### Program

<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
<th>Speaker</th>
<th>Organizer/Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30</td>
<td>Welcoming Remarks</td>
<td>Tony Waldrop MJ Soileau</td>
<td>UCF Provost &amp; Vice President UCF Vice-President for Research</td>
</tr>
<tr>
<td>8:50</td>
<td><strong>CREOL, The College of Optics and Photonics – Overview</strong></td>
<td>Bahaa Saleh</td>
<td>Dean &amp; Director, CREOL The College of Optics &amp; Photonics</td>
</tr>
</tbody>
</table>

### Symposium on Far IR and Terahertz Photonics

- **Tabletop Exhibits**

### Student of the Year Talk

<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
<th>Speaker</th>
<th>Organizer/Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:50</td>
<td>A low noise chirped pulse laser with an intra-cavity Fabry-Pérot etalon and high precision etalon characterization</td>
<td>Dimitrios Mandridis</td>
<td>Graduate Student CREOL, The College of Optic Photonics</td>
</tr>
</tbody>
</table>

2:05   Walk to the CREOL Building

<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
<th>Speaker</th>
<th>Organizer/Position</th>
</tr>
</thead>
</table>
| 2:20  | **Poster Sessions**  
**Lab Tours**  
**Table-Top Exhibits**                                                      | Graduate Students                | CREOL rooms 102 & 103; Tours start from lobby CREOL Lobby   |
| 4:00 - 5:30 | **Poster award presentation**  
**Reception**                                                               | Bahaa Saleh                      | CREOL Lobby                                                   |
Industrial Affiliates Day Exhibitors
Tony Waldrop
Provost & Vice President for
Academic Affairs
MJ Soileau
V.P. for Research
Professor of Optics, ECE & Physics
Founder of CREOL
Brief History

1987 **CREOL founded** *(Center for Research & Education in Optics and Lasers)*

1998 **School of Optics**

2004 **College of Optics & Photonics**

1987 Lin
1988 Soileau
1989 Guenther
1990 Van Stryland
1991 Hagan
1992 Moharam
1993 Chang
1994 Amescua
1995 Lin
1996 Soileau
1997 Guenther
1998 Van Stryland
1999 Hagan
2000 Moharam
2001 Chang
2002 Amescua
2003 Lin
2004 Soileau
2005 Guenther
2006 Van Stryland
2007 Hagan
2008 Moharam
2009 Chang
2010 Amescua
2011 Lin
Vision

Be the nation’s leader in education, research, scholarship in OS&E

&

aid in the development of Florida’s technology-based industries
Centers within the College of Optics & Photonics

2005
Florida Photonics Center of Excellence (FPCE)
Nanophotonics, Biophotonics, Imaging & Display

Eric Van Stryland
2006  Townes Laser Institute

Industrial & Medical Applications of lasers
Ceramic laser materials
Fiber lasers

2009
Partnership with Fraunhofer Institute in lasers & laser materials processing

CREOL
The College of Optics & Photonics
Connections with Other UCF Colleges & Centers

Nanophotonics
Optoelectronics
Optomechanics
Optical physics
Biophotonics
Medical Optics
Optical materials

NanoScience Technology Center
Advanced Materials Processing & Analysis Center
CREOL
Burnett School of Biomedical Sciences
College of Engineering & Computer Science
College of Science
College of Medicine

CREOL
The College of Optics & Photonics
## Overview of the College

<table>
<thead>
<tr>
<th>Facts in 2010-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 faculty</td>
</tr>
<tr>
<td>14 joint faculty</td>
</tr>
<tr>
<td>37 research scientists</td>
</tr>
<tr>
<td>20 visiting scientists</td>
</tr>
<tr>
<td>117 PhD students</td>
</tr>
<tr>
<td>23 PhD degrees</td>
</tr>
<tr>
<td>18 MS degrees</td>
</tr>
<tr>
<td>$\sim$10M External grants</td>
</tr>
<tr>
<td>145 Journal papers</td>
</tr>
<tr>
<td>56 Seminars</td>
</tr>
<tr>
<td>18 Patents issued</td>
</tr>
</tbody>
</table>
Faculty Distinctions

**OSA**
- 20 Fellows
  - Born Award (Zel’dovich)
  - Holonyak Award (Deppe)
  - Wood Prize (Stegeman, Christodoulides)
  - Beller Award (Soileau, Saleh)
  - Distinguished Service (Saleh)
  - Fraunhofer Prize (Wu)

**SPIE**
- 11 Fellows
  - Kingslake Medal & Prize (Boreman)
  - Gold Medal (Soileau)
  - BACUS Prize (Saleh)
  - Stokes Award (Wu)
  - Gabor Award (Glebov)

**IEEE Photonics Society**
- 10 Fellows
  - Engineering Achievement Award (Deppe)

**IEEE**
- 1 Fellow
  - Rajchman Prize (Wu)
  - Slotto-Owaki Prize (Wu)

**APS**
- 3 Fellows
  - Bouchet Award (Delfyett)

**ACS**
- 1 Fellow
  - Abbe Medal (Riza)
OSA's 2011 R. W. Wood Prize
Demetrios Christodoulides

for contributions in nonlinear and linear beam optics, which initiated new areas, among them:
the discovery of optical discrete solitons,
Bragg and vector solitons in fibers,
nonlinear surface waves,
the discovery of self-accelerating optical (Airy) beams.
Editors-in-Chief of Optics & Photonics Journals

Michael Bass

Glenn Boreman

Glenn Boreman

Peter Delfyett

Peter Delfyett

Optical Materials Express (2010-Present)  
David Hagan

Bahaab Saleh

Advances in Optics & Photonics (2008-present)  
Bahaab Saleh

Shin-Tsong Wu
Graduate Program

117 PhD Students
23 PhD degrees
18 MS degrees

Numerous student awards
Excellent job offers

Goal: Expand our MS online program and attract more students from industry

International MS program: Atlantis-MILMI
Dual MS degrees from:
• University of Bordeaux, France
• Friedrich Schiller University in Jena, German
• CREOL, the College of Optics & Photonics;
• Clemson University.
Undergraduate Programs

NSF Research Experiences for Undergraduates (REU), National & International
Brings students from all over USA to work in CREOL labs.
Developing a BS Degree in Photonics

Active student chapters
Strong outreach programs

CREOL
The College of Optics & Photonics
Inventions

Patents

- Disclosures Filed
- Provisional Applications
- Utility Applications
- Patents Issued

FY 02 FY 03 FY 04 FY 05 FY 06 FY 07 FY 08 FY 09 FY 10

CREOL
The College of Optics & Photonics
Entrepreneurial Activities

SPINOFFs

- CRYSTAL PHOTONICS (donated e-microscope)
- Beam
- Laser Classics (laser crystals)
- OPTICAL DIAGNOSTICS
- LIGHT PROCESSING TECH
- Laser Energetics
- POLARA
- Applied Photonics
- NUONICS (Riza)
- OPTIUM

- Raydiance (loaned laser, 6 PhDs hired)
- FEMTOPTICS
- OPTIGRATE
- BD Displays – Bass/Deppe
- Medical Lighting Solutions (Schoenfeld)
- SD Photonics LTD.-Deppe/Freisem
- Tera Byte Mining-Delfyett
- Coherent Photonics-Li
- Speckodyne-Dogariu
- LP Photonics-Richardson
Partnership with Florida’s Photonics Industries

Supports the growth and profitability of the photonics industry in Florida

148 photonics companies
16,000 Employees
$4 Billion in annual revenues

Central Florida

106 photonics companies
$2.2 Billion in annual revenues

CREOL
The College of Optics & Photonics
## Industrial Affiliates Members (64)

### Life Members
- Cobb Family Foundation
- Northrop Grumman Corporation
- Nufern

**Memoriam Members:** Dr. Arthur H. Guenther and Dr. William C. Schwarz

### Medallion Members
- Agilent Technologies
- Breault Research
- Northrop Grumman Laser
- Newport Corporation
- Optical Research Associates
- Paul G. Suchoski, Jr
- Powerlase Limited
- Zemax Development Corp.

### Senior Members
- Coherent, Inc.
- CST of America
- Edmund Optics
- ER Precision Optical
- Lambda Research Corporation
- LightPath Technologies
- LAS-CAD GmbH
- Lockheed Martin
- Newport Corporation
- Ocean Optics
- Ophir-Spiricon
- Optimax Systems
- Tektronix
- TRUMPF, Inc.
- Veconix Inc.
- Veeco Instruments-Metrology
- Zygo Corporation

### Affiliate Members
- American Photonics Co.
- Analog Modules
- Applicote Associates, LLC
- Cubic Defense Applications
- DILAS Diode Laser, Inc.
- Gooch & Housego, LLC
- Harris Corporation
- HORIBA Jobin Yvon
- Insight Technology
- JENOPTIK Optical Systems Inc.
- Kaufman & Robinson, LLC
- L-3 Communications
- Laser Institute of America
- Lee Laser
- Luna Innovations, Inc.
- Northrop Grumman Aerospace Systems
- OKO Technologies
- Optigrate Corp.
- Photonics Spectra
- Photonics Online
- Princeton Instruments
- Quioptic
- QPC Lasers/Laser Operations LLC
- R-Soft Design Group
- Ray Williamson Consulting
- Sciperio, Inc.
- SPIE- The Int’l Society for Optics & Photonics
- The Optical Society
- Tower Optical Corporation
- TwinStar Optics, Coatings & Crystals
- Vytran LLC
- Yokogawa Corporation of America
Research Highlights

CREOL
The College of Optics & Photonics
Lasers

- Ultrafast Lasers
- Optical Freq Combs
- High Power Lasers
- IR Lasers
- EUV & X-ray Lasers
- Solid State Lasers
- Ceramic Lasers
- Fiber Lasers
- Semiconductor Lasers

Applications
- Laser Fabrication & Lithography
- Laser Material Processing
- Lasers in Medicine

Laser & Plasma Laboratory

Power combining

Optical Frequency Comb
Ultrafast Lasers
Optical Freq Combs

Worlds’ lowest noise multi-GHz stabilized optical comb source.

- 1.1 ps pulse width
- 50 dB optical comb tine OSNR.
- ~500 Hz comb tine linewidth
- < 150 kHz max freq deviation in 30 s.
- 3 fs timing jitter

Student-of-the-year talk

Optical Frequency Comb
Attosecond Light

Generation and stabilization (of Carrier-Envelope Phase).

Applications
- Autoionization of Argon,
- Double Ionization Argon Dimer
- Monitoring and controlling electron dynamics in Helium
- Determining time resolution of microchannel plate detectors
High-Power TM-Doped Fiber Lasers in Mid-IR (2 µm)

Cross-relaxation pumping

Nufem fibers

Applications: Laser-Induced Breakdown Spectroscopy of Copper

Pump at ~790 nm

\[ ^3H_4 \rightarrow ^3H_5 \]

\[ ^3H_4 \rightarrow ^3F_4 \]

\[ ^3F_4 \rightarrow ^2\mu m \]

\[ ^3P_6 \rightarrow ^2\mu m \]

Martin Richardson

TRUMPF
Ocean Optics
THORLABS
IMRA
Newport
NKT

UV spectrometry
Opt. Tweezers
Laser Material processing
2-μm laser atmospheric test at the ISTEF laser range facility

Atmospheric transmission (left scale)

Maximum Permitted Energy (right scale)

aerosol absorption

Yb gain (a.u.)

Er,Yb gain (a.u.)

Tm gain (a.u.)

MPE (J/m²)

ISTEF Laser Range Facility
A team led by Richardson has just won the ARO MURI competition for the Air Filamentation program (fundamental science of the propagation of high intensity ultrafast lasers in the atmosphere).

$6.1M (over 5 years)

Other members of the team are: UNM, U. Buffalo, SMU, Northwestern, UNCC, RPI and Laval U and Ottawa U (Paul Corkum).

This follows a similar 5-year $2.5M MRI awarded last year by the DoD High Energy Laser Joint Technology Office for Filamentation Interaction Studies
Lasers

High Power Lasers

Photo-Thermo-Refractive (PTR) Glass

Volume Bragg Gratings (VBG)

- VBG Spectral Combining and Coherent Coupling of Lasers
- Chirped VBG in tunable narrowband OPOs
- VBG for non-collinear THG
- VBG assisted broadband tunability and spectral narrowing of Ti:Sapphire oscillators
- Multiplexed VBG mirrors for 2-Color InGaAs Lasers

CREOL
The College of Optics & Photonics

Spun off from UCF in 1999
~5,000 sqft manufacturing facility
making highest quality glass for HOEs
Fiber Optics

- Fiber Fabrication Technology
- Multimaterial Fibers
- Nano-structured Fibers
- Mid Infrared Fibers
- Fiber Lasers

Applications

- Fiber Optic Communication
- Fiber Optic Networks
- Fiber Optic Sensing
- Fiber Optic Solar Energy Collectors

CREOL
The College of Optics & Photonics
Photonic crystal and nanostructured fibers for fiber lasers and devices

Chiral nanostructures in fiber core for polarization control
Goal: Scavenging solar energy with concentrating textured fibers and fabrics

Fiber Optic Solar Energy Collectors

Ayman Abouraddy

First complete solar-concentrating-fabric assembly
Spectral Concentration

(a) Doped preform fluorescing under UV light.

(b) The doped preform is now drawn into a fiber fluorescing uniformly under UV light.

(c) Fibers up-converting from 980 nm to RGB.
Mode-Division Multiplexed Fiber-Optic Transmission

Back-to-back After 1050 km

Results for 2-mode fiber at 10 Gb/s; no intermodal coupling no modal dispersion induced impairment
Semiconductor & Integrated Photonics

- Epitaxial Growth
- LEDs & Laser Diodes
- Quantum Dots & Nanostructures
- Optoelectronics
- Oxide Semiconductors
- Photovoltaics
- Integrated Optics
- Periodic Structures & Photonic Crystals
- Nanophotonics & Plasmonics
- Silicon Photonics
- Gratings & HOEs

Applications

- Optical Communication
- Optical Processing & Switching
- Solar Energy Applications
- Integrated-Optic Sensing
- Integrated-Optic Signal Processing

CREOL
The College of Optics & Photonics

MBE Facility

Nanophotonics Fabrication Facility
class 100/1000 cleanroom
Leica 5000 + e-beam lithography with on-chip 10 nm resolution. 1 of 3 in the US!
New quantum dot lasers with record low thresholds & record low internal losses

\[ J_{th} = 8.8 \text{ A/cm}^2 \]
High power laser diode technologies providing greater power, efficiency, brightness & reliability.

Lithographic VCSEL technology: Oxide-free with better VCSEL performance

Epitaxial VCSEL surface

Applications
Optical sensors, lidar, atomic clock, optical pumping, high speed optical data processing

sdPhotonics, LLC
NiMgO & ZnMgO alloys address the UV-C region!

Applications
Air-water purification, Chem-bio detection, DVD optical storage, Currency authentication, Polymer curing, Deep-UV fluorescence lifetime measurements. NLOS
Breaking News!

Photovoltaic Manufacturing Consortium

- SEMATECH-CNSE-UCF Partnership to establish first US PVMC through DOE support ($62M – 5 Years) & commitment from >80 U.S. PV Industry/University/National Lab members
- Initial Technical Objectives in Florida for cSi
  - Develop advanced in-line and off-line metrology systems
  - Develop new wafering technologies
- Future effort to establish 100,000 ft² PVMC Center in Florida with industrial-scale 30 MW cSi cell/module manufacturing pilot line
Silicon is ideal for Mid IR

- Large Raman gain coefficient
- High damage threshold
- Good thermal conductivity
- Excellent transmission window

Mid IR Raman Amplifier
12 dB Gain @ 3.4 μm in bulk Si

STOKES CW
12 dB on-off gain at 3.4 μm
I_p=238 MW/cm²

PUMP - (2.88 um)
5 nsec pulse @10 Hz
Si on $\text{SiO}_2$ (SOI) is not possible at mid-IR since $\text{SiO}_2$ is lossy.
Instead, SOS technology has been developed.

Applications:
nonlinear integrated optics, e.g., Raman lasers, four-wave mixing, etc.
Proposed integrated cascaded Raman cavity in a SOS waveguide using Bragg mirror pairs to selectively reflect the various orders of the Stokes beam.
Metal nanoparticle surface plasmon resonance


Ultrawide bandwidth resonance tuning demonstrated

Surface plasmon on 20 nm silver particle
Coupled plasmon resonances on dissimilar particles

Cascaded field enhancement
Improved figure of merit for nonlinear optical absorption
Enhanced sensing, effective media for nonlinear switching

Toroghi et al., in preparation.
Nonlinear & Quantum Optics

- Nonlinear Guided Waves & Fibers
- Nonlinear Optical Materials
- Nonlinear Optics & Spectroscopy
- Nonlinear Optics in Periodic Structures
- Photosensitive Glasses
- Solitons
- Quantum Optics

Applications
- Laser Protectors
- Optical Communication
- Quantum Information

CREOL
The College of Optics & Photonics
Extremely NonDegenerate 2-Photon Absorption for IR detection

IR at 5.6 μm

Intense Pump at 390 nm

GaN

Output voltage [mV]

Input energy at 5.6 μm (nJ)

Of course – only works well for short IR pulses. And requires $$$ for pump!

# Nonlinear & Quantum Optics
- Nonlinear Guided Waves & Fibers
- Nonlinear Optical Materials
- Nonlinear Optics & Spectroscopy
- White-Light Continuum

David Hagan Eric Van Stryland
Nonlinear & Quantum Optics

- Nonlinear Optics in Periodic Structures
- Photosensitive Glasses
- Solitons

Airy beam
- Diffractionless laser following parabolic trajectory

2D Airy beam
- Spatio-temporal optical bullets
- Diffraction-less
- Dispersion-less

Circumventing opaque obstacles

Demetri Christodoulides
Curved plasma channel generation (filamentation) using ultra-intense fs Airy beams in air

Apps: diagnostic spectroscopy
• Airy Plasmon: A Nondiffracting Surface Wave
• Diffusion-Trapped Airy Beams in Photorefractive Media
• Oblique Airy wave packets in bidispersive optical media
Infrared Systems Lab

- Optical Design & Image Analysis
- Near Field Imaging
- Propagation in Random Media
- X-ray & EUV Technology
- Infrared Sensors & Systems
- Millimeter & THz Technology
- Optics of Liquid Crystals

Applications

- Optical Sensing & Imaging
- Biological & Medical Imaging
- Microscopy
- Optical EUV & X-ray Astronomy
- Optical, EUV & X-ray Lithography
- Displays
- Optical Signal Processing

CREOL
The College of Optics & Photonics
Extension of radio-frequency (RF) concepts to IR & THz using electron-beam lithography.

Glenn Boreman
Symposium Speaker
Photonic Control of Cells’ Motility

Using optical torques induced by light polarization to dynamically guide cell migration & differentiation without inducing phototoxicity.

Applications:
Regenerative medicine & cell therapies

Photonic “scaffolds” for tissue repair and engineering

Cell migration and motility assays

Groups of SH-Sy5 cells after exposure to light polarized as indicated.
Enhancing FOV
without scanning
or loss of resolution

Technology:
Degenerate Polarization
Multiplexing

Other benefits:
• incorporate target-specific sensing based on polarimetric signatures
• superresolution approaches possible

Recording
Single FPA-based polarimeter records incoherent superposition of all inputs

Recovery
Example using $\ell_1$-norm minimization in wavelet basis
Design, Characterization, and Modeling

Design composite materials with strong spatial variation (shape, size, and packing of elements) to optimize optical properties (gloss, opacity and other unique optical signatures)

Characterization: Novel polarization techniques are used to examine the structures and identify relevant characteristic length scales

Modeling: Advanced numerical techniques are being developed to model the optical performance
Wideband High Efficiency Gratings for Spectrometer Applications

Jim Moharam
Patrick Likamwa
High-temperature, extreme environment, SiC sensors using blackbody radiation, optical pyrometry, laser interferometry. Gas turbines applications

Wireless Gas Sensor by Laser Doping Technique in SiC
Laser Gas Sensor by Photoexcitation Effect on Refractive Index

SiC temperature front-end probe
Blue Phase LCD
Nematic LCD

E-field ➔ rotation (5 ms)

E-field ➔ Kerr anisotropy (1ms)

Liquid crystal materials
Blue Phase LCD
LC-filled photonic crystal fibers

Adaptive lenses,
Laser beam steering
## Far IR and Terahertz Photonics

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:20</td>
<td>Quantum Cascade Lasers: widely tailorable light source from the mid-infrared to TeraHertz</td>
<td>Federico Capasso</td>
<td>Harvard School of Engineering and Applied Optics</td>
</tr>
<tr>
<td>9:55</td>
<td><strong>Break &amp; Exhibit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:10</td>
<td>Novel nano architectural concepts for THz/IR based bio-sensing</td>
<td>Dwight Woolard</td>
<td>Army Research Laboratory</td>
</tr>
<tr>
<td>10:35</td>
<td>Far IR and Terahertz Technology – at the Turning Point of Change!</td>
<td>Michael Dudzik</td>
<td>Lockheed Martin Corp.</td>
</tr>
<tr>
<td>11:00</td>
<td><strong>Break &amp; Exhibit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:15</td>
<td>Infrared Imaging in the Military: Status and Challenges</td>
<td>Ronald Driggers</td>
<td>Optical Sciences Division Naval Research Laboratory</td>
</tr>
<tr>
<td>11:40</td>
<td>Open Questions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:00</td>
<td><strong>Lunch Served – UCF Alumni Center</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Tabletop Exhibits – Alumni Center Lobby</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:00</td>
<td>Next generation optical fibers for IR applications</td>
<td>Axel Schülzgen</td>
<td>CREOL, The College of Optics &amp; Photonics</td>
</tr>
<tr>
<td>1:25</td>
<td>Infrared Antennas and Frequency Selective Surfaces</td>
<td>Glenn Boreman</td>
<td>CREOL, The College of Optics &amp; Photonics</td>
</tr>
<tr>
<td>Time</td>
<td>Title</td>
<td>Presenter</td>
<td>Affiliation</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------------------------------------</td>
<td>---------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>1:50</td>
<td>A low noise chirped pulse laser with an intra-cavity Fabry-Pérot etalon and high precision etalon characterization</td>
<td>Dimitrios Mandridis</td>
<td>Graduate Student, CREOL, The College of Optics &amp; Photonics</td>
</tr>
<tr>
<td>Time</td>
<td>Event</td>
<td>Participants</td>
<td>Location</td>
</tr>
<tr>
<td>---------</td>
<td>--------------------------------------------</td>
<td>------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>2:05</td>
<td>Walk to the CREOL Building</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:20</td>
<td><strong>Poster Sessions</strong></td>
<td>Graduate Students</td>
<td>CREOL rooms 102 &amp; 103;</td>
</tr>
<tr>
<td></td>
<td>Lab Tours</td>
<td></td>
<td>Tours start from lobby</td>
</tr>
<tr>
<td></td>
<td><strong>Table-Top Exhibits</strong></td>
<td></td>
<td>CREOL Lobby</td>
</tr>
<tr>
<td>4:00 – 5:30</td>
<td><strong>Poster award presentation</strong></td>
<td>Baha Saleh</td>
<td>CREOL Lobby</td>
</tr>
<tr>
<td></td>
<td>Reception</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Thank you
besaleh@creol.ucf.edu

www.creol.ucf.edu