University of Central Florida

# School of Optics / CREOL HIGHLIGHTS


Spring/Summer 2003



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***OISE 2003***

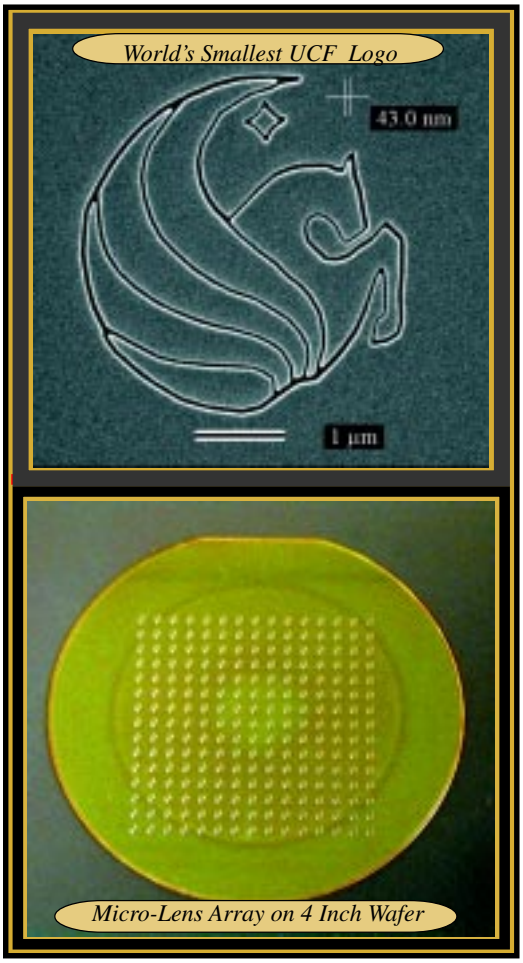
***Nov. 12 - 13, 2003***

***OSA's Southeast Regional Meeting will be held at UCF***

***For details go to www.osa.org***

## Nanophotonics Systems Fabrication Facility Under Construction

The School of Optics has started re-constructing a 3000-sq-ft area of the CREOL building to house our new Nano-Photonics Systems Fabrication Facility (NPSFF). This state-of-the-art laboratory will have class-100 and class-1000 cleanrooms devoted to nanofabrication and integration of next-generation photonic devices. It will be a centerpiece of our new Florida Photonics Center of Excellence (FPCE); and will help students and faculty continue cutting-edge research in areas which are key to enabling a wider range of practical applications for optical microchips.

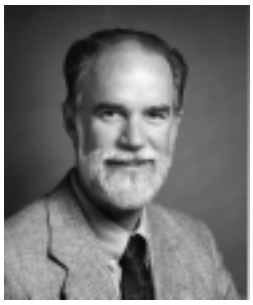



Two examples of nano-fabrication are shown on the right. To show off the versatility of a new electron beam Nano-Pattern Generation system in their laboratory, Eric Johnson's research team decided to write a 'nano-sized' UCF Pegasus logo on a polymer film. The line creating the Pegasus shape is only 40 nanometers wide. Just how small is that? There are 1 billion nanometers in one meter, so you could fit about 100 of these logos across the width of a single human hair. The lower photo shows a micro-lens array created on a four inch wafer.

Some focal point applications for the new facility include bio-photonic modules for manipulating biological functions at the cellular level, optical circuits for processing data at terabyte frequencies, laser diodes for high power applications, optical antennae for imaging in infrared and miniature photonic modules for medical use in-vivo. The objective of this new facility is to transition photonics from its present "vacuum tube" era into the next generation of photonic devices relying on wafer based manufacturing methods common to the IntegratedCircuit industry. This facility will be a major resource for photonics research by all of Florida's universities. It will also be available for partnerships with Florida industry.

While some existing CREOL equipment will be moved into the NPSFF, new equipment is also being acquired. The School has received equipment donations from several partners including Lucent, Sandia National Labs, and Sawtech. Eric Johnson, Glenn Boreman, and Patrick LiKamWa have received $1.9M in first-year funding of a multi-year project grant from DARPA that will allow the purchase of a state-of-the-art 100-kV electron-beam lithography system with on-chip resolution of better than 10 nanometers. Other capabilities to be added: UV and DUV lithography for wafer patterning, advanced etching tools for high-aspect-ratio devices, molecular-beam epitaxial growth for advanced laser diode development, chemical-vapor deposition tools, and flip chip integration. The NPSFF will also include lab space for several new nanophotonics faculty members. Initial operations will be on-line by the end of 2003.

# Director's Corner



*Dr. Eric W. Van Stryland*

Hurray! We will receive $10M from Governor Jeb Bush's initiative to form new centers of excellence at Florida Universities. Our proposal to establish the Florida Photonics Center of Excellence (FPCE) was ranked number one by the Emerging Technology Commission, out of 16 submissions. The new research center will be housed within the CREOL building; and it will be built on the substantial and sustained investment in the School of Optics/CREOL, recognized as a world leader in optics research and education. The FPCE will provide the resources, together with co-investments from UCF, government, and industry partners, needed to expand our photonics efforts into the growing areas of nano-photonics, biophotonics, and advanced imaging / 3D displays, along with the necessary ultra-high bandwidth communication capabilities. Our thanks go out to many Florida industrial supporters and to the university partners of this new center.

The 20th century was the Century of the Electron. The 21st century will be the Century of the Photon/Photonics. Evidence for this is seen everywhere, from the optical fiber communications revolution in information availability (the internet), to data storage, music and movies with CD and DVD optical memories, to lasers in manufacturing, medicine, sensing, and defense. Photonics is the key enabling technology for these and other industries.

The objective of the FPCE is to develop the intellectual capital in photonics and transition this to the private sector in Florida. The Center will be a full partner with other state and regional efforts to diversify the Florida economy by attracting, retaining and growing wealth-producing industry in photonics, and enabled by photonics. We are planning to add 5 chaired professorships (2 from FPCE funds and 3 from matching funds). The world-leading scholars we recruit will be magnets for attracting the top graduate students, post docs, and grant support for internationally competitive research.

Inherent in our proposal is a realization of the limited nature of State funds and the concomitant need to include co-investors: the university and our region; industry, and other private, and federal partners. Also inherent is the realization that to achieve the desired success in economic diversification, we must discipline our efforts and focus our resources on topics for which Florida has an existing cluster of industries. That means including the Florida Photonics Cluster, for which significant growth is possible.

It's widely expected that the movement to nano-photonics will do for the optics industry what similar advancements did for the semiconductor industry from the 1960's to the present era. A major goal of the FPCE is the establishment of a new nano-photonics fabrication laboratory (see page 1). The objective of this new facility is to move photonics from the vacuum tube to discreet components to integrated systems. It will be a major resource in photonics research for all of Florida's universities, and available for partnerships with Florida industry. It will position UCF to compete nationally for the expansion of the NSF Nano-Fabrication Network.

The School of Optics Industrial Affiliates program will be expanded and called upon to provide a significant role in the leadership of this program. The Imaging/ 3D display area will be led by Peter Delfyett and Jannick Rolland, Nano-photonics by Eric Johnson and Glenn Boreman, and Biophotonics by Aristide Dogariu and Craig Siders. Our initial academic partners will be from the University of South Florida, the Florida Institute of Technology, the University of Florida and Florida Atlantic University. In addition, we will issue a request for proposals to attract talent from all of Florida's universities to ensure that top talent across the state is involved in the FPCE. Preference will be given to proposals that are in partnership with Florida industry and/ or use FPCE support as matching funds for proposals to federal agencies.

The plan for the FPCE will be to hire excellent people; provide adequate initiation funds, leverage matching funds, and involve top talent from throughout Florida through a competitive RFP process. We will make commercialization and incubation infrastructure available to entrepreneurs in and outside the university system, and demand collaboration and industry outreach.To find out more about the FPCE, look at several articles published on the FPCE at http://www.optics.org/articles/news/9/3/18/1, http://www.photonicsclusters.org/ http://oemagazine.com/?oe=res and http://news.ucf.edu/FY2002-03/030319.html.

Just before this issue of Highlights goes to press, we hold our annual Industrial Affiliates Day, a grand event this year with the FPCE inauguration. The Inauguration program includes Lieutenant Governor Toni Jennings , US Representative Tom Feeney and Orange County Chair Richard Crotty. We'll tell you all about the event in our next issue of HighLights.

## New Degree at UCF: Bachelor of Science in Photonics

The University of Central Florida has recently approved a new undergraduate degree in Photonics. This degree is being offered by the Engineering Technology Department and is the first of its kind anywhere in the Nation. The Bachelors of Science in Electrical Engineering Technology with a concentration in Photonics (BSEET-Photonics) will provide students with a solid foundation in Electronics and a specialization in Photonics. It was designed as part of a "2+2" program: accepting students who already have a 2-year degree in Electrical Engineering Technology from community colleges such as Valencia Community College. The degree program was developed through a collaborative effort between Engineering Technology and the School of Optics/CREOL.

School of Optics/CREOL
**Highlights**

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# Focus on Alumni: Dr. Alfred Ducharme

The School of Optics/CREOL is proud to congratulate Dr. Alfred D. Ducharme on becoming the first CREOL graduate to join the regular Faculty at the University of Central Florida. Professor Ducharme returned to UCF as a visiting Faculty member in February of last year to develop the newly approved undergraduate degree in Photonics. Professor Ducharme has just accepted a full-time Faculty position as Assistant Professor in the Engineering Technology Department where the BSEET-Photonics program will be offered.

Professor Ducharme received his doctoral degree in Electrical Engineering from UCF/CREOL in 1994 under the direction of Dr. Glenn Boreman. While a graduate student in Dr. Boreman's Infrared Systems Laboratory, Dr. Ducharme's research focused on Modulation Transfer Function (MTF) testing of detector arrays. The result of his work was a novel method and product for testing MTF using a random scene now used by companies and laboratories around the world. Another result of his work was a paper entitled "Random transparency targets for modulation transfer measurement in the visible and infrared regions" (A. Daniels, G. Boreman, A. Ducharme, and E. Sapir) that was ultimately awarded the 1995 Rudolph Kingslake Award by SPIE. Professor Ducharme was also instrumental in developing the CREOL Educational Outreach Program that continues to provide local area high school students with the opportunity to learn about the exciting field of photonics.

Much of Dr. Ducharme's industry experience focused on the research and development of innovative products and processes in several fields of optics. Prior to joining UCF, Professor Ducharme was the Principal Optical Engineer for Color Kinetics in Boston, Massachusetts. Color Kinetics is a pioneer in the emerging field of Solid-State lighting, or light sources based on high-brightness Light Emitting Diodes (HB-LEDs). Their core technology enables the networking of HB-LED based lights to provide simple inexpensive lighting control. Initial products were based on the combination of red, green, and blue HB-LEDs into a common fixture to form a full-spectrum light source. These sources are used in what is now called "Retailtainment" or the use of lighting and animation shows in a retail simulated environments (i.e., Rain Forest Café). Much of the research in this emerging field has led to the development of a Solid-State lighting initiative focused on revolutionizing the general illumination industry. Dr. Ducharme's research was in the design of efficient optical systems for use in HB-LED based fixtures. While at Color Kinetics he invented several new technologies for use in white-light solid-state lighting. Color Kinetics is now in the process of patenting several patents covering Dr. Ducharme's research.

From 1996 to 1999, Dr. Ducharme was a research scientist with Visidyne, Inc. where he developed commercial products based on technologies funded by SBIR contracts and other government sources. The core of his research was in the development of a Digital Phase Processor (DPP) to measure the phase difference between two electronic signals with a high-degree of accuracy and precision. The DPP is now used

in a system called the MicroRanger™ that can detect micron level distance changes several meters away without the need for retro-reflectors. The speed of the system also allows for the detection of vibration in the kilo-hertz range. This technology was also expanded to create an optical GPS like system for helmet tracking in a product called MicroTracker™. Several patents were issued for Dr. Ducharme's work.

Upon graduating in 1994 and until 1996 Dr. Ducharme held a position with Physical Sciences, Inc (PSI), a School of Optics/CREOL Senior Industrial Affiliate. Here Dr. Ducharme worked on a variety of SBIR contracts and was awarded his first patent for a solar simulator invention entitled "Integrating Projection Optic". This non-imaging optic combines the output of high-flux light sources such as Xenon arc lamps and projects a highly uniform circular distribution of light onto a flat surface. The optic was developed for the Department of Energy for the controlled indoor testing of photovoltaic cells.

## Graduates - Spring 2003

| NAME | ADVISOR | PROGRAM | DEGREE |
|---|---|---|---|
| Amar Amouri | *Non Thesis* | Optics | MS |
| Vesselin Chaoulov | *Non Thesis* | Optics | MS |
| Susan Hallman | Elias | Physics | PhD |
| Cheiw-Seng Koay | *Non Thesis* | Optics | MS |
| Ricardo F. Martins | *Non Thesis* | Optics | MS |
| Alok Ajay Mehta | *Non Thesis* | Optics | MS |
| Michael Gritz | Boreman | ElctrEng | PhD |
| Sergei Polyakov | Stegeman | Optics | PhD |
| Glenn Sellar | Boreman | Optics | PhD |
| Sergei Syunkov | *Non Thesis* | Optics | MS |
| Vladislav Dubikovski | Hagan/VanStryland | Physics | PhD |
| Erica Wells | *Non Thesis* | Optics | MS |
| Tolga Yilmaz | Delfyett | Optics | PhD |
| Fumiyo Yoshino | Stegeman | Optics | PhD |

# Graduate Students Teach with Demonstration Projects

*by Joel Hales ,OSA Student Chapter President*

The OSA Student Chapter at the School of Optics and our student group **CAOS** (CREOL Association of Optics Students) are developing a powerful partnership that has resulted in a large number and variety of student activities. One example is an outreach program that involves groups ranging from elementary school students to heads of industry; and includes tours of CREOL labs, demonstrations and many active discussions of Optics.

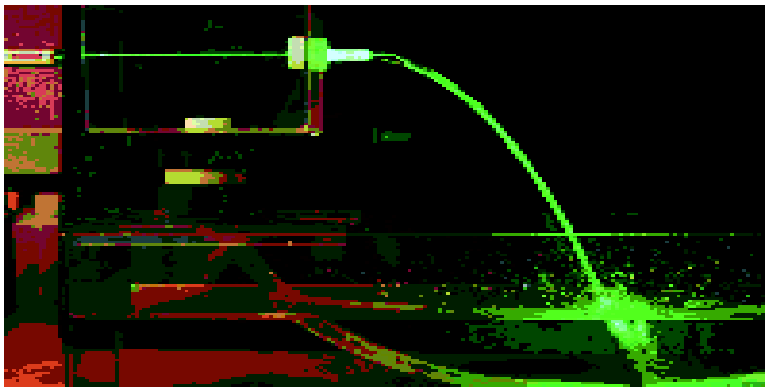
One of the most successful parts of this program resulted from many hours of volunteer work by passionate, dedicated students: They produced a set of ten Optics Display Projects, for use as educational outreach tools. Normally on display in the CREOL lobby; each project is contained in a specially created Lucite case and is transportable offsite, e.g., to schools or shows. These display projects are intended to help us visually demonstrate fundamental concepts and phenomena of optical physics in a very concrete and accessible way, while also showing a few practical applications. They involve some spectacular phenomena, such as total internal reflection; diffraction; phase conjugation; polarization of light; and modulation or scanning of laser beams. Because it is often difficult to clearly convey these very abstract concepts, the projects are a very good supplement to our CREOL lab tours, especially for non-technical groups. They also provide an entertaining and attractive educational introduction to some of the research conducted at the School of Optics/CREOL. Some examples are described below. The CAOS web site has full descriptions of all ten projects.
**See http://caos.creol.ucf.edu/htmls/projects.html.**

### Total Internal Reflection Fountain

This is a classical demonstration by analogy of how a fiber optic works. It also demonstrates fundamental laws of reflection and refraction at the water/air interface. We shine a laser into a tube of water coming from the nozzle of a water tank, and the light is confined to the tube of water by total internal reflection, just as it is confined in a glass fiber on a much smaller scale. One can see the laser beam bouncing back and forth within the tube of water, following the curvature of the water fountain (bend of the fiber). See Photo above.

### Optical Communications via Direct and Nonlinear Interactions

There are 2 projects showing optical data links. In one a deep red diode laser beam is modulated through a current driver by the audio signal from a radio. The laser beam is incident on a photo-detector connected to a speaker. As an extension to this project, an optical fiber can be used to guide the laser light from the source to the detector. In the second demonstration, a similar modulated diode laser actually modulates the optical properties of an organic dye solution similar to food coloring (here the index of refraction is changed by heating and expansion of the liquid). A second laser beam (green) senses this modulation upon transmission through the dye. Interrupting either beam turns off the music. Thus, the audio signal carried by the red beam is picked up by the green beam through the nonlinear liquid and is detected by the photodetector and transferred to the speaker.



*Total Internal Reflection Fountain*

### Full Color Laser Projector

The system generates and projects text and images in full color; demonstrating colorimetric principles for combining the three fundamental colors to cover the whole visible spectrum, and other interesting optical phenomena: acousto-optic modulation and laser beam directionality. People who've seen the fascinating laser shows at entertainment parks have the chance here to understand how they really work.

### Polarization – Birefringence

This project illustrates physical concepts such as: polarization of light, retardance, birefringence, and mechanical stress; with important applications in the investigation of defects in transparent materials (windows, plastic or glass covers, windshields), and stress distribution in various mechanical structures. The object analyzed here is a piece of plastic. Plastic is a birefringent material, i.e .the index for one polarization of light is different for the orthogonal polarization; and when forces (pressure or stretch) are applied, its birefringent properties change. By placing it between two polarizers, one can see a color map of the stress distribution across the object.

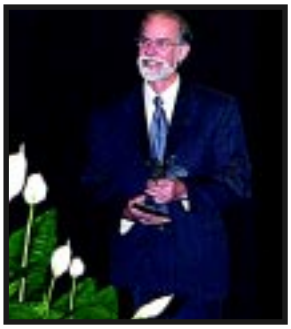
### Fiber Optics Display

This project is a spectacular and attractive demonstration of guiding light through optical fibers. (See photo below.) Graduate student Mircea Mujat painstakingly embedded about 4600 (!) plastic fibers in this display with each one positioned carefully to catch the incoming colored light from a rotating color wheel at just the right time to form a moving "logo" for the School of Optics/CREOL. By changing the intensity along with the color of light that is guided through the fibers, the display sparkles with "stars" and undulating light waves.


*This photo shows the undulating light waves in a portion of the Fiber-Optic dispay sign created by Mircea Mujat, who also took both of the photos on this page.*

# Kudos

## UCF Pegasus Professor



*Dr. Eric W. Van Stryland*

At the University of Central Florida Founders' Day Convocation on April 2, School of Optics Director **Eric W. Van Stryland** was awarded the title of Pegasus Professor.

The UCF Pegasus Professorship was established in 2000 to honor faculty who have made an extraordinary contribution to the University through excellence in teaching, research and service.

UCF Provost Emeritus Gary Whitehouse presented the award. "Eric Van Stryland is best known for revolutionizing the measurement of nonlinear optical properties of materials, paving the way for major advancements in understanding how light interacts with matter."

## Student Honors

Peter Delfyett's senior graduate student **Mike Mielke** is the winner of the School of Optics Student of the Year Award for 2002-2003. The winner of this annual award receives a cash prize of $500 and makes a presentation on Affiliates Day. Two semifinalists, **Joel Hales** and **Mircea Mujat**, were also formally recognized and awarded prizes of $100 each.

**Mike Mielke** and **Joel Hales** have also recently received national prizes: They are both 2003 winners of New Focus Awards of at least $2500 each and are competing with only four other contenders at the 2003 CLEO/QELS meeting for the coveted $10,000 top prize!

### Patent Updates

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**Y. Huang, T. X. Wu and S. T. Wu**, "Achromatic quarter-wave films." (UCF-387P, filed Apr. 1, 2003)

**S. T. Wu**, Dopants for improving the thermal and UV stability of high birefringence liquid crystals.US 6,495,066 (Dec. 17, 2002)

**S. T. Wu, R. Lu, Q. Hong and T. X. Wu**, "Liquid crystal displays with wide view angle and fast response time." (UCF-388P, filed Apr. 1, 2003)

## Wood Prize Winner

We are very pleased to announce that Professor **George Stegeman** is to receive the Optical Society of America's Wood Prize for 2003.

*Dr. George Stegeman*

The R.W. Wood Prize is endowed by the Xerox Corporation. It was established by the OSA Board of Directors in 1975 to honor the many contributions that R.W. Wood made to optics. It is intended to recognize an outstanding discovery, scientific or technical achievement, or invention in the field of optics, and is a very high honor of the society.The accomplishment for which this prize is given is evaluated chiefly by its impact on the field of optics generally i.e., one that opens a new era of research, or significantly expands an established one. Dr. Stegeman is being recognized "for pioneering nonlinear integrated optics through seminal experiments and continuing leadership".

# Updates

***Papers Published:***

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**S. Carrasco, H. Kim, G. Stegeman and L. Torner**, "Observation of self-focusing of light mediated by cubic nonlinearities in potassium titanyl phosphate," Opt. Lett., 27:2016-8 (2002).

**L. Davis, J. Rolland, F. Hamza-Lup, and Y. Ha**, "Enabling a Continuum of Virtual Environment Experiences," IEEE Computer Graphics and Applications, Feb. 2003.

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**Q. Hong, T. X. Wu and S. T. Wu**, "Optical wave propagation in cholesteric liquid crystals," Liq. Cryst. 30, 367-75, 2003.

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**T. D. Visser, G. Gbur and E. Wolf**, "Effect of the State of Coherence on the Three-Dimensional Spectral Intensity Distribution near Focus," Opt. Commun., 213, 13-19 (2002).

**W. Zou**, "A new phasing algorithm for large segmented telescope mirrors," Optical Engineering Vol.41,NO.9, pp2338-2344, 2002

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**A. Dogariu**, "Near-field nanooptics," Nano-technology Tutorial Session of the 2003 FSM/ FLAVS Joint Symposium, Orlando, March 2003.

**M. Mielke, G.A. Alphonse, and P.J. Delfyett**, "168 Channels × 6 GHz (1 THz Aggregate) from a Multiwavelength Modelocked Semiconductor Laser," Optical Fiber Communication Conference (OFC), Atlanta, GA, March 2003.

**M. Mielke, G.A. Alphonse, and P.J. Delfyett**, "High Pulse Rate and Reduced Noise Multiwavelength Modelocked Semiconductor Lasers," OSA Topical Meeting on Ultrafast Electronics and OptoElectronics, Washington, DC, January 2003.

**B. Resan, L. Archundia, P. Delfyett and G. Alphonse,** "Dispersion managed semiconductor mode-locked ring laser," presented at OSA Topical Meeting Ultrafast Electronics and Optoelectronics, Jan 15-16, 2003, Washington, DC.

**E. Wolf**, "Some Recent Researches Concerning the Structure of a Wavefield in the Focal Region," Invited Talk at AFOSR Electromagnetic Workshop, San Antonio, TX, January 19, 2002.

**E. Wolf**, "Scientists Who Created the World of Optics," Seminar, Laboratory for Laser Energetics, University of Rochester, Rochester, NY, March 8, 2002.

**E. Wolf**, "The History of Optics from Middle Ages to Present," Seminar, Robbins Library, University of Rochester, Rochester, NY, April 25, 2002.

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**E. Wolf**, "Effects of Coherence on Spectra of Radiated Fields," (Colloquium), Department of Physics, The City College of New York, June 5, 2002.

**E. Wolf**, "Effects of Coherence on Spectra of Radiated Fields," Plenary Talk, 7th International Conference on Near Field Optics, Rochester, NY, August 11, 2002.

**E. Wolf and J. Foley**, "The Phenomenon of Spectral Switches as a New Effect in Singular Optics with Polychromatic Light,", Annual Meeting, Optical Society of America, Orlando, FL, September 30, 2002.

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**M. Atanassova and J. E. Harvey**, "New X-ray Telescope Design", 12th International School on Quantum Electronics; Laser Physics.

**S. Carrasco, H. Kim, G. Stegeman and L. Torner**, "Self-focusing of light mediated by cubic nonlinearities in potassium titanyl phosphate," Nonlinear Guided Wave Phenomena: Physics and Applications, Stresa Italy, Sept. 1-4, 2002, paper NLTuD37.

**S. Carrasco, L. Torner, H. Kim, S. Polyakov, L. Jankovic, G. Stegeman and M. Katz**, "Soliton birth from radiation," Nonlinear Guided Wave Phenomena: Physics and Applications, Stresa Italy, Sept. 1-4, 2002, postdeadline paper.

**L. Davis, F., Hamza-Lup, J.P. Rolland**, "Application of Augmented Reality to Visualizing Anatomical Airways," SPIE AeroSense, 2002.

**F. Hamza-Lup, L.Davis, C. Hughes and J. Rolland**, "Where Digital meets Physical – Distributed Augmented Reality Environments," ACM Crossroads, 2003.

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**R. Iwanow, R. Schiek, G. Stegeman, T. Pertsch, F. Lederer, Y. H. Min and W. Sohler**, "Diffractionless Propagation in Low Loss $LiNbO_3$ Channel Waveguide Arrays," CLEO'2002, Long Beach, May 19-24, 2002, paper CTuK13.

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