three times received the SID's distinguished paper award (2001, 2004, 2009). Other important awards include 2011 Taiwan National Award of Academia Inventor, 2010 Advantech Young Professor Award, 2009 Journal-SID: Best paper of the Year Award, and 2005 Golden Dissertation Award of Acer Foundation. For the International Society Service, he is now the Secretary General of Taipei Chapter, Chair of Applied Vision Committee of SID, Editorial Board Committee of Journal of 3D Research, and Associate Editor of Journal-SID.

Novel Display Possibilities Using Upconversion

Michael Bass, UCF

Abstract: Upconversion is the process in which a material is excited by two or more low energy photons to emit a higher energy photon. When the latter is visible the process can be used to make novel displays possible. In this talk up conversion will be applied to volumetric 3D displays, low voltage microdisplays, emissive fibers and making nanoparticles detectable in microbiological applications.

Michael Bass received his B.S. degree in physics from Carnegie-Mellon University in 1960 and his M.S. and Ph. D. degrees in physics from the University of Michigan in 1962 and 1964. His career has been in lasers and optical materials. His studies of the spectroscopy of rare earth doped crystals led to the demonstration of their potential in displays.



Bahaa Saleh, UCF

Abstract: More than 50 years after the first operation of the laser, optics and photonics has become a mature field. It would be foolhardy to try to predict the disruptive discoveries and inventions that will no doubt create new directions in the next 25 years but it is surely safe to predict steady progress along established R&D directions. Advances in the underlying fundamental sciences along with improvements in technology will enable increasing numbers of applications. *Light is a carrier of information.* The transmission of information is limited by the resolution and precision with which light can be shaped or confined in time and space. Future advances will no doubt include *finer resolution and greater precision*: the delivery (or detection) of shorter optical pulses – or CW light with narrower spectral width – to (or from) smaller volumes, or along prescribed paths, with greater precision in time, position, and energy. This will enable: 1) 3D, 4D, or 5D "*reading"* and "*writing*" (imaging, printing, lithography, display, data storage, etc) with higher speed and finer resolution and precision; and 2) *communicating* at greater data rates with less power over longer distances and among a greater number of users (or interconnected points). There will also be progress in achieving information transmission through thicker absorbing, scattering, dispersive, or random media, such as biological tissue or the turbulent atmosphere, with the help of better adaptive optics and/or computational methods. *Light is also a carrier of energy.* Future advances will no doubt bring about more efficient conversion into (or from) other forms of energy, thereby improving the harvesting of solar energy, lighting and illumination, actuation, photochemistry, cutting and welding, ablation, surgery, etc. In some applications, optical energy/power at levels currently unavailable is needed, while in others the task is to be accomplished at low energy levels, thereby involving quantum effects, which may also be utilized for information transmission. Progress along these directions will require new materials and devices. The upcoming decades will surely see the development of new synthetic materials with optical properties that do not currently exist. These will be fabricated using combinations of dielectric and metallic materials, arranged in micro- and nanostructures of various spatial configurations, and incorporating what are currently considered novel structures such as metamaterials, negative-index materials, and plasmonic structures. We are also sure to see more efficient arrayed optical sources and detectors, integrated-optic active devices, and fluorescing particles and markers that are, for example, custom-made for specific biophotonics applications. And there will surely be far more! One thing is certain: CREOL, the College of Optics & Photonics, will continue to play an expanding and leading role in driving the new discoveries and inventions along these directions and expanding the scope their applications.

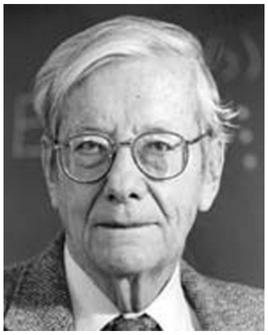
Bahaa E. A. Saleh has been Dean of CREOL, The College of Optics and Photonics at the University of Central Florida, since 2009. He was a faculty member in the Department of Electrical and Computer Engineering (ECE) at Boston University in 1994-2008, and he served as Department Chair in 1994-2007. He was also Deputy Director of the Center for Subsurface Sensing and Imaging Systems, an NSF Engineering Research Center in 2000-2008. He received the Ph.D. in electrical engineering from Johns Hopkins University in 1971 and held faculty and research positions at various places including the University of Wisconsin-Madison where he served as ECE Department Chair in 1990-1994. His research contributions cover many topics in optics and photonics including statistical, nonlinear, and quantum optics, and image science. He is the author of Photoelectron Statistics (Springer, 1978), Introduction to Subsurface Imaging (Cambridge, 2011), Fundamentals of Photonics (with M. Teich, Wiley, 1991, 2007), and more than 500 papers in technical journals and conference proceedings. He is the founding editor of OSA's Advances in Optics and Photonics, and former editor of JOSA A (1991-1997). Saleh is Fellow of the IEEE, OSA, and the Guggenheim Foundation. He received the 1999 OSA Beller Award, the 2004 SPIE BACUS award, the 2006 Kuwait Prize, and the 2008 OSA Distinguished Service Award.

Plenary Talk

The Origin of Nonlinear Optics

Nicolaas Bloembergen, University of Arizona

Abstract: The generation of the second harmonic of light by Peter Franken and colleagues at the University of Michigan in 1961is generally considered as the origin of a new subfield of optics, based on a nonlinear relationship between the polarization and the electric field amplftude. The rapid development of this new subfield was aided experimentally by the availability of Q-switched ruby laser pulses. It should however be noted that the operation of the ruby laser itself is an example of nonlinear optics.



Nicolaas Bloembergen was born in Dordrecht, the Netherlands, on 11 March 1920. He obtained the Phil. Cand. and Phil. Drs. degrees at the University of Utrecht in 1941 and 1943, respectively. After surviving World War II in Holland, he came to America in the spring of 1946, walked into Professor Edward Purcell's office at Harvard University and requested the opportunity to do graduate work in the emerging field of nuclear magnetic resonance. This fateful step started a lifelong association with Harvard which continues to the present day. It also set the future pattern for his scientific work, which began with magnetic resonance and evolved in a natural way in quantum electronics, non-linear optics, and lasers.

His Ph.D. thesis on nuclear magnetic relaxation became the classic Bloembergen, Pound and Purcell paper (BPP) in the Physical Review of 1949. He returned briefly to the University of Leiden in Holland to receive the Ph.D. degree in 1948. A measure of the continuing influence of his Ph.D. thesis is that it was first published as a book in 1961 - a full 13 years after he graduated.

In 1949 Bloembergen returned to Harvard as a Junior Fellow of the Society of Fellows. He became Associate Professor of Applied Physics in 1951, Gordon McKay Professor in 1957, Rumford Professor of Physics in 1974, and Gerhard Gade University Professor in 1980. His magnetic resonance work was recognized by the Oliver E. Buckley Prize for Solid State Physics awarded by the American Physical Society in 1958.

Bloembergen´s work in electron spin resonance led to his invention of the three-level solid-state maser in 1956. This found use as a microwave amplifier and was a forerunner of the subsequent laser developments which rely most heavily on the three-level pumping system. Primarily in recognition for this work, he shared the Morris Liebmann Memorial Award of the Institute of Radio Engineers for 1959 and the Stuart Ballantine Medal of the Franklin Institute in 1961.

The rapid evolution of quantum electronics into the optical region led Bloembergen into the field of nonlinear optics of which he is one of the founders.

In the past two decades his scientific work has emphasized laser spectroscopy and laser interaction with matter.

His excitement with science and his productivity have continued at the same high level from the time he was a young scientist right up to the present. In 1974 he was awarded the National Medal of Science by the President of the United States for pioneering applications of nuclear magnetic resonance. His other awards include the 1979 Frederic Ives Medal of the Optical Society of America for contributions to nonlinear optics and the 1981 Nobel Prize for Physics for his contributions to the development of laser spectroscopy. The IEEE awarded him the Medal of Honor in 1983, "For pioneering contributions to Quantum Electronics including the invention of the three-level maser."

Novel Nonlinear Photonic Devices

Alexander Gaeta, Cornell University

Abstract: Since the birth of nonlinear optics, researchers have continually focused on developing efficient nonlinear optical devices that require low optical powers. Silicon nanophotonics has emerged as a highly promising platform for such devices and for enabling massively parallel, integrated optical and electronic devices on a single chip. The key feature for nonlinear photonics in Silicon is the strong light confinement that enables both a high effective nonlinearity and tuning of the dispersion, which is essential for phase matching of parametric nonlinear optical processes such as four-wave-mixing (FWM). We demonstrate a wide range of devices based on FWM in Silicon chips that offer the potential for ultrahigh bandwidth all-optical processing, CMOS-compatible multiple-wavelength sources, and optical clocks.

Alex Gaeta received his B.S degree in 1983 and his Ph.D. in 1991, both in Optics from the University of Rochester. In 1992 he joined the faculty at the School of Applied and Engineering Physics at Cornell University where he is currently a Professor and the Director for the School. His research interests include integrated nonlinear optical devices, nanophotonics, ultrafast nonlinear optics, the development and application of photonic crystal fibers, and quantum effects in nonlinear optics. He is a Fellow of the OSA and the APS.

Single Photons to Multiple Octaves: NLO in Microstructured Media

Martin Fejer, Stanford University

Abstract: Microstructured nonlinear materials like periodically poled ferroelectrics and orientation-patterned semiconductors have been used for more than 20 years as efficient alternatives to conventional birefringently phasematched crystals in a large variety of frequency conversion devices. More recently, the additional degrees of freedom available in aperiodic media, often used in combination with waveguide confinement, have enabled novel applications. In this talk, two examples, generation of octave-spanning continua in the mid-IR, and quantum frequency conversion at the single photon level, will be discussed.

Martin Fejer is Professor of Applied Physics, and was Senior Associate Dean of Humanities and Sciences (2004 – 2009) and Chair of the Applied Physics department (2001-2004) at Stanford University. He received his B.A. in Physics from Cornell University, and his M.S. and Ph.D. in Applied Physics from Stanford University. His current research interests are in nonlinear optical materials and devices, guided wave optics, microstructured ferroelectrics and semiconductors, THz and ultrafast optics, classical and quantum optical signal processing, and materials with low dissipation. He has published over 300 papers in these areas, and holds over 30 patents. He is active in professional society activities; is a fellow of the IEEE and of the Optical Society of America whose R. W. Wood Prize he was awarded in 1998, has been a member of the OSA Board of Directors and the Board of Governors of IEEE-LEOS, and was general co-chair of CLEO 2002.

Detecting IR with Wide-Gap Semiconductors

David Hagan, UCF

Abstract: Two-photon absorption (2PA) in semiconductors has long been known to scale as the inverse third power of the energy gap, i.e. E_g^{-3}, which limits the 2PA coefficients available in large gap semiconductors However it is also known that in the highly nondegenerate case, where the input wavelengths are very different, the 2PA rate can be greatly enhanced over the degenerate case. We have recently verified this for several direct gap semiconductors in pump-probe transmission experiments with femtosecond and picosecond pulses where we showed that, in many direct-gap semiconductors, nondegenerate 2PA coefficients are enhanced approximately 100-fold over the degenerate case. In GaAs, we observed 2PA coefficients around 1,000 cm/GW. Coefficients this large were previously only observed in narrow-gap semiconductors such as InSb.

Based on this effect, one may obtain sensitive gated detection using conventional semiconductor photodiodes. We have demonstrated this with standard GaN and GaAs photodiodes using extreme non-degenerate photon pairs with up to 14:1 energy ratio. We can also detect weak IR radiation by employing intense UV gating pulses. The minimum detected IR pulse energy in GaN is as low as 20 pJ energy while for a standard cooled MCT detector, the minimum detectable energy is 200 pJ. It is worth noting that this process does not IR crystals or phase-matching, as employed by $\chi^{(2)}$ upconversion detection. In this talk, will show how this detection scales to other semiconductors and how one may optimize device geometries for practical detection.

David Hagan received his PhD degree in Physics at Heriot-Watt University, Edinburgh, Scotland in 1985. From 1985 -87 he was a research scientist at the Center for Applied Quantum Electronics and the University of North Texas. He moved to UCF in 1987 as a founding member of the CREOL faculty, where he is currently Professor of Optics and Physics and also serves as Associate Dean for Academic Programs. He is currently Editor in Chief of the OSA journal, *Optical Materials Express*. His current research interests include: nonlinear optical materials, techniques for nonlinear optical characterization, optical power limiting and switching, nanostructural enhancement of optical nonlinearities and nonlinear optical spectroscopy.

Linear and Nonlinear Dynamics of Optical Airy Beams

Demetri Christodoulides, UCF

Abstract: We provide an overview of recent developments in the area of optical Airy beams and bullets. The properties of these waves under linear and nonlinear conditions are discussed along with their applications in both the spatial and temporal domain.

Demetrios Christodoulides is a Provost's Distinguished Research Professor at CREOL, The College of Optics & Photonics, at the University of Central Florida. He received his Ph.D. degree from Johns Hopkins University in 1986 and subsequently joined Bellcore as a postdoctoral fellow at Murray Hill. Between 1988 and 2002 he was with the faculty of the Department of Electrical Engineering at Lehigh University. His research interests include linear and nonlinear optical beam interactions, synthetic optical materials, optical solitons and quantum electronics. He has authored and co-authored more than 240 papers. He is a fellow of the Optical Society (OSA) and the American Physical Society. In 2011 he received the R.W. Wood Prize of the Optical society of America.

Strong Coupling Effects and Polariton Lasers

Pallab Bhattacharya, University of Michigan

Abstract: Microcavity exciton-polaritons, which are elementary excitations in strongly coupled exciton-photon systems, have been the subject of interest and intense research since their first observation almost two decades ago. Research in this field with semiconductors has been driven with two interrelated goals. The first is the achievement of a coherent light source, also termed a *polariton laser*, wherein a degenerate and coherent state of exciton-polaritons is generated by a combination of polariton-phonon and stimulated polariton-polariton scattering. The coherent polariton states generate coherent light by spontaneous radiative recombination. At the other extreme is the case of a degenerate Bose-Einstein condensate in perfect thermal equilibrium with the lattice and the polariton lifetime is extremely long, leading to long-term temporal coherence and long-range spatial coherence. In this talk I will describe the design and properties of room temperature optically excited GaN and ZnO nanowire polariton lasers with the lowest measured threshold (90nJ/cm^2) and the first electrically injected polariton laser. The characteristics of dynamic Bose condensation in the nanowire microcavities will also be described.

Pallab Bhattacharya is the Charles M. Vest Distinguished University Professor of Electrical Engineering and Computer Science and the James R. Mellor Professor of Engineering in the Department of Electrical Engineering and Computer Science at the University of Michigan, Ann Arbor. He received the M. Eng. and Ph.D. degrees from the University of Sheffield, UK, in 1976 and 1978, respectively. Professor Bhattacharya was an Editor of the *IEEE Transactions on Electron Devices* and Editor-in-Chief of *Journal of Physics D*. He has authored the textbook *Semiconductor Optoelectronic Devices* (Prentice Hall, 2nd edition). His teaching and research interests are in the areas of compound semiconductors, low-dimensional quantum confined systems, nanophotonics and optoelectronic integrated circuits. He is currently working on high-speed quantum dot lasers, quantum dot infrared and terahertz photodetectors, spin-based and nanowire heterostructure devices, and strong coupling phenomena in nanostructures. Professor Bhattacharya is a member of the National Academy of Engineering. He has received the John Simon Guggenheim Fellowship, the Heinrich Welker Prize, the IEEE (EDS) Paul Rappaport Award, the IEEE (LEOS) Engineering Achievement Award, the Optical Society of America (OSA) Nick Holonyak Award, the SPIE Technical Achievement Award, the Quantum Devices Award of the International Symposium on Compound Semiconductors, the IEEE (Nanotechnology Council) Nanotechnology Pioneer Award, and the TMS John Bardeen Award. He is a Fellow of the IEEE, the American Physical Society, the Institute of Physics (UK), and the Optical Society of America.

Quantum Dot Laser Diodes and Mode-Locking

Luke F. Lester, University of New Mexico

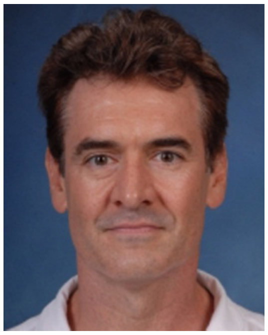
Abstract: The unique advantages of quantum dot (QD) materials, such as ultra broad bandwidth, ultra fast gain dynamics, low linewidth enhancement factor and easily saturated gain and absorption, make them a desirable choice for semiconductor monolithic mode-locked lasers (MLLs). This talk will discuss the modeling and characterization of quantum dot MLLs and identify what differentiates them from other semiconductor lasers in terms of temperature performance and pulse stability. Reconfigurable devices will also be presented that are capable of repetition rates from 2-100 GHz. These multi-section QD MLLs are beneficial for diverse waveform generation since they can demonstrate higher order harmonics of a laser's fundamental repetition rate simply by placing the saturable absorber section at different locations within the laser cavity. The small size, low power consumption, and direct electrical pumping of quantum dot monolithic MLLs make them promising candidates for optical clock distribution, high bit-rate optical time division multiplexing, and compact microwave generation.

Dr. Lester is a Professor in the Department of Electrical and Computer Engineering (ECE), the Microelectronics Endowed Chair Professor, and Interim Chair of the ECE Department at the University of New Mexico (UNM). He received his B.S. in Engineering Physics in 1984 and his Ph.D. in Electrical Engineering in 1992, both from Cornell University. Prior to his arrival at UNM in 1994, Dr. Lester worked as an engineer for the General Electric Electronics Laboratory in Syracuse, New York for 6 years. There he co-invented the first Pseudomorphic HEMT, a device that was later highlighted in the Guinness Book of World Records as the fastest transistor. In the late '90s, he and his colleagues at UNM developed quantum dot and quantum dash light emitters with the lowest threshold and linewidth enhancement factor of any semiconductor laser at the time. From 2001-2003, he was a co-Founder and Chief Technology Officer of Zia Laser, Inc., a startup company using quantum dot laser technology to develop products for communications and computer/microprocessor applications. The company was later acquired by Innolume, GmbH. Since returning to UNM in 2003, he has studied quantum dot mode-locked lasers for RF signal generation, optical interconnects, and short pulse generation. For this work, Dr. Lester was awarded the 2012 Harold Edgerton Award from the SPIE.

Nano-Vertical-Cavity Surface-Emitting Lasers and Other Novel Photonics Devices

Dennis Deppe, UCF

Abstract: In this talk we will describe nano-vertical-cavity surface-emitting lasers (nano-VCSELs) that reduce the VCSEL cavity into the 100s of nanometers. Nano-VCSELs could offer superior thermal and reliability properties relative to both other laser diodes, and other nanolasers. One of the most important applications of nanolasers could be in optical data transmission within silicon photonic chips. One of the most interesting questions for these and other applications deal with the nanolaser's modulation speed and its temperature properties. In this talk we will show that the intrinsic modulation speed for all nanolasers is thermally limited, and set by cavity and gain spectral detuning that comes from self-heating. The detuning and self-heating degrade the differential gain, and limit the modulation response. We show that nano-VCSELs can have superior thermal properties, providing both wide temperature operation needed for silicon photonic chips, as well as very high speed modulation. We present data on larger VCSELs, discuss the main technical hurdles to scaling to small size, and present experimental data on cavities as small 100 nm in diameter. In addition we will also present results on quantum dot lasers and light emitters, applications to displays, and describe a new device based on a photonic heat pump that converts heat to light.



Professor Dennis G. Deppe is the Florida Photonics Center of Excellence Endowed Chair in Nanophotonics in the College of Optics and Photonics at the University of Central Florida. He received his B.S., M.S., and Ph.D. degrees in electrical engineering from the University of Illinois in 1981, 1985, and 1988, respectively. He was a member of the technical staff at AT&T Bell Laboratories from 1988 to 1990, when he took a faculty position at the University of Texas at Austin. In 2005 he joined UCF. His research has led to awards that include the IEEE LEOS Engineering Achievement Award and the OSA Nicholas Holonyak Award. He is a Fellow of the IEEE and the OSA. Prof. Deppe has published over 200 journal articles, and made over 200 conference presentations. He holds numerous patents in the area of semiconductor lasers and other devices.

Optical Fibre Technology and the Global Internet - Where to Next?

David Payne, University of Southampton; CBE, FRS, FREng

Abstract: Telecommunications capacity demand continues to grow at a startling rate, doubling every two years, while the Internet is estimated as burning 4% of world energy usage (similar to air transport!). We are now at the point where consumer bandwidth demand in Western countries is such that it is being rationed by a number of ISP's through throttling and 'traffic management'. We are thus at the threshold of a new optical telecoms research paradigm (Internet 2.0) and it is challenging to predict the areas of greatest interest for new component development. The solution to both of these unexpected consequences of success is more photonics, reaching further into the network with optics to overcome the existing bottlenecks and employing next-generation optical components. All-optical technologies can save considerably on the burgeoning energy consumption of communications systems, as well as substituting for travel. Incredibly, the milliwatts of fibre telecommunications can also be scaled to powers of many kilowatts in fibre amplifiers not much thicker than a human hair.

Professor David Neil Payne CBE FRS FREng is a leading Professor at the University of Southampton and Director of the Optoelectronics Research Centre. A world class pioneer of technology, his work has had a great impact on telecommunications and laser technology over the last forty years. The vast transmission capacity of today's internet results directly from the erbium-doped fibre amplifier (EDFA) invented by David and his team in the 1980s. His pioneering work in fibre fabrication in the 70s resulted in almost all of the special fibres in use today including fibre lasers which are currently undergoing rapid growth for application in manufacturing and defence. David has made numerous leading contributions to many diverse fields of photonics and is widely acknowledged as an inventor of key components.

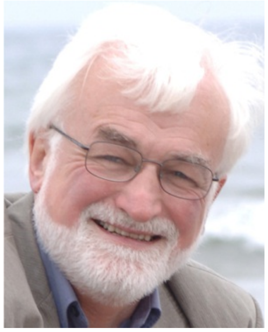
Currently, his main research interest is high-power fibre lasers. With US funding, he led the team that broke the kilowatt barrier for fibre laser output to international acclaim and now holds many other fibre laser performance records. An original member of the Highly Cited Researchers (USA) he is honoured as one of the most referenced, influential researchers in the world. He has published over 650 Conference and Journal papers and is a frequent plenary and invited speaker at major international optics conferences.

As an entrepreneur David's activities have led to a cluster of 11 photonics spin out companies in and around Southampton - helping to boost the local economy. He founded SPI Lasers PLC, which has recently been purchased by the Trumpf Corporation of Germany for $40M. Recently elected Chairman of the Marconi Society and to the Russian Academy of Sciences, David is a fellow of the Royal Society and the Royal Academy of Engineering. He became a Commander of the British Empire in the 2007 New Years Honours list. In addition he has been awarded the top American, European and Japanese prizes in photonics. Recent awards include the Marconi Prize in 2008 and the 2007 IEE Photonics Award the first to be awarded to a person outside the USA. Most recently, in 2010, David received the AILU (Association of Laser Users) Award for his pioneering work with fibre lasers.

Optical Fibre Sensors – Principles, Achievements and Prospects

Brian Culshaw, University of Strathclyde

Abstract: This talk will endeavor to review the science, technology and applications of fibre optics as sensing technologies. Over approaching five decades of evolution, many success stories have evolved, including distributed and multiplexed sensing systems, electrical power monitoring and the fibre optic gyroscope. As the user community consolidates its confidence in the technology, the optical technologies and emerging needs continue to stimulate innovation. The presentation will comprise an inevitably personal perspective on this intriguing evolution and its prospects for the future.



Brian Culshaw graduated from University College London with a BSc in Physics and thereafter a PhD in Electronic and Electrical Engineering, specialising in microwave semiconductors, completed in 1969. He spent 1970 in the US as a post-doc at Cornell, joining the staff of Bell Northern Research (now Nortel) immediately afterwards and evolving into microwave system design, especially for long haul transmission. He returned to UCL after three years in Ottawa joining the academic staff at UCL in 1975 thereafter developing an interest in fibre optics for sensing and measurement. With many co-workers, he produced some basic results in the use of phase modulation in sensors and the interferometric architectures to demodulate them. A sabbatical year with John Shaw at Stanford in 1982 gave an opportunity to contribute to basic research in fibre gyros. These interests in fibre sensing evolved into applications in ultrasonics, NDE, smart structures, advanced materials technologies, environmental sensing and MEMS. He has founded or co-founded three small companies, of which two survive! He moved to Strathclyde University in Glasgow in 1983 as professor of optoelectronics, and since then has also become involved in a number of professional activities including multi partner national and international research project management, conference organisation and journal editing. His work with professional societies includes serving as President of SPIE during 2007.At Strathclyde, he served six years as vice Dean (Engineering) and has completed a five year term as Head of Department. He is currently research professor in Electrical Engineering.

A 40 Year Perspective on Fiber Innovation

Alan Evans, Corning

Abstract: 40 years after the invention of low loss optical fiber, the strength of the market and pipeline of technological innovations has never been greater. While standard single mode fiber is largely unchanged since its commercial introduction in 1985 and is used extensively in the medium distance part of the network, low loss and large effective area fibers are becoming essential for long haul and submarine distances, bendable fibers are widely deployed in FTTH and new fibers are being introduced for very short distance networks like between consumer electronics devices. Even multimode fiber is seeing a variety of attribute improvements to meet future data center and high performance computing needs. Behind these new products and attribute enhancements is the relentless drive toward lower cost and high capacity fiber manufacturing. This talk will describe Corning's pursuit and steady stream of innovations that have kept it the world leading supplier of optical fiber.

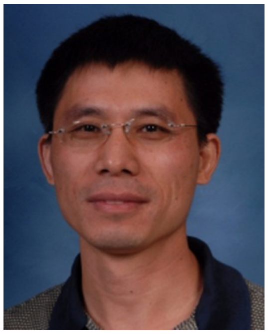
Dr. Evans received his undergraduate degree in applied math, engineering and physics from the University of Wisconsin-Madison and his PhD in Optics from the University of Rochester, Institute of Optics. He joined Corning in 1992 as an optical physics research scientist where he has worked on optical nonlinearities, fiber optic devices, and optical amplification and transmission systems. He led Corning's development of Raman amplifiers and now leads Corning's research in optics with key programs in photovoltaics, optical fiber, laser processing techniques, lasers and bio-optics. Evans is the author of over 40 conference papers, journal articles, and has been awarded 28 patents.

Optical Communication Beyond the Fundamental Capacity Limit of Single-Mode Fibers

Guifang Li, UCF

Abstract: The transmission capacity of single-mode fibers will be exhausted in the near future due to exponential growth of the internet traffic. This talk will describe optical and electronic techniques that will provided orders of magnitude capacity expansion beyond the fundamental capacity limit of single-mode fibers.

Guifang Li is currently FPCE Professor of Optics, Electrical & Computer Engineering and Physics at the University of Central Florida. He received his PhD degree in Electrical Engineering from the University of Wisconsin at Madison. His research interests include optical communications and networking, RF photonics and all-optical signal processing. He is the recipient of the NSF CAREER award, the Office of Naval Research Young Investigator award. He is a fellow of SPIE and the Optical Society of America and served as an associate editor for Optical Networks. He currently serves as a Deputy Editor for Optics Express and an Associate Editor for IEEE Photonics Technology Letters.



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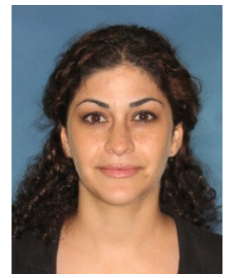
Student of the Year Award



Nazanin Hoghooghi
CREOL, The College of Optics and Photonics
University of Central Florida

Thesis: Linear modulation, direct demodulation and channel filtering using injection-locked semiconductor lasers

A novel linear interferometric intensity modulator based on an injection-locked laser as an arcsine phase modulator, is described. Spur-free dynamic range of ~130 $dB.Hz^{2/3}$ is achieved in an analog link employing this modulator. Also, direct demodulation and channel filtering of phase-modulated optical signals using and injection-locked semiconductor laser is presented.

Nazanin Hoghooghi was born in Iran. She received her B.S. degree in Computer Engineering from Iran University of Science and Technology, Tehran, Iran in 2005 and M.S. degree in Optical Engineering from Rose-Hulman Institute of Technology, Terre-Haute, Indiana in 2007. She joined CREOL in August 2007.Currently she is pursuing her Ph.D. in Optics as a member of Ultrafast Photonics group under Professor Peter Delfyett. She is the author or coauthor of 9 journal papers, 17 conference presentations and 1 patent.

Posters

Poster 1

Line-by-Line Pulse-Shaping Reconfigurable at GHz Rates Using Injection-Locked VCSELs

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Abstract
The spectrum of an ultrashort optical pulse train consists of discrete, equidistant optical frequencies, an optical frequency comb. By setting the amplitude and phase of each optical frequency combline (line-by-line shaping), one can generate complex pulse shapes the fill the pulse repetition period, which are, nonetheless, still periodic in time. To generate truly arbitrary optical waveforms, the spectral amplitude or phase of each combline must be updated at rates comparable to the repetition rate of the source. We demonstrate update rates of up to 3.125 GHz for each combline, for a combline separation of 6.25 GHz. Four comblines are spectrally demultiplexed into separate channels, where each combline is independently modulated by a commercially available VCSEL injection-locked to that combline. The modulated comblines are then multiplexed back into a single channel, where pulses are synthesized due to the coherent addition of the different comblines. The pulse shape depends on the time-varying modulation of each of the comb lines. Using a fast photodiode and a real-time oscilloscope, we capture the complete intensity profile of the pulses. By combining line-by-line pulse shaping and GHz update rates, we show the modulation of the envelope of the pulses, pulses that fill the original pulse period and a change in the pulse shapes on a pulse-to-pulse (sub-nanosecond) timescale.

Poster 2

Micro-spectroscopy of intracellular hemoglobin in a single erythrocyte

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Abstract
We employ micro-spectroscopic techniques at the single cell level to study protein conformational changes with pressure in the cellular environment. The iron-histidine vibrational mode probes the crucial iron-protein linkage in heme proteins, and it has been established as a sensitive structural probe of the proximal heme pocket from studies of proteins in solution. We present Raman measurements on individual erythrocytes under physiological conditions over the frequency range from 150 to 1700 cm^{-1}. We investigate the pressure dependence of the iron-histidine stretching mode and compare with results on isolated hemoglobin and myoglobin. A pressure dependent shift suggests a conformational change of the heme environment with pressure.

Poster 3

Sub-bandgap energy detection using extremely nondegenerate two-photon absorption in direct gap semiconductors

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Abstract

Two-photon absorption (2PA) is an instantaneous process that occurs in semiconductors by annihilation of two photons of the same (degenerate (D)) or different (non-degenerate (ND)) energies creating a single electron-hole pair. This process is automatically phase matched thus allowing beams incident at different angles. As the non-degeneracy increases there is a several orders of magnitude increase in the 2PA coefficient over the degenerate case in direct-gap semiconductors. In this work, we compare theoretically and experimentally two gated detectors based on the direct-gap semiconductors GaAs (E_{gap}^{GaAs} = 1.42 eV) and GaN (E_{gap}^{GaN} = 3.28 eV) for sub-bandgap (including IR) detection at room temperature. For detection of low energy photons the high energy photon pulses are used as gating pulses and vice versa. It is observed that the gated detection based on the ND-2PA is more sensitive in narrow gap semiconductors than in wide-gap semiconductors. However, for detection of infrared photons the ND-2PA signal voltage is accompanied by a signal from photocarriers created through D-2PA of the high energy photon pulses which can be discriminated against using synchronous detection. However, this background 2PA results in additional noise and possible detector saturation. Thus the small gap material has a large ND-2PA signal for detection and hence better sensitivity, but the suitability of the particular detector material for low energy photon detection depends on the relative scaling of the ND-2PA and D-2PA signals.

Poster 4

Are Speckles Really Disturbing?

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Abstract

Random electromagnetic fields resulting from light-matter interaction have strong intensity fluctuations commonly known as speckle and are characterized by various statistical parameters. Often the ensemble average is used to assess the statistical average properties of the medium. The local polarization of these fields can also vary randomly leading to a different set of statistical parameters. We demonstrate that the spatial variability of the vectorial properties contains information about the origins of randomly scattered fields. In particular, we show that the complex degree of mutual polarization provides the high-order polarization correlations necessary to identify the sources of different random fields or the presence of non-stationarities all from a single realization of the light-matter interaction.

Poster 5

Intensity Fluctuations and Polarization

Thomas Kohlgraf-Owens and Aristide Dogariu*
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Abstract

We examine the relationship between the strength of the intensity fluctuations of a Gaussian random electromagnetic field and its polarimetric properties. It is known that the intensity fluctuations depend on the degree of polarization of the random field but not the state of polarization. We show that incoherently mixing the random field with a known reference field produces a total field whose intensity fluctuations depend on both the degree and state of polarization of the original random field. Furthermore, we demonstrate that by controlling the reference field the full polarimetric information of the original random field can be uniquely determined.

Poster 6

Nonlinear optics of molecular triplet states

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Abstract

A molecule with electrons total spin angular momentum equal to one is said to be in triplet state. Due to the typically long lifetimes of triplet states, organic molecules with large triplet quantum yield (φ_T) have become of great interest for several different applications. One of the most important applications lies in the production of singlet oxygen for photodynamic therapy. There are two main approaches to making molecules with large φ_T. The traditional approach is to increase of φ_T was obtained by substituting “heavy atoms” in the molecular structure. However, this method is not successful for all materials. We have taken a new approach where the molecular energy level structure is engineered to increase the probability of singlet-triplet intersystem crossing. We have shown this to work in several squaraine-type molecules, resulting in singlet quantum yields approaching 100% in some cases. We report on the linear and nonlinear properties of these molecules, together with singlet oxygen generation quantum yields for several different molecules. Nonlinear measurements methods include z-scan and double pump-probe technique (DPP). The DPP method [*Appl. Phys. Lett.* **71**, 10 (1997)], well known technique that allows determination of all excited state parameters, was optimized to allow characterization of photochemically unstable molecules.

Poster 7

Widely Spaced Semiconductor Optical Frequency Comb Sources and Applications

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Abstract

Optical frequency combs have applications in a variety of fields, including spectroscopy, metrology, and signal processing. We present two schemes for the generation of ultralow noise optical frequency combs from semiconductor amplifiers. The coupled-cavity approach incorporates a Fabry-Pérot etalon inside a long, fiber laser cavity to suppress undesirable supermode noise and thus enables a frequency comb with widely spaced, ultra-narrow linewidth comblines. The injection-locked harmonically modelocked laser approach produces a source with tunable repetition rate. We explore the use of these comb sources in multiheterodyne detection, specifically examining the development of a novel linear arbitrary waveform measurement technique. Utilizing the mode spacing tunability of the injection-locked source, we are able to extract the relative spectral phase of both comb sources and consequently determine their pulseshapes.

Poster 8

Polymer Optical Fibers for Luminescent Solar Concentration

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Abstract

Luminescent Solar Concentrators (LSC's) are a cost-efficient alternative to traditional solar concentrators for solar energy conversion. Recent progress in planar LSC's in the form of slab waveguides coated with active materials in particular has led to the development of devices with conversion efficiencies in excess of 6% and has consequently attracted attention within the last few years. Advances in organic luminescent materials and multi-material fiber production make feasible the fabrication of LSC's in cylindrical geometry, i.e., in the form factor of an optical fiber with the luminescent materials doping the fiber core. We propose a rectangular fiber structure capped with a cylindrical lens along the fiber. The cylindrical lens serves as a first concentrator to focus light onto small active regions in the fiber core. The rectangular fiber, then, guides the concentrated and converted light to the fiber ends where the PV cells are attached for light-to-electricity conversion. The rectangular cross-section allows easy and stable alignment of fibers on a surface while maintaining a large fill factor.

We report on design optimization through simulation of the concentration process comprising of the ambient light capture and fluoresced light guiding to the fiber ends. Optimization is performed over a wide range of geometrical and material parameters.

We also present experimental realization of such a fiber-based LSC in multiple configurations with performance characterization and efficiency measurement results.

Poster 9

Detailed Investigation of Mode-field Adapters utilizing Multimode-Interference in Graded Index Fibers

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Abstract

We examine the relationship between the strength of the intensity fluctuations of a Gaussian random electromagnetic field and its polarimetric properties. It is known that the intensity fluctuations depend on the degree of polarization of the random field but not the state of polarization. We show that incoherently mixing the random field with a known reference field produces a total field whose intensity fluctuations depend on both the degree and state of polarization of the original random field. Furthermore, we demonstrate that by controlling the reference field the full polarimetric information of the original random field can be uniquely determined.

Poster 10

Transparent Ceramics for Application in Optics and Photonics

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Abstract

The spectrum of an ultrashort optical pulse train consists of discrete, equidistant optical frequencies, an optical frequency comb. By setting the amplitude and phase of each optical frequency combline (line-by-line shaping), one can generate complex pulse shapes the fill the pulse repetition period, which are, nonetheless, still periodic in time. To generate truly arbitrary optical waveforms, the spectral amplitude or phase of each combline must be updated at rates comparable to the repetition rate of the source. We demonstrate update rates of up to 3.125 GHz for each combline, for a combline separation of 6.25 GHz. Four comblines are spectrally demultiplexed into separate channels, where each combline is independently modulated by a commercially available VCSEL injection-locked to that combline. The modulated comblines are then multiplexed back into a single channel, where pulses are synthesized due to the coherent addition of the different comblines. The pulse shape depends on the time-varying modulation of each of the comb lines. Using a fast photodiode and a real-time oscilloscope, we capture the complete intensity profile of the pulses. By combining line-by-line pulse shaping and GHz update rates, we show the modulation of the envelope of the pulses, pulses that fill the original pulse period and a change in the pulse shapes on a pulse-to-pulse (sub-nanosecond) timescale.

Poster 11

Photonic Crystal Fiber Research @ CREOL

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Abstract

The spectrum of an ultrashort optical pulse train consists of discrete, equidistant optical frequencies, an optical frequency comb. By setting the amplitude and phase of each optical frequency combline (line-by-line shaping), one can generate complex pulse shapes the fill the pulse repetition period, which are, nonetheless, still periodic in time. To generate truly arbitrary optical waveforms, the spectral amplitude or phase of each combline must be updated at rates comparable to the repetition rate of the source. We demonstrate update rates of up to 3.125 GHz for each combline, for a combline separation of 6.25 GHz. Four comblines are spectrally demultiplexed into separate channels, where each combline is independently modulated by a commercially available VCSEL injection-locked to that combline. The modulated comblines are then multiplexed back into a single channel, where pulses are synthesized due to the coherent addition of the different comblines. The pulse shape depends on the time-varying modulation of each of the comb lines. Using a fast photodiode and a real-time oscilloscope, we capture the complete intensity profile of the pulses. By combining line-by-line pulse shaping and GHz update rates, we show the modulation of the envelope of the pulses, pulses that fill the original pulse period and a change in the pulse shapes on a pulse-to-pulse (sub-nanosecond) timescale.

Poster 12

Anomalous Transport of Light near a Spectral Pseudogap in a Disordered, 3D Photonic Crystal

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Abstract

Diffusive and subdiffusive transport of light was observed in reflection from the same disordered photonic crystal. A model that is based on the scaling theory of localization explains the behavior of the path length-resolved reflectance at two different wavelengths. Imperfections in the crystalline structure and local minima in the optical density of states, also known as pseudogaps, are the cause for the subdiffusive transport. The results demonstrate for the first time the continuous renormalization of the photon diffusion coefficient for light reflected from random media. This work points towards new materials for controlling optical transport at micro- and mesoscopic length scales.

Poster 13

Measurements and Models of the Microscopic Structure of Complex Fluids using Low Coherence Dynamic Light Scattering

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Abstract
Low coherence dynamic light scattering was employed to examine the microscopic mechanical properties of complex fluids including colloidal suspensions, polymer solutions, and human blood. A generalized model was developed that links the measured motion of microscopic tracer particles to the viscoelastic response of a variety of different materials. These analysis tools were applied in the development of a tissue phantom for simulating blood coagulation and a fiber optic catheter for determining the activated clotting time of blood for use by doctors in the operating room.

Poster 14

Advanced Laser-Induced Breakdown Spectroscopy Methodology for Food and Environment Monitoring

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Abstract
Safety and quality of food products as well as the environment in which they are produced is a major concern that requires sensitive analysis of their chemical composition. Laser-Induced Breakdown Spectroscopy (LIBS) is considered to be one of the potential superstars in analytical science due to its advantages such as fast analysis speed, simple instrumentation, multi-element and on-line analysis capabilities. Such advantages match very well with the requirements of food and environment monitoring. However researches focused on new methodologies are still needed to successfully adapt LIBS to these specific applications.

Water content in samples usually leads to negative effects such as reduction of signals or increase of the breakdown thresholds. In this study, the water content in cheese samples was found to be highly correlated to the normalized oxygen intensity. Based on this linear relationship, LIBS can be a potential tool for rapid and in-situ moisture measurements.

The performance of LIBS for detection of minor or trace elements is partially limited by the transient lifetime of the laser plasma. The Microwave-Assisted LIBS (MA-LIBS) was found to be effective for LIBS signal enhancement by extending the plasma lifetime from microseconds to milliseconds. Our quantitative study on Cu concentration in soil samples shows that the sensitivity can be improved 23 times by switch from traditional LIBS to MA-LIBS. Successful detection of 30 ppm of Cu and 23.3 ppm of Ag in soil was achieved by MA-LIBS, which was not by conventional LIBS method in this study.

Poster 15

Octave-spanning mid-infrared supercontinuum generation in robust chalcogenide nanowires

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Abstract

We report octave-spanning mid-infrared low-power-threshold supercontinuum generation in robust step-index chalcogenide nanowires. By fabricating small-core-diameter tapers having a high refractive-index-contrast between the core and cladding materials, we obtain high-mode confinement, thereby enhancing the nonlinearity of the nanowires. Furthermore, the capability to engineer the taper dimensions enables us to control the chromatic dispersion to shift the zero-dispersion-wavelength towards the pumping wavelength. We produce more than an octave of near-infrared and mid-infrared supercontinuum spectrum ranging from 0.85 μm to 2.3 μm using a 1.55 μm picosecond pump laser and from 1.1 μm to >2.4 μm using a 2 μm femtosecond pump laser.

Poster 16

Structural identification of a novel axially-chiral binaphthyl fluorene based Salen ligand in solution using electronic circular dichroism: A Theoretical-experimental analysis.

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Abstract

Herein, we present the synthesis and the structural identification of a novel Salen ligand AFX-155[i] in THF solution, with potential applications in homogeneous catalysis, biophotonics and sensing. The full comparative theoretical-experimental analysis of the UV-vis and ECD spectra of the 10 primary isomers (comprising stereoisomers and optical isomers) revealed the presence of a unique structure in solution, the Trans-R-Intra//Trans-R-Extra. A proposed route of attack of the (R)-(+)-2,2'-diamino-1,1'-binapthalene onto a salicaldehyde 5-(2-(2-(diphenylamino)-9,9-dihexyl-9H-fluoren-7-yl)ethynyl)-2-hydroxybenzaldehyde, followed by a consecutive attack of the resulting species onto another salicaldehyde, both via Burgi:Dunitz trajectory, validates the unambiguous formation of the Trans-R-Intra//Trans-R-Extra isomer. Steric hindrances during the synthetic process seem to be the determinant factor that defines the 3D structural conformation of this particular stereoisomer of AFX-155 with triple axial chirality.

The determination of every optimal structure and the dominant conformers of AFX-155 were calculated evaluating, in CONFLEX, their steric energies using force fields at MMFF94S (2006-11-24HGTEMP) level in gas phase. The structures geometries were optimized in THF using PCM and Gaussian 09 at the DFT/B3LYP level of theory using the 6-31G* basis set. The first 100 electronic excited states were calculated using the same level of theory and basis set.

[i]AFX-155 = [2,2'-(1E,1'E)-(R)-1,1'-binaphthyl-2,2'-diylbis(azan-1-yl-1-ylidene)bis(methan-1-yl-1-ylidene)bis(4-((7-(diphenylamino)-9,9-dihexyl-9H-fluoren-2-l)ethynyl)phenol)]

Poster 17

Bell's Measure in Classical Optical Coherence

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Abstract

Classical coherence theory is a venerable branch of optics that deals with the study of the spatial, spectral and polarization properties of light. Partial coherence is generally ascribed to underlying statistical fluctuations originating at the source or arising upon passage of a coherent beam through a turbulent medium. A less acknowledged source of partial coherence results from neglecting a degree of freedom (DoF) of a beam when observing another DoF correlated with it. From recent advances in quantum optics, we adapt the use of Bell's inequality and address this issue for a model optical beam with two binary DoFs: polarization and spatial parity. These DoFs are readily coupled using a polarization-sensitive spatial light modulator. We perform a series of experiments to test the use of the Bell's measure in three different scenarios: when the beam is coherent with coupled polarization and parity, when it is partially coherent with coupled polarization and parity, and when the parity-polarization coupling is random. We also present a unique ordering of all physically admissible partially coherent beams based on a quantity that we designate as the degree of intrinsic coherence. We expect this approach will lead to improvements for many applications in metrology and astronomy.

Poster 18

Parabolic pulse generation through spectral intensity and phase modulation for long range, sub-millimeter resolution laser ranging and velocimetry

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Abstract

A fiber based chirped pulse amplification (CPA) system with an active feedback loop utilizing spectral phase and intensity modulation is used to generate pulses with parabolic temporal intensity profiles. Moreover, the pulses are transform limited and exhibit a 10 dB suppression of pedestals. At high power levels, the parabolic intensity profile results in a linear frequency chirp across the duration of the pulses due to self phase modulation (SPM). Such pulses are especially suitable for applications such as a chirped pulsed lidar that employs a chirped fiber Bragg grating (CFBG) to generate temporally stretched, frequency chirped pulses from a mode-locked laser. Spectral phase modulation of the optical pulses is used to remove the ripple in the group delay arising from the CFBG. Sub-millimeter resolution ranging is performed at target distances > 10 km (in fiber) and a pulse tagging scheme is also demonstrated to remove range ambiguities. Simultaneous ranging and velocimetry of a target moving at > 331 km/h is performed with > 25 dB signal to noise ratio (SNR).

Poster 19

The Topography of Light

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Abstract

As the feature sizes of optical devices continues to shrink, tools to characterize optical properties below the diffraction limit of light become increasingly important. One option is to use a near-field scanning optical microscope (NSOM), which utilizes a sharp probe scanning close to the sample surface to convert evanescent waves to propagating waves to be measured in the far field. We demonstrate that light exerts a detectible force upon the probe, causing it to retract in the presence of the optical radiation. By measuring these retractions, we are able to quantitatively map the local optical force distribution acting on the probe. We demonstrate that this alternative light measurement modality opens up the possibility to either circumvent the need for a photon counting detector or collect a complementary measurement of the local field distribution without increasing the complexity of the experiment.

Poster 20

Pulse energy scaling in a novel thulium doped flexible photonic crystal fiber (PCF)

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Abstract

Utilizing new thulium doped flexible PCF fabricated by NKT Photonics, with >1000 μm^2 mode area and 50 μm core diameter, we investigate pulse energy and peak power scaling of nanosecond pulses at 2 μm wavelength. Following a similar design as ytterbium doped PCFs, this fiber has a 250 μm air cladding surrounding for pump guidance and included boron doped stress rods in the lattice to provide polarizing/polarization maintaining behavior.

We were the first to experimentally demonstrate high polarization purity (PER >18 dB) and excellent beam quality (M^2<1.15) in both cw and Q-switched oscillator configurations pumped with a 790 nm diode laser. To the best of our knowledge, this configuration produced the highest polarized peak power to date from a thulium fiber Q-switched oscillator, with a maximum peak power generated of ~8.9 kW with 435 μJ pulse energy and 49 ns pulse duration at 10 kHz repetition rate.

The large mode area and high pump absorption of the Tm:PCF make it an excellent choice for use as an amplifier. Here we report new results using this ultra large mode fiber as a power amplifier in a MOPA configuration. We amplify ~88 ns, ~40 μJ pulses to 1.05 mJ energies producing a maximum peak power of 11.8 kW and ~14 dB of gain while maintaining spectral, polarization, and beam quality. Thus far, we have not yet realized the limit of facet damage or degradation in amplification due to higher order modes or nonlinear effects.

Poster 21

Two-photon absorption spectrum of a single crystal cyanine-like dye

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Abstract

We present a single crystal made from organic Donor-π-Acceptor cyanine-like molecules. The optical properties of the single crystal, linear and nonlinear, are spectroscopically investigated and compared with the properties in its toluene solution of monomeric form. Strong transmission and reflection anisotropy is observed in the single crystal which is related with the directional molecular packing. The maximum polarization dependent 2PA coefficient of the single crystal is 52 ± 9 cm/GW, which is more than twice as large as the inorganic semiconductor CdTe with a similar bandgap to the crystal's absorption edge. X-ray diffraction analysis shows π-stacking dimer formation in the crystal, which according to quantum chemical calculations, leads to a splitting of the energy bands and the appearance of new, red-shifted 2PA bands.

Poster 22

Quantum Discrete Optics

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Abstract

The union of quantum optics and discrete optics is a promising platform for exploring fundamental phenomena in both fields and holds the potential to produce devices useful for photonic and quantum computational applications. We explore the evolution of pairs of photons that are produced in a crystal by nonlinear processes and injected into arrays of evanescently coupled parallel waveguides that are either regularly or randomly spaced. Such devices are produced by writing the waveguides in a glass substrate using femtosecond laser pulses. At the output of these arrays we measure the coincidences of these photon pairs. In the regularly spaced arrays we observe ballistic propagation in the single and two photon regimes. In the randomly spaced arrays, we make the first observation of single photon and two photon Anderson localization. These devices and the observed quantum effects have garnered recent interest due to their potential to be exploited and used as components in an optical quantum computer. Such a computer, once realized, will offer significant advantages over its classical counterpart.

Poster 23

Post-Fabrication Voltage Controlled Resonance Tuning of Gold Nanoparticles

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Abstract

Frequency control of plasmon resonances is crucial for optical sensing applications such as Surface Enhanced Raman Spectroscopy. Prior studies of substrate-based control of noble metal nanoparticle plasmon resonance relied on thin-film deposition to form a spacer layer between the nanoparticles and substrates which resulted in a fixed resonance frequency after particle deposition. Here we introduced a new approach that allows post-fabrication nanoparticle plasmon resonance tuning through controlled substrate anodization. Localized Surface Plasmon of gold nanoparticles on an aluminum film is demonstrated in single-particle microscopy and spectroscopy measurements. An aluminum oxide layer is subsequently grown through anodization on the particle coated sample. Dark field microscopy reveals scattering from separated Au nanoparticles with a dipole moment perpendicular to the aluminum surface. Single particle spectra show a consistent blue-shift of the resonance peak as the oxide thickness is increased. The observed trend is explained with an image charge coupling model. Experimental results are reproduced in numerical simulations.

Poster 24

High quality ZnO epilayers grown on C-plane sapphire and ZnO substrates by plasma-assisted molecular beam epitaxy

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Abstract

There has been a great deal of interest in wide bandgap semiconductors, owning to their application in the ultraviolet (UV) region, such as the environment, biological research, aerospace or military. We will report on growth of oxide wide bandgap semiconductors, ZnMgO, grown by plasma-assisted molecular beam epitaxy (MBE). By applying a low temperature nucleation layer, we obtained high quality ZnO thin films with low heat budget, high crystalline quality, low dislocation density, low carrier concentration, high mobility and sub-nanometer surface roughness, indicating possible application for efficient ZnO emitters. Homoepitaxial ZnO films, which have the potential for developing high efficiency light emitters because of lattice match between substrates and films, were also grown on high quality ZnO substrates with atomic flat surface. Ga doping up to ~1019/cm3 was demonstrated for both sapphire and ZnO substrates. These high quality films indicate great potential for next generation solid state ultraviolet laser diodes.

Poster 25

Seeded White Light Continuum in Noble Gases for Broadband Nonlinear Characterization

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Abstract

We observe a remarkable 4x enhancement of the total energy contained in a white-light continuum (WLC) generated in a noble gas when using femtosecond, millijoule level pump pulses seeded by pulses 3 orders of magnitude less in irradiance. The largest enhancement occurs with visible seed pulses while the near-IR seed pulses result only in modest enhancement that generally resembles the spectrum of the unseeded WLC. The enhancement is also observed to occur only when there is temporal overlap between the pump and seed pulses. The spectral energy density enhancement in the visible and near-IR frequency range can ultimately lead to the ability to replace conventional tunable sources of radiation such as optical parametric generators/amplifiers (OPGs/OPAs) for nonlinear spectroscopic measurements such as the Z-Scan technique that require high spectral irradiance sources.

Poster 26

Ultrafast electron and lattice dynamics in gold metal nanostructures

Oliver Kahl[1]*, Dmitry Fishman[1], Scott Webster[1], Fabian Niesler[2], Martin Wegener[2], David Hagan[1] and Eric Van Stryland[1]
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Abstract

We are investigating the non-equilibrium electron and lattice dynamics of metal nanostructures under high laser irradiance on femtosecond and picosecond time scales. In pump-probe experiments around the plasmon resonances of various samples containing lithographically fabricated gold nanorods and gold split-ring resonators, transient transmittance changes are measured. Standard two-temperature model approaches are utilized to link the transmittance changes to variations in the material's permittivity. The experiments are conducted at sufficiently low photon energies to avoid d-band transitions, which allows us to correlate the temperatures of the electron and lattice subsystems with the Drude-type damping coefficient. On longer timescales of up to several hundred picoseconds after the initial pump pulse, acoustic modes become visible. In the case of split-ring resonators, transmittance changes of up to 2% are observable which is attributed to an increase in the structure thickness due to thermal expansion.

Poster 27

Color Displays Based On Voltage-Stretchable Liquid Crystal Droplet

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Abstract

We demonstrate a single-pixel color display based on voltage-stretchable liquid crystal (LC) droplet. By choosing proper liquid materials, the dye-doped droplet shrinks with the smallest surface-to-volume ratio at V=0. As V increases, the droplet is stretched to spread like a film by dielectrophoretic force. The gray scale is achieved by stretching the droplet to different extent. Upon removing the voltage, the droplet returns to its initial state. Such a display does not need any polarizer and color filters. It shows wide viewing angle, good contrast ratio and large aperture ratio, as well as easy integration with the edge-lit backlight. Both transmissive and reflective modes can be configured. The relatively low operating voltage and reasonably fast transition speed make it promising for mobile displays.

Poster 28

Multimode Fiber Amplifier with Tunable Modal Gain

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Abstract

As the communication capacity of single-mode fiber (SMF) reaches its ultimate limit, mode-division multiplexing (MDM) has been proposed as a solution to overcome the capacity crunch. MDM system transmits independent information over parallel mode channels. To enable MDM transmission in long haul distance, suitable inline amplifier is required to compensate loss for each mode. In the poster, we propose a multimode Erbium-doped fiber amplifier (MM-EDFA) with tunable modal gain. By adjusting the powers of input pump modes, modal dependent gain can be tuned over a large dynamic range. Moreover, a two-mode erbium-doped fiber amplifier is experimentally characterized. Mode dependent gain is measured for different pump modes. It is verified that higher-order pumping can help equalize mode-dependent gain. The MM-EDFA is potentially a key element for ultra-high capacity long haul transmission system in the future.

Poster 29

Optical and RF Frequency Stability Transfer Mediated Through Four-Wave Mixing in Monolithic Quantum Dot Modelocked Laser

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Abstract

Colliding pulse modelocked (CPM) lasers are an excellent source of ultrashort high repetition rate pulses with widely spaced frequency combs but exhibit large timing jitter in the absence of external stabilization. We report a novel and simple quantum dot based laser design where a stable high-Q master laser is used to injection lock a monolithic CPM laser. Four-wave mixing (FWM) in the common saturable absorber region is used to achieve this injection locking and hence stabilize and reduce the timing jitter as well as the long-term frequency drift of the CPM. To the best of our knowledge this is the first time that FWM has been used to achieve injection locking. A stable 30-GHz optical pulse train is generated and both the RF and optical linewidths are significantly reduced. These results confirm the potential of the laser design for all monolithic stabilization architecture.

Poster 30

Mid-Infrared Silicon Photonics

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Abstract

The field of silicon photonics has been the topic of active research for several decades in the near infrared wavelength range. More recently, the technology has been extended into the mid-infrared regime with potential biochemical and medical applications. The omnipresent problem of nonlinear silicon devices in the near-infrared, i.e., two photon absorption induced free carrier absorption, is inherently nonexistent in the mid-infrared. This key advantage, combined with unsurpassed quality of commercial crystals, low cost, high optical damage threshold and excellent thermal conductivity, renders silicon as a very attractive nonlinear crystal in the mid-infrared. Here we post our recent research on fabrication and characterization of integrated silicon-on-sapphire waveguides, mid-infrared silicon Raman lasers, as well as design and optimization of optical parametric amplifiers and continuum sources in this wavelength range. These studies predict strong prospects for mid-infrared silicon photonic devices for the mentioned applications.

Poster 31

One-step extrusion for multi-material structured fibers

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Abstract

We review our recent progress in the emerging area of multi-material fibers based on one-step extrusion. We demonstrate our up-to-date results for multi-material extrusion of optical fibers with different structures: glass core/polymer cladding, glass core/glass cladding/polymer built-in jacket, and microstructured fibers. In particular, the first chalcogenide glass core/tellurite glass cladding/polymer built-in jacket fiber is studied for nonlinear applications. Furthermore, the complex fiber structures produced, coupled with the use of an in-fiber fluid instability controllably induced by thermal processing, introduce a novel pathway to synthesizing structured micro- and nanoparticles on an unprecedented dynamical range of sizes in an efficient manner.

Poster 32

Towards Linear Interferometric Intensity Modulator for Photonic ADCs Using an Injection Locked AlInGaAs Quantum Well Fabry-Pérot Laser

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Abstract

A monolithic AlInGaAs quantum well Fabry-Pérot laser (FPL) injection locked by a mode-locked monolithic master laser is presented here for the first time. By modulating the current of the injection locked FPL, one imparts arcsine phase modulation on each injected comb component. By interfering this modulated signal with its unmodulated counterpart, we can generate the desired true linear intensity modulator for pulsed light.

Lab Tours

Labs & Facilities

The main facilities of the College are housed in a state-of-the art 104,000 sq. ft. building dedicated to optics and photonics research and education.

Shared Facilities

Nanophotonics Systems Fabrication Facilities. A 3,000 ft² multi-user facility containing Class 100 and Class 1000 cleanrooms and a Leica 5000+ e-beam lithography instrument capable of 10-nm resolution. These facilities are used for fabrication and study of nanostructured materials and nanophotonic integrated circuits. The Laboratory is designed and operated as a multi-user facility, with availability to companies and other outside users. Rm 180.

Optoelectronic Fabrication Cleanroom. 800 sq. ft. multiuser facility consisting of class 100 and class 10,000 cleanrooms. Used in the development of optoelectronic semiconductor devices. The facility equipment includes a Suss MJB-3 aligner, a Plasma-Therm 790 RIE/PECVD, an Edwards thermal evaporator, along with a bonder, a scriber and microscope. Rm 211

Scanning Electron Microscope (SEM) Facility. Vega SBH system built by Tescan is a tungsten-filament scanning electron microscope. The system is designed with a fully electronic column and is capable of imaging from 1-30 keV with nanometer scale resolution. Additionally, the system is equipped with the state of the art sample positioning stage with 5 nm resolution and a full scale travel of 42 mm. The shared SEM is ideal for checking the fidelty of travel of 42 mm. The shared SEM is ideal for checking the fidelity of the microfabrication routinely performed in the CREOL cleanroom. Rm 176

Cary Spectra-Photometer and Microscope. Cary 500 is Spectrophotometer that is capable of measuring light absorption in both transmitted and reflected light in the UV, visible and near IR spectrum. Rm 159

Varian Cary 500 Scan UV-Vis-NIR Spectrophotometer. Rm 159

Olympus Nomarski Interference Microscope. Rm 159

Zygo Facility. Zygo New View 6300 Interferometer shared facility. Rm 211B. Martin Richardson.

Machine Shop. Has two modern Sharp LMV milling machines and a 16-50G lathe capable of achieving the tolerances required for the instruments used in CREOl. Classes are offered to qualify research scientists and students to safely modify and construct instruments critical to their research. Rm A106. Richard Zotti.

Faculty Laboratories

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Ayman Abouraddy	
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Demetri Christodoulides

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Peter Delfyett

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David Hagan and Eric Van Stryland

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James Harvey

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Bahaa Saleh

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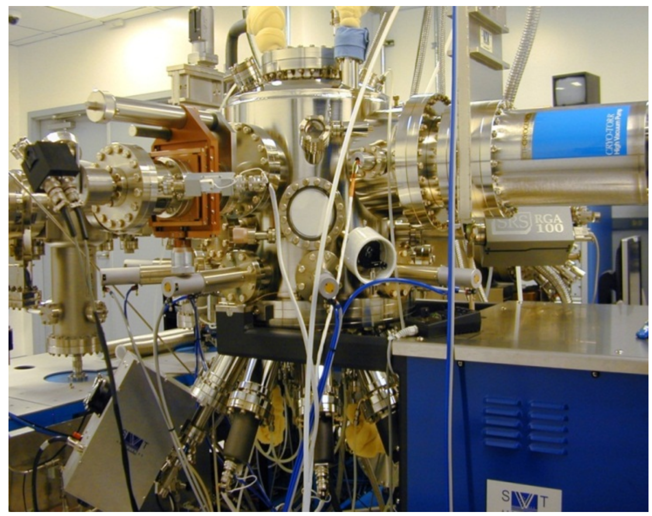
• Wide Band Gap Characterization Lab	A112
• Oxide MBE Lab	180C

Eric Van Stryland (See Drs. Hagan and Van Stryland)

Nanophotonics Fabrication Facility



MBE Facility

Lab Tour Schedule

Guided tours start at **3:30 pm** and at **4:15 pm** in the CREOL lobby and last about 40 minutes.

Be sure to have a look at the video feed of the CREOL cleanroom showing the ebeam writer (screen located in the lobby), and at the monitors near several laboratories on the ground floor.

TOUR A Start times: 3:30 pm and 4:15 pm

A105 **Fiber Fabrication Facility**
Dr. Ayman Abouraddy, Dr. Rodrigo Amezcua Correa, and Dr. Axel Schulzgen
http://www.townes.ucf.edu/

154 **Laser beam control by volume Bragg gratings**
Dr. Leonid Glebov
http://ppl.creol.ucf.edu/

201 **Fiber optics laboratory; fiber lasers and fiber device characterization**
Dr. Axel Schulzgen
http://fol.creol.ucf.edu

TOUR B Start times: 3:30 pm and 4:15 pm

259 **Liquid Crystal Laboratory**
Dr. Shin Tson Wu
http://lcd.creol.ucf.edu

244A **Coherent Signal Processing using Optical Frequency Combs**
Dr. Peter Delfyett
http://up.creol.ucf.edu

246 **Nanophotonics Laboratory**
Dr. Pieter G. Kik
http://kik.creol.ucf.edu

TOUR C Start times: 3:30 pm and 4:15 pm

227 **Femtosecond White Light Continuum**
Dr. David Hagan and Dr. Eric Van Stryland
http://nlo.creol.ucf.edu

180 **Semiconductor Laser Lab**
Dr. Dennis Deppe
http://deppe.creol.ucf.edu

PS140 **FAST (Florida Attosecond Science and Technology) Lab**
Dr. Zenghu Chang
http://fast.creol.ucf.edu

Building Map

First Floor

Office
Classroom
Laboratory
Cleanroom
Conference Rm
Utilities
Restroom
Elevator

Building Map

Second Floor

Industrial Affiliates Program

Program

Membership in the Industrial Affiliates (IA) program provides to industrial corporations, organizations, and individuals many benefits, most of which are also of mutual benefit to the College of Optics and Photonics. One of these mutual benefits is the regular communication and contact the program provides between the research faculty and students at the College and the IA member company's engineers and scientists who are developing new technologies and products for their business. Other benefits include:

- Establishing a close association with this leading institute in optics, lasers, and photonics
- Exposure to the latest research and developments in cutting edge technologies
- Availability of sophisticated measurement, test, and calibration facilities
- Early notice of students approaching graduation (the next generation of experts in the field) and access to their CVs
- Ability to post job openings on the College's website (exclusive benefit for IA members)
- Close interactions with the faculty, each of whom are leaders in their fields
- Opportunity to make presentations about the member's company and products to the faculty and students of the College
- Access to the College's periodic newsletter, Highlights, and monthly e-Highlights
- Notification of seminars at the College
- Opportunity for free presentation space at the annual Industrial Affiliates Day meeting
- Several Web-based benefits, including linkage to the company's web site from the College website
- For companies who donate equipment, getting their hardware/software in the hands of some of the leading researchers—faculty and students—in the field provides visibility to future customer prospects and information on its impact in leading-edge research
- Demonstration by the company of its support of the College, its research programs, and its effective corporate cooperation and partnership activities

In addition, we use many mechanisms to give visibility to our Industrial Affiliates that can be valuable to them in marketing their products. Wherever possible, the level of the membership is indicated. Examples of current practices include:

- Listing in the CREOL Highlights quarterly newsletter
- Special recognition at the annual Industrial Affiliates Day
- Listing in other publications, where appropriate, including on the website (with a link to the company's website)
- Company name plaque prominently displayed in the entrance lobby of the CREOL building.

There are also many intangible benefits that accrue from association with this dynamic research and education institution. Among these are facilitated access to and collaboration with other specialized facilities within the University of Central Florida and the central Florida area. In addition to resources in the Center for Research & Education in Optics & Lasers (CREOL) the Florida Photonics Center of Excellence (FPCE), and the Townes Laser Institute, UCF facilities include the following major research centers:

- Nano-Sciences & Technology Center (NSTC)
- Advanced Materials Characterization Facility (AMPAC)
- Materials Characterization Facility (MCF)
- Biomolecular Science Center
- Institute for Simulation and Training (IST)
- Center for Distributed Learning
- National Center for Forensic Science (NCFS)
- Florida Solar Energy Center (FSEC)
- Florida Space Institute (FSI)

The College's faculty and students play leading roles in both local and international professional associations and can provide effective introductions to the extensive network of industry and expertise to which CREOL, The College of Optics &

Photonics, connects. Through the IA program, members can also readily connect with other optics, photonics, and industrial organizations through local Florida organizations in which the College maintains an active participation, including the Florida Photonics Cluster (FPC), the Laser Institute of America (LIA), Florida High Technology Corridor Council (FHTCC), the UCF Technology Incubator — ranked #1 in the US in 2004 — and a large family of laser and optics companies in the Central Florida region.

Industrial Affiliates Members

Life Members

Cobb Family Foundation
Northrop Grumman Corporation
Nufern
Memoriam Members: *Dr. Arthur H. Guenther and Dr. William C. Schwartz*

Medallion Members

Breault Research
Newport Corporation
Northrop Grumman Laser
Optical Research Associates
Paul G. Suchoski, Jr

Senior Members

Coherent, Inc.
CST of America
Cubic Defense Applications
Edmund Optics
ER Precision Optical
Lambda Research Corporation
LAS-CAD GmbH
LightPath Technologies
Lockheed Martin
Ocean Optics
Ophir-Spiricon
Optimax Systems
Thorlabs
Tektronix
TRUMPF, Inc.
Vectronix Inc.
Veeco Instruments-Metrology
Zemax Development Corp.
Zygo Corporation

Affiliate Members

Aerotech, Inc.
Analog Modules
Applicote Associates, LLC
eVision, LLC
Gooch & Housego, LLC.
Harris Corporation
HORIBA Jobin Yvon
Imagine Optics, Inc.
JENOPTIK Optical Systems Inc.
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L-3 Communications
Laser Institute of America
Lee Laser
NKT Photonics
Northrop Grumman Aerospace Systems
Optigrate Corp.
Optoelectronics Industry Development Assoc.
Photonics Online
Photonics Spectra
Princeton Instruments
Quioptic
QPC Lasers/Laser Operations LLC
Ray Williamson Consulting
R-Soft Design Group
Sciperio, Inc.
SPIE- The Int'l Society for Optics & Photonics
StellarNet, Inc.
Teledyne ODI
OSA, The Optical Society
Tower Optical Corporation
TwinStar Optics, Coatings & Crystals
Vytran LLC
Yokogawa Corporation of America

Why Florida?

All high-tech companies benefit from Florida's business environment, which emphasizes innovation, collaboration, and talent formation for today's global markets. From start-ups focused on turning the latest academic research into commercially viable products and technologies, to established industry giants, Florida has what high-tech companies need.

Florida Photonics Industry Cluster

Florida's photonics cluster is the 4th largest in the US, with over 270 companies employing over 5,700 professionals focused on the design, development, manufacturing, testing, and integration of photonics products and related systems. The photonics and optics cluster in Florida spans a very broad range of industry sectors, including lasers, fiber optics, optical and laser materials, thin film coatings, optical components, optoelectronic fabrication and packaging, and photonic systems integrators, addressing almost all applications from energy to medicine to defense. The state's colleges and universities have established interdisciplinary programs and centers focusing on pho-tonics/optics, which graduate over 100 photonics specialists (AS to PhD) each year. The Florida Photonics Cluster, a 501c(6) trade association, (www.floridaphotonicscluster.com) is dedicated to serving the industry and to making Florida the place to go for photonics solutions.

Innovation Economy

Nowhere else is the spirit of innovation more evident than in the State of Florida, which has the reputation as the "Innovation Hub of the Americas". The state's pro-business, pro-technology climate, combined with easy trade access to key growth regions of the Americas, as well as the rest of the world, provide a fertile environment for establishing and growing businesses. Some of the unique resources available to entrepreneurs include the Florida Virtual Entrepreneur Center (www.flvec.com), GrowFL (www.growfl.com), and several business incubators (www.floridahightech.com/region.php) including the rapidly growing and award-winning UCF Business Incubator (www.incubator.ucf.edu).

Top Quality of Life & Great Place for Photonics

Since 2001, Florida has earned top rankings in Harris Poll's "most desirable place to live" survey, so it's no surprise why Florida has become a top destination for high-tech industry, and in particular for the photonics industry. The University of Central Florida houses CREOL, The College of Op-tics and Photonics, and in addition to CREOL, the College houses the Townes Laser Institute and the Florida Photonics Center of Excellence. In addition, the Florida Photonics Cluster, several vigorous university incubators, proactive regional and state-level economic development organizations, and a dynamic grouping of cutting-edge companies form a photonics hub focused on advancing Florida's photonics industry.

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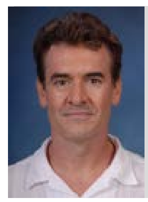

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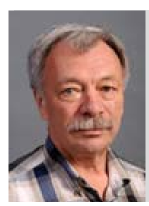

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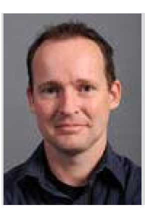

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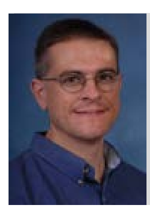

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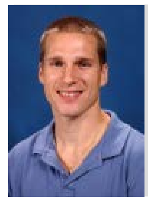

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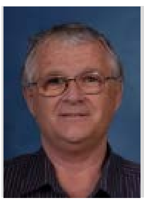

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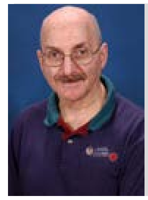

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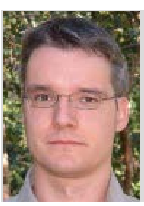

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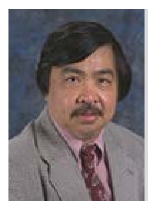

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