Application of Lasers for Sensing & Free Space Communication (LS&C)

10 July - 14 July 2011, The Westin Harbour Castle, Toronto, Ontario, Canada

Sophisticated laser system concepts are increasingly being used to address high bandwidth free space communications needs and for remote sensing applications. We are coming into the age of Free Space Optics, where laser systems are seen as a viable competitor to RF systems for many applications. However, system requirements continue to demand increased performance from the various components used to implement these systems. Both application areas require high laser modulation rates and methods of mitigating atmospheric effects. Laser based sensing and free space communications both employ sophisticated detection schemes. Both mine historic microwave analog technologies to develop new optical approaches, in spite of very different device technologies in the optical region. Laser, modulator, beam steering, and detection technologies are rapidly advancing system enablers. This meeting reports the latest results in the development of this technology.

The conference chairs invite you to share your latest work with colleagues and network with leaders in the field including distinguished **invited speakers** and the **program committee**.

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This event is part of the Imaging and Applied Optics Congress, allowing attendees to access to all meetings within the Congress for the price of one and to collaborate on topics of mutual interest.

Imaging and Applied Optics

- Adaptive Optics: Methods, Analysis and Applications (AO)
- Application of Lasers for Sensing & Free Space Communication (LS&C)
- Applied Industrial Optics: Spectroscopy, Imaging, & Metrology (AIO)
- Computational Optical Sensing and Imaging (COSI)
- Fourier Transform Spectroscopy (FTS)
- Hyperspectral Imaging and Sounding of the Environment (HISE)
- Imaging Systems Applications (IS)
- Signal Recovery & Synthesis (SRS)

Chairs:

Paul McManamon, *Exciting Technology LLC, USA,* **General Chair**
Edward A. Watson, *US Air Force, USA,* **General Chair**

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Imaging and Applied Optics: OSA Optics and Photonics Congress

July 10-14, 2011, The Westin Harbour Castle, Toronto, Canada

The Imaging and Applied Optics Congress –exploring the growing need for optical imaging technologies.

Optical imaging technologies and its wide adaption for commercial, military and medical applications are progressing rapidly. Additionally, optical techniques applied to sensing, process control, metrology, and laser remote sensing are impacting and enabling many applications. This Optics and Photonics Congress explores the latest advances in imaging technologies as well as the development and use of other optical sensing and data transfer techniques and reports on new implementations that exploit these advances. Numerous advances in optical technologies have enabled new applications and these too will be presented at this Congress. Novel computational and conventional imaging theory, component developments, and demonstrations will be discussed in five of the meetings (AO, COSI, FTS, IS, SRS) while the application of imaging techniques will represent the important themes in three of the meetings (HISE,IS, AIO). Optical measurement and sensing applications also form an important component to this Congress and are covered in IS, AIO, LS&C, and HISE.

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- Imaging Systems Applications (IS)
- Signal Recovery & Synthesis (SRS)

OSA Congresses are intimate, medium sized meetings where 300-500 industry experts and top researchers and developers share their latest research and collaborate on new and future applications. Exhibiting at The OSA Imaging and Applied Optics Congress offers you an extremely targeted opportunity to display your company's products. Previous exhibitors include representatives from companies involved in nanotechnology. Precision optics, optical thin film coatings, optoelectronics and imaging, fabrication and testing and scientific instruments.

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Special Events

AIO Plenary Session
Monday, 11 July, 08:00-10:00
Pier 3
Atle Honne
Senior Research Scientist, SINTEF, Oslo, Norway
Atle Honne is the project manager for ANITA at SINTEF, the largest independent research organization in Scandinavia. His responsibilities include calibration, measurement, testing and data evaluation for ANITA with special interests in FTIR-based multi-gas analyses, optical measurements, and measurement technology in general. He holds a Master of Science in Applied Physics, and has recently been awarded the 2009 Wright Brothers Award for one of his background research papers on this subject.

Networking for Lunch
Tuesday, 12 July 12:30 – 14:00
Sponsored by the OSA Information Acquisition, Processing and Display Technical Division
David Brady, Division Chair, and Chris Dainty, OSA President, invite you to join them over lunch for some lively networking with your colleagues. OSA is pleased to offer complimentary sandwiches and beverages to all who attend.

Joint Conference Reception
Tuesday, 11 July, 19:00-20:30
Metro West Ballroom, 2nd Floor Conference Room
The reception will feature light fare and is open to all registrants

Poster Presentations
Poster presentations offer an effective way to communicate new research findings and provide an opportunity for lively and detailed discussion between presenters and interested viewers.

Joint IS/AIO/LS&C Poster Session
Tuesday, 12 July, 10:30-12:30
Salon B

Joint FTS/HISE/AO/COSI Poster Session
Wednesday, 13 July, 10:30-12:30
Salon B

Postdeadline Paper Presentations
The program committees of AO/COSI/FTS/HISE accepted postdeadline papers for presentation. The purpose of postdeadline sessions is to give participants the opportunity to hear new and significant materials in rapidly advancing areas. Only those papers judged to be truly excellent and compelling in their timelines were accepted.

For more information, including the schedule and locations see the Postdeadline papers appended to the back of the program book.

AO Postdeadline Paper Session
Tuesday, 12 July 16:30-18:30
Pier 5

COSI Postdeadline Paper Session
Wednesday, 13 July 10:30-12:30
Salon C

Joint FTS/HISE Postdeadline Paper Session
Wednesday, 13 July 16:30-18:30
Pier 7/8

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Application of Lasers for Sensing & Free Space Communication (LS&C)

10 July - 14 July 2011, The Westin Harbour Castle, Toronto, Ontario, Canada

Program

The Application of Lasers for Sensing & Free Space Communication (LSC) topical meeting reports the latest results in the development of laser, modulator, beam steering, and detection technologies. If you would like to be considered as a presenter, please review the topic categories below and the author/presenter information for submission guidelines.

A number of distinguished **invited speakers** have been invited to present at the meeting. In addition, the organizers have planned a number of **special events** to make your meeting experience more enjoyable!

View the conference program and plan your itinerary for the conference

- Browse speakers and the agenda of sessions
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- Search by author, title, OCIS code and more.
- Plan and print your personal itinerary before coming to the conference

Download pages from the Congress program book (includes all meetings in the Imaging and Applied Optics Congress)!

Abstracts (pdf)
Agenda of Sessions (pdf)
Key to Authors and Presiders (pdf)

Meeting-at-a-Glance

A tentative general schedule of the meeting (as well as all meetings in the Congress) is listed below. Please check back frequently for updates.

	11 July	12 July	13 July	14 July
AIO Technical Sessions	8.00-10.00 10:30-13:10 14:00-16:00 16:30-18:30	8:00-10:00 14:00-16:00 16:30-18:30	8:00-10:00 10:30-12:30 14:00-16:00 (joint with IS) 16:30-18:30 (joint with IS)	

AO Technical Sessions	8:00–10:00 10:30–12:30 14:00–16:00 16:30–18:30 (joint with LS&C)	8:00–10:00 (joint with SRS) 10:30–12:30 (joint with SRS) 14:00–16:00 (joint with SRS) 16:30–18:30 (Postdeadline Papers)	8:00–10:00	
COSI Technical Sessions	8:00–10:00 10:30–12:30 14:00–16:00 16:30–18:30	8:20–10:00 10:30–12:30 14:00–16:00 (joint with IS) 16:30–18:30 (joint with IS)	8:00–10:00 11:30–12:30 (Postdeadline Papers) 14:00–16:00 16:30–18:30	
FTS Technical Sessions	8:00–10:00 (joint with HISE) 10:30–12:30 14:00–16:00 16:30–18:30	8:00–10:00 10:30–12:30 14:00–16:00 16:30–18:30	8:00–10:00 14:00–16:00 16:30–18:30 (Postdeadline Papers)	8:20–10:00 10:30–12:30
HISE Technical Sessions	8:00–10:00 (joint with FTS) 10:30–12:30 14:00–16:00 16:30–18:30	8:00–10:00 10:30–12:30 14:00–16:00 16:30–18:30	8:00–10:00 14:00–16:00	

IS Technical Sessions	8:00–9:40 10:30–12:30 14:00–16:00 16:30–18:30	8:00–10:00 14:00–16:00 (joint with COSI) 16:30–18:30 (joint with COSI)	8:00–10:00 10:30–12:30 14:00–16:00 (joint with AIO) 16:30–18:30 (joint with AIO)	
LS&C Technical Sessions	8:00–10:00 10:30–12:30 14:00–16:00 16:30–18:30 (joint with AO)	8:00–10:00 10:30–12:50 14:00–16:00 16:30–18:30	8:00–10:00 10:30–12:30 14:00–16:00 16:30–18:30	8:00–10:00 10:30–12:20
SRS Technical Sessions	8:00–10:00 10:30–12:30 14:00–16:00 16:30–18:30	8:00–10:00 (joint with AO) 10:30–10:50 (joint with AO) 14:00–16:00 (joint with AO)		
Poster Sessions		10:30–12:30 (joint AIO/IS)	10:30–12:30 (joint FTS/HISE/AO/COSI)	
Coffee Breaks	10:00–10:30 16:00–16:30	10:00–10:30 16:00–16:30	10:00–10:30 16:00–16:30	10:00–10:30
Exhibit Time				
Conference Reception		19:00–20:30		

Invited Speakers

Monday 11 July

LMA1, **Optical Modem Technologies for Long Range Terrestrial FSO Communications**, D.W. Young, *JHU APL, USA*

LMB1, **Self-Referencing Interferometer Adaptive Optics for Improving Free Space Laser Communications**, T.A. Rhoadarmer, *SAIC, USA*

LMB2, **Title to Be Announced**, Patrick Collier, *USA*

LMC1, **Strategies for enhancing the reliability and availability of lasercom**, M. Northcott, *Aoptix Technologies, Inc., USA*

Tuesday 12 July

LTuA1, **Addressing Security Issues in Quantum Key Distribution using Seed Keys and Entangled Sources**, G. Kanter[1], Y. Huang[2], P. Kumar[2], [1]NuCrypt LLC, USA, [2]*Ctr. for Photonic Communication and Computing, Northwestern Univ., USA*

LTuA2, **Novel protocols for free-space quantum key distribution**, U. Yurtsever, *MathSense Analytics, USA*

LTuA3, **Stochastic electromagnetic beams for sensing and free-space communications**, Olga Korotkova, *Univ. of Miami, USA*

LTuB1, **Diversity Rateless Round Robin for Networked FSO Communications**, Roger Hammons, *JHU APL, USA*

LTuC1, **Authentication of quantum messages**, P. Hayden[1,2], D. Leung[1,3], D. Mayers[3], [1]McGill Univ., Canada, [2]*Univ.of Waterloo, Canada,* [3]*Caltech, USA*

LTuC2, **Defeating Eavesdropping with Quantum Illumination**, J. Shapiro, *Research Laboratory of Electronics, MIT, USA*

LTuC3, **MIMO FSO Communications in Cloud and Turbulence**, M. Kavehrad, J. Fadlullah, Z. Hajjarian, *Pennsylvania State Univ., USA*

LTuC4, **Special beam arrays for scintillation reduction**, G. Gbur, *Univ. of North Carolina at Charlotte, USA*

LTuD1, **Coherent Optical Technologies for Free-Space Optical Communication and Sensing**, Guifang Li, *Univ. of Central Florida, USA*

LTuD2, **Far-field scintillation reduction utilizing Gaussian-Schell model beams**, Michael Roggemann, *MTU, USA*

Wednesday 13 July

LWA1, **A Tunable Filter for Laser Communication**, Tom Baur, *Meadowlark Optics, USA*

LWA2, **Blue Light Sources based on Ti:Sapphire Lasers**, Kevin Wall, *Q Peak, USA*

LWA3, **An Optical Filter for Underwater Laser Communications**, Fred Levinton, *NovaPhotonics, USA*

LWB1, **Blue-Green Laser Communications in Support of Undersea Dominance: Connecting with the Undersea Network**, G. Mooradian, *QNA TSG, USA*

LWB2, **Pulsed Yb Fiber Laser for Underwater Communications**, A.R. Grant, D.P. Holcomb, T.H. Wood, *LGS Innovations, USA*

LWB3, **Parameter Estimates For Free Space Optical Communications**, H. Pike[1], L. Stott[2], P. Kolodzy[3], M. Northcott[4], [1]*Defense Strategies & Systems Inc., USA,* [2]*DARPA, USA,* [3]*Kolodzy Consulting, USA,* [4]*AOptix, USA*

LWC1, **The Lunar Laser Communications Demonstration**, Bryan Robinson, *MIT Lincoln Lab, USA*

LWC2, **Mobile Lasercom Systems Using Modulating Retro-reflectors**, Peter G. Goetz, William S. Rabinovich, Rita Mahon, Mike S. Ferraro, James L. Murphy, Michele R. Suite, Christopher I. Moore, Harris R. Burris, and Walter R. Smith, and Warren W. Schultz, *Naval Research Laboratory, USA*

LWD1, **A Transportable Atmospheric Testing Suite**, R. Mahon, M. Ferraro, W.S. Rabinovich, C.I. Moore, H.R. Burris, M.R. Suite, L. Thomas, *Naval Research Laboratory, USA*

LWD2, **Robust Fiber-to-fiber Free-Space Optical Communications under Strong Atmospheric Turbulences**, Y. Arimoto, *Space Communication Systems Lab, Natl. Inst. of Information and Communications Technology, Japan*

Thursday 14 July

LThA1, **Haiti 3D ladar flights**, Rick Heinrich, *MIT Lincoln Lab, USA*

LThA2, **Real-Time 3D Intelligence Products Using the Total Sight LiDAR System**, R. Patrick Earhart, *Ball Aerospace, USA*

LThA3, **Geiger-mode Avalanche Photodiode Focal Plane Arrays for 3D LIDAR Imaging**, Mark Itzler, **Princeton Lightwave, USA**

LThA4, **Single Photon Imaging Cameras for 3D Imaging Applications**, R. Sudharsanan[1,2], P. Yuan[1], J. Boisvert[1], *[1]Boeing Spectralab, USA, [2]Boeing Directed Energy Systems, USA*

LThB1, **Next Generation Infrared Imaging Sensors**, A. Sarangan, J. Duran, *Electro-Optics, University of Dayton, USA*

LThB2, **Considerations for Remote Sensing of Atmospheric Particles**, Tahllee Baynard, *Lockheed Martin Coherent Technologies, USA*

LThB3, **Stand-off Biometric Identification using Fourier Transform Profilometry for 2D/3D Face Imaging**, B.C. Redman[1], S.J. Novotny[1], T. Grow1, V. Rudd[1], N. Woody[1], M. Hinckley[1], P. McCumber[1], N. Rogers[1], M. Hoening[1], K. Kubala[1], S. Shald[1], R. Uberna[1], T. D'Alberto[1], T. Hoft[2], R. Sibel[3], F.W. Wheeler[4], *[1]Lockheed Martin Coherent Technologies, USA, [2]Tufts Univ., USA, [3]SIBELLOPTICS, USA, [4]GE Global Res., USA*

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About Application of Lasers for Sensing & Free Space Communication (LSC)

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Call for Papers

View the Application of Lasers for Sensing & Free Space Communication (LSC) Call for Papers PDF in December 2010.

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Signal Recovery & Synthesis (SRS)

10-14 July 2011

The Westin Harbour Castle, Toronto, Ontario, Canada

OSA continues the tradition of outstanding conferences and focused meetings with the 2011 Optics and Photonics Congress on Imaging and Applied Optics in beautiful Toronto, Ontario. Like last year's meeting in Tucson, this year's meeting promises to be very exciting. The Congress has co-located eight topical meetings (listed above) in order for attendees to benefit from exposure to a diverse collection of optical technologies. The Program includes scientific leaders from around the globe in each topical area which should facilitate networking and the cross-pollination of ideas between attendees. Please join us on Tuesday evening for the joint Welcome Reception on the 2nd floor of the conference center in the Metro West Ballroom.

The Applied Industrial Optics (AIO) meeting was an unprecedented success last year, and promises to be very exciting this year. The conference begins on the International Space Station thanks to our plenary speaker Atle Honne. The remaining 28 invited speakers, spanning the full three days of the conference cover a wide range of applied optical technologies and a very diverse set of application areas including security, forensics, environmental monitoring, and Smart Grid technology. In addition, our invited speakers and contributors include industrial, governmental, and academic scientist at the forefront of applied optics from around the globe. Join us for an exciting meeting and volunteer to join the team to help make next year's meeting even better.

The Adaptive Optics meeting brings together technologies which have enabled significant performance improvements in different applications of adaptive optics such as astronomy, free space communications, optometry/ophthalmology, microscopy, laser microfabrication, lithography, laser fusion, fiber optics, and x-ray optics. This meeting represents a forum in which many of the latest advances and challenges will be presented by well-known experts in this discipline. The topics to be presented include discussions of various systems that use adaptive optics techniques, control systems, wavefront sensing and correcting, system and component modeling, imaging techniques through distorting or scattering media, and achievable performance improvements.

This meeting will also include two special joint sessions. The first is with the Signal Recovery and Analysis meeting and the second with the Application of Lasers for Sensing & Free Space Communication meeting covering common topics. Invited speakers will present talks on the application of complex Adaptive Optic systems for two very different applications in the fields of ophthalmology and astronomy.

The Computational Optical Sensing and Imaging (COSI) meeting covers subject matter in fundamental physics, numerical methods and physical hardware that has led to significant improvements in the fields of imaging and sensing including applications in medical, defense, homeland security, inspection, testing, etc. Topics in this meeting include wave-front coding, light field sensing, compressive optical sensing, tomographic imaging, structured illumination imaging, digital holography, SAR, lensless imaging, point spread function engineering, digital/optical super-resolution, unusual form-factor cameras, synthetic aperture optical systems, etc. Computational Optical Sensing and Imaging is an important discipline being applied to solve numerous problems in modern optics and the techniques developed in this field have been incorporated in to numerous commercial products.

Benefiting from innovative techniques and mature instrumentation, Fourier-transform spectrometers push forward the limits of sensing in a growing number of fields. Inheriting from its predecessors, the 2011 Fourier Transform Spectroscopy (FTS) meeting welcomes you to inspiring and stimulating conferences. In-depth invited talks and up-to-date contributions will cover the vast FTS field. Attendees will hear about atmospheric science, astronomy, planetary science, and advanced laboratory spectroscopy. The meeting will exhibit expanding applications of imaging, static, and spatial heterodyne spectrometers. Novel developments like polarimetric and comb techniques will also be highlighted.

The Hyperspectral Imaging and Sounding of the Environment (HISE) meeting will cover many important research results in cloud monitoring, surface and atmospheric research, advances in sensors and measurement approaches, atmospheric profiling and gas sensing, radiometric and spectral remote sensing, and new applications arising from merged imager and sounder data. Invited papers delivered by widely recognized experts in this area will present a picture of the state of the art in environmental sensing. Remote sensing data from passive and active measurement technologies provide unprecedented monitoring capabilities and are leading to a more refined understanding of our planet. The uniqueness of the data obtained from these hyperspectral sensors requires new approaches for managing, processing and using the data, including the integration of observations from different sensor constellations to better assess the information that these new measurements provide.

The Imaging Systems (IS) meeting is an "all-encompassing" conference on imaging that covers topics in imaging optics, sensors, computational imaging and 3-D imaging. Invited speakers from the military, academic, and commercial imaging sectors will address the current status and future of imaging in their organizations. The conference includes 16 invited, 17 contributed oral presentations, and 6 poster presentations that describe recent developments in lens design (including aperture masks and wavefront coding), pixel optics, novel imaging sensors (including curved focal plane arrays, superresolution systems, and MEMs deformable mirrors), compressive sensing, image processing, computational photography and human vision.

The Application of Lasers for Sensing & Free Space Communication meeting (LS&C) is designed to report on many of the important advances realized in the last few years to make FSO more robust, increase data rate capabilities, and demonstrate its usefulness in numerous field applications. Adaptive optics (AO) is an important component to addressing the limiting effects encountered when propagating in the atmospheric and in water. To be reported at this meeting will be diversity techniques including MINO as well as AO are used to combat fading channels, coherent communications, hybrid laser/RF technologies, and networking with FSO. The latest research results on information assurance in quantum communications will be discussed along with advances in LADAR system and technology development. Important applications in standoff bio-detection, uses of lasers in Naval environments involving blue-green communications, and lunar laser communications will be described. Also included in the meeting is a joint session with the Adaptive Optics topical meeting on the latest advances in wave front control and turbulence. Laser systems are being used in numerous free space communications and remote sensing applications. Free space optical (FSO) communications has become a viable competitor to RF systems for many special applications; however, there still are several issues that need to be addressed to make FSO more robust relative to propagation impairments

The Signal Recovery & Synthesis (SRS) meeting consists of topics that range from theoretical to experimental, but all with a common theme of signal processing to achieve desired ends. You will hear the latest research results in the areas of ghost imaging, blind deconvolution, optical turbulence characterization, optical signal processing, and more. In addition, the SRS meeting has two joint sessions with the AO meeting, with topics that involve signal processing and adaptive optics. There are 6 invited and 22 contributed presentations as part of this exciting meeting.

AIO
Sean Christian, *Optrology, Inc., USA,* **General Chair**
Jess Ford, *Weatherford Intl., USA,* **General Chair**
Joe Dallas, *Avo Photonics Inc., USA,* **Program Chair**
Bertrand Lanher, *Process Analytical Chemistry Services, USA,* **Program Chair**

AO
Julian Christou, *Gemini Observatory, USA,* **Chair**
Donald T. Miller, *Indiana Univ., USA,* **Chair**

COSI
Michael Gehm, *Univ. of Arizona, USA,* **Chair**
Rafael Piestun, *Univ. of Colorado at Boulder, USA,* **Chair**

FTS
Pierre Tremblay, *Univ. Laval, Canada*, **General Chair**
Felix Friedl-Vallon, *Karlsruhe Inst. of Technology, Germany,* **Program Chair**

HISE
Bryan Baum, *Space Science and Engineering Ctr., Univ. of Wisconsin-Madison, USA,* **General Chair**
Ping Yang, *Texas A&M Univ., USA,* **General Chair**

IS
Gisele Bennett, *Georgia Tech, USA,* **General Chair**
Joyce Farrell, *Stanford Univ., USA,* **General Chair**
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Peter Catrysse, *Stanford Univ., USA,* **Program Chair**
Joseph N. Mait, *ARL, USA,* **Program Chair**

LS&C
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Larry Stotts, *DARPA/STO, USA,* **Co-Chair**
Ed Watson, *US Air Force, USA,* **Co-Chair**

SRS
Charles Matson, *Air Force Res. Lab, USA,* **General Chair**
Chris Dainty, *Natl. Univ. of Ireland Galway, Ireland,* **Program Chair**
Edmund Lam, *Univ. of Hong Kong, Hong Kong,* **Program Chair**

Imaging and Applied Optics Program Committee

Adaptive Optics: Methods, Analysis and Applications (AO)

Chairs

Julian Christou, *Gemini Observatory, USA*

Donald T. Miller, *Indiana Univ., USA*

Committee Members

Matthew Britton, *The Optical Sciences Company (tOSC), USA*

Chris Dainty, *National Univ. of Ireland Galway, Ireland,* **liaison with SRS**

Nathan Doble, *New England College of Optometry, USA*

Brent Ellerbroek, *Thirty Meter Telescope Project, USA*

Simone Esposito, *INAF - Osservatorio Astrofisico di Arcetri, Italy*

Robert Johnson, *AFRL, USA*

Caroline Kulcsar, *Univ. Paris 13, France*

Gordon Love, *Univ. of Durham, UK*

Lisa Poyneer, *LLNL, USA*

Sergio Restaino, *NRL, USA*

Erez Ribak, *Technion Israel Inst. of Technology, Israel*

Michael Vorontsov, *Univ. of Maryland, USA*

Tony Wilson, *Univ. of Oxford, UK*

Application of Lasers for Sensing & Free Space Communication (LS&C)

General Chairs

Paul McManamon, *Exciting Technology, LLC, USA,* **Chair**

Larry Stotts, *DARPA/STO, USA,* **Co-Chair**

Ed Watson, *US Air Force, USA,* **Co-Chair**

Committee Members

Larry Andrews, *CREOL, Univ. of Central Florida, USA*

Tim Carrig, *Lockheed Martin Coherent Technologies, USA*

Rick Heinrich, *MIT Lincoln Lab, USA*

Sammy Henderson, *Lockheed Martin Coherent Technologies, USA*

David Hughes, *Air Force Research Lab*

Juan Juarez, *Johns Hopkins APL, USA*

Mike Lovern, *SPAWAR, USA*

Brian Miles, *FastMetrix, Inc., USA*

Malcom Northcott, *Aoptix Technologies, Inc., USA*

Ron Phillips, *Univ. of Central Florida, USA*

Pete Poirier, *SPAWAR, USA*

Troy Rhoadarmer, *SAIC, USA*

Jason Schmidt, *Air Force Inst. of Technology, USA*

Brian Stadler, *US Air Force Res. Lab, USA*

Linda Thomas, *Office of Naval Res., USA*

Bob Tyson, *Univ. of North Carolina at Charlotte, USA*

Applied Industrial Optics: Spectroscopy, Imaging, & Metrology (AIO)

General Chairs

Sean Christian, *Optrology, Inc., USA*

Jess Ford, *Weatherford Intl., USA*

Program Chairs

Joe Dallas, *Avo Photonics Inc., USA*

Bertrand Lanher, *Process Analytical Chemistry Services, USA*

Committee Members

Haji-saeed Bahareh, *Air Force Res. Lab, USA,* **Young Professional**

Steve Buckley, *Photon Machines, Inc., USA*

Chun-Hung (Frank) Kuo, *Newport Corp., USA,* **Young Professional**

Bin (Bill) Li, *Coherix, Inc., USA,* **Young Professional**

Fred Long, *Spectroscopic Solutions, USA*

Marion O'Farrell, *SINTEF ICT, Norway*

Prasanna Pavani, *Ricoh Innovations, USA,* **Young Professional**

Dominick Polizzi, *Optics Technology Inc., USA*

Milan Poudel, *US Southwestern Medical School, USA,* **Young Professional**

Arel Weisberg, *Energy Research Co., USA*

Computational Optical Sensing and Imaging (COSI)

Program Chairs

Michael Gehm, *Univ. of Arizona, USA*

Rafael Piestun, *Univ. of Colorado at Boulder, USA*

Committee Members

Saeed Bagheri, *IBM TJ Watson Res. Ctr., USA*

George Barbastathis, *MIT, USA*

Scott A Basinger, *JPL, USA*

David Brady, *Duke Univ., USA*

Chris Dainty, *Natl. Univ. of Ireland, Ireland*

Aristide Dogariu, *Univ. of Central Florida, CREOL, USA*

Fredo Durand, *MIT, USA*

Michael Fiddy, *Univ. of North Carolina at Charlotte, USA*

Jason W. Fleischer, *Princeton Univ., USA*

François Goudail, *Inst. d'Optique, France*

Gerd Haeusler, *Univ. of Erlangen-Nuremberg, Germany*

Kenny Kubala, *FiveFocal, USA*

Kyros Kutulakos, *Univ. of Toronto, Canada*

Abhijit Mahalanobis, *Lockheed Martin Corp., USA*

Joseph Mait, *US ARL, USA*

Wolfgang Osten, *Inst. für Technische Optik, Univ. Stuttgart, Germany*

Joseph O'Sullivan, *Washington Univ. in St Louis, USA*

Chrysanthe Preza, *Univ. of Memphis, USA*
Demetri Psaltis, *EPFL, Switzerland*
Ramesh Raskar, *MIT, USA*
Joseph Rosen, *Ben Gurion Univ., of the Negev, Israel*
Michael Stenner, *MITRE Corp., USA*
JunTanida, *Osaka Univ., Japan*
PeterTörök, *Imperial College London, UK*

Fourier Transform Spectroscopy (FTS)

General Chair

Pierre Tremblay, *Univ. Laval, Canada*

Program Chair

Felix Friedl-Vallon, *Karlsruhe Inst. of Technology, Germany*

Committee Members

Peter F. Bernath, *Univ. of York, UK*
Jérôme Genest, *Univ. Laval, Canada*
John Harlander, *St. Cloud State Univ., USA*
Donald E. Jennings, *NASA/Goddard Space Flight Ctr., USA*
Akihiko Kuze, *Japan Aerospace Exploration Agency, Japan*
Jean-Pierre Maillard, *Inst. d'Astrophysique de Paris, France*
Johannes Orphal, *Karlsruhe Inst.of Technology, Germany*
Luca Palchetti, *Istituto di Fisica Applicata "Nello Carrara" IFAC-CNR, Italy*
Juliette Pickering, *Imperial College London, UK*
Nathalie Picqué, *Max-Planck-Inst. fuer Quantenoptik, Germany*
Joe Taylor, *Space Science and Engineering Ctr., Univ. of Wisconsin-Madison, USA*
Geoffrey C. Toon, *Jet Propulsion Lab, USA*

Hyperspectral Imaging and Sounding of the Environment (HISE)

General Chairs

Bryan Baum, *Space Science and Engineering Ctr., Univ. of Wisconsin-Madison, USA*
Ping Yang, *Texas A&M Univ., USA*

Committee Members

Chris Barnet, *NOAA, USA*
Caroline Cox, *Rutherford Appleton Lab, UK*
John Dykema, *Harvard Univ., USA*
Joanna Joiner, *NASA Goddard Space Flight Ctr., USA*
Margaret Kalacska, *McGill Univ., Canada*
Jhoon Kim, *Yonsei Univ., Republic of Korea*
Allen M. Larar, *NASA Langley Res. Ctr., USA*
Betsy Middleton, *NASA Goddard Space Flight Ctr., USA*
Marty Mlynczak, *NASA Langley Res. Ctr., USA*
Shaima Nasiri, *Texas A&M Univ., USA*
Peter Pilewskie, *Lab for Atmospheric and Space Physics (LASP), Univ. of Colorado-Boulder, USA*
Heli Wei, *Lab of Atmospheric Composition and Optical Radiation, Chinese Acad. of Sciences, China*
Elisabeth Weisz, *Space Science and Engineering Ctr., Univ. of Wisconsin-Madison, USA*

Imaging Systems and Applications (IS)

General Chairs

Gisele Bennett, *Georgia Tech, USA*
Joyce Farrell, *Stanford Univ., USA*
Boyd Fowler, *Fairchild Imaging, USA*

Program Chairs

Peter Catrysse, *Stanford Univ., USA*
Joseph N. Mait, *ARL, USA*

Committee Members

Ken Barnard, *AFRL, USA*
Glenn Boreman, *Univ. of Central Florida, USA*
David Brady, *Duke Univ., USA*
Ed Dowski, *Ascent Imaging, USA*
Ronald Driggers, *NRL, USA*
Michael Eismann, *AFRL, USA*
Michael Fiddy, *Univ. of North Carolina at Charlotte, USA*
Jim Fienup, *Univ. of Rochester, USA*
Patti Gillespie, *ARL, USA*
Francisco Imai, *Canon USA, Inc., USA*
Eddie Jacobs, *Univ. of Memphis, USA*
Keith Krapels, *Army Night Vision Lab, USA*
Michael Kriss, *MAK Consultants, USA*
Matt Kupinski, *Univ. of Arizona, USA*
Dale Linne von Berg, *NRL, USA*
Pierre Magnan, *Supérieur de l'Aéronautique et de l'Espace, France*
Ricardo Motta, *Attom Res., USA*
David Pope, *Aptina, USA*
Dennis Prather, *Univ. of Delaware, USA*
Jennifer Ricklin, *Lockheed Martin, USA*
John Sheridan, *Univ. College Dublin, Ireland*

Signal Recovery & Synthesis (SRS)

General Chair

Charles Matson, *Air Force Res. Lab, USA*

Program Chairs

Chris Dainty, *Natl. Univ. of Ireland Galway, Ireland*
Edmund Lam, *Univ. of Hong Kong, Hong Kong*

Program Committee

Philip Bones, *Univ. of Canterbury, New Zealand*
Jun Cheng, *Shenzhen Inst. of Advanced Technology, Chinese Acad. of Sciences, China*
Christy Fernandez Cull, *MIT Lincoln Lab, USA*
David Gerwe, *Boeing Corp., USA*
Andrew Lambert, *Australian Defense Force Acad., Univ. of New South Wales, Australia*
Vincent Michau, *ONERA, France*
Rick Millane, *Univ. of Canterbury, New Zealand*
Jannick Rolland, *Inst. of Optics, Univ. of Rochester, USA*
Markus Testorf, *Dartmouth College, USA*
Peter Tsang, *City Univ. of Hong Kong, Hong Kong*

Special Events

AIO Plenary Session
Monday, 11 July, 08:00-10:00
Pier 3

Atle Honne
Senior Research Scientist, SINTEF, Oslo, Norway

Atle Honne is the project manager for ANITA at SINTEF, the largest independent research organization in Scandinavia. His responsibilities include calibration, measurement, testing and data evaluation for ANITA with special interests in FTIR-based multi-gas analyses, optical measurements, and measurement technology in general. He holds a Master of Science in Applied Physics, and has recently been awarded the 2009 Wright Brothers Award for one of his background research papers on this subject.

Joint Conference Reception
Tuesday, 11 July, 19:00-20:30
Metro West Ballroom, 2nd Floor Conference Room

The reception will feature light fare and is open to all registrants

Poster Presentations

Poster presentations offer an effective way to communicate new research findings and provide an opportunity for lively and detailed discussion between presenters and interested viewers.

Joint IS/AIO/LS&C Poster Session
Tuesday, 12 July, 10:30-12:30
Salon B

Joint FTS/HISE/AO/COSI Poster Session
Wednesday, 13 July, 10:30-12:30
Salon B

Postdeadline Paper Presentations

The program committees of AO/COSI/FTS/HISE accepted postdeadline papers for presentation. The purpose of postdeadline sessions is to give participants the opportunity to hear new and significant materials in rapidly advancing areas. Only those papers judged to be truly excellent and compelling in their timelines were accepted.

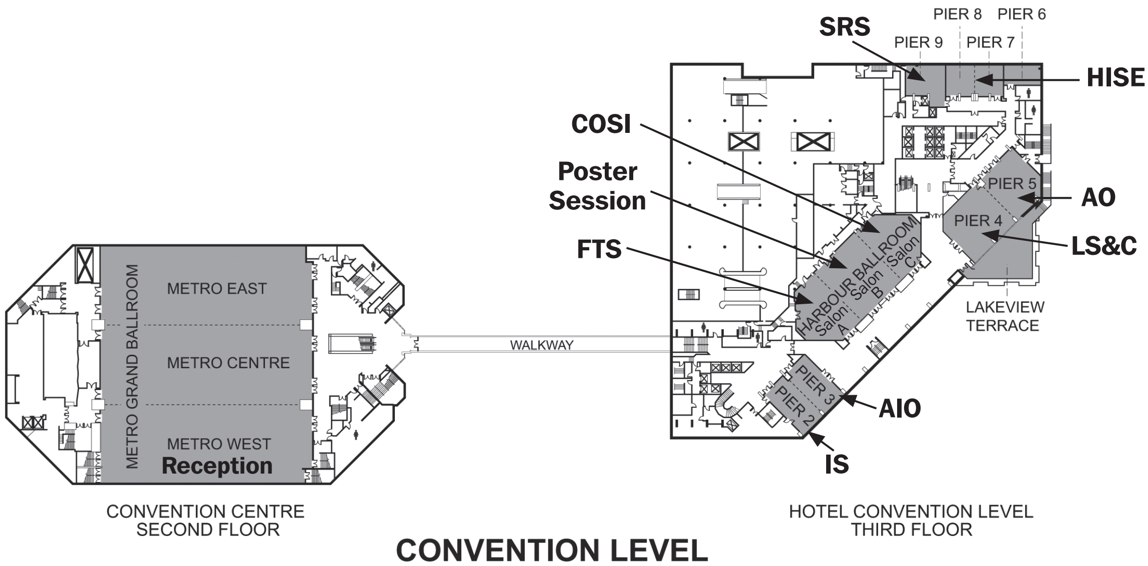
For more information, including the schedule and locations see the Postdeadline papers appended to the back of this program book.

AO Postdeadline Paper Session
Tuesday, 12 July 16:30-18:30
Pier 5

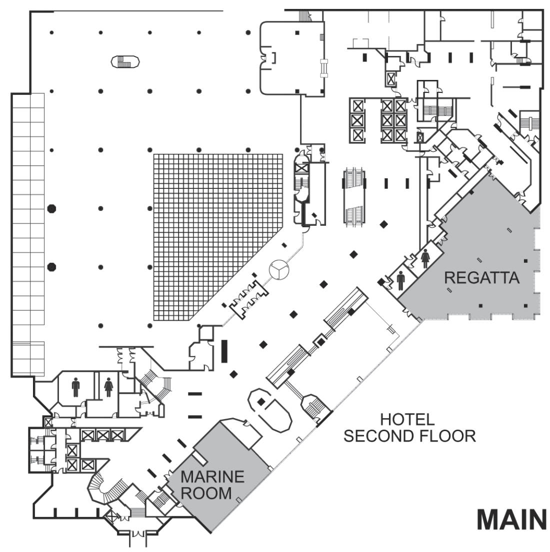
COSI Postdeadline Paper Session
Wednesday, 13 July 10:30-12:30
Salon C

Joint FTS/HISE Postdeadline Paper Session
Wednesday, 13 July 16:30-18:30
Pier 7/8

The Westin Harbour Castle, Toronto



CONVENTION LEVEL



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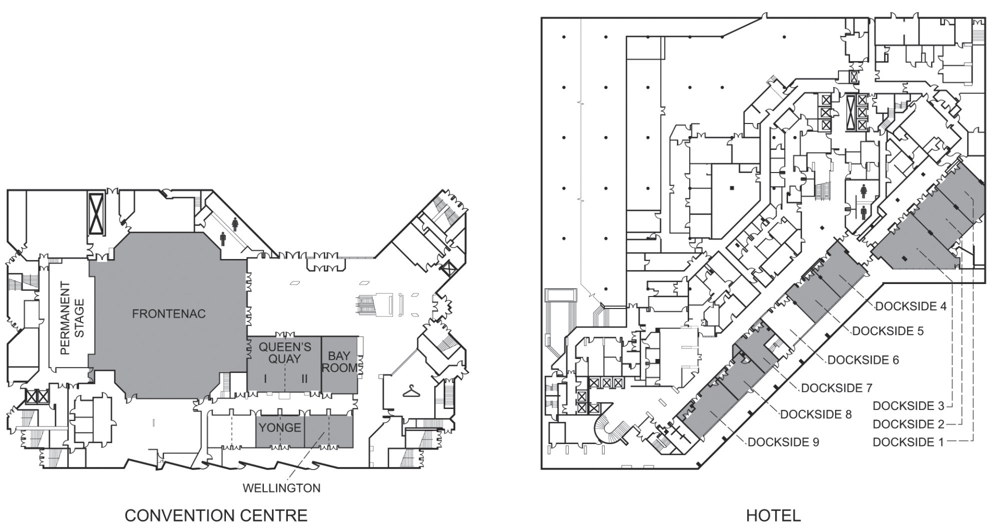

LOWER LEVEL

Agenda of Sessions — Sunday, 10 July

15:00–18:00	**Registration Open,** *Ballroom Foyer, Convention Level*

— Monday, 11 July

	Pier 4	Pier 2	Pier 3	Pier 9	Salon A	Pier 7/8	Pier 5	Salon C
	LS&C	IS	AIO	SRS	FTS	HISE	AO	COSI
07:00–18:00	**Registration Open,** *Ballroom Foyer, Convention Level*							
07:45–08:00	**Opening Remarks**							
08:00–10:00	**Opening Remarks** (8:20) **LMA • Hybrid Laser/RF Communications**	**IMA • Image Sensors** (Ends at 09:40)	**AIMA • Space Applications** (Ends at 09:40)	**SMA • Optical System Design, Analysis & Optimization**	**JMA • Joint FTS/HISE Session,** *Salon A*		**AMA • Systems I**	**CMA • Seeing the Future: A Symposium in Memory of Dennis Healy I**
10:00–10:30	**Coffee Break/ Exhibits Open,** *Ballroom Foyer, Convention Level*							
10:30–12:30	**LMB • Adaptive Optics I** (Ends at 12:10)	**IMB • Emerging Technologies for Imaging Systems**	**AIMB • Fiber Optic Sensors** (Ends at 13:10)	**SMB • Ghost Imaging, Superresolution & Blind Deconvolution**	**FMA • Atmospheric Science from Space I** (Ends at 12:10)	**HMA • Upcoming Missions**	**AMB • Control Systems**	**CMB • Seeing the Future: A Symposium in Memory of Dennis Healy II** (Begins at 11:10)
12:30–14:00	**Lunch** *(On Your Own)*							
14:00–16:00	**LMC • Adaptive Optics II**	**IMC • Image Processing**	**AIMC • Industrial Monitoring** (Ends at 15:20)	**SMC • Information Theory & Processing Time Considerations**	**FMB • Atmospheric Science from Space II**	**HMB • Advances in Sensors and Measurements**	**AMC • Wavefront Control**	**CMC • Phase-based Techniques**
16:00–16:30	**Coffee Break/ Exhibits Open,** *Ballroom Foyer, Convention Level*							
16:30–18:30	*See Joint AO/ LS&C session in Pier 5*	**IMD • Human Vision and Imaging Systems**	**AIMD • Healthcare and Pharma**	**SMD • Optical Processing & Algorithms** *(Ends at 17:50)*	**FMC • Atmospheric Science with Ground Based Instrumentation**	**HMC • Radiative Transfer**	**JMB • Joint AO/LS&C Session: Waterfront Control Turbulence** (Begins at 17:10)	**CMD • Computational Spectroscopy and Spectral Imaging** (Ends at 18:10)

Key to Conference Abbreviations

AIO	Applied Industrial Optics: Spectroscopy, Imaging, & Metrology
AO	Adaptive Optics: Methods, Analysis and Applications
COSI	Computational Optical Sensing and Imaging
FTS	Fourier Transform Spectroscopy
IS	Imaging Systems and Applications
HISE	Hyperspectral Imaging and Sounding of the Environment
LS&C	Application of Lasers for Sensing & Free Space Communication
SRS	Signal Recovery & Synthesis

Agenda of Sessions — Tuesday, 12 July

	Pier 4	Pier 2	Pier 3	Salon A	Pier 7/8	Pier 5	Salon C
	LS&C	IS	AIO	FTS	HISE	AO/SRS	COSI
07:00–18:00	**Registration Open,** *Ballroom Foyer, Convention Level*						
08:00–10:00	**LTuA • Information Assurance in Quantum Communications I**	**ITuA • Coded Optical Imaging**	**AITuA • LIBS** (08:40–9:20)	**FTuA • Astronomy and Planetary Science**	**HTuA • Merged Imager and Sounder**	**JTuA • Joint AO/SRS Session I: Atmospheric Turbulence; Adaptive Optics Systems; Image Analysis**	**CTuA • Imaging with Scattering and Aberrations** (Begins at 08:20)
10:00–10:30	**Coffee Break/ Exhibits Open,** *Ballroom Foyer, Convention Level*						
10:30–12:30	**LTuB • Network Technologies** (Ends at 12:10)	**JTuB • Joint IS/AIO/LS&C Poster Session,** *Salon B*		**FTuB • IFTS in Astronomy** (Ends at 12:10)	**HTuB • MODIS**	**ATuA • Wavefront Sensing** (Begins at 10:50)	**CTuB • PSF Engineering and Pupil Encoding**
12:30–14:00	**Lunch** *(On Your Own)*						
14:00–16:00	**LTuC • Information Assurance in Quantum Communications II** (Ends at 16:20)	*See Joint COSI/IS session in Salon C*	**AITuB • Optical Metrology**	**FTuC • IFTS in Atmospheric Research and Air Quality Control**	**HTuC • Surface and Atmosphere**	**JTuC • Joint AO/SRS Session II: Wavefront Estimation and Image Analysis**	**JTuD • Joint COSI/IS Session I: Computational Photography**
16:00–16:30	**Coffee Break/ Exhibits Open,** *Ballroom Foyer, Convention Level*						
16:30–18:30	**LTuD • Laser Propagation**	*See Joint COSI/IS session in Salon C*	**AITuC • Semiconductor Applications**	**FTuD • IFTS for Other Applications**	**HTuD • Atmospheric Profiles and Trace Gases** (Ends at 18:10)	**AO Post deadline Session**	**JTuE • Joint COSI/IS Session II: Wide Field of View and Large Format Imaging**
18:30–19:00	**30 Minute Break**						
19:00–20:30	**Welcome Reception,** *Metro West Ballroom, Conference Center, 2nd floor*						

Key to Conference Abbreviations

AIO Applied Industrial Optics: Spectroscopy, Imaging, & Metrology
AO Adaptive Optics: Methods, Analysis and Applications
COSI Computational Optical Sensing and Imaging
FTS Fourier Transform Spectroscopy
IS Imaging Systems and Applications
HISE Hyperspectral Imaging and Sounding of the Environment
LS&C Application of Lasers for Sensing & Free Space Communication
SRS Signal Recovery & Synthesis

Agenda of Sessions — Wednesday, 13 July

	Pier 4	Pier 2	Pier 3	Salon A	Pier 7/8	Pier 5	Salon C
	LS&C	IS	AIO	FTS	HISE	AO	COSI
07:30–18:00	**Registration Open,** *Ballroom Foyer, Convention Level*						
08:00–10:00	**LWA • Naval Applications I**	**IWA • Military Applications I**	**AIWA • Spectroscopy**	**FWA • Static Spectrometers and New Developments I**	**HWA • Clouds**	**AWA • Systems II** (Ends at 9:40)	**CWA • Superresolution**
10:00–10:30	**Coffee Break/ Exhibits Open, Ballroom Foyer, Convention Level**						
10:30–12:30	**LWB • Naval Applications II**	**IWB • Military Applications II**	**AIWB • Laser Applications**	**JWA • Joint FTS/HISE/AO/COSI Poster Session,** *Salon B*			**COSI Postdeadline Session**
12:00–14:00	**Lunch** *(On Your Own)*						
14:00–16:00	**LWC • Laser Communication/ Atmosphere I** (Ends at 15:40)	**JWB • Joint AIO/IS Session I: Biophotonics,** *Pier 2* (Ends at 15:40)		**FWB • Static Spectrometers and New Developments II**	**HWB • Spectral Analyses**		**CWB • Computational Holography**
16:00–16:30	**Coffee Break/Exhibits Open,** *Ballroom Foyer, Convention Level*						
16:30–18:30	**LWD • Laser Communication/ Atmosphere II**	**JWC • Joint AIO/IS Session II: 3D Imaging,** *Pier 2*		**Joint FTS/HISE Postdeadline Session,** *Salon A*			**CWC • Other Sensing Modalities** (Ends at 18:10)

— Thursday, 14 July

	Pier 4	Salon A
	LS&C	FTS
07:30–12:00	**Registration Open,** *Ballroom Foyer, Convention Level*	
08:00–10:00	**LThA • Ladar I**	**FThA • Laboratory Spectroscopy** (Begins at 08:20)
10:00–10:30	**Coffee Break/ Exhibits Open,** *Ballroom Foyer, Convention Level*	
10:30–12:30	**LThB • Ladar II** (Ends at 12:15)	**FThB • Comb Techniques**

Key to Conference Abbreviations

AIO	Applied Industrial Optics: Spectroscopy, Imaging, & Metrology
AO	Adaptive Optics: Methods, Analysis and Applications
COSI	Computational Optical Sensing and Imaging
FTS	Fourier Transform Spectroscopy
IS	Imaging Systems and Applications
HISE	Hyperspectral Imaging and Sounding of the Environment
LS&C	Application of Lasers for Sensing & Free Space Communication
SRS	Signal Recovery & Synthesis

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

Pier 4

Application of Lasers for Sensing & Free Space Communication

08:20–08:40
Opening Remarks

08:40–10:00
LMA • Hybrid Laser/ RF Communications
Juan Juarez; John Hopkins University, United States, Presider

LMA1 • 08:40 Invited
Optical Modem Technologies for Long Range Terrestrial FSO Communications, *David W. Young[1]; [1]Applied Physics Laboratory, John Hopkins University, USA.* The optical modem, which provides the interface between the end-user equipment and the free space optical communication (FSOC) optical terminal, is a critical part of the overall FSOC system design FSOC links commonly suffer from frequent deep fade events, which can lead to errors in, or complete loss of data being transmitted over the link. This paper will discuss developments in optical modem technology that take a layered approach to eliminating data loss even in a fading link. These methods have been recently demonstrated during both ground and flight tests of extended range (>100 km) FSOC communications systems in operationally relevant environments. This paper will describe optical modem designs for FSOC terminals that couple light into either single-mode or multi-mode optical fibers, discuss their field performance, and discuss the impact of FSOC terminal type selection on overall system performance, especially as it is linked to optical modem design.

LMA2 • 09:20
Hybrid Rateless Coding Scheme in Free-Space Optical Communications, *Anhong Dang[1], Ling Liu[2], Hong Guo[3]; [1]Peking University, China; [2]Peking University, China; [3]Peking University, China.* In this paper, a free space optical (FSO) communication scheme approaching the channel capacity is proposed. Numerical simulation results show that channel capacity can be automatically traced under a wide range of fluctuation in channel condition.

LMA3 • 09:40
Optical Automatic Gain Controller for High-Bandwidth Free-Space Optical Communication Links, *Juan C. Juarez[1], Joseph E. Sluz[1], David W. Young[1]; [1]Johns Hopkins University Applied Physics Laboratory, USA.* We developed an optical automatic gain controller for free-space optical communications with a noise figure of 4.1 dB to maximize link margin and a dynamic range of >60 dB to overcome link dynamics.

Pier 2

Imaging Systems and Applications

07:45–08:00
Opening Remarks

08:00–09:40
IMA • Image Sensors
Boyd Fowler; Fairchild Imaging, United States, Presider

IMA1 • 08:00 Invited
Toward Photon Counting Image Sensors, *Nobukazu Teranishi[1]; [1]Image Sensor BU, Panasonic Corporation, Japan.* Photon counting by "normal" image sensors, which do not use avalanche multiplication, are discussed. If QE is >0.95 and source follower noise is <0.3 electrons, photon counting is possible in case of photon number <3.

IMA2 • 08:40
A Disdrometer Based On Ultra-Fast SPAD Cameras, *Alain Berthoud[1], Samuel Burri[1], Claudio Bruschini[1], Alexis Berne[2], Edoardo Charbon[1,3]; [1]SCI-STI-EC, Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland; [2]ENAC IIE LTE, Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland; [3]EEMCS, Delft University of Technology, Netherlands.* We present a new environmental application of SPAD imagers, the continuous measurement of size and shapes of hydrometeors. A first 32×32 pixel prototype allows real-time operation at very low light levels, 6000 fps and 1:100 average data reduction.

IMA3 • 09:00
Radiation Damages in CMOS Active Pixel Sensors, *Vincent Goiffon[1], Pierre Magnan[1]; [1]ISAE, France.* This paper presents a summary of the main results we observed on irradiated imagers manufactured using a0.18µm CMOS processes dedicated to imaging. Several types of energetic particles have been used to irradiate the devices.

IMA4 • 09:20
Position Noise in Images, *Maurus Tacke[1]; [1]Fraunhofer IOSB, Germany.* Relative position of imaging sensors is due to movements of sensor and object. Discrete sampling usually underestimates maximum intensity. Such variations of intensity data are treated as a specific noise type: position noise.

Pier 3

Applied Industrial Optics: Spectroscopy, Imaging, & Metrology

07:45–08:00
Opening Remarks

08:00–9:40
AIMA • Space Applications
Jess Ford; Weatherford Intl., United States, Presider

AIMA1 • 08:00 Plenary
ANITA - an FTIR-based Continuous Air Quality Monitoring System on the ISS (International Space Station), *Atle Honne[1], Henrik Schumann-Olsen[1], Kristin Kaspersen[1], Herbert Mosebach[2], Dirk Kampf[2]; [1]SINTEF, Norway; [2]Kayser-Threde GmbH, Germany.* ANITA applies a modified commercial FTIR instrument and novel analysis SW that solves most challenges of multi-gas measurement. Its fast and fully automatic analyses make it suitable for air quality monitoring and other multi-component measurements.

AIMA2 • 09:00 Invited
Space-based Lasers for Remote Sensing Applications, *Anthony Yu[1]; [1]NASA Goddard Space Flight Center, USA.* There are currently three operational lidar systems orbiting the Earth, the Moon and the planet Mercury gathering scientific data and images to form a better understanding of our Earth and solar system. In this paper we will present an overview of the spaceborne laser programs and offer insights into future spaceborne lasers for remote sensing applications.

Pier 9

Signal Recovery & Synthesis

07:45–08:00
Opening Remarks

08:00–10:00
SMA • Optical System Design, Analysis & Optimization
Charles Matson; Air Force Res. Lab, United States, Presider

SMA1 • 08:00 Invited
Inverse Optical Design and Its Applications, *Julia A. Sakamoto[1], Harrison Barrett[1]; [1]College of Optical Sciences, Univ. Arizona, USA; [2]Department of Radiology, Univ. Arizona, USA; [3]Center for Gamma-Ray Imaging, Univ. Arizona, USA.* We discuss the utility of likelihood methods in estimating optical prescription parameters for a broad range of applications. Rapid ray-tracing and a simulated annealing algorithm are employed in a proof-of-principle study.

SMA2 • 08:40
A Probe Beam Which Encodes Aberrations, *Andrew J. Lambert[1], Elizabeth Daly[2], Chris Dainty[2]; [1]School of Engineering and IT, UNSW@ADFA, Australia; [2]Applied Optics, National University of Ireland, Galway, Ireland.* A Bessel probe beam provides the potential for extraction of strengths of aberrations experienced by the beam as it traverses the optical system. The single pass PSF is observed as a distorted annulus when imaged.

SMA3 • 09:00
Coded Aperture Spectroscopy with Regularization via Convex Optimization, *Alex Mrozack[1], Daniel L. Marks[1], David J. Brady[1]; [1]ECE, Duke University, USA.* Three coded aperture spectrometers are compared for performance. The classic understanding of performance under poisson noise is shown to be incomplete through simulation. The slit spectrometer code is not the optimal code for compressible signals.

SMA4 • 09:20
Bounds on Condition Numbers of Spatially Variant Convolution Matrices, *Stanley Chan[1], Ankit Jain[1], Truong Nguyen[1], Edmund Y. Lam[2]; [1]ECE, UC San Diego, USA; [2]EEE, University of Hong Kong, Hong Kong.* In this paper, we study the condition numbers of spatially variant convolution matrices in a least-squares minimization problem. The bound we derive is informative, and can be computed easily in practice.

SMA5 • 09:40
Ambiguity Function And Phase Space Tomography For Nonparaxial Partially Coherent Optical Fields, *Seongkeun Cho[1], Miguel Alonso[2]; [1]Physics and Astronomy, University of Rochester, USA; [2]Institute of Optics, University of Rochester, USA.* A nonparaxial ambiguity function that resembles its paraxial counterpart is presented, both in two and three dimensions, and is used for the recovery of the coherence properties of scalar partially coherent fields in two-dimensional space.

10:00–10:30 Coffee Break/ Exhibits Open,
Ballroom Foyer, Convention Level

Salon A

Joint FTS / HISE

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

07:45–08:00
Opening Remarks

08:00–10:00
JMA • Joint FTS/ HISE Session
Pierre Tremblay; University Laval, Canada; Peter Pilewskie; University of Colorado, Boulder, United States, Presiders

JMA1 • 08:00 Invited
Testing Space-based Infrared Sensors for Systematic Errors, *John Dykema[1], Mark Witinski[1], James Anderson[1]; [1]School of Engineering and Applied Sciences, Harvard University, USA.* Recent developments in compact, monochromatic, high-power infrared light sources allow the implementation of analogs of laboratory measurement tests on-orbit for infrared sensors. This paper presents experimental results to demonstrate this concept.

JMA2 • 08:40 Invited
Meteosat Third Generation: The Infrared Sounder Instrument, *Daniel Lamarre[1], Donny Aminou[1], Peter van den Braembussche[1], Pascal Hallibert[1], Berit Ahlers[1], Mark Wilson[1], Hans-Juergen Luhmann[1]; [1]Earth Observation, European Space Agency, Netherlands.* ESA & Eumetsat have given the go-ahead for the Meteosat Third Generation programme. A design overview and the development status of the InfraRed Sounder, an imaging Fourier Transform spectrometer aboard MTG-S, will be presented.

JMA3 • 09:20
Lessons Learned from GOSAT and Improvements for the Next Mission, *Akihiko Kuze[1], Hiroshi Suto[1], Kei Shiomi[1], Masakatsu Nakajima[1]; [1]JAXA, Japan.* TANSO-FTS onboard GOSAT has observed CO2 and CH4 globally from space. From two years operation, we have learned much and will discuss items to improve performance, function, and robustness for the next mission.

JMA4 • 09:40
AIRS and MODIS Synergy and the Next Generation of Imaging Sounders, *Thomas Pagano[1]; [1]NASA/JPL, CalTech, USA.* Similar measurements made by AIRS and MODIS including temperature, water vapor, cloud and surface properties, and their impact to science and weather are discussed. We show their individual limitations and value of a combined imaging sounder.

Pier 5

Adaptive Optics: Methods, Analysis and Applications

07:45–08:00
Opening Remarks

08:00–10:00
AMA • Systems I
Brent Ellerbroek; TMT Observatory Corporation, United States, Presider

AMA1 • 08:00 Invited
AO System Considerations for Retinal Imaging, *Stephen Burns[1], Weiyao Zou[1], Zhangyi Zhong[1], Gang Huang[1], Xiaofeng Qi[1]; [1]Indiana University School of Optometry, USA.* Modern adaptive optics systems for retinal imaging represent a blend between optical design and software control. The problems faced for real-world clinical imaging include the need to obtain high quality data rapidly in less than ideal conditions, including variable size and shape moving pupils, the need to control low order aberrations of 10's of microns while also correcting high order aberrations to RMS values on the order of 20-40 ums.

AMA2 • 08:40
Adaptive Optics at the LBT Telescope: from NGS to LGS and Interferometry, *Simone Esposito[1], Phil Hinz[4], Tom Herbst[3], Sebastian Rabien[2]; [1]Adaptive Optics, Osservatorio di Arcetri, Italy; [2]MPE, Germany; [3]MPIA, Germany; [4]Steward Observatory, USA.* The paper reports the status and future development of Adaptive Optics at LBT. On sky results of NGS system are given together with a summary of LGS and interferometric AO systems present and future implementation.

AMA3 • 09:00
CANARY MOAO Demonstrator : On-Sky First Results, *Matthieu Brangier[1], Fabrice Vidal[1], Tim Morris[3], Eric Gendron[1], Zoltan Hubert[1], Alastair Basden[3], Gérard Rousset[1], Richard Myers[3], Fanny Chemla[2], Andy Longmore[4], Tim Butterly[3], Nigel Dipper[3], Colin Dunlop[4], Gilles Fasola[1], Deli Geng[3], Damien Gratadour[1], David Henry[3], Jean-michel Huet[1], Philippe Laporte[2], Nik Looker[3], Michel Marteaud[1], Denis Perret[1], Arnaud Sevin[1], Harry Shepherd[4], Gordon Talbot[3], Eddy Younger[3], Richard W. Wilson[4]; [1]LESIA, Observatoire de Meudon, France; [2]GEPI, Observatoire de Meudon, France; [3]Centre for Advanced Instrumentation, Durham University, United Kingdom; [4]UKATC, Royal Observatory Edinburgh, United Kingdom.* We present the first on-sky results of CANARY, the multi-object adaptive optics demonstrator of EAGLE.

AMA4 • 09:20
Performance of an Off-Axis Ophthalmic Adaptive Optics System with Toroidal Mirrors, *Zhuolin Liu[1], Omer P. Kocaoglu[1], Ravi S. Jonnal[1], Qiang Wang[1], Donald T. Miller[1]; [1]School of Optometry, Indiana University, USA.* Ophthalmic adaptive optics is commonly implemented with off-axis telescopes formed by spherical mirrors. As these systems often suffer from astigmatism, beam displacement and beam distortion, we investigate toroidal mirrors as a possible solution.

AMA5 • 09:40
Expected Performance Of Solar Adaptive Optics In Large Aperture Telescopes, *Jose Marino[1], Thomas Rimmele[1]; [1]National Solar Observatory, USA.* We study the performance of solar adaptive optics (AO) in large aperture telescopes and find that the extended field-of-view of the wavefront sensor and large zenith angle operations can compromise the quality of the AO correction.

Salon C

Computational Optical Sensing and Imaging

07:45–08:00
Opening Remarks

08:00–10:00
CMA • Seeing the Future: A Symposium in Memory of Dennis Healy I
Rafael Piestun; University of Colorado, United States, Presider

CMA1 • 08:00 Invited
Imaging Sensors that Asks 20 Questions: Fulfilling Dr. Healy's Vision, *Ravi Athale[1]; [1]MITRE, USA.* Dennis painted a vision in launching his Integrated Sensing Processing program more than 12 years ago. In this talk I will elaborate on how it will look in the context of imaging systems.

CMA2 • 08:40
Field-Portable Lensless Holographic Microscope using Pixel Super-Resolution, *Waheb Bishara[1], Uzair Sikora[1], Onur Mudanyali[1], Ting-Wei Su[1], Oguzhan Yaglidere[1], Shirley Luckhart[2], Aydogan Ozcan[1,3]; [1]Electrical Engineering Department, University of California, Los Angeles, USA; [2]Department of Medical Microbiology and Immunology, University of California, Davis, USA; [3]California NanoSystems Institute, University of California, Los Angeles, USA.* We report a portable lensless holographic microscope utilizing pixel super-resolution to achieve <1um resolution and 24mm2 field-of-view. The performance of this light-weight (95g) microscope is validated by imaging malaria parasites in blood-smears.

CMA3 • 09:00
Adaptive Compressive Imaging via Sequential Parameter Estimation, *Amit Ashok[1], Mark Neifeld[1,2]; [1]Electrical and Computer Engineering, University of Arizona, USA; [2]College of Optical Sciences, University of Arizona, USA.* We describe a compressive imager that adapts the measurement basis based on past measurements within a sequential Bayesian estimation framework. Simulations show a 7% improvement in reconstruction performance compared to a static measurement basis.

CMA4 • 09:20 Invited
Dennis Healy, ISP, Montage and MOSAIC, *David J. Brady[1]; [1]Duke Imaging and Spectroscopy Program, Duke University, USA.* Dennis Healy's unique grasp of the mathematical and physical structure of data and his equally unique tolerance for implausible ideas revolutionized the theory of image acquisition.

10:00–10:30 Coffee Break/ Exhibits Open, *Ballroom Foyer, Convention Level*

Pier 4	Pier 2	Pier 3	Pier 9
Application of Lasers for Sensing & Free Space Communication	Imaging Systems and Applications	Applied Industrial Optics: Spectroscopy, Imaging, & Metrology	Signal Recovery & Synthesis

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

10:30–12:10
LMB • Adaptive Optics I
Malcolm Northcott; Aoptix Technologies, Inc., United States; Troy Rhoadarmer; Science Applications International Corporation, United States, Presiders

LMB1 • 10:30 Invited
Self-Referencing Interferometer Adaptive Optics for Improving Free Space Laser Communications, *Troy A. Rhoadarmer[1]; [1]Lasers & Imaging Technology Laboratory, Science Applications International Corporation, USA*. Self-referencing interferometer adaptive optics (SRI AO) provides innovative technologies for improving performance of free space laser communications. We provide an overview of the next generation SRI AO system and results from system testing.

LMB2 • 11:10 Withdrawn

10:30–12:30
IMB • Emerging Technologies for Imaging Systems
Peter Catrysse; Stanford University, United States, Presider

IMB1 • 10:30 Invited
High Efficiency and High Resolution Plasmonic Color Filters for Display Applications, *L. Jay Guo[1], Ting Xu[1], Alex F. Kaplan[1], Yi-Kuei Wu[1]; [1]University of Michigan, USA*. By selective conversion between the free-space waves and spatially confined modes in plasmonic nanoresonators, frequency-selective transmission and reflection spectra can be engineered and can be used as spectrum filters for display and imaging applications.

IMB2 • 11:10 Invited
Some Recent Progress on Curvilinear Imagers and Eyeball Cameras, *John Rogers[1]; [1]Univ. of Illinois at Urbana-Champaign, USA*. We present curvilinear imagers using photodetector arrays on elastomeric membranes, capable of reversible deformation into hemispherical shapes via hydraulics. Combining with tunable, fluidic plano-convex lenses yields hemispherical cameras of adjustable zoom and excellent imaging characteristics.

10:30–13:10
AIMB • Fiber Optic Sensors
Sean Christian; Optrology, Inc., United States, Presider

AIMB1 • 10:30 Invited
Fiber Optic Strain Sensors for Chemical and Acoustic Measurements, *Hans-Peter Loock[1]; [1]Queend's Univ. College, USA*. Single FBGs and FBG Fabry-Pérot cavities were used to measure the strain on a fiber optic waveguide. Chemical concentration measurements and audio recordings of an acoustic guitar were obtained from shifts of the transducer spectra.

AIMB2 • 11:10 Invited
Shape Sensing of Multiple Core Optical Fiber, *Mark Froggatt[1]; [1]Luna Technologies, USA*. The shape of a fused silica fiber having four guiding cores that are configured in a helix is reconstructed using a measurement of the phase shift in the Rayleigh scatter patterns of the four cores.

10:30–12:30
SMB • Ghost Imaging, Superresolution & Blind Deconvolution
Sudhakar Prasad; University of New Mexico, United States, Presider

SMB1 • 10:30 Invited
Promises and Challenges of Ghost Imaging, *Robert Boyd[1]; [1]. Department of Physics, University of Ottawa, Ottawa, ON K1N 6N5 Canada and The Institute of Optics and Department of Physics and Astronomy, University of Rochester, NY, USA*. In this contribution we review research on the imaging protocol known as ghost (or coincidence) imaging. We also describe some current research directions within this topical area.

SMB2 • 11:10
High Precision Object Segmentation and Tracking for use in Super Resolution Video Reconstruction, *Terrell N. Mundhenk[1], David R. Gerwe[2], Yang Chen[1]; [1]ISSL, HRL Labs, USA; [2]Directed Energy Systems, Boeing, USA*. We apply a synthesis of mean-shift kernel density estimation and foreground object motion estimation to find areas of common motion. These are then enhanced using super resolution methods apart from the background enhancement.

SMB3 • 11:30
Light Field Superresolution Reconstruction in Computational Photography, *Zhimin Xu[1], Edmund Lam[1]; [1]Department of Electrical and Electronic Engineering, The University of Hong Kong, Hong Kong*. By formulating a general light field acquisition model and incorporating the prior knowledge existing in the observations, we propose a resolution enhancement scheme for the captured light field. Meanwhile, the depth map can be obtained.

Salon A — Fourier Transform Spectroscopy

Pier 7/8 — Hyperspectral Imaging and Sounding of the Environment

Pier 5 — Adaptive Optics: Methods, Analysis and Applications

Salon C — Computational Optical Sensing and Imaging

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

Salon A

10:30–12:10
FMA • Atmospheric Science from Space I
Peter F. Bernath; University of York, United Kingdom, Presider

FMA1 • 10:30 Invited
Science, Measurement, and Technology Requirements for Infrared Climate Benchmark Missions, *David G. Johnson[1], Martin Mlynczak[1]; [1]NASA Langley Research Center, USA.* Quantifying climate change in the presence of natural variability requires highly accurate global measurements covering more than a decade. Instrument design considerations for trending terrestrial emitted radiance are described.

FMA2 • 11:10
The University of Wisconsin Space Science and Engineering Center Absolute Radiance Interferometer (ARI), *Joe Taylor[1,3], Henry Revercomb[1], Henry Buijs[2], Frédéric Grandmont[2], Jonathan Gero[1], Fred Best[1], David Tobin[1], Robert Knuteson[1], Daniel LaPorte[1], Richard Cline[1], Mark Schwarz[1], Jeff Wong[1]; [1]Space Science and Engineering Center, University of Wisconsin-Madison, USA; [2]ABB-Bomem Inc, Canada; [3]Université Laval, Canada.* A summary of the development of the Absolute Radiance Interferometer (ARI) at the University of Wisconsin Space Science and Engineering Center (UW-SSEC) is presented. This effort is funded under the NASA Instrument Incubator Program (IIP).

FMA3 • 11:30
On-orbit Absolute Blackbody Emissivity Determination Using the Heated Halo Method, *Jonathan Gero[1], Joe Taylor[1], Fred Best[1], Henry Revercomb[1], Robert Knuteson[1], David Tobin[1], Douglas P. Adler[1], Nick Ciganovich[1], Steven Dutcher[1], Ray Garcia[1]; [1]Space Science and Engineering Center, University of Wisconsin, USA.* The Heated Halo method can be used to accurately measure the spectral emissivity of a blackbody, on-orbit, using a broadband thermal source.

Pier 7/8

10:30–12:30
HMA • Upcoming Missions
W. Paul Menzel; University of Wisconsin-Madison, United States, Presider

HMA1 • 10:30 Invited
NOAA's Joint Polar Satellite System and the NPP Satellite Delivering the Next Generation of Environmental Earth Observations, *Mitchell D. Goldberg[1], James Gleason[1], Robert Murphy[1], Carl Hoffman[1], John Furgerson[1]; [1]Satelliet Meteorology Division, NOAA\NESDIS, USA.* The current status and plans for the Joint Polar Satellite System and its predecessor mission, the NPOESS Preparatory Project (NPP), are discussed with more detail provided for the five sensors scheduled to be flown on NPP.

HMA2 • 11:10
Pre-Launch Evaluation of NPP-CrIMSS EDR Algorithm Products with Matched ECMWF Analysis, RAOB Measurements, and IASI Retrievals, *Murty G. Divakarla[1], Mitchell D. Goldberg[2], Christopher Barnet[2], Degui Gu[3], Xu Liu[4], William Blackwell[5], Guang Guo[6], Susan Kizer[4], Eric Maddy[6], Antonia Gambacorta[6], Nick Nalli[6], Kexin Zhang[6]; [1]I.M. Systems Group., Inc., USA; [2]STAR, NOAA/NESDIS, USA; [3]NGAS, USA; [4]NASA/LaRC, USA; [5]MIT Lincoln Laboratories, USA; [6]DELL, USA.* Atmospheric vertical temperature and moisture profiles retrieved by the Cross-track Infrared Sounder and Advanced Technology Microwave Sounder (CrIMSS) algorithm were evaluated with radiosonde measurements, ECMWF analysis, and IASI retrievals.

HMA3 • 11:30
A Cross-Comparison of The NOAA/NESDIS AIRS, IASI and CrIS Operational Channel Selections: Methodology and Information Content, *Antonia Gambacorta[1], Christopher Barnet[2], Eric Maddy[1], Walter Wolf[2], Tom King[1], Murty G. Divakarla[3], Mitchell D. Goldberg[2]; [1]Dell, Inc, USA; [2]NOAA/NESDIS/STAR, NOAA, USA; [3]IMSG, USA.* We present a cross-comparison of the NOAA/NESDIS operational channel selection for AIRS, IASI and CrIS. The focus of this study is on the channel selection methodology and the final information content in the three systems.

Pier 5

10:30–12:30
AMB • Control Systems
Simone Esposito; INAF - Osservatorio Astrofisico di Arcetri, Italy, Presider

AMB1 • 10:30
The Durham AO Real-Time Controller and the CANARY Implementation, *Alastair Basden[1]; [1]Physics, Durham University, United Kingdom.* A new real-time control system (the Durham Adaptive optics Real-time controller, DARC) was used with the MOAO demonstrator instrument CANARY. Available as an open-source release, the major features are described and the CANARY implementation.

AMB2 • 10:50
Gemini Planet Imager Minimum-Variance Tip-Tilt Controllers, *Carlos Correia[1], Jean-Pierre Véran[1], Lisa Poyneer[2]; [1]Herzberg Institute of Astrophysics, Canada; [2]Lawrence Livermore National Lab, USA.* Minimum-variance controllers for \emph{Gemini Planet Imager} tip-tilt modes are investigated and compared to optimised-gain integrators through time- and frequency-domain simulations, using common and non-common path disturbances.

AMB3 • 11:10
Fast Off-Line Kalman Filter Gain Computation for Astronomical Adaptive Optics Systems, *Paolo Massioni[1,2], Caroline Kulcsar[1], Henri-François Raynaud[1], Jean-Marc Conan[2]; [1]Institut Galilée, L2TI, Université Paris 13, France; [2]DOTA, ONERA, France.* We introduce a new procedure for quickly approximating the Kalman gain for the optimal control of large astronomical adaptive optics systems. A computational simplification is obtained in Fourier domain by working on infinite-size phase screens.

AMB4 • 11:30
Advanced NGS-Mode Control In NFIRAOS Using Split-tomography, *Carlos Correia[1], Jean-Pierre Véran[1], Glen Herriot Herriot[1], Brent Ellerbroek[2], Lianqi Wang[2], Luc Gilles[2], Corinne Boyer[2]; [1]Herzberg Institute of Astrophysics, Canada; [2]Thirty Meter Telescope Observatory Corporation, USA.* Controllers based on simple and double integrators are compared to Linear-Quadratic-Gaussian controllers for the Natural-Guide Star loop of NFIRAOS, the 1st light multi-conjugate Adaptive Optics facility for the Thirty Meters Telescope.

Salon C

11:10–11:50
CMB • Seeing the Future: A Symposium in Memory of Dennis Healy II
Michael Gehm; University of Arizona, United States, Presider

CMB1 • Withdrawn

CMB2 • 11:10
Experimental Demonstration of Compressive Target Tracking, *Tariq Osman[1], Phillip K. Poon[1,2], Dan Townsend[3], Scott Wehrwein[3], Adrian Mariano[3], Michael Stenner[3], Michael E. Gehm[1,2]; [1]Electrical and Computer Engineering, University of Arizona, USA; [2]College of Optical Science, University of Arizona, USA; [3]MITRE Corp., USA.* We present an experimental demonstration of compressive target tracking—detection of mover locations with a spatial resolution finer than that provided by the detector pixel dimensions. The tracking performance is evaluated with a customized metric.

CMB3 • 11:30
Imaging Skins: Cameras with Extremely Thin Form Factors, *Jordan Burch[1], Ying Wan[1], Molly Korgstad[2], James R. Leger[1]; [1]Electrical and Computer Engineering, University of Minnesota, USA; [2]Physics, University of Minnesota, USA.* We describe a camera architecture that is capable of high resolution imagery generated by a completely planar device. The camera utilizes grating coupled waveguides to selectively couple light from object points in the far-field.

Monday, 11 July

Pier 4	Pier 2	Pier 3	Pier 9
Application of Lasers for Sensing & Free Space Communication	Imaging Systems and Applications	Applied Industrial Optics: Spectroscopy, Imaging, & Metrology	Signal Recovery & Synthesis

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

LMB • Adaptive Optics I—Continued

LMB3 • 11:50
Compact Integrated Wavefront Corrector for Lasercom Applications, *Allan Wirth[1], Thomas Price[1]; [1]Xinetics, Inc., USA.* The design and test results for a compact optic that combines the functionality of a fast steering mirror and a deformable mirror in a single component are presented.

IMB • Emerging Technologies for Imaging Systems—Continued

IMB3 • 11:50
High Color Accuracy Image Acquisition in Single Capture, *Giacomo Langfelder[1], Cesare Buffa[1], Antonio Longoni[1], Federico Zaraga[1]; [1]Politecnico di Milano, Italy.* A tunable sensor enables image acquisition with high color accuracy. A different tuning of alternate rows implements a quasi-colorimetric six-color sensor. Tuning all the pixels identically gives higher resolution with usual color errors.

IMB4 • 12:10
Picosecond Camera for Time-of-Flight Imaging, *Andreas Velten[1], Ramesh Raskar[1], Moungi Bawendi[2]; [1]MIT Media Lab, USA; [2]Department of Chemistry, MIT, USA.* We present an ultrafast imaging system capable of capturing images with picosecond time resolution or movies with a frame rate of 5x10^11 frames per second.

AIMB • Fiber Optic Sensors—Continued

AIMB3 • 11:50 Invited
Strain Measurements Using Embedded Fiber Bragg Sensors, *Ken V.T. Grattan[1]; [1]City Univ. London, United Kingdom.* Abstract Not Available

AIMB4 • 12:30 Invited
Optical Fiber Gas Sensors using UV and MidIR Spectroscopy for Exhaust Gas Monitoring, *Elfed Lewis[1]; [1]University of Limerwick, Ireland.* Results are presented for on-board and on-line sensing of vehicle exhaust Gases. The sensor was located downstream of the Diesel Particle Filter of a Fiat Croma and data were simultaneously recorded from reference gas analysis instrumentation.

SMB • Ghost Imaging, Superresolution & Blind Deconvolution—Continued

SMB4 • 11:50
An Iterative Blind Deconvolution Algorithm as an Attempt to Search the Global Minimum, *Tohru Takahashi[1]; [1]Oita National College of Technology, Japan.* We propose an iterative blind deconvolution algorithm which is an attempt to search the global minimum of a cost function. This algorithm works for small sized images although it needs a lot of iterations.

SMB5 • 12:10
Using Blind Deconvolution to Simultaneously Retrieve Two Ultrashort Laser Pulses, *Vikrant Chauhan[1], Peter Vaughan[1], Jacob Cohen[1], Tsz Chun Wong[1], Justin Ratner[1], Lina Xu[1], Antonio Consoli[2], Rick Trebino[1]; [1]Physics, Georgia Tech, USA; [2]E.T.S.I. de Telecomunicación, Universidad Politécnica de Madrid, Spain.* We demonstrate a simple method, based on blind deconvolution, for simultaneously measuring two arbitrary ultrashort laser pulses.

12:30–14:00 Lunch *(On Your Own)*

14:00–16:00
LMC • Adaptive Optics II
Malcolm Northcott; Aoptix Technologies, Inc., United States; Troy Rhoadarmer; Science Applications International Corporation, United States, Presiders

LMC1 • 14:00 Invited
Strategies for Enhancing the Reliability and Availability of Lasercom, *Malcolm Northcott[1]; [1]Aopitix Technologies, USA.* Free space laser communications offers large improvements in data bandwidth. Lasercom also has some implementation difficulties, we will describe the difficulties and approaches to their mitigation. Examples are drawn from AOptix lasercom product performance.

14:00–16:00
IMC • Image Processing
Ankit Mohan; Canon, USA, Inc., United States, Presider

IMC1 • 14:00 Invited
High-Order Statistics for Point Prediction in Natural Images, *Wilson S. Geisler[1], Jeffrey S. Perry[1]; [1]Psychology, Univ. of Texas at Austin, USA.* Results are presented for a simple conditional-moments method that directly measures high-order statistics of natural images. In four estimation tasks significant increases in performance are obtained in comparison to traditional methods.

14:00–15:20
AIMC • Industrial Monitoring
Sri Rama Prasanna Pavani; Ricoh Innovations, United States, Presider

AIMC1 • 14:00 Invited
In-Situ Near- and Mid-Infrared Laser Spectrometers: from Lab to Industry, *Peter Kaspersen[1], Peter Geiser[1], Axel Bohman[1], Dung Do Dang[1]; [1]Norsk Elektro Optikk AS, Norway.* Two new near- and mid-infrared spectrometers for in-situ measurements in harsh environments are presented in this paper including their development from an idea through a laboratory prototype to an industrial instrument.

14:00–16:00
SMC • Information Theory & Processing Time Considerations
Andrew Lambert; University of New South Wales, Australia, Presider

SMC1 • 14:00 Invited
Applications of Shannon Information and Statistical Estimation Theory to Inverse Problems in Imaging, *Sudhakar Prasad[1], Srikanth Narravula[1]; [1]Physics and Astronomy, University of New Mexico, USA.* We apply statistical information and estimation theories to derive fundamental Bayesian bounds on image recovery from noisy data for two highly simplified imaging problems, namely single-pixel source localization and a two-pixel correlated image.

Salon A	Pier 7/8	Pier 5	Salon C
Fourier Transform Spectroscopy	Hyperspectral Imaging and Sounding of the Environment	Adaptive Optics: Methods, Analysis and Applications	Computational Optical Sensing and Imaging

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

FMA • Atmospheric Science from Space I—Continued

FMA4 • 11:50
Wideband Far Infrared FTS For The FORUM Explorer Mission, *Luca Palchetti[1]; [1]Istituto di Fisica Applicata "Nello Carrara" - IFAC-CNR, Italy.* The FTS designed for the FORUM space mission is presented. The instrument covers 100 to 1600 cm−1 spectral range of the Earth emission to space with spatial resolution optimized for the characterization of the atmospheric processes affecting the ERB.

HMA • Upcoming Missions—Continued

HMA4 • 11:50 Invited
NASA's Aerosol-Cloud-Ecosystems (ACE) Mission, *David O'C Starr[1]; [1]NASA Goddard Space Flight Center, USA.* Plans for NASA's Aerosol-Cloud-Ecosystem (ACE) mission is described. Recommended by Earth Science Decadal Survey in 2007, ACE is nominally planned for a 2021 launch. ACE is comprised of passive and active sensors (radar and lidar).

AMB • Control Systems—Continued

AMB5 • 11:50
Computation-free Adaptive Optics for High-Contrast Imaging and Other Applications, *Feiling Wang[1]; [1]Alethus LLC, USA.* This paper describes an AO control method that can be implemented using analog circuits. The simple relationships between the cost functions and the modal perturbations provide reliable convergences for phase-conjugation and high-contrast imaging.

AMB6 • 12:10
Discrete-Time Model for Adaptive Optics with Discrete-Time Atmospheric Model, *Douglas Looze[1]; [1]ECE, U. Massachusetts, USA.* This paper models the incident wavefront of an AO system as being constant within each frame. It has shown that the performance degradation is almost insignificant for astronomical AO applications.

CMB • Seeing the Future: A Symposium in Memory of Dennis Healy II—Continued

CMB4 • 11:50 Withdrawn

12:30–14:00 Lunch *(On Your Own)*

14:00–16:00
FMB • Atmospheric Science from Space II
Joe Taylor; University of Wisconsin-Madison, United States, Presider

FMB1 • 14:00 Invited
Panchromatic Fourier Transform Spectrometer (Pan-FTS) for Geostationary Measurements of Atmospheric Composition, *Stanley P. Sander[1]; [1]NASA/JPL, Caltech, USA.* The Panchromatic Fourier Transform Spectrometer (PanFTS) instrument is being developed, to meet the science demands of measuring a wide range of trace gases with unprecedented vertical resolution, by sensing the UV, visible, and IR in one instrument.

14:00–16:00
HMB • Advances in Sensors and Measurements
Steven Platnick; NASA/GSFC, United States, Presider

HMB1 • 14:00 Invited
Scientific Results from the FIRST Instrument Deployment to Cerro Toco, Chile and from the Flight of the INFLAME Instrument, *Martin Mlynczak[1], David G. Johnson[1], Richard P. Cageao[1]; [1]NASA Langley Res. Ctr., USA.* Transform Spectrometers are presented. These are comprehensive measurements of the far-IR spectrum (FIRST) and the net infrared fluxes within the atmosphere (INFLAME).

14:00–16:00
AMC • Wavefront Control
Caroline Kulcsar; Univ. Paris 13, France, Presider

AMC1 • 14:00
Adaptive Grazing Incidence X-Ray Optics, *Allan Wirth[1], David Pearson[1]; [1]Xinetics, Inc., USA.* Active figure control will be necessary to meet the challenging requirements of the Gen-X optics. In this paper we present our adaptive grazing incidence mirror design and the results from laboratory tests of a prototype mirror.

14:00–16:00
CMC • Phase-based Techniques
Marc Christensen, Southern Methodist University, United States, Presider

CMC1 • 14:00 Invited
Compressive Phase Retrieval, *George Barbastathis[1], Justin W. Lee[1], Lei Tian[1], Se Baek Oh[1]; [1]MIT, USA.* We discuss and provide experimental results on the application of compressive sampling to the problem of quantitative tomographic phase reconstruction.

Pier 4	Pier 2	Pier 3	Pier 9
Application of Lasers for Sensing & Free Space Communication	Imaging Systems and Applications	Applied Industrial Optics: Spectroscopy, Imaging, & Metrology	Signal Recovery & Synthesis

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

LMC • Adaptive Optics II—Continued

LMC2 • Withdrawn

LMC3 • 15:20
Towards Experimental Validation of Full-Wave Precompensation for Laser Telecommunications, *Rudolph Biérent[1], Marie-Thérèse Velluet[1], Vincent Michau[1], Nicolas Védrenne[1], Laurent M. Mugnier[1]; [1]DOTA/HRA, ONERA, France.* We designed an optical bench to demonstrate full-wave precompensation for laser telecommunications. This technique requires a device performing time reversed waves. We propose and characterize a solution to realize such a function.

LMC4 • 15:40
Generating Function and Diffractive Optics Approach for MIMO Free Space Optical Communication System, *Shoam Shwartz[1], Michael A. Golub[1], Shlomo Ruschin[1]; [1]Electrical Engineering, Tel Aviv University, Israel.* Several channels in optical complex spatial filters for multimodal communication systems have design freedom in choice of modal phases. We show that analytical generating functions of orthogonal polynomials provide optimization of required phases.

IMC • Image Processing—Continued

IMC2 • 14:40
Optimal Image-based Defocus Estimates from Individual Natural Images, *Johannes Burge[1], Wilson S. Geisler[1]; [1]Center for Perceptual Systems, University of Texas at Austin, USA.* We present a general method for estimating defocus blur from first principles, given a set of natural scenes and properties of the vision system. Local, high-precision, signed estimates are obtained for a model human visual system.

IMC3 • 15:00
Local Linear Learned Image Processing Pipeline, *Steven Lansel[1], Brian Wandell[1]; [1]Stanford Univ., USA.* The local linear learned (L3) algorithm is presented that simultaneously performs the demosaicking, denoising, and color transform calculations of an image processing pipeline for a digital camera with any color filter array.

IMC4 • 15:20
Ultrafast Non Sequential AF Algorithms Using Liquid Lens Technology: An Experimental Study, *Daniel Moine[2], Hilario Gaton[1], Bruno Berge[1]; [1]VARIOPTIC, France; [2]on-leave, VARIOPTIC, France.* Liquid lens enables non sequential algorithms for the search for the best focus, accelerating search times up to 2X. We will present an experimental study related to step dynamics, signal control and golden search algorithms.

IMC5 • 15:40
OTF Estimation Using a Siemens Star Target, *Samuel T. Thurman[1]; [1]Lockheed Martin Coherent Technologies, USA.* Some practical aspects of estimating the optical transfer function of an imaging system with a Siemens star target are described.

AIMC • Industrial Monitoring—Continued

AIMC2 • 14:40 Invited
Optical Measurements in Recycling Operations, *Andreas Nordbryhn[1]; [1]Tomra Systems ASA, Norway.* Recycling of post-consumer package materials requires proper materials sorting. Different operation regimes have individual requirements on the measurements needed. An overview will be given on imaging and spectroscopic solutions developed for this.

SMC • Information Theory & Processing Time Considerations—Continued

SMC2 • 14:40
Achievability of Multi-Frame Blind Deconvolution Cramér-Rao Lower Bounds, *Charles Matson[1], Charles C. Beckner[1], Michael Flanagan[2]; [1]Air Force Res. Lab, USA; [2]SAIC, USA.* The achievability of MFBD CRBs for both object and blurring functions using Fourier-domain metrics depend upon signal-to-noise ratios and the quality of the prior knowledge included in the reconstruction process.

SMC3 • 15:00
A Fast Approximation Method for Broadband Phase Retrieval, *Alden S. Jurling[1], James Fienup[1]; [1]Institute of Optics, University of Rochester, USA.* We introduce a new approximation method for broadband phase retrieval. We show that it yields results of comparable quality to the traditional broadband phase retrieval algorithm with a large improvement in speed.

SMC4 • 15:20
Fast PSF Reconstruction using the Frozen Flow Hypothesis, *James Nagy[1], Qing Chu[1], Sarah Knepper[1], Stuart Jefferies[2]; [1]Math and CS, Emory University, USA; [2]Institute for Astronomy, University of Hawaii, USA.* Using a Taylor frozen flow hypothesis, correlations in multiple wavefront sensor measurements are exploited to obtain accurate PSF estimates. The approach requires solving a large and sparse least squares problem.

SMC5 • 15:40
Near Real-Time Restoration of Non-Uniformly Warped Images from a Dynamic Scenery, *Murat Tahtali[1], Andrew J. Lambert[1]; [1]School of Engineering and IT, UNSW@ADFA, Australia.* We consider a variant of the FRTAAS algorithm to restore warped images from dynamic scenery. We test the usefulness of including a Kalman filter to compensate the loss of statistical data after each scenery change.

16:00–16:30 Coffee Break/ Exhibits Open, *Ballroom Foyer, Convention Level*

Salon A	Pier 7/8	Pier 5	Salon C
Fourier Transform Spectroscopy	Hyperspectral Imaging and Sounding of the Environment	Adaptive Optics: Methods, Analysis and Applications	Computational Optical Sensing and Imaging

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

FMB • Atmospheric Science from Space II—Continued

FMB2 • 14:40
Atmospheric Chemistry Experiment (ACE): Latest Results, *Peter Bernath[1]; [1]Chemistry, University of York, United Kingdom.* An overview of some the latest results from the ACE satellite Fourier transform spectrometer will be presented.

FMB3 • 15:00
Atmospheric Chemistry Experiment (ACE): Detecting Trace Organic Compounds from Orbit, *Jeremy Harrison[1], Nick Allen[1], Peter Bernath[1]; [1]Department of Chemistry, University of York, United Kingdom.* We highlight recent laboratory spectroscopic measurements of organic molecules made in support of the ACE mission, and preliminary retrievals from ACE spectra.

FMB4 • 15:20
Validation of the ACE-FTS Version 3.0 Dataset Against Other Satellite Instrument Datasets, *Claire Waymark[1], Kaley Walker[1,2], Chris Boone[2], Eric Dupuy[3], Peter Bernath[1,4]; [1]Department of Physics, University of Toronto, Canada; [2]Department of Chemistry, University of Waterloo, Canada; [3]National Institute of Information and Communications Technology, Japan; [4]Department of Chemistry, University of York, United Kingdom.* The ACE-FTS version 3.0 dataset is being validated against the previous (well validated) data version 2.2 as well as other satellite instruments such as HALOE.

FMB5 • 15:40
Developments for Future Atmospheric Composition Measurements Using Space-based Solar Occultation Fourier Transform Spectrometry, *Kaley Walker[1,2], Stella Melo[3], Gaetan Perron[4], Louis Moreau[4]; [1]Physics, University of Toronto, Canada; [2]Chemistry, University of Waterloo, Canada; [3]Canadian Space Agency, Canada; [4]ABB-Bomem, Canada.* This paper will discuss CSA-funded studies that have been undertaken in Canada to develop new satellite missions and instruments using solar occultation Fourier Transform spectrometry to build on heritage from the Atmospheric Chemistry Experiment.

HMB • Advances in Sensors and Measurements—Continued

HMB2 • 14:40 Invited
Measurements of Shortwave Radiation: The Value of Spectral Resolution for Cloud and Aerosol Remote Sensing, *Sebastian Schmidt[1], Peter Pilewskie[1]; [1]Laboratory for Atmospheric and Space Physics, University of Colorado, USA.* Spectrally resolved airborne and ground-based measurements of shortwave radiation have advanced cloud and aerosol remote sensing. They provide new insights into the radiative energy budget. We illustrate this with results from recent experiments.

HMB3 • 15:20 Invited
Advanced Sounder Measurement Information Dependence on System Characteristics, *Allen M. Larar[1], Daniel Zhou[1], Xu Liu[1], William Smith[2,3]; [1]NASA Langley Res. Ctr., USA; [2]Hampton University, USA; [3]University of Wisconsin, USA.* Improved observations of Earth system are needed for enhancing weather prediction, climate monitoring capability, and environmental change detection. This study addresses impact of system characteristics on advanced sounder information content.

AMC • Wavefront Control—Continued

AMC2 • 14:20
Advances In The Analysis And Design Of Adaptive Optics, *Gregory Michels[1], Victor Genberg[1]; [1]Sigmadyne, Inc., USA.* Opto-mechanical analysis and design techniques for development of adaptive optics are presented. Topics include actuator stroke limits, actuator failures, optimum placement of actuators, and optimum structural design.

AMC3 • 14:40
Novel Beacon Creation in an Adaptive Optics System, *Elizabeth Daly[1], Andrew J. Lambert[2], Chris Dainty[1]; [1]Applied Optics Group, National University of Ireland Galway, Ireland; [2]School of Engineering and IT, UNSW@ADFA, Australia.* We describe the use of supplementary active optics for beacon shaping in an adaptive optics system for the human eye. We determine the effects of such shaping on system performance for model and real eyes.

AMC4 • 15:00
Controlling Spatial Coherence in Multimode Fibers, *Fanting Kong[1], Nicholas V. Proscia[1], Kotik K. Lee[1], Ying-Chih Chen[1]; [1]Physics and Astronomy, Hunter College of the City University of New York, USA.* We demonstrate that the randomized output field of multimode fibers can be focused in the near field or collimated in the far field by wavefront shaping in the input or the output fields

AMC5 • 15:20
Laser Microfabrication Using Adaptive Optics: Parallelization and Aberration Correction, *Patrick S. Salter[1], Alexander Jesacher[2], Hassan Al-Wakeel[1], Martin Booth[1]; [1]Engineering Science, University of Oxford, United Kingdom; [2]Division of Biomedical Physics, Innsbruck Medical University, Austria.* Pulsed lasers are used for sub micron scale fabrication. We employ adaptive optics for correction of focal depth induced aberrations and beam shaping. Adaptive multispot schemes are used for rapid parallel fabrication.

AMC6 • 15:40
Photoacoustic-guided Convergence of Light Through Optically Diffusive Media, *Fanting Kong[1], Ronald H. Silverman[2,3], Liping Liu[1], Parag Chitnis[3], Kotik K. Lee[1], Ying-Chih Chen[1]; [1]Physics and Astronomy, Hunter College of the City University of New York, USA; [2]Department of Ophthalmology, Columbia University, USA; [3]Riverside Research Institute, USA.* We report the use of photoacoustic signals originating from an optically absorptive target as feedback for shaping the incident wavefront to increase optical energy density at the absorptive target delivered through a diffusive medium.

CMC • Phase-based Techniques—Continued

CMC2 • 14:40 Invited
Nanoscale-Resolution Coherent Diffractive Imaging using Tabletop Soft X-ray Light Sources, *Henry Kapteyn[1]; [1]JILA and Univ. of Colorado, USA.* The combination of Coherent Diffractive Imaging (CDI) with new tabletop-scale coherent EUV and x-ray light sources has enabled a new imaging modality, with demonstrated resolution of ~20 nm and the potential for further rapid improvement.

CMC3 • 15:20
Schulz-Snyder Phase Retrieval Algorithm as an Alternating Minimization Algorithm, *Figen S. Oktem[1], Richard E. Blahut[1]; [1]Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign, USA.* We derive the Schulz-Snyder phase retrieval algorithm as an alternating minimization method, and discuss its advantages and drawbacks. An annealing-type Schulz-Snyder algorithm is proposed to avoid convergence to nonglobal solutions.

CMC4 • 15:40
Phase-Space Imaging of Partially Coherent Beam Propagation Using a Spatial Light Modulator, *Laura Waller[1], Guohai Situ[1], Jason W. Fleischer[1]; [1]Electrical Engineering, Princeton University, USA.* We measure the phase-space of coherent and partially coherent light beams as they propagate. The 4D distributions are captured by scanning and Fourier-transforming an aperture created by a spatial light modulator (SLM).

16:00–16:30 Coffee Break/ Exhibits Open, *Ballroom Foyer, Convention Level*

Pier 2 — Imaging Systems and Applications

Pier 3 — Applied Industrial Optics: Spectroscopy, Imaging, & Metrology

Pier 9 — Signal Recovery & Synthesis

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

16:30–18:30
IMD • Human Vision and Imaging Systems
Joyce Farrell; Stanford University, United States, Presider

IMD1 • 16:30 Invited
Learning the Mosaic: Unsupervised Identification of Sensor Spectral Types, *David Brainard[1]; [1]Univ. of Pennsylvania, USA.* Accurate processing of color information requires knowledge of the spectral class of each light-sensitive receptor. Unsupervised learning algorithms can identify the class of individual sensors in a mosaic from the sensor responses to natural images.

IMD2 • 17:10 Invited
Simulating Imaging Systems: Photons, Parts and People, *Brian Wandell[1]; [1]Stanford Univ., USA.* The interest in the spatial statistics of the signal encoded by the eye motivated us to assemble and distribute software for calculating the retinal irradiance and cone absorptions of scene radiance. We hope that this simulation will provide a more realistic approximation of the statistical properties encoded by the nervous system. The statistics of the retinal irradiance image is significantly different from the scene radiance, and the cone absorption properties add further complexity. By making it simple to account for optical and retinal factors, we hope to enable new experimentation and insights.

16:30–18:30
AIMD • Healthcare and Pharma
Jess Ford; Weatherford Intl., United States, Presider

AIMD1 • 16:30 Invited
Process Analytical Technology: Bringing Solutions to the Plant Floor, *Katherine A. Bakeev[1]; [1]CAMO Software Inc., USA.* Process analytical technology using spectroscopic tools for real-time monitoring will be presented. PAT provides fuller process understanding and contributes to process control. Challenges in implementation of PAT in manufacturing will be discussed.

AIMD2 • 17:10 Invited
How To Measure The Size of Tumors: The RECIST Standard vs. Volumetrics, *Zachary H. Levine[1]; [1]Optical Technology Division, NIST, USA.* Response Evaluation Criteria for Solid Tumours (RECIST) proposed 1D criteria for determining if 3D tumors are growing malignantly. Here, the error introduced is quantified using physical ellipsoids and fitting to clinical data on liver malignoma.

16:30–17:50
SMD • Optical Processing & Algorithms
Julia Sakamoto; University of Arizona, United States, Presider

SMD1 • 16:30 Invited
Optical Signal Processing: Holography, Speckle and Algorithms, *John Sheridan[1]; [1]Univ. of Pennsylvania, USA.* Modeling the propagation of light through free space and simple paraxial systems continue to be enduring, and practically important topics in optics. Is there anything new or interesting that remains to be said? Given the pervasive use of digital cameras and numerical algorithms, examples are given indicating that the answer is yes. Satisfactory modeling requires the interactions of the whole optical information processing system (optics, optoelectronics and software) be included.

SMD2 • 17:10
Image Reconstruction from Nonuniform Samples in Spectral Domain Optical Coherence Tomography, *Jun Ke[1], Rui Zhu[1], Edmund Y. Lam[1]; [1]Electrical and Electronic Engineering, The University of Hong Kong, Hong Kong.* We cast the signal reconstruction in spectral domain optical coherence tomography as a minimization problem with total variation regularization. A cross-sectional image in SD-OCT is estimated directly from non-uniformly spaced frequency samples.

Salon A — Fourier Transform Spectroscopy

Pier 7/8 — Hyperspectral Imaging and Sounding of the Environment

Pier 5 — Joint AO / LS&C

Salon C — Computational Optical Sensing and Imaging

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

16:30–18:30
FMC • Atmospheric Science with Ground Based Instrumentation
Luca Palchetti; Instituto di Fisica Applicata Nello Carra, Italy, Presider

FMC1 • 16:30 Invited
NDACC IRWG: Evolution of Ground-Based Global Trace Gas Infrared Remote Sensing, *James W. Hannigan[1]; [1]Atmospheric Chemistry Division, NCAR, USA.* Review and current state of the global IRWG FTS atmospheric observational network.

FMC2 • 17:10
The NOy budget above Eureka, Nunavut from ground-based FTIR measurements, space-based ACE-FTS measurements, and the CMAM-DAS, GEM-BACH, and SLIMCAT models, *Rodica Lindenmaier[1], R. L. Batchelor[2], Kimberly Strong[1], S. Beagley[3], R. Menard[4], A. I. Jonsson[1], M. Neish[1], S. Chabrillat[5], M. P. Chipperfield[6], G. L. Manney[7,8], W. H. Daffer[7], S. Polavarapu[4], T. G. Shepherd[1], Peter F. Bernath[9], Kaley Walker[1]; [1]Physics, University of Toronto, Canada; [2]Atmospheric Chemistry Division, NCAR, USA; [3]Earth and Space Science and Engineering, York University, Canada; [4]Atmospheric Science and Technology Directorate, Environment Canada, Canada; [5]Belgium Institute for Space Aeronomy, Belgium; [6]Institute for Atmospheric Science, School of Earth and Environment, University of Leads, United Kingdom; [7]Jet Propulsion Laboratory, California Institute of Technology, USA; [8]New Mexico Institute of Mining and Technology, USA; [9]Chemistry, University of York, United Kingdom.* Reactive nitrogen species, NOy, play an important role in stratospheric chemistry. Using a Bruker 125HR FTIR installed at Eureka, Nunavut, ACE-FTS satellite data, and model simulations, we study the NOy budget for this Arctic site.

16:30–18:30
HMC • Radiative Transfer
Allen M. Larar; NASA Langley Research Center, United States, Presider

HMC1 • 16:30 Invited
Radiative Transfer Modeling for Hyperspectral Applications: Status and Validation of LBLRTM, *Vivienne Payne[1], Jennifer Delamere[1], Eli Mlawer[1], Jean-Luc Moncet[1]; [1]Atmospheric and Environmental Res. (AER), USA.* LBLRTM, its associated spectroscopic databases and continua are subject to ongoing validation against measurements spanning submillimeter to visible wavelengths. Here we present examples of recent updates in the far- and mid-infrared.

HMC2 • 17:10
Water Vapor Continuum Results in the Far IR from the CAVIAR And RHUBC Field Measurement Campaigns, *Paul Green[1], Ralph Beeby[1], Alan E. Last[1], Juliet C. Pickering[1], John E. Harries[1], Stuart Newman[2], David Turner[3]; [1]SPAT Physics, Imperial College London, United Kingdom; [2]UK Meteorological Office, United Kingdom; [3]University of Wisconsin-Madison, USA.* We report results from the second CAVIAR and first RHUBC field campaigns, comparing a derived water vapor continuum parametrisation in the far IR spectral region with those in the mid IR and the literature.

17:10–18:30
JMB • AO/LSC Joint Session: Wavefront Control and Turbulence
Matthew Britton; The Optical Sciences Company (tOSC), United States, Presider

JMB1 • 16:30 Withdrawn

JMB2 • 17:10
Simulating Wide-Field Optical Wavefront Propagation through Single-Layer Turbulence, *Stephen J. Weddell[1], Russell Y. Webb[1], Philip Bones[1]; [1]Electrical & Computer Engineering, University of Canterbury, New Zealand.* Optical wavefront propagation over a wide field-of-view (FOV) was modeled on empirical data representing a single, dominant layer of atmospheric turbulence. We found the Taylor hypothesis is not appropriate for wide-field application.

16:30–18:10
CMD • Computational Spectroscopy and Spectral Imaging
David Brady; Duke University, United States, Presider

CMD1 • 16:30
Joint Segmentation and Reconstruction of Coded Aperture Hyperspectral Data, *David S. Kittle[1], David J. Brady[1], Sudhakar Prasad[4], Qiang Zhang[2], Robert Plemmons[3]; [1]ECE, Duke University, USA; [2]Biostatistical Sciences, Wake Forest University, USA; [3]Computer Science and Mathematics, Wake Forest University, USA; [4]Physics and Astronomy, University of New Mexico, USA.* This work presents experimental verification of a joint segmentation reconstruction algorithm on real data from a snapshot hyperspectral imager. Accurate spectra can be computed for any pixel location in the data cube.

CMD2 • 16:50
Information-Optimal Adaptive Feature-Specific Spectroscopy for Rapid Chemical Classification, *Ivan Rodriguez[1], Peter A. Jansen[1], Dinesh Dinakarababu[1], Michael E. Gehm[1,2]; [1]Electrical and Computer Engineering, University of Arizona, USA; [2]College of Optical Science, University of Arizona, USA.* An information-optimal version of Adaptive Feature-Specific Spectrometry (AFSS) is presented. The system achieves dramatically shorter time-to-classification than traditional architectures in low SNR scenarios.

CMD3 • 17:10
Adaptive, Feature-Specific Spectral Imaging Classifier, *Matthew J. Dunlop[1], Peter A. Jansen[1], Michael E. Gehm[1,2]; [1]Electrical and Computer Engineering, University of Arizona, USA; [2]College of Optical Science, University of Arizona, USA.* We describe our design for an adaptive, feature-specific spectral imaging classifier. The system utilizes adaptive spectral codes to spectrally-classify multiple spectral locations in parallel.

Pier 2	Pier 3	Pier 9
Imaging Systems and Applications	Applied Industrial Optics: Spectroscopy, Imaging, & Metrology	Signal Recovery & Synthesis

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

IMD • Human Vision and Imaging Systems—Continued

IMD3 • 17:50 Invited

Video Acuity: A Metric to Quantify the Effective Performance of Video Systems, *Andrew Watson[1]; [1]NASA Ames Res. Ctr., USA.* There is a widely acknowledged need for metrics to quantify the performance of video systems.

AIMD • Healthcare and Pharma—Continued

AIMD3 • 17:50 Invited

Glucose and Other Measurements, *Joe Chaiken[1,3], Bin Deng[2], Jerry Goodisman[1], George Shaheen[3], Rebecca Bussjager[3]; [1]Chemistry, Syracuse University, USA; [2]Biomedical Engineering, Syracuse University, USA; [3]600 East Genesee Street, LighTouch Medical, Inc., USA.* Simultaneous measurement of elastic and inelastic remitted light from tissues being irradiated with a single near infrared laser wavelength can be used to calculate the plasma and red blood cell volumes of the included blood.

SMD • Optical Processing & Algorithms—Continued

SMD3 • 17:30

Three-dimensional Surface Recovery with a Regularized Multi-frame Phase Shift Algorithm, *Fuqin Deng[1], Edmund Y. Lam[1]; [1]University of Hong Kong, Hong Kong.* We develop a modified four-frame phase shift algorithm that incorporates a smoothness constraint. This is applied to a high-precision full-profile reconstruction and measurement for integrated circuit packages.

NOTES

Salon A	Pier 7/8	Pier 5	Salon C
Fourier Transform Spectroscopy	Hyperspectral Imaging and Sounding of the Environment	Joint AO / LS&C	Computational Optical Sensing and Imaging

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

FMC • Atmospheric Science with Ground Based Instrumentation—Continued

FMC3 • 17:30
University of Wisconsin Calibration Performance Certification of Atmospheric Emitted Radiance Interferometer (AERI) Systems, *Robert Knuteson[1], Joe Taylor[1], Fred Best[1], Henry Revercomb[1], Denny Hackel[1], Ray Garcia[1]; [1]Space Science & Engineering Center, Uni. of Wisconsin-Madison, USA.* The University of Wisconsin-Madison Space Science and Engineering Center (UW-SSEC) is certifying the calibration performance of a new generation of instruments for the measurement of the downwelling atmospheric infrared spectrum at the surface.

FMC4 • 17:50
The REFIR-PAD far-infrared Fourier transform spectroradiometer, *Giovanni Bianchini[1], Luca Palchetti[1]; [1]Istituto di Fisica Applicata "Nello Carrara" - IFAC-CNR, Italy.* The REFIR-PAD spectroradiometer is based on a misalignment-compensated Mach-Zehnder design with Ge-coated Mylar beamsplitters and uncooled pyroelectric detectors for broadband, room-temperature operation in the mid/far-infrared range.

FMC5 • 18:10
Ground-Based FTIR Spectrometer Observation of Nitrous Oxide And Its Validation Over Addis Ababa, Ethiopia, *Samuel T. Kenea[1]; [1]Physics, Addis Ababa University, Ethiopia.* Since May 2009 high-resolution Fourier transform infrared (FTIR) solar absorption spectra are recorded at Addis Ababa, Ethiopia. The vertical distribution of nitrous oxide (N2O) was deduced from the spectra by the code PROFFIT (V9.5).

HMC • Radiative Transfer—Continued

HMC3 • 17:30
A Combined Atmospheric Radiative Transfer Model (CART) and Its Applications, *Heli Wei[1]; [1]Key Laboratory of Atmospheric Composition and Optical Radiation, Anhui Institute of Optics and Fine Mechanics, the Chinese Academy of Sciences, China.* A Combined Atmospheric Radiative Transfer model (CART) has been developed to rapidly calculate atmospheric spectral transmittance and background radiance. The algorithms and the applications of CART are presented in the paper.

HMC4 • 17:50
Satellite Retrieval of Percent Liquid Water in Tropical Clouds Between -20° and -38°C, *David L. Mitchell[1], Robert P. d'Entremont[2]; [1]Atmospheric Sciences, Desert Research Institute, USA; [2]Atmospheric and Environmental Research, Inc., USA.* A method for estimating the fraction of liquid water using the 11 and 12 micron MODIS channels is described. The mean liquid fraction at -20°C was ~ 10%, strongly affecting cloud optical properties.

HMC5 • 18:10
Retrieving Atmospheric Profiles Data in the Presence of Clouds from Hyperspectral Remote Sensing Data, *Xu Liu[1], Allen M. Larar[1], Daniel Zhou[1], Susan Kizer[1], Wan Wu[1], Christopher Barnet[2], Murty G. Divakarla[2], Guang Guo[2], William Blackwell[3], William L. Smith[4], Ping Yang[5], Degui Gu[6]; [1]NASA Langley Research Center, USA; [2]NOAA Center for Satellite Applications, USA; [3]MIT Lincoln Laboratory, USA; [4]Hampton University, USA; [5]Texas A& M University, USA; [6]Northrop Grumman Aerospace Systems, USA.* Different methods for retrieving atmospheric profiles in the presence of clouds will be described. We will present results from the JPSS cloud-clearing algorithm and NASA Langley cloud retrieval algorithm.

JMB • AO/LSC Joint Session: Wavefront Control and Turbulence—Continued

JMB3 • 17:30
Grid Size Optimization for Atmospheric Turbulence Phase Screen Simulations, *Roopashree M b[1], Vyas Akondi[1,2], Raghavendra Prasad Budihala[1]; [1]Laser Lab, CREST, Indian Institute of Astrophysics, India; [2]Department of Physics, Indian Institute of Science, India.* Atmospheric phase screens are used for numerical evaluation of large telescope systems. In this paper, we optimized the grid size of the simulated phase screens in terms of the error in the structure function assuming a Kolmogorov turbulence model.

JMB4 • 17:50
Beam Wavefront Control of TIL for ICF Application, *Wanjun Dai[1]; [1]Research Center of Laser Fusion,China Academy of Engineering Physics,CAEP, China.* A novel scheme to correct aberration of each beam from the front-end to target point in TIL is presented.

JMB5 • 18:10
Towards Low Cost Turbulence Generator for AO Testing: Utility, control and stability, *M. B. Roopashree[1], Akondi Vyas[1,2], S. Amritha Krishnan[3], R. Sri Ram[3], S. Siva Shankar Sai[3], B. Raghavendra Prasad[1]; [1]Indian Institute of Astrophysics, Karnataka, India; [2]Indian Institute of Science, Karnataka, India; [3]Sri Sathya Sai Institute of Higher Learning, Andhra Pradesh, India.* We demonstrate and characterize an effective, statistically repeatable atmospheric turbulence generator with the aim of testing a 2m class telescope adaptive optics system in a cost effective manner.

CMD • Computational Spectroscopy and Spectral Imaging—Continued

CMD4 • 17:30
Optimization of Spectrally Coded Mask for Multi-modal Plenoptic Camera, *Kathrin Berkner[1], Sapna Shroff[1]; [1]Ricoh Innovations, Inc., USA.* We introduce a framework to optimize the layout of a spectral filter mask inserted into the aperture of a plenoptic camera. The optimization merit function evaluates spectral crosstalk at the sensor caused by lens aberrations.

CMD5 • 17:50
Defocus-invariant Blur by Using Spectrum Coding, *Stan Szapiel[1], Catherine Greenhalgh[1]; [1]Raytheon ELCAN Optical Technology, Canada.* Defocus-invariant blur is obtained by specifying chromatic focal shift vs wavelength dependence which provides the best match to the spectral response of an electronic imaging system. Impact on thermal IR and fluorescence imaging is discussed.

NOTES

Pier 4

Application of Lasers for Sensing & Free Space Communication

08:00–10:00
LTuA • Information Assurance in Quantum Communications I
David Hughes; Air Force Research Lab, United States, Presider

LTuA1 • 08:00 Invited
Addressing Security Issues in Quantum Key Distribution using Seed Keys and Entangled Sources, *Greg Kanter[1], Yu-Ping Huang[2], Prem Kumar[2]; [1]NuCrypt LLC, USA; [2]Center for Photonic Communication and Computing, Northwestern University, USA.* After years of analysis, security issues still remain in theory and practice of traditional quantum key distribution. A modified method offers alternate analysis paths and fewer hacking points. We consider entangled sources in this method.

LTuA2 • 08:40 Invited
Novel Protocols for Free-Space Quantum Key Distribution, *Ulvi Yurtsever[1]; [1]MathSense Analytics, USA.* We discuss alternative technologies to the decoy-state protocol based on the use of entangled light randomly mixed with weak laser pulses.

LTuA3 • 09:20 Invited
Stochastic Electromagnetic Beams for Sensing and Free-Space Communications, *Olga Korotkova[1]; [1]University of Miami, USA.* Stochastic and vectorial (electromagnetic) nature of the optical beams can improve communication links and can be effectively used for sensing of objects when the propagation channels involve atmospheric turbulence.

Pier 2

Imaging Systems and Applications

08:00–10:00
ITuA • Coded Optical Imaging
Gisele Bennett; Georgia Tech, United States, Presider

ITuA1 • 08:00 Invited
Recent Advances in Diffraction and Geometry Related Super Resolution Approaches, *Zeev Zalevsky[1], Ohad Fixler[1], Aviram Gur[1], Dror Fixler[1], Vicente Micó[2], Javier Garcia[2]; [1]School of engineering, Bar-Ilan Univ., Israel; [2]Departamento de Óptica, Univ. Valencia, Spain.* In this paper we present two recently developed approaches while one is aiming to overcome diffraction limitation and the other the geometrical bounds while using a unified spatial light modulator (SLM) based configuration.

ITuA2 • 08:40 Invited
What Would You Do With Precision in Optics If You Had It?, *Edward Dowski[1]; [1]Ascentia Imaging, Inc, USA.* With increasing precision a number of important changes in imaging could become possible and practical, such as new configurations, separating design from manufacture and seamless merging of optics and electronics.

ITuA3 • 09:20
Spatially Selective Mask for Single Pixel Video Rate Imaging, *Orges Furxhi[1], Eddie Jacobs[1]; [1]Electrical and Computer Engineering, University of Memphis, USA.* We present a spatially selective mask that is used with a single pixel detector to reconstruct images in real-time. Reconstructed image sizes are variable; the mask works in multiple electromagnetic regimes. Experimental results are shown.

Pier 3

Applied Industrial Optics: Spectroscopy, Imaging, & Metrology

08:40–09:20
AITuA • LIBS
Arel Weisberg; Energy Research Co., United States, Presider

AITuA1 • 08:00 Withdrawn

AITuA2 • 08:40 Invited
Laser-Induced Breakdown Spectroscopy (LIBS) for On-line Control in Mining Industry, *Michael Gaft[1]; [1]Laser Distance Spectrometry, Israel.* We manufacture industrial on-line analyzers based on LIBS. The main installations are: (a) phosphate industry in USA and Russia; (b) metallurgical plant in Russia; (c) successful test for ash analysis of coal in South Africa.

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

Salon A

Fourier Transform Spectroscopy

Pier 7/8

Hyperspectral Imaging and Sounding of the Environment

Pier 5

Joint AO / SRS

Salon C

Computational Optical Sensing and Imaging

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

08:00–10:00
FTuA • Astronomy and Planetary Science
David Naylor; University of Lethbridge, Canada, Presider

FTuA1 • 08:00 Invited
Measurements at NIST in Support of the Search for Exoplanets, *Gillian Nave[1]; [1]National Institute of Standards and Technology, USA.* I shall summarize work at NIST to measure reference spectra for the detection of exoplanets using Fourier transform spectroscopy.

FTuA2 • 08:40
The Mars Atmosphere Trace Molecule Occultation Spectrometer, *Geoffrey C. Toon[1], Paul O. Wennberg[2], Victoria Hipkin[3], James Drummond[4]; [1]Jet Propulsion Laboratory, USA; [2]California Institute of Technology, USA; [3]Canadian Space Agency, Canada; [4]Dalhousie University, Canada.* The Mars Atmosphere Trace Molecule Occultation Spectrometer (MATMOS) FTS is described, with emphasis on the data acquisition and on-board data processing.

FTuA3 • 09:00
The Canadian contribution to the MATMOS instrument, *Louis Moreau[1], James Veilleux[1], Fortin Serge[1], Phillippe Bérubé[1], Marc-André Soucy[1]; [1]ABB Bomem, Canada.* MATMOS is a solar-occultation FTS part of the Exomars mission. It will measure the transmittance of the Martian atmosphere to characterize its chemical composition. We present an overview of the Canadian hardware contribution to MATMOS.

FTuA4 • 09:20
Six-fold Spectral Resolution Boosting with an Interferometer upon the Mt. Palomar Near-infrared Spectrograph, *David J. Erskine[1], Jerry Edelstein[2], Philip S. Muirhead[3], Kevin R. Covey[3], James P. Lloyd[3], Matthew W. Muterspaugh[4]; [1]Lawrence Livermore Nat. Lab., USA; [2]Space Sciences Lab., Univ. of California, USA; [3]Astronomy, Cornell University, USA; [4]Research Sponsored Programs, Tennesee State Univ., USA.* An interferometric method for increasing a dispersive spectrograph's resolution by large factors beyond classical limits at full simultaneous bandwidth is demonstrated on Mt. Palomar Triplespec near-infrared spectrograph. A 6-fold boost is achieved.

08:00–10:00
HTuA • Merged Imager and Sounder
Elisabeth Weisz: University of Wisconsin-Madison, United States, Presider

HTuA1 • 08:00 Invited
Merging High Spectral Resolution Sounder Data with High Spatial Resolution Imager Data To Infer Global Cloud Cover Properties, *W. Paul Menzel[1], Elisabeth Weisz[1], Eva Borbas[1]; [1]Space Science and Engineering Ctr., Univ. of Wisconsin-Madison, USA.* AIRS cloud top pressure (CTP) determinations are regressed against AIRS measurements convolved to MODIS spectral response functions; that regression is applied to MODIS measurements. Resulting CTPs are compared to CALIPSO and CloudSat measurements.

HTuA2 • 08:40
Combining AIRS and MODIS: High Resolution Radiances and Atmospheric Profiles in the Presence of Different Cloud Types, *Mathias Schreier[1,2], Brian Kahn[1], Steve Ou[2], Qing Yue[1], Johannes Karlsson[1], Shaima Nasiri[3]; [1]Jet Propulsion Lab, USA; [2]Joint Institute for Regional Earth System Science and Engineering, UCLA, USA; [3]Department of Atmospheric Sciences, Texas A&M University, USA.* We use a combination of AIRS and MODIS to analyze atmospheric profiles and high-resolution infrared spectra for different cloud types. By using simulated spectra we can test the influence of parameters on the high-resolution spectra.

HTuA3 • 09:00
Improved Soundings Using Collocated Imager and Sounder Data From MetOp-A, *Eric Maddy[1,2], Tom King[1,2], Haibing Sun[1,2], Antonia Gambacorta[1,2], Walter Wolf[2], Christopher Barnet[2], Andrew Heidinger[2], Mitchell D. Goldberg[2], Kexin Zhang[1,2], Chen Zhang[1,2]; [1]Dell, Inc, USA; [2]NOAA/NESDIS/STAR, USA.* We present an analysis of the uncertainties in a candidate operational MetOp-A IASI/AVHRR/AMSU cloud-clearing and geophysical state retrieval system. Strategies for improving the system will also be described.

HTuA4 • 09:20
Relationships Between Cloud Thermodynamic Phase, Temperature, and Height from AIRS and CALIPSO, *Shaima Nasiri[1], Hongchun Jin[1], Brian Kahn[2], Mathias Schreier[2]; [1]Atmospheric Sciences, Texas A&M University, USA; [2]Jet Propulsion Laboratory, USA.* Hyperspectral infrared observations from AIRS are used to determine cloud thermodynamic phase. These phase retrievals are compared with co-located CALIPSO lidar products to investigate relationships between cloud phase, height, and temperature.

08:00–10:00
JTuA • Joint AO/SRS Session I: Atmospheric Turbulence; Adaptive Optics Systems; Image Analysis
Christy Fernandez Cull; MIT Lincoln Lab, United States, Presider

JTuA1 • 08:00 Invited
Optical Turbulence Profiling and Applications for Astronomy, *Richard W. Wilson[1], Timothy Butterley[1], James Osborn[1], Harry Shepherd[1]; [1]Physics, Durham University, United Kingdom.* Recovery of the vertical profile of atmospheric turbulence strength from optical crossed-beam measurements is reviewed with particular reference to the effects of deviations from the commonly assumed Kolmogorov turbulence spectrum.

JTuA2 • 08:40
Wide Field Adaptive Optics Microscopy Using Both Closed Loop Correction and Image Sharpness Optimization, *Gordon D. Love[1], Cyril Bourgenot[1], Christopher D. Saunter[1], John M. Girkin[1]; [1]Dept. of Physics, Durham University, United Kingdom.* We report on results from a wide field microscope fitted with adaptive optics. We describe results based on both image optimization (wavefront sensorless adaptive optics) and full closed loop correction.

JTuA3 • 09:00
Exact Theory of Adaptive Optics Speckle and its Applications, *Natalia Yaitskova[1], Szymon Gladysz[2], Rao Gudimetla[3]; [1]European Organisation for Astronomical Research in the Southern Hemisphere, Germany; [2]Technion - Israel Institute of Technology, Israel; [3]Air Force Research Laboratory, USA.* We derive the first order statistical moments of intensity of AO corrected images. We demonstrate that applicability of one or another distribution law depends not only on the level of correction, but also on the observation point in the focal plane.

JTuA4 • 09:20
Cumulative Wavefront Reconstructor for Single Conjugate Adaptive Optics, *Mariya Zhariy[1]; [1]IndMath, JKU Linz, Austria.* We present a wavefront reconstructor for the Shack-Hartmann wavefront sensor with linear complexity. This algorithm allows for a simple adaptation to the aperture geometry. We derive theoretical performance estimates and verify them numerically.

08:20–10:00
CTuA • Imaging with Scattering and Aberrations
Jason W. Fleischer; Princeton University, United States, Presider

CTuA1 • 08:20 Invited
Imaging Through Turbid Media Using Phase Conjugation, *Ye Pu, Chia-Lung Hsieh, Rachel Grange, Xin Yang, Demetri Psaltis; Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland.* We describe how second harmonic nanoparticles inserted deep inside tissues can be used as beacons to enable the formation of a phase conjugate wavefront that propagates through the scattering tissue and comes to a sharp focus inside. We show how the optical memory effect can be used to scan the phase conjugate beam in 3D inside the tissue and obtain an image.

CTuA2 • 09:00
Backscattering Scanning Fluorescence Microscopy, *Donald B. Conkey[1], Antonio Caravaca[1], Rafael Piestun[1]; [1]Electrical, Computer, and Energy, University of Colorado at Boulder, USA.* We present a microscopy technique in which a scattering optical element is used for scanning and resolution enhancement. The measured backscattering matrix is used to scan light with a twofold improvement in system resolution.

CTuA3 • 09:20
PSF Engineering to Reduce the Impact of Depth-Induced Aberrations on Wide-field Microscopy Imaging, *Shuai Yuan[1], Chrysanthe Preza[1]; [1]Electrical and Computer Engineering, The University of Memphis, USA.* We evaluated different phase mask designs for PSF engineering using wavefront encoding, to reduce the impact of depth-induced aberrations, due to refractive index mismatch, on 3D computational wide-field microscopy imaging with high NA lenses.

Pier 4

Application of Lasers for Sensing & Free Space Communication

Pier 2

Imaging Systems and Applications

Pier 3

Applied Industrial Optics: Spectroscopy, Imaging, & Metrology

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

LTuA • Information Assurance in Quantum Communications I—Continued

ITuA • Coded Optical Imaging—Continued

ITuA4 • 09:40
Code Aperture Agile Spectral Imaging (CAASI), *Henry Arguello[1], Gonzalo Arce[1]; [1]Electrical and Computer Engineering, University of Delaware, USA.* This paper shows the mathematical framework for a new architecture, the Code Aperture Agile Spectral Imaging (CAASI), which extends the capabilities of the Code Aperture Spectral Imaging (CASSI) to allow multiple measurements.

10:00–10:30 Coffee Break/ Exhibits Open, *Ballroom Foyer, Convention Level*

NOTES

Tuesday, 12 July

Salon A	Pier 7/8	Pier 5	Salon C
Fourier Transform Spectroscopy	Hyperspectral Imaging and Sounding of the Environment	Joint AO / SRS	Computational Optical Sensing and Imaging

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

FTuA • Astronomy and Planetary Science—Continued

FTuA5 • 09:40
Pre-Commissioning Status of FTS-2, the SCUBA-2 Imaging Fourier Transform Spectrometer, *Brad Gom[1], David A. Naylor[1], Coskun Oba[1]; [1]Physics, University of Lethbridge, Canada.* We present the installation and pre-commissioning status of FTS-2, the imaging Fourier transform spectrometer for use with SCUBA-2 at the James Clerk Maxwell Telescope, and discuss synergies with the HERSCHEL\SPIRE and SPICA\SAFARI instruments.

HTuA • Merged Imager and Sounder—Continued

HTuA5 • 09:40
Sensitivity of Monthly Cloud Statistics to Space and Time Considerations, *Nadia Smith[1], W. Paul Menzel[1], Elisabeth Weisz[1], Bryan Baum[1]; [1]Space Science and Engineering Center, University of Wisconsin-Madison, USA.* A monthly mean is calculated for MODIS high cloud top pressures (CTP≥440 hPa) at 1.0 degree spatial grid. Results indicate sensitivity to sample size, a function of both time and space. Three threshold methods are compared.

JTuA • Joint AO/SRS Session I: Atmospheric Turbulence; Adaptive Optics Systems; Image Analysis—Continued

JTuA5 • 09:40
Correct Normalization Of Scintillation Autocovariance for Generalized SCIDAR: Theory and Application, *Remy Avila[1,2]; [1]Centro de Física Aplicada y Tecnología Avanzada, Universidad Nacional Autonoma de Mexico, Mexico; [2]Centro de Radioastronomía y Astrofísica, Universidad Nacional Autonoma de Mexico, Mexico.* I present the theory for the correct normalization of scintillation autocovariance for the generalized SCIDAR and the application to turbulence profile measurements at San Pedro Martir Astronomical Observatory.

CTuA • Imaging with Scattering and Aberrations—Continued

CTuA4 • 09:40
Mitigation of Optical Aberrations Using Binary-Amplitude Masks and Digital Image Processing, *Gonzalo Muyo[1], Tom Vettenburg[1], Andy R. Harvey[1]; [1]Electrical Engineering, Heriot-Watt University, United Kingdom.* We report the design of binary-amplitude masks that in conjunction with digital restoration enable mitigation of optical aberrations. Essentially, the design process aims to reduce destructive interferences in the optical transfer function.

10:00–10:30 Coffee Break/ Exhibits Open, *Ballroom Foyer, Convention Level*

NOTES

Pier 4 | Salon B | Salon A

Application of Lasers for Sensing & Free Space Communication | Joint IS / AIO | Fourier Transform Spectroscopy

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

Tuesday, 12 July

10:30–12:10
LTuB • Network Technologies
Juan Juarez; John Hopkins, United States, Presider

LTuB1 • 10:30 Invited
Diversity Rateless Round Robin for Networked FSO Communications, *Roger A. Hammons[1], Frederic Davidson[1]; [1]APL, John Hopkins University, USA.* In this paper, we show how the Rateless Round Robin protocol can be applied in a free space optical communications network. We discuss explicit code designs for the Rateless Round Robin packet-level coding and show how the Rateless Round Robin can be extended to make integrated use of diversity to further enhance performance.

LTuB2 • Withdrawn Invited

LTuB3 • 11:50
Customized Bit Error Rate (cBERT) Tester for Characterizing Frequent Fade Communications Channels, *James L. Riggins[1], Joseph E. Sluz[1], Juan C. Juarez[1], David W. Young[1]; [1]Johns Hopkins University Applied Physics Laboratory, USA.* Posited, a custom BERT (cBERT) that provides stats for faded channels. The cBERT has BER and histogram statistics to measure error distributions, thru-put, and packet error rates for network protocol design. Results of a 10Gb FSO test covered.

12:30–14:00 Lunch *(On Your Own)*

10:30–12:30
JTuB • Joint AIO/IS/LS&C Poster Session

JTuB1
High Speed 2D Optic Image Measurement System, *Lu Zongqing[1], Jun Cheng[1], Liao Qingmin[2]; [1]Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China; [2]The Graduate School at Shenzhen, Tsinghua University, China.* Objectives of the project are to develop a high speed 2D optic image measurement system. we have to meet three problems: very short exposure time, fast marks matching and fast image nonlinear filtering, lens deformation correction.

JTuB2
Description and Performance of CrystalEyeCam II Radiographic Camera for Use in Shock Physics Experiments, *David Partouche-Sebban[1], Isabelle Abraham[1], Carole Missault[1]; [1]CEA, DAM, DIF, France.* We have developed a new radiographic camera (called CrystalEyeCam II) for use in shock physics experiments. The camera includes a scintillator constructed using a specific (patented) technique of assembling monolithic scintillating crystals.

JTuB3 • Withdrawn

JTuB4 • Withdrawn

JTuB5
FDTD Opto-Electrical Methodology Applied to CMOS Image Sensor: from QE to White Light, *Flavien Hirigoyen[1], Axel Crocherie[1], Pierre Boulenc[2], Jérôme Vaillant[3], Didier Hérault[1], Clément Tavernier[2]; [1]TRD/TLM Imagers, STMicroelectronics, France; [2]TRD/STD, STMicroelectronics, France; [3]Imaging Division, STMicroelectronics, France.* We propose in this paper to demonstrate the advances of our 3D FDTD-based optical methodologies applied to CMOS image sensors. Diffraction and carriers diffusions are rigorously described to extract final white light illumination performance.

JTuB6
Image Quality Estimate of a Head Mounted Display for Low Vision Aids, *Jean-Francois Lavigne[1], Fabien Claveau[1], Stephane Melancon[1], François Lagacé[1], Mélanie Leclerc[1], Donald Prevost[1]; [1]Institut national d'optique, Canada.* The image quality of a HMD apparatus composed of a camera, a data processing chain, a display and a reimaging optical element is evaluated. Its most problematic components are identified for further improvement.

JTuB7
Color Spaces Analysis of Photoelasticity Images of Plastics Thin Films, *Alejandro Restrepo[1], Francisco Lopez[1]; [1]ITM, Colombia.* This paper presents preliminary studies of RGB and HSV color spaces analysis for polarized light images of plastic films under tensile deformation. The results obtained show a tool for differentiating phenomena of deformation analyzing plastics.

JTuB8
Propagation of Radial Gaussian-Schell Model Beam Array in Non-Kolmogorov Turbulence, *Hua Tang[1], Baolin Ou[1], Bin Luo[2], Hong Guo[2], Anhong Dang[2]; [1]School of Electronics and Information Engineering, Beihang University, China; CREAM Group, State Key Laboratory of Advanced Optical Communication Systems and Networks and Institute of Quantum lectronics, School of Electronics Engineering and Computer Science, Peking University, China.* The propagation spreading of improved radial Gaussian-Schell model beam array in non-Kolmogorov turbulence is investigated. Influences of ring radius and generalized exponent are studied. An optimum ring radius is suggested.

JTuB9
Spreading of Linear Gaussian Beam Array in Non-Kolmogorov Turbulence, *Hua Tang[1], Baolin Ou[1], Bin Luo[2], Hong Guo[2], Anhong Dang[2]; [1]School of Electronics and Information Engineering, Beihang University, China; [2]CREAM Group, State Key Laboratory of Advanced Optical Communication Systems and Networks and Institute of Quantum Electronics, School of Electronics Engineering and Computer Science, Peking University, China.* Spreading of linear Gaussian beam array is analyzed, and optimum separation distance is proposed, which decreases with the increase of beam number. The optimizing effect is proved existed within certain travelling distance.

10:30–12:10
FTuB • IFTS in Astronomy
Jean-Pierre Maillard; Institut d'Astrophysique de Paris, France, Presider

FTuB1 • 10:30 Invited
In-orbit Performance of the Imaging Fourier Transform Spectrometer of the Herschel Space Observatory, *David A. Naylor[1]; [1]on behalf ot the SPIRE team, Univ. of Lethbridge, Canada.* The imaging spectroscopic capability of the SPIRE instrument onboard ESA's Herschel mission is provided by an imaging FTS. Results from the in-orbit performance of SPIRE are presented and conformance with its design specifications is reviewed.

FTuB2 • 11:10 Invited
SITELLE, a wide-field Imaging FTS at the CFH Telescope, *Frédéric Grandmont[1], Laurent Drissen[2], Simon Thibault[2]; [1]Remote Sensing, ABB, Canada; [2]Physique, Université Laval, Canada.* This paper gives an overview of SITELLE, one of the three instruments planned for CFHT in the 2013-2020 era. SITELLE is a UV-VIS-NIR wide-field imaging Fourier transform spectrometer optimized for astronomical observations of extended objects.

FTuB3 • 11:50
Retrieving a High Resolution Spectrum from a Moving Target in an Imaging FTS for Astronomy, *Ahmed Mahgoub[1], Thanh Nguyen[2], Raphael Desbiens[3], Andre Zaccarin[4]; [1]Electrical, Laval university, Canada; [2]Electrical, Laval university, Canada; [3]ABB Bomem, Canada; [4]Electrical, Laval university, Canada.* Motion estimation is used to align the frames resulting from an imaging FTS for astronomy scanning a moving target. An off-axis correction algorithm is then applied on the resulted spectrum to correct for the non uniform off-axis distortion.

12:30–14:00 Lunch *(On Your Own)*

Pier 7/8

Hyperspectral Imaging and Sounding of the Environment

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

10:30–12:30
HTuB • MODIS
Mitchell Goldberg; NOAA\NESDIS, United States, Presider

HTuB1 • 10:30 Invited
MODIS Cloud Optical Property Retrieval Uncertainties Derived from Pixel-Level Radiometric Error Estimates, *Steven Platnick[1], Xiaoxiong Xiong[1], Galina Wind[2]; [1]NASA/GSFC, USA; [2]SSAI, USA.* MODIS retrievals of cloud optical properties employ a well-known VNIR/SWIR solar reflectance technique. We evaluate the retrieval uncertainty to pixel-level (scene-dependent) radiometric error estimates as well as other tractable error sources.

HTuB2 • 11:10
The Next Generation of Ice Cloud Bulk Scattering/Absorption Models at Visible through Infrared Wavelengths, *Bryan A. Baum[1], Ping Yang[2], Andrew J. Heymsfield[3]; [1]Space Science and Engineering Center, University of Wisconsin-Madison, USA; [2]Department of Atmospheric Science, Texas A&M University, USA; [3]National Center for Atmospheric Research, USA.* Recent improvements are detailed regarding the development of ice cloud bulk scattering models based on a comprehensive set of microphysical in situ measurements and a set of modeled ice particles used for light scattering calculations.

HTuB3 • 11:30
An Assessment of Differences Between Cloud Effective Particle Radius Retrievals for Marine Water Clouds from Three MODIS Spectral Bands, *Zhibo Zhang[1], Steven Platnick[2]; [1]GEST, University of Maryland, USA; [2]GSFC, NASA, USA.* MODIS provides three separate retrievals of cloud particle effective radii (re). In this study, differences among the three re retrievals for maritime water clouds (designated as re,1.6 re,2.1 and re,3.7) were systematically investigated.

HTuB4 • 11:50
Regaining MODIS Aerosol Retrievals for Excessive Thin Cirrus Screening Cases over Water Vapor Deficit Regions, *Jingfeng Huang[1,2], Christina N. Hsu[2], Si-Chee Tsay[2], Myeong-Jae Jeong[3], Richard A. Hansell[4,2]; [1]Goddard Earth Sciences and Technology Center, University of Maryland Baltimore County, USA; [2]Goddard Space Flight Center, National Aeronautics and Space Administration, USA; [3]Department of Atmospheric & Environmental Sciences, Gangneung-Wonju National University, Democratic People's Republic of Korea; [4]Earth System Sciences Interdisciplinary Center, University of Maryland Baltimore County, USA.* A joint use of the reflectance ratio between 1.38µm and 0.66µm (RR1.38/0.66) and the brightness temperature difference between 11µm and 12µm (BTD11-12) are discussed to regain aerosol retrieval over thin cirrus over-screening regions.

HTuB5 • 12:10
Cirrus Retrievals with the MODIS 1.38 µm Channel: Algorithm, Uncertainties, and Evaluation, *Kerry Meyer[1,2], Steven Platnick[2]; [1]GEST/UMBC, USA; [2]NASA/GSFC, USA.* Ice cloud optical thickness retrievals using the 1.38 µm MODIS channel will be discussed. Retrieval components and results are evaluated with the MODIS cloud product, as well as with CALIPSO.

Pier 5

Adaptive Optics: Methods, Analysis and Applications

10:50–12:30
ATuA • Wavefront Sensing
Erez Ribak; Technion Israel Inst. of Technology, Israel, Presider

ATuA1 • 10:50
Evaluation of the Performance of Centroiding Algorithms with Varying Spot Size: Case of WFS Calibration for the TMT NFIRAOS, *Vyas Akondi[1,2], Brent Ellerbroek[3], Roopashree M.b[1], David R. Andersen[4], Raghavendra Prasad Budihala[1]; [1]Laser Lab, CREST, Indian Institute of Astrophysics, India; [2]Department of Physics, Indian Institute of Science, India; [3]Thirty Meter Telescope, USA; [4]NRC-HIA, Canada.* In this AO system, a low-bandwidth truth wavefront sensor detects biases in the laser-guide-star-based wavefront measurement, arising from uncertainties in the sodium layer profile. Here, the performance of centroiding algorithms was compared.

ATuA2 • 11:10
Impact of Under-Sampling on Centroiding Methods for Wavefront Sensing on Extended Guide Sources, *Damien Gratadour[1], Eric Gendron[1], Gérard Rousset[1]; [1]Université Paris Diderot / LESIA Observatoire de Paris, France.* We study the impact of undersampling on various centroiding methods for wavefront sensing on an elongated spot. Because of its robustness against model errors, correlation appears to be the best option for extreme elongations.

ATuA3 • 11:30
Measuring the Stroke Performance of a Ferrofluid Based Deformable Mirror by Fourier Transforms of Shack-Hartmann Spot Patterns, *Denis Brousseau[1], Ermanno F. Borra[1], Simon Thibault[1]; [1]Universite Laval, Canada.* We describe how we measured large actuator strokes, produced by a magnetic liquid deformable mirror, by Fourier demodulation of the Shack-Hartmann spot images using basic MATLAB® commands.

ATuA4 • 11:50
Multi-Dither Shack Hartmann Sensor for Large Telescopes: A Numerical Performance Evaluation, *Vyas Akondi[1,2], Roopashree M.b[1], Raghavendra Prasad Budihala[1]; [1]Laser Lab, CREST, Indian Institute of Astrophysics, India; [2]Department of Physics, Indian Institute of Science, India.* Wavefront reconstruction accuracy strongly depends on the way the wavefront distortion points match the wavefront sensing locations. A multi-dither sensor largely improves the wavefront reconstruction accuracy in large telescope AO systems.

ATuA5 • 12:10
Automated ROI Selection and Calibration of a Microlens Array Using A MEMS CDM, *Roopashree M b[1], Vyas Akondi[1,2], Raghavendra Prasad Budihala[1]; [1]Laser Lab, CREST, Indian Institute of Astrophysics, India; [2]Department of Physics, Indian Institute of Science, India.* A method of automated selection of region of interest for sensing using a microlens array by imposing Zernikes on a 140 actuator deformable mirror is presented. The positional sensitivity and optimal noise removal techniques are investigated.

Salon C

Computational Optical Sensing and Imaging

10:30–12:30
CTuB • PSF Engineering and Pupil Encoding
Michael Stenner, MITRE Corporation, United States, Presider

CTuB1 • 10:30
Phase Transfer Function of Sampled Imaging Systems, *Vikrant R. Bhakta[1], Manjunath Somayaji[1], Marc P. Christensen[1]; [1]EE, Southern Methodist University, USA.* We analyze the effects of aliasing and sampling phase on the PTF of sampled imaging systems. We present an image-based PTF estimation method and propose through-focus PTF as a tool for characterizing wavefront coding imagers.

CTuB2 • 10:50
Phase Mask Fabrication for Pupil Encoding in Computational Optical Imaging, *Sean Quirin[1], Ginni Grover[1], Rafael Piestun[1]; [1]Department of Electrical, Computer, and Energy Engineering, University of Colorado, Boulder, USA.* Phase masks are used in computational optical imaging for pupil encoding and point spread function (PSF) engineering. Continuous surface relief masks are fabricated by maskless lithography and demonstrated in double-helix PSF systems.

CTuB3 • 11:10
Frequency Content of the Double-Helix PSF for 3D Microscopy in the Presence of Spherical Aberration, *Sreya Ghosh[1], Chrysanthe Preza[1]; [1]Electrical and Computer Engineering, The University of Memphis, USA.* We examine the Fourier content of the double helix point-spread function (DH-PSF) by computing the DH optical transfer function (OTF). DH-OTFs are compared to OTFs of conventional fluorescence microscopy in the presence of spherical aberration.

CTuB4 • 11:30
Weighted Average Auxiliary System for Parallel Optics, *Iftach Klapp[1], David Mendlovic[1]; [1]Physical Electronics, Tel Aviv University, Israel.* Space variant image restoration is often limited by the matrix condition of the optical system. We introduce a new approach to improve matrix condition, by designing a "Rim-ring" phase mask for parallel optics.

CTuB5 • 11:50
Full-Resolution Light-Field Single-Shot Acquisition with Spatial Encoding, *Ryoichi Horisaki[1], Jun Tanida[1]; [1]Osaka University, Japan.* We show a method for single-shot acquisition of spatially and angularly full-resolution light-field with spatially coded point spread functions. The system was demonstrated by numerical experiments.

CTuB6 • 12:10
Field-of-View Extension Using Code-Division-Multiple-Access Technique: Numerical Analysis, *Zahra Kavehvash[2], Khashayar Mehrany[2], Saeed Bagheri[1]; [1]IBM T J Watson Research Center, USA; [2]Sharif University of Technology, Islamic Republic of Iran.* We discuss the use of code-division-multiple-access technique for enhancing the field-of-view in 3D imaging and display. This approach is numerically analyzed and simulations show measurable improvements in the quality of final 3D image.

Tuesday, 12 July

12:30–14:00 Lunch *(On Your Own)*

Pier 4

Application of Lasers for Sensing & Free Space Communication

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

14:00–16:20
LTuC • Information Assurance in Quantum Communications II
David Hughes; Air Force Research Labs, United States, Presider

LTuC1 • 14:00 Invited
Authentication of Quantum Messages, *Patrick Hayden[1,2], Debbie Leung[1,3], Dominic Mayers[3]; [1]McGill University, Canada; [2]University of Waterloo, Canada; [3]Caltech, USA.* We show that the protocolin is universal composably secure, and most of the required key can be reused with universal composable security.

LTuC2 • 14:40 Invited
Defeating Eavesdropping with Quantum Illumination, *Jeffrey Shapiro[1]; [1]Research Laboratory of Electronics, Massachusetts Institute of Technology, USA.* Theory has shown that quantum illumination can defeat passive eavesdropping on a two-way communication protocol. We report a preliminary experiment to demonstrate that immunity, and extend the analysis to minimizing vulnerability to active attacks.

LTuC3 • 15:20 Invited
MIMO FSO Communications in Cloud and Turbulence, *Mohsen Kavehrad[1], Jarir Fadlullah[1], Zeinab Hajjarian[1]; [1]Pennsylvania State University, USA.* FSO communications can facilitate secure broadband airborne communications with enormous rates. However, atmospheric phenomena drastically degrade performance. Here, improvements achievable with MIMO FSO systems are presented.

LTuC4 • 15:40 Invited
Special Beam Arrays for Scintillation Reduction, *Greg Gbur[1]; [1]Univ. of North Carolina at Charlotte, USA.* A number of spatial coherence-related strategies are considered for the reduction of optical beam scintillation in turbulence. Among these are Bessel beam arrays, Airy beam arrays, and nonuniform polarization.

Pier 3

Applied Industrial Optics: Spectroscopy, Imaging, & Metrology

14:00–16:00
AITuB • Optical Metrology
Sean Christian; Optrology, Inc., United States, Presider

AITuB1 • 14:00 Invited
Optical Current Sensing, *Paul Duncan[1]; [1]8544 Electric Ave, USA.* Abstract Not Available

AITuB2 • 14:40 Invited
Evolution of a Planar Waveguide Interferometric Sensor, *Daniel Campbell; GTRI, USA.* Planar waveguides interferometers provide a commercially viable sensor technology for the detection of an array of chemical and biological species. This presentation will follow the progress of one interferometric sensor from its inception to its current status.

AITuB3 • 15:20
Optical Methods for Sensing Temperature, *Rami Reddy Bommareddi[1]; [1]Physics, Alabama A&M University, USA.* Temperature sensing is critical in some special cases. Different optical techniques based on interferometry, fluorescence lifetime sensing, fluorescence ratio method and photothermal deflection techniques will be discussed.

AITuB4 • 15:40
Surface Metrology using an Elastomeric Sensor, *Micah K. Johnson[1], Edward H. Adelson[1]; [1]CSAIL, MIT, USA.* We describe a method for measuring microscopic surface topography using an elastomeric sensor combined with machine vision. The system is fast, low-cost, and offers micron-scale resolution.

Salon A

Fourier Transform Spectroscopy

14:00–16:00
FTuC • IFTS in Atmospheric Research and Air Quality Control
Akihiko Kuze; Japan Aerosapce Exploration Agency, Japan, Presider

FTuC1 • 14:00 Invited
PREMIER - A Candidate ESA Mission For UTLS Research, *Johannes Orphal[1]; [1]Karlsruhe Institute of Technology (KIT), Germany.* PREMIER is one of three candidate ESA Earth Explorer mission concepts currently undergoing feasibility studies and related science activities. The objective of the mission is to make global high resolution observations of mid / upper tropospheric and lower stratospheric composition.

FTuC2 • 14:40
Progress with GLORIA, *Felix Friedl-Vallon[1]; [1]IMK, KIT, Germany.* The hardware status of the airborne GLORIA imaging FTS is outlined. A summary of characterization and performance tests with the first flight model of the instrument and the campaign planning is presented.

FTuC3 • 15:00
Pre-Flight Performance Assessment and Environmental Testing of the GLORIA Airborne Imaging FTS, *Erik Kretschmer[1]; [1]Institut für Meteorologie und Klimaforschung, Karlsruher Institut für Technologie, Germany.* The GLORIA airborne FTS is undergoing environmental and performance testing in preparation for its fall 2011 campaign. The test bed is presented along with testing results. Initial performance assessment of the spectrometer is discussed.

FTuC4 • 15:20 Invited
Remote Sensing of Gases and Liquids by Imaging Infrared Fourier-Transform Spectroscopy, *Roland Harig[1]; [1]Technische Universität Hamburg-Harburg, Germany.* Methods and systems for remote sensing of gases in the atmosphere as well as for analysis of liquids have been developed. Analysis methods include a quantification algorithm based on nonlinear modelling of spectra and a parametric model for the instrument line shape. This paper provides an overview of methods, systems, and applications.

16:00–16:30 Coffee Break/ Exhibits Open, *Ballroom Foyer, Convention Level*

Pier 7/8	Pier 5	Salon C
Hyperspectral Imaging and Sounding of the Environment	Joint AO / SRS	Joint COSI / SIS

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

Pier 7/8

14:00–16:00
HTuC • Surface and Atmosphere
Daniel Zhou; NASA Langley Research Center, United States, Presider

HTuC1 • 14:00 Invited
Hyperspectral Detection of Clandestine Graves, *Margaret Kalacska[1]; [1]McGill Univ., Canada.* Abstract Not Available

HTuC2 • 14:40
Full-Scene Surface Reflectance Retrievals, *Jean-Claude Thelen[1], Stephan Havemann[1], Jonathan P. Taylor[1]; [1]UK MetOffice, United Kingdom.* We demonstrate the feasibility of retrieving the reflectance spectra from hyperspectral imagery at speeds comparable to AC schemes by using a fast scattering radiative transfer code in conjunction with a 1D-Var scheme.

HTuC3 • 15:00 Invited
The Eyjafjallajökull Volcanic Ash Plume Over Central Europe: Lidar Observations of Aerosol Composition and Ash-Induced Cloud Modification, *Andreas Macke[1], Albert Ansmann[1]; [1]Leibniz-Institute for Tropospheric Research, Germany.* The optically thickest volcanic ash plume ever measured over Germany was monitored with a multiwavelength Raman lidar. Polarized lidar signals reveal occurrence, type, concentration as well as freezing of supercooled droplets by entrainment of ash particles.

HTuC4 • 15:40
Ultra-Spectral Measurements of Surface Emissivity with an Imaging Interferometer Spectrometer, *William Smith[1], Leanne West[2], Gary Gimmestad[2], Sarah E. Lane[2]; [1]Hampton University/U. of Wisconsin, USA; [2]Georgia Tech Research Institute, USA.* Surface emissivity and skin temperature measurements were conducted with the Telops Hyper-Cam imaging spectrometer for a scene consisting of wet, dry, and ice covered concrete and a wet, dry, and ice covered non-skid surfaces.

Pier 5

14:00–16:00
JTuC • Joint AO/SRS Session II: Wavefront Estimation and Image Analysis
Chris Dainty; National Univ. of Ireland Galway, Ireland, Presider

JTuC1 • 14:00 Invited
Image Reconstruction in Optical Interferometry, *Eric Thiébaut[1]; [1]AiRi, Centre de Recherche Astrophysique de Lyon, France.* Inverse problem approach is a suitable framework to analyze the issues in image reconstruction from interferometric data. It can be exploited to describe and formally compare the new methods specifically developed for optical interferometry.

JTuC2 • 14:40
Improving Retinal Resolution by Multiple Oversampling, *Nizan Meitav[1], Erez N. Ribak[1]; [1]Physics, Technion, Israel.* We take advantage of ocular saccades to average out some of the high order aberrations. Combining a long sequence of oversampled retinal images we were able to resolve single cells outside the fovea.

JTuC3 • 15:00
Measurement of Packing and Spacing of Photoreceptors, *Nizan Meitav[1], Erez N. Ribak[1]; [1]Physics, Technion, Israel.* We developed two automated methods for measuring the hexagon size and the fraction of hexagonally packed cones. Density is mostly set by adjacent cones, decreasing with eccentricity. High frequencies are also being sampled in the periphery.

JTuC4 • 15:20
Adaptive Optics Enabled Wavefront Diversity Sensing, *Allan Wirth[1], Robert Gonsalves[2], Andrew Jankevics[1]; [1]Xinetics, Inc., USA; [2]Tufts University, USA.* Phase diversity has proven a viable technique for wavefront sensing but converges too slowly for real-time applications. The small wavefront changes in a closed loop system allow much more rapid convergence.

JTuC5 • 15:40
Joint-Optimization of Phase-Diversity and Adaptive Optics, *Visa Korkiakoski[1], Christoph Keller[1], Niek Doelman[2], Rufus Fraanje[3], Michel Verhaegen[3]; [1]Utrecht University, Netherlands; [2]TNO Science and Industry, TNO, Netherlands; [3]Delft Center for Systems and Control, Delft TU, Netherlands.* We demonstrate the potential of joint-optimization of adaptive optics (AO) and phase-diversity (PD). The wavefront sensor information reduces computational costs by a factor of 20, and PD can reconstruct much better the AO corrected images.

Salon C

14:00–16:00
JTuD • Joint COSI/IS Session I: Computational Photography
Rafael Piestun; University of Colorado, United States; Edward H. Adelson; MIT, United States, Presiders

JTuD1 • 14:00 Invited
A Frequency Analysis of Light Transport, *Frédo Durand[1]; [1]MIT Cambridge, USA.* The simulation of light in complex 3D scenes is challenging because of the number of rays that must be simulated. We use a Fourier analysis of the 4D set of rays for insights and acceleration.

JTuD2 • 14:40 Invited
Visualizing and Measuring Detailed Shape And Texture with an Elastomeric Sensor, *Edward H. Adelson[1], Micah K. Johnson[1]; [1]MIT, USA.* We have developed a sensor made of clear elastomer which converts distortion due to a contact with a surface into visual images. Using machine vision techniques, we can quantify the surface properties with great detail.

JTuD3 • 15:20
Plenoptic Principal Planes, *Todor Georgiev[1], Andrew Lumsdaine[2], Sergio Goma[3]; [1]Digital Imaging, Adobe, USA; [2]Computer Science, Indiana University, USA; [3]QCT mmedia R&D and standards, Qualcomm, USA.* We show that the plenoptic camera is optically equivalent to an array of cameras. We compute the parameters that establish that equivalence and show where the plenoptic camera is more useful than the camera array.

JTuD4 • 15:40
3D Imager Design through Multiple Aperture Optimization, *Sri Rama Prasanna Pavani[1], Jorge Moraleda[1], David G. Stork[1], Kathrin Berkner[1]; [1]Ricoh Innovations Inc., USA.* 3D imagers exhibit a tradeoff between device size and accuracy. We design compact and accurate 3D imagers by optimizing subsystem parameters using a multiple-aperture image simulator and an accuracy estimator operating on distorted views.

16:00–16:30 Coffee Break/ Exhibits Open, *Ballroom Foyer, Convention Level*

Pier 4	Pier 3	Salon A
Application of Lasers for Sensing & Free Space Communication	Applied Industrial Optics: Spectroscopy, Imaging, & Metrology	Fourier Transform Spectroscopy

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

Tuesday, 12 July

16:30–18:30
LTuD • Laser Propagation
Larry Stotts, DARPA/STO, United States, Presider

LTuD1 • 16:30 Invited
Coherent Optical Technologies for Free-Space Optical Communication and Sensing, *Guifang Li[1]; [1]Univ. of Central Florida, USA.* Coherent optical detection enabled by digital signal processing (DSP) can be applied to free-space optical communication and sensing. Applications including electronic wavefront correction for communication and diffraction-limited laser energy delivery through turbulent atmosphere will be discussed.

LTuD2 • 17:10 Invited
Far-field Scintillation Reduction Utilizing Gaussian-Schell Model Beams, *Michael Roggemann[1], Kyle Drexler[1]; [1]Elictrical Engineering Dept., Michigan Technological Univ., USA.* Using a controlled Gaussian-Schell Model beam to mitigate turbulence effects has been suggested as a means to improve the statistics of the received signal in long-range freespace optical communications. Specifically we have shown in simulation that by using this transmission method it is possible to decrease the scintillation index in the far-field, regardless of turbulence strength, when compared to the intensity of a fully coherent source in turbulence.

LTuD3 • 17:50
Observations of Channel Reciprocity in Optical Free-Space Communications Experiments, *Ronald R. Parenti[1], Jeffrey M. Roth[1], Jeffrey Shapiro[1], Frederick G. Walther[1]; [1]Lincoln Laboratory, USA.* Since 2008, MIT Lincoln Laboratory has performed a series of field demonstrations of high-bandwidth optical free-space links. Bi-directional scintillation fading measurements have shown near-unity correlation coefficients in all air-to-ground tests.

LTuD4 • 18:10
A Capacity-Based Approach to Receiver Sensitivity for Atmospheric Lasercom Systems, *Andrew Fletcher[1], Todd Ulmer[2], Steven Bernstein[2], Don Boroson[1], David Caplan[1], Scott Hamilton[2], Steven Michael[2], Bryan Robinson[1], Neal Spellmeyer[2]; [1]Optical Communications Technology, MIT Lincoln Laboratory, USA; [2]Advanced Lasercom Systems & Operations, MIT Lincoln Laboratory, USA.* We present an approach to analyzing receiver sensitivity in a fading channel that is rooted in capacity analysis. The approach supports rapid design trades during the early stages of system design.

16:30–18:30
AITuC • Semiconductor Applications
Sri Rama Prasanna Pavani; Ricoh Innovations, United States, Presider

AITuC1 • 16:30 Invited
Optical Inspection and Metrology in Semiconductor Manufacturing, *Mehdi Vaez-Iravani[1]; [1]KLA-Tencor Corp., USA.* This presentation is a short account of the nature of the problem of defect detection on wafers, and the increasing role of physics in evolving techniques to address the problem.

AITuC2 • 17:10 Invited
Improving Yield in Wafer Level Cameras through Specialized Design and Process Monitoring, *Kenny Kubala[1], Robert Bates[1]; [1]Five Focal LLC, USA.* This paper describes the wafer level manufacturing process and an in-line process monitoring algorithm that leverages common image test data to estimate the manufacturing errors in camera modules.

AITuC3 • 17:50 Invited
Diffractive Optics for High Throughput Screening, *Ethan Schonbrun[1]; [1]Rowland Institute for Science, Harvard Univ., USA.* We demonstrate several fluorescence measurement systems based on the integration of diffractive optical lens arrays with microfluidics. These parallel measurement systems enable quantitative analysis at higher throughput than current systems.

16:30–18:30
FTuD • IFTS for Other Applications
Felix Friedl-Vallon; Karlsruher Institut fuer Technologie, Germany, Presider

FTuD1 • 16:30 Invited
IFTS for Turbulent Flow Field Diagnostics, *Kevin C. Gross[1], Pierre Tremblay[2,3], Martin Chamberland[3]; [1]Department of Physics, Air Force Institute of Technology, USA; [2]Centre d'optique, photonique et laser, Université Laval, Canada; [3]Telops, Inc., Canada.* Turbulent flow study could benefit from spatially-resolved spectra. We report a method for imaging FTS which minimizes scene-change artifacts due to rapid, stochastic temperature variations and enables recovery of temperature fluctuation statistics.

FTuD2 • 17:10 Invited
A New Imaging FTS for LWIR Polarization Sensing: Principle and Application, *Jean-Marc Thériault[1], Gilles Fortin[2], Hugo Lavoie[1], Francois Bouffard[1], Paul Lacasse[2], Yan Montembeault[3], Alexandre Vallieres[3], Vincent Farley[3], Martin Chamberland[3]; [1]National Defence, DRDC Valcartier, Canada; [2]AEREX Avionics Inc, Canada; [3]Telops Inc, Canada.* We discuss a new imaging FTIR instrument optimized for spectral polarization sensing. Laboratory results demonstrate the capability of the instrument for the remote detection of surface contamination and its potential for probing fluctuating scenes.

FTuD3 • 17:50
MR-i, High Speed Hyperspectral Imaging Spectroradiometer, *Florent Prel[1], Louis Moreau[1], Stephane Lantagne[1], Christian Vallieres[1], Claude Roy[1], Luc Levesque[1]; [1]ABB Bomem Inc., Canada.* MR-i is a high speed hyperspectral imaging spectroradiometer. It generates spectral data cubes in the MWIR and LWIR and is designed to acquire the spectral signature of various scenes with high temporal, spatial and spectral resolution.

FTuD4 • 18:10
Defining the Specifications of an Imaging Fourier Transform Spectrometer Working in the Far-UV (IFTSUV), *Claudia Ruiz de Galarreta Fanjul[1], Anne Philippon[1], Jean-Claude Vial[1], Jean-Pierre Maillard[2], Thierry Appourchaux[1]; [1]Institut d'Astrophysique Spatiale (IAS), France; [2]Institut d'Astrophysique de Paris (IAP), France.* We present the advancements on the specification and the performance requirements of an imaging Fourier transform spectrometer working in the Ly-α domain (λ=121,567 nm).

19:00–20:30 Welcome Reception, *Metro West Conference Center, 2nd floor*

Pier 7/8	Pier 5	Salon C
Hyperspectral Imaging and Sounding of the Environment	Adaptive Optics: Methods, Analysis and Applications	Joint COSI / SIS

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

16:30–18:10
HTuD • Atmospheric Profiles and Trace Gases
Xu Liu; NASA Langley Research Center, United States, Presider

HTuD1 • 16:30 Invited
PanFTS: Panchromatic Measurements for Unprecedented Vertical Sensitivity and Temporal Resolution of Trace Gases, *Annmarie Eldering[1], Stanley P. Sander[1], Reinhard Beer[1], Jean-Francois Blavier[1], Richard Key[1], David Rider[1], John Worden[1], Kevin Bowman[1], Jessica Neu[1], Vijay Natraj[1], Dejian Fu[1], Geoffrey C. Toon[1], Wesley A. Traub[1]; [1]JPL/California Inst Tech, USA.* The Panchromatic Fourier Transform Spectrometer (PanFTS) instrument is being developed, to meet the science demands of measuring a wide range of trace gases with unprecedented vertical resolution, by sensing the UV, visible, and IR in one instrument.

HTuD2 • 17:10
NASA ESTO IIP Tropospheric Infrared Mapping Spectrometers (TIMS) Demonstration First Deployment on an Airship: Preliminary Results, *John B. Kumer[1], Richard Rairden[1], Aidan Roche[1], Robert Chatfield[2]; [1]ADCS, Lockheed Martin ATC, USA; [2]NASA Ames, USA.* We compare preliminary retrieval from data acquired in airship deployment with ground based data acquired in our IIP demonstration campaign.

HTuD3 • 17:30
Hyperspectral Detection of Aircraft Exhaust, *Leanne West[1], Sarah E. Lane[1], Gary Gimmestad[1], William L. Smith[2], Edward Burdette[1]; [1]Electro-Optical Systems Laboratory, Georgia Tech Research Institute, USA; [2]Hampton University, USA.* Hyperspectral datacubes of passing aircraft are investigated. Of particular interest is the feasibility of detecting aviation hazards in these data. Sub-pixel processing algorithms are implemented, and aircraft exhaust gases have been identified.

HTuD4 • 17:50
Geologically Emitted Gas Identification Using Hyperspectral Data Processing Algorithms, *Edward Burdette[1], Leanne West[1], Sarah E. Lane[1], Kevin Caravati[1]; [1]Georgia Tech Research Institute, USA.* Applying gas plume detection algorithms to LWIR hyperspectral data of a mixed gas cloud emitted continuously from thermal features at Yellowstone National Park, the positive identification of carbon dioxide from among the mixture is reported.

16:30–18:30
AO Postdeadline Session

16:30–18:30
JTuE • Joint COSI/IS Session II: Wide Field of View and Large Format Imaging
Rafael Piestun; University of Colorado, United States; William Rhodes; Florida Atlantic Univ., United States, Presiders

JTuE1 • 16:30 Invited
The Quanta Image Sensor (QIS): Concepts and Challenges, *Eric Fossum[1]; [1]Dartmouth Univ., USA.* New type image sensing paradigm proposed. Based around binary, nano-scale active pixels, called jots, a Quanta Image Sensor (QIS) architecture allows high spatial (>109/sensor) and temporal resolution (>102-103 Hz) of photon strikes on image plane.

JTuE2 • 17:10
A Multiscale, Wide Field, Gigapixel Camera, *Hui Son[1], Daniel L. Marks[1], Eric J. Tremblay[2], Joseph Ford[2], Joonku Hahn[1], Ronald Stack[3], Adam Johnson[3], Paul McLaughlin[4], Jeffrey Shaw[4], Jungsang Kim[1], David J. Brady[1]; [1]Electrical and Computer Engineering, Duke University, USA; [2]Electrical and Computer Engineering, UC San Diego, USA; [3]Distant Focus Corporation, USA; [4]RPC Photonics, Inc., USA.* Recent investigations into high pixel count imaging using multiscale optics have led to a novel optical design for a wide field, gigapixel camera. We review the mechanical design and optical performance of this imager.

JTuE3 • 17:30
Optimizing Microcamera Aperture in Gigapixel Monocentric Multiscale Cameras, *Daniel L. Marks[1], David J. Brady[1], Eric J. Tremblay[2], Joseph Ford[2]; [1]Electrical and Computer Engineering, Duke University, USA; [2]Electrical and Computer Engineering, University of California at San Diego, USA.* Multiscale designs divide the imaging task between a simple objective and many complex microcameras. We study imaging quality as the microcamera aperture size varies from 0.375 to 36 mm with 2 and 50 gigapixel objectives.

JTuE4 • 17:50
Image Formation in Multiscale Optical Systems, *Dathon Golish[1], Esteban Vera[1], Kevin Kelly[2], Qian Gong[3], David J. Brady[3], Michael E. Gehm[1,2]; [1]Electrical and Computer Engineering, University of Arizona, USA; [2]College of Optical Science, University of Arizona, USA; [3]Electrical and Computer Engineering, Duke University, USA.* We present image formation (IF) strategies developed for multiscale imaging systems. In this context, IF takes advantage of significant prior knowledge of array geometry and relies on parallelizable algorithms to handle the high data bandwidth.

JTuE5 • 18:10
Space-Bandwidth Scaling for Wide Field-of-View Imaging, *Predrag Milojkovic[1], Joseph Mait[1]; [1]U.S. Army Research Laboratory, USA.* To examine how the space-bandwidth of imaging systems scale as a function of field-of-view, we extend the analysis for flat focal plane detectors to curved focal plane detectors.

19:00–20:30 Welcome Reception, *Metro West Conference Center, 2nd floor*

Pier 4

Application of Lasers for Sensing & Free Space Communication

Pier 2

Imaging Systems and Applications

Pier 3

Applied Industrial Optics: Spectroscopy, Imaging, & Metrology

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

08:00–10:00
LWA • Naval Applications I
Mike Lovern; SPAWAR, United States; Peter Poirier; SPAWAR Systems Center – Pacific, United States, Presiders

LWA1 • 08:00 Invited

A Tunable Filter for Laser Communication, *Tom Baur[1]; [1]Meadowlark Optics, USA.* We describe the design and measured performance of the largest (470 cm2) wide angular field tunable Lyot optical filter system ever built. It can be calibrated to pass any wavelength of visible light. It is presently calibrated for non-mechanical wavelength tuning to 457 nm, 473 nm and 486.1 nm using liquid crystal variable retarders as the tuning element. The band pass center wavelength can be tuned ±0.2 nm from these center wavelengths in 0.01 nm steps. The band pass full width at half maximum is 0.232 nm at 457 nm and is proportional to the wavelength. The large aperture and wide angular field of view make this system useful for receiving laser communications through a scattering medium in the presence of sunlight.

LWA2 • 08:40 Invited

Blue Light Sources Based on Ti:Sapphire Lasers, *Kevin F. Wall[1]; [1]Q-Peak, Inc., USA.* We review the use of Ti:sapphire lasers to produce blue laser sources with particular emphasis on wavelengths useful for underwater communications. We discuss past designs as well as future prospects.

LWA3 • 09:20 Invited

An Optical Filter for Underwater Laser Communications, *Fred Levinton[1]; [1]NovaPhotonics, USA.* A free space laser communications system operating underwater in the blue-green portion of the electromagnetic spectrum requires a narrow bandwidth, high throughput filter to transmit the laser light and block unwanted background light.

8:00–10:00
IWA • Military Applications I
Dale Linne von Berg; US Naval Research Laboratory, United States, Presider

IWA1 • 08:00 Invited

Taxonomy of Tactical Non-Cooperative Biometry and Opportunities for Research, *Keith Krapels[1]; [1]Army Night Vision Lab, USA.* This paper will explain what tactical non-cooperative biometry means; outline the taxonomies; describe some human signatures; describe sensors which could be employed; and explore a few opportunities for research to meet Army needs in the expanding use space of this relatively new field.

IWA2 • 08:40 Invited

Technology Challenges for Aerial Infrared Imaging for Wide Area Persistent Surveillance, *Mel Kruer; [1]NRL, USA.* There is an exponentially increasing need for airborne surveillance using wide field-of-view sensors providing persistent imagery of conflicted areas. This presentation will discuss technology challenges in the areas of infrared arrays, wide field-of-view optics, lightweight pointing and stabilization, and exploitation capabilities for advanced day/night systems for wide area persistent surveillance.

IWA3 • 09:20 Invited

Adaptive Imaging for ISR Applications, *David V. Wick[1], Brett E. Bagwell[1], Grant H. Soehnel[1]; [1]Sandia National Laboratories, USA.* Imaging intelligence is hindered by the diametrically opposed needs of high resolution and wide area surveillance. Multi-Gigapixel focal plane arrays are one solution, but we have successfully demonstrated adaptive imaging systems as an alternative.

08:00–10:00
AIWA • Spectroscopy
Jess Ford; Weatherford Intl., United States, Presider

AIWA1 • 08:00 Invited

Raman Chemical Imaging of Explosive-Contaminated Fingerprints for Forensic Attribution, *Augustus (Way) Fountain[1]; [1]Aberdeen Proving Ground, USA.* This study shows the ability to identify explosives non-destructively so that the fingerprint remains intact for further biometric analysis. Prospects for forensic examination of contaminated fingerprints are discussed.

AIWA2 • 08:40 Invited

New technologies in Field Soil Survey, *David C. Weindorf[1], Somsubhra Chakraborty[1], Yuanda Zhu[1], John Galbraith[2], Yufeng Ge[3]; [1]School of Plant, Environmental, and Soil Science, LSU AgCenter, USA; [2]Department of Crop and Soil Environmental Sciences, Virginia Tech, USA; [3]Texas Agrilife Research, USA.* Visible near infrared diffuse reflectance spectroscopy (VisNIR DRS) and field portable x-ray fluorescence spectrometry were used to quantify soil parameters on site. Their operational theory and application to soil science are presented.

AIWA3 • 09:20 Invited

A Quantitative UV Chemometric Model for the Determination of Zeaxanthin Cis and Trans Isomers, *Jim Barren[1]; [1]Kalsec Corp., USA.* PLS1 modeling was used for UV/Vis against HPLC data on >300 samples to create a rapid industrial quantification method (correlation $R2 > 0.95$) for the totality and each of the individual isomers of zeaxanthin.

Salon A

Fourier Transform Spectroscopy

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

08:00–10:00
FWA • Static Spectrometers and New Developments I
John Harlander; St. Cloud State University, United States, Presider

FWA1 • 08:00 Invited

Results of SIFTI phase A study: design, budget and performances of a static FT interferometer, *Philippe Hébert[1], E. Cansot[1], C. Pierangelo[1], C. Buil[1], F. Bernard[1]; [1]CNES, France.* We present the phase A study of SIFTI (Static Infrared Fourier Transform Interferometer) led by CNES with TAS-F. This static interferometer is designed to provide high spectral resolution and SNR spectra of the atmosphere.

FWA2 • 08:40

Towards a Handheld Cryogenic FTIR Spectrometer, *Frédéric Gillard[1], Sylvain Rommeluère[1], Florence de la Barrière[1], Guillaume Druart[1], Nicolas Guérineau[1], Yann Ferrec[1], Sidonie Lefebvre[1], Manuel Fendler[3], Jean Taboury[2]; [1]ONERA, France; [2]Laboratoire Charles Fabry, Institut d'optique, France; [3]CEA, France.* A new concept of Fourier-transform interferometer integrated in the focal plane array has been developed. Properties of this element, compact optical design and experimental results obtained with a prototype will be detailed.

FWA3 • 09:00

Infrared Focal Plane Array with a Built-In Stationary Fourier-Transform Spectrometer (MICROSPOC): Physical Limitations and Numerical Solutions, *Yann Ferrec[1], Sylvain Rommeluère[1], Sidonie Lefebvre[1], Céline Benoît[1], Frédéric Gillard[1], Nicolas Guérineau[1]; [1]Onera, France.* Microspoc is a compact Fourier transform spectrometer, with the interferometer integrated on the focal plane array. This paper discusses the way to overcome the limitations due to parasitic interferences inside the active layer of the photodetectors.

FWA4 • 09:20

Low Cost "Laserless" FTIR Spectrometer with Resolution Better Than 0.5 cm-1, *Karl Henrik Haugholt[1], Matthieu Lacolle[1], Kari Anne Bakke[1], Jon Tschudi[1], Atle Honne[1], Olav Storstrom[1]; [1]ICT, SINTEF, Norway.* The traditional He-Ne reference laser is replaced by a low-cost linear encoder in a new FTIR instrument. By oversampling interferogram and encoder signal and then resample, using a correction table, we achieve an RMS sampling error of less than 50nm.

Pier 7/8

Hyperspectral Imaging and Sounding of the Environment

08:00–10:00
HWA • Clouds
Shaima Nasiri; Texas A&M University, United States, Presider

HWA1 • 08:00 Invited

Fast Simulator for Cloud Optical Centroid Pressure, *Joanna Joiner[1]; [1]NASA Goddard Space Flight Ctr., USA.* Here, we describe a fast simulator for satellite-derived cloud optical centroid pressure, a parameter commonly used in trace-gas retrieval algorithms to describe the mean photon pathlength for backscattered sunlight in a cloud.

HWA2 • 08:40

Modeling Infrared Radiances with a Fast, High Spectral Resolution Cloudy-Sky Radiative Transfer Model, *Chenxi Wang[1], Ping Yang[1]; [1]Texas A&M Univ., USA.* A fast, high spectral resolution, cloudy-sky radiative transfer model is developed for simulating cloudy-sky radiances at the TOA by coupling the clear-sky transmittance database with cloud bulk scattering properties.

HWA3 • 09:00 Invited

Applications of Airborne Hyperspectral Remote Sensing for Retrievals of Cloud Properties, *Manfred Wendisch; [1]Leipzig Inst. for Meteorology, Germany.* Hyperspectral measurement techniques in the visible to near infrared wavelength region offer unique possibilities for the remote sensing of clouds from aircraft or satellite. In this presentation two specific fields of cloud observations using hyperspectral reflectivity data are covered.

Pier 5

Adaptive Optics: Methods, Analysis and Applications

08:00–9:40
AWA • Systems II
Robert Johnson; Air Force Research Lab, United States, Presider

AWA1 • 08:00 Invited

Progress Toward Wide-Field Adaptive Optics for Future Extremely Large Telescopes, *Brent Ellerbroek[1]; [1]Instrumentation Department, TMT Observatory Corporation, USA.* We describe recent progress in system design, hardware component development, performance modeling, and lab- and field testing of concepts for ground layer, multi-conjugate, and multi-object adaptive optics for future extremely large telescopes.

AWA2 • 08:40

Robo-AO: An Autonomous Laser Adaptive Optics and Science System, *Christoph Baranec[1], Reed Riddle[1], A. Ramaprakash[2], Nicholas Law[3], Shriharsh Tendulkar[4], Shrinivas Kulkarni[1,4], Richard Dekany[1], Khanh Bui[1], Jack Davis[1], Jeff Zolkower[1], Jason Fucik[1], Mahesh Burse[2], Hillol Das[2], Pravin Chordia[2], Mansi Kasliwal[4], Eran Ofek[4], Timothy Morton[4], John Johnson[4]; [1]Caltech Optical Observatories, California Institute of Technology, USA; [2]Inter-University Centre for Astronomy & Astrophysics, India; [3]Dunlap Institute for Astronomy and Astrophysics, University of Toronto, Canada; [4]Caltech Astronomy Department, California Institute of Technology, USA.* Robo-AO, a fully autonomous, laser guide star adaptive optics and science system, is being commissioned at Palomar Observatory's 60-inch telescope. Here we discuss the instrument, scientific goals and results of initial on-sky operation.

AWA3 • 09:00

Improving LGS Sky Coverage at Gemini North, *Julian C. Christou[1]; [1]Hilo Base Facility, Gemini Observatory, USA.* We report on work being done to operate the GN Altair LGS AO system using PWFS2 to track (i.e. TT correction) with a guide star at 6'-7'from the LGS target as opposed to an NGS TT star within the Altair FoV (25").

AWA4 • 09:20

NFIRAOS —TMT Early Light Adaptive Optics System, *Glen Herriot Herriot[1], David R. Andersen[1], Jenny Atwood[1], Carlos Correia[1], Peter Byrnes[1], Corinne Boyer[2], Kris Caputa[1], Jennifer Dunn[1], Brent Ellerbroek[2], Joeleff Fitzsimmons[1], Luc Gilles[2], Paul Hickson[3], Alexis Hill[1], John Pazder[1], Vlad Reshetov[1], Scott Roberts[1], Malcolm Smith[1], Jean-Pierre Veran[1], Lianqi Wang[2], Ivan Wevers[1]; [1]Herzberg Instituted Astrophysics, Canada; [2]TMT, USA; [3]U. British Columbia, Canada.* NFIRAOS is the early-light facility Adaptive Optics System for the Thirty Meter Telescope. We present the specifications, novel architecture and design of NFIRAOS.

Salon C

Computational Optical Sensing and Imaging

08:00–10:00
CWA • Superresolution
Joseph Mait; US Army Research Laboratory, United States, Presider

CWA1 • 08:00 Invited

Model-Based Metrology of Resist Patterns in Lithography, *Arie J. den Boef[1], Hugo Cramer[1], Paul Hinnen[1], Henry Megens[1], Michael Kubis[1], Maurits van der Schaar[1], Kaustuve Bhattacharyya[1], Noelle Wright[1]; [1]Research, ASML, Netherlands.* A metrology concept is presented that is used for measuring the shape and position of resist patterns in the production of semiconductor devices. Some application examples are presented that demonstrate the capabilities of this concept.

CWA2 • 08:40

Multiplexed Agile Fourier Sampling for Doppler Encoded Excitation Pattern (DEEP) 3D Microscopy, *Daniel Feldkhun[1], Kelvin H. Wagner[1]; [1]ECEE, University of Colorado at Boulder, USA.* A DEEP microscope synthesizes images from Fourier data measured using dynamic structured light and a single-element detector. We describe acousto-optic multiplexed pattern generation and Fourier sampling strategies for tomographic DEEP 3D imaging.

CWA3 • 09:00

Super-resolution via Nonlinearity in Computational Optics, *Christopher Barsi[1], Jason W. Fleischer[1]; [1]Electrical Engineering, Princeton University, USA.* All computational methods suffer from resolution limits due to finite-aperture effects. Using digital holography, we show that nonlinearity surpasses linear limits, as formulated by Abbe, as high-frequency spatial modes mix with low-frequency ones.

CWA4 • 09:20

Limits of 3D Dipole Localization and Orientation Estimation with Application to Single-Molecule Imaging, *Anurag Agrawal[1], Sean Quirin[1], Ginni Grover[1], Rafael Piestun[1]; [1]University of Colorado at Boulder, USA.* A two channel polarization sensitive microscope provides higher Fisher information content than conventional single channel designs, enabling a better estimation of the location and orientation of dipole emitters such as static single molecules.

Pier 4	Pier 2	Pier 3
Application of Lasers for Sensing & Free Space Communication	Imaging Systems and Applications	Applied Industrial Optics: Spectroscopy, Imaging, & Metrology

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

LWA • Naval Applications I—Continued

IWA • Military Applications I—Continued

AIWA • Spectroscopy—Continued

10:00–10:30 Coffee Break/ Exhibits Open, *Ballroom Foyer, Convention Level*

Pier 4	Pier 2	Pier 3	Salon C
Application of Lasers for Sensing & Free Space Communication	Imaging Systems and Applications	Applied Industrial Optics: Spectroscopy, Imaging, & Metrology	Computational Optical Sensing and Imaging

Pier 4

10:30–12:30
LWB • Naval Applications II
Peter Poirier; SPAWAR Systems Center – Pacific, United States; Mike Lovern; SPAWAR, United States, Presiders

LWB1 • 10:30 Invited
Blue-Green Laser Communications in Support of Undersea Dominance: Connecting with the Undersea Network, *Greg Mooradian[1]; [1]QNA TSG, USA.* Considerable progress has been made in Submarine Laser Communications. As Network-Centric operations expand, however, the Navy needs to be a fully integrated part of the Joint Force and communications must be improved to ensure Undersea Dominance.

LWB2 • 11:10 Invited
Pulsed Yb Fiber Laser for Underwater Communications, *Andrew R. Grant[1], Douglas P. Holcomb[1], Thomas H. Wood[1]; [1]LGS Innovations, USA.* We propose using an array of high efficiency, frequency-doubled, pulsed Yb fiber lasers for underwater communications. A 1036.7nm pulsed Yb laser producing over 1mJ of energy in a 30µm core fiber is demonstrated.

Pier 2

10:30–12:30
IWB • Military Applications II
Gisele Bennett; Georgia Tech, United States, Presider

IWB1 • 10:30 Invited
Distributed Aperture Millimeter Wave Imaging, *Christopher A. Schuetz[1], Richard D. Martin[1], Thomas E. Dillon[1], Dennis Prather[2]; [1]Phase Sensitive Innovations, Inc., USA; [2]Electrical Engineering, University of Delaware, USA.* We present advancements of a distributed aperture technique for the realization of a passive millimeter-wave imager based on optical upconversion. Specific advancements realized by the implementation of aperiodic aperture distribution are discussed.

IWB2 • 11:10 Invited
Optical Imaging through Horizontal-Path Turbulence: A New Solution to a Difficult Problem?, *William T. Rhodes[1]; [1]Florida Atlantic Univ., USA.* Imaging through long-path (e.g., several km) turbulence presents difficulties that have until now been largely insurmountable. In this paper we describe a new active-illumination method that we think has good potential for allowing diffraction-limited imaging with large isoplanatic patch size.

Pier 3

10:30–12:30
AIWB • Laser Applications
Joseph Dallas; Avo Photonics Inc., United States, Presider

AIWB1 • 10:30 Invited
New Laser Developments: Approaching Fundamental Limits to Surgery and Biodiagnostics, *R. J. Dwayne Miller[1]; [1]University of Toronto, Canada.* The Picosecond IR Laser (PIRL) Scalpel has finally achieved the promise of lasers for surgery - and may even surpass this goal by opening up molecular level guidance for surgery and biodiagnostics.

AIWB2 • 11:10 Invited
Advances in High Power Fiber Lasers for Defense Applications, *Mike O'Connor[1]; [1]IPG Photonics Corp, USA.* Fiber laser development for defense applications fall into two primary areas: spectrally broad, and spectrally narrow fiber lasers. The former are useful for tactical, close-range applications, and are used as single lasers, or as multiple lasers which are incoherently combined. The latter are being developed for long-range applications, and narrow linewidth is required for either coherent or spectral combining of multiple beams. In this paper, we discuss the recent advances in both types of fiber lasers.

Salon C

10:30–12:30
COSI Postdeadline Session

Wednesday, 13 July

Salon A	Pier 7/8	Pier 5	Salon C
Fourier Transform Spectroscopy	Hyperspectral Imaging and Sounding of the Environment	Adaptive Optics: Methods, Analysis and Applications	Computational Optical Sensing and Imaging

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

FWA • Static Spectrometers and New Developments I—Continued

FWA5 • 09:40
Fourier Transform Spectrometry: The SNR Disadvantage of the Multiplex Architecture, *Alessandro Barducci[1], Donatella Guzzi[1], Cinzia Lastri[1], Paolo Marcoionni[1], Vanni Nardino[1], Ivan Pippi[1]; [1]Istituto di Fisica Applicata "Nello Carrara", Consiglio Nazionale delle Ricerche, Italy.* Recent works revealed unexpected theoretical bounds to the radiometric performance of FTS. These findings, regarding the SNR of FTS as assessed in the interferogram and the spectral domains, are summarized and validated by experimental results.

HWA • Clouds—Continued

HWA4 • 09:40
Improved Profile and Cloud Top Height Retrieval by Using Dual Regression on High-Spectral Resolution Measurements, *Elisabeth Weisz[1], William L. Smith[1,2], Jun Li[1], W. Paul Menzel[1], Nadia Smith[1]; [1]Cooperative Institute for Meteorological Satellite Studies, UW-Madison, USA; [2]Hampton University, USA.* The dual regression method, which is based on the joint use of clear sky and cloudy sky eigenvector regression relations, simultaneously provides an improved definition of the sounding profiles and of cloud altitude.

AWA • Systems II—Continued

AWA5 • 09:40 Withdrawn

CWA • Superresolution—Continued

CWA5 • 09:40
Space-Variant Optical Super-Resolution using Sinusoidal Illumination, *Prasanna Rangarajan[1], Vikrant R. Bhakta[1], Indranil Sinharoy[1], Manjunath Somayaji[1], Marc P. Christensen[1]; [1]Southern Methodist University, USA.* The present work extends the scope of Optical Super-Resolution to imaging systems with spatially-varying blur, by using sinusoidal illumination. It also establishes that knowledge of the space-variant blur is not a pre-requisite for super-resolution.

10:00–10:30 Coffee Break/ Exhibits Open, *Ballroom Foyer, Convention Level*

Salon B

Joint FTS / HISE / AO / COSI

10:30–12:30
JWA • Joint FTS/HISE/AO/COSI Poster Session

JWA1
FTS Measurements of Uranium Emission Lines in the Near-Infrared and their Application to the Search for Earth-Mass Exoplanets, *Stephen Redman[1], James E. Lawler[2], Gillian Nave[1], Lawrence Ramsey[3], Suvrath Mahadevan[3]; [1]Atomic Physics Division, National Institute of Standards and Technology, USA; [2]Department of Physics, University of Wisconsin, USA; [3]Department of Astronomy & Astrophysics, The Pennsylvania State University, USA.* Precise calibrations are needed for high-resolution near-infrared astronomical spectrographs. We have measured the wavenumbers of over 7500 uranium emission lines and used a subset of them to make precise radial velocity measurements.

JWA2
Performance Model of Sitelle, a Wide-Field Imaging FTS for The Study of Visible Emission Lines of Astronomical Objects, *Julie Mandar[1,2], Frédéric Grandmont[2], Simon Thibault[1], Laurent Drissen[1]; [1]Université Laval, Canada; [2]ABB Bomem inc., Canada.* We are developing a dedicated performance model for Sitelle. We study the sensitivity in wavefront and misalignment to choose the best configuration. As Sitelle is particularly sensitive to vibration we analyze the impact of fluctuation in OPD.

JWA3
Ground-based FTIR Measurements and Modeling of Tropospheric Trace Gases Over Toronto, *Cynthia Whaley[1], Kimberly Strong[1], Dylan Jones[1], Daniel Weaver[1]; [1]Physics, University of Toronto, Canada.* Trace gas time series measured with a Bomem DA8 FTIR at the Toronto Atmospheric Observatory are presented. These species are important for air quality and global warming. TAO measurements are compared to GOSAT and GEOS-Chem.

JWA4
Apodization Function Retrieval with an Improved General Expression, *Libing Ren[1], Haoyun Wei[1], Yan Li[1]; [1]Precision Instruments, State Key Laboratory of Precision Measurement Technology and Instruments, China.* To obtain unknow apodization function in target spectrometer, an improved general form for apodization function was proposed. Simulation retrievals for some typical apodization functions show the expression is highly efficient.

JWA5
Concepts of Fourier Transform Spectroscopy Using a Sagnac Interferometer, *Stephen Lipson[1], Eyal Schwartz[1]; [1]Physics, Technion, Israel.* A common path interferometer has exceptional stability. The problem is how to introduce significant variable path difference between counter-propagating beams. Two concepts will be presented. A proposed application is to observational astronomy.

JWA6
Obliquity Effects in the Herschel/SPIRE Imaging Fourier Transform Spectrometer, *Gibion Makiwa[2], Locke D. Spencer[1], David A. Naylor[2], Brad Gom[2]; [1]School of Physics and Astronomy, Cardiff University, United Kingdom; [2]Physics and Astronomy, University of Lethbridge, Canada.* The Herschel/SPIRE imaging Fourier transform spectrometer employs detector arrays at each output port. The effects of divergence within the spectrometer, known as obliquity effects, are discussed within the context of Herschel/SPIRE.

JWA7
Phase Correction of Fourier Transform Spectrometer Interferograms by Optimization of the Local Oscillator Phase Angle Term, *Kathryn J. Conroy[1], K. Paul Kirkbride[2], Charles C. Harb[1]; [1]School of Engineering and Information Technology, University of New South Wales, Australia; [2]Forensic and Data Centres, Australian Federal Police, Australia.* Phase error compensation is an important consideration in Fourier transform spectroscopy, particularly when obtaining background and sample information from one interferogram. A phase angle optimization algorithm is discussed to address this issue.

JWA8
Sampling Jitter Reduction in CCD-Based Imaging FTS with Predictive Centered Triggering of Detector Integration, *Jean-Philippe Déry[1,2], Jérôme Genest[1], Martin Chamberland[2]; [1]Centre d'optique, photonique et laser (COPL), Université Laval, Canada; [2]Telops Inc., Canada.* A new triggering scheme is developed to minimize the non-causal problem of matching delays of the metrology and the IR channels in an IFTS when an integrating camera is used. Predictive OPD-centered integration, challenges and results are presented.

JWA9
Open-Path Large Aperture Static Imaging Spectrometer Measurement System, *Ruyi Wei[1,3], Juanjuan Jing[1,3], Jinsong Zhou[4], Xuemin Zhang[1,3], Sizhong Zhou[2], Qiongshui Wu[5]; [1]Key Laboratory of Spectral Imaging Technology of Chinese Academy of Sciences, China; [2]Xi'an Institute of Optics and Precision Mechanics of Chinese Academy of Sciences, China; [3]Graducate university of Chinese Academy of Sciences, China; [4]Academy of Opto-Electronics of Chinese Academy of Sciences, China; [5]Electronic Information School, Wuhan University, China.* Two open-path Fourier Transform Spectrometer measurement systems based on the Large Aperture Static Imaging Spectrometer (LASIS) are described. Their principles, performances and feasibilities are briefly introduced and discussed.

JWA10
Recovery of Exoplanetary Signals in Re-dispersed Speckle Clutter, *Szymon Gladysz[1], Erez N. Ribak[2]; [1]Asher Space Research Institute, Technion, Israel; [2]Physics, Technion, Israel.* We use a Wynne corrector to radially disperse images of exoplanets while shortening the stellar speckles. This results in a morphological difference between speckles and sources (circles vs. lines). We then apply a matched filter to the data.

JWA11
Kerr-Induced Nonlinear Focal Shift Measurements, *Georges Boudebs[1]; [1]Universite d'Angers, France.* We report on third order optical nonlinear experimental characterization through focal shift measurements. The focus in the nonlinear regime is related to the nonlinear phase shift. Numerical and experimental results are in very good agreement.

Wednesday, 13 July

Pier 4	Pier 2	Pier 3	Salon C
Application of Lasers for Sensing & Free Space Communication	Imaging Systems and Applications	Applied Industrial Optics: Spectroscopy, Imaging, & Metrology	Computational Optical Sensing and Imaging

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

LWB • Naval Applications II—Continued

LWB3 • 11:50 Invited

Parameter Estimates For Free Space Optical Communications, *H. Alan Pike[1], Larry Stotts[2], Paul Kolodzy[3], Malcolm Northcott[4]; [1]Defense Strategies & Systems Inc., USA; [2]Defense Advanced Research Projects Agency, USA; [3]Kolodzy Consulting, USA; [4]AOptix, USA.* We have developed a methodology, successful at predicting key parameters in propagating 1.55 micron laser beams over distances from 10 km to 200 km, including estimating the effectiveness of adaptive optics systems at both end of these links.

IWB • Military Applications II—Continued

IWB3 • 11:50

Optical Turbulence Strength Sensing Using a Video Camera, *Omer Y. Porat[1], Joseph Shapira[1]; [1]Applied Optics Division, Soreq Nuclear Research Center, Israel.* We present a method for remote sensing of the path-average turbulence strength, based on measurement of the angle-of-arrival fluctuations of reflections from a naturally illuminated arbitrary target. Experimental estimation shows reliable results.

IWB4 • 12:10

Cramer-Rao Lower Bound for Passive and Active Imaging Systems, *Jean Dolne[1]; [1]Boeing, USA.* This paper will present results on the fundamental performance of passive and active systems. In the passive Phase diversity mode (PD), we will show how using diversity other than defocus or a combination of multiple diversity functions can improve the performance of phase diversity systems. In the active mode, we will show the fundamental performance of various LADAR systems operating in the Geiger and linear modes.

AIWB • Laser Applications—Continued

AIWB3 • 11:50 Invited

New Wide Angle Electro-Optic Laser Scanners Enable Optical Sensors on Previously Inaccessible Platforms, *Scott Davis; [1]Vescent Photonics Inc., USA.* New wide angle (270 degrees demonstrated), analog, 2-D electro-optic laser scanners will be presented. The low size, weight, and power requirements of these scanners expand the range of platforms that are suitable for optical sensors.

CPDWA • COSI Post deadline Session—Continued

12:30–14:00 Lunch *(On Your Own)*

NOTES

Wednesday, 13 July

Joint FTS / HISE / AO / COSI

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

JWA • Joint FTS/HISE/AO/COSI Poster Session—Continued

JWA12
Improvement of Image Resolution Beyond Classical Limit By Phase-Sensitive Optical Parametric Amplifier, *Zun Huang[1], Doug French[2], Igor Jovanovic[2], Hsueh-Yuan Pao[3]; [1]ECE, Purdue University, USA; [2]Mechanical and Nuclear Engineering, Pennsylvania State University, USA; [3]Lawrence Livermore National Laboratory, USA.* When an optical parametric amplifier (OPA) operated as a phase-sensitive amplifier (PSA) is used for point source imaging, the angular resolution improvement can defeat the classical Rayleigh limit, and approach the de Broglie resolution.

JWA13
Numerical Simulations of Metamaterial-based Infrared Sensor for Remote Environmental Monitoring, *Alexander K. Popov[1], Sergey A. Myslivets[2]; [1]University of Wisconsin-Stevens Point, USA; [2]Institute of Physics, Siberian Division of the Russian Academy of Sciences, Russian Federation.* The possibility of creation of all-optically controlled, remotely actuated, ultraminiature nonlinear-optical sensor which utilizes negative-index metamaterial and can be exploited for the environmental sensing is shown and numerically simulated.

JWA14
Widefield Ultrastable Heterodyne Interferometry Using a Custom CMOS Modulated Light Camera, *Rikesh Patel[1], Matt Clark[1], Samuel Achamfuo-Yeboah[1]; [1]Applied Optics Group, Electrical Systems and Optics Research Division, University of Nottingham, United Kingdom.* A method of detecting optical heterodyne interferometry fringes using a custom CMOS modulated light camera array has been developed. Widefield phase images are generated using quadrature demodulation and are kept stable using a feedback system.

JWA15
Tunable Single Pixel MEMS Fabry-Perot Interferometer, *Annette Rivas[1], John Kerekes[1], Alan Raisanen[1]; [1]Imaging Science, Rochester Institute of Technology, USA.* Typically, MEMS Fabry Perot devices use electrostatic actuation to control mirror spacing and snap in is an issue. A thermally actuated device has been modeled in COMSOL that lifts the mirror through thermal expansion.

JWA16
Aircraft Measurements of the Aerosol Direct Radiative Effect, *Samuel E. LeBlanc[1], Sebastian Schmidt[1], Peter Pilewskie[1]; [1]ATOC and LASP, University of Colorado, USA.* Aerosol relative forcing efficiency obtained from multiple field experiments is used to compare the direct radiative effect of various different aerosol types.

JWA17
Fourier Synthesis in Classical Ghost Imaging, *Tomohiro Shirai[1], Henri Kellock[2], Tero Setälä[2], Ari T. Friberg[3,4]; [1]National Institute of Advanced Industrial Science and Technology (AIST), Japan; [2]Aalto University, Finland; [3]University of Eastern Finland, Finland; [4]Royal Institute of Technology (KTH), Sweden.* We describe an optical setup for performing spatial Fourier filtering in ghost imaging with classical incoherent light. It is shown that phase contrast imaging is possible with this setup to visualize a pure phase object.

JWA18
Pump Actuated Tunable Liquid Lens, *Amir Hassan Firoozi[1], Mohammadreza Maddah[1], Mohammad Hossein Ardekani Baghaei[1]; [1]Department of Electrical Engineering, Semnan University, Semnan, Iran; [2]Department of Physics, Shahid Beheshti University, Tehran, Iran.* A novel liquid-filled lens array design is demonstrated. Liquid lens is sandwiched in transparent flat cell. This Packaged liquid lens created by the vacuum pumping force. It can be tuned either by changing the shape of the liquid-filled lens into bi-convex or meniscus or by changing a filling media with different refractive index via pump actuating. As a result, lens array are less sensitive to vibration and convenient for portable devices compared to previous models.

JWA19
Error Budget and Estimation in Ultraspectral Sounding Retrieval, *Daniel Zhou[1], Allen M. Larar[1], Xu Liu[1], William L. Smith[2,3], Larrabee Strow[4]; [1]NASA Langley Research Center, USA; [2]Hampton University, USA; [3]University of Wisconsin, USA; [4]University of Maryland Baltimore County, USA.* A consistency error analysis scheme through RTM forward and inverse calculations has been developed to estimate the error budget in terms of bias and standard deviation of differences in both radiance and retrieved geophysical parameter domains.

JWA20
Using Rotational Raman Scattering in the Atmosphere for Satellite Retrieval of Aerosol Properties, *Alexander Vasilkov[1], Joanna Joiner[2], Omar Torres[2], Changwoo Ahn[1], Robert Spurr[3]; [1]Science Systems and Applications, Inc., USA; [2]NASA Goddard Space Flight Center, USA; [3]RT Solutions, Inc., USA.* Raman scattering is used for retrieval of aerosol properties from satellite hyperspectral measurements in UV. Comparisons of retrieved aerosol heights and single scattering albedo with CALIOP and OMI data show reasonable agreement.

JWA21
Longwave Radiative Energetics of Mineral Dust Aerosol, *Richard A. Hansell[2,1], Si-Chee Tsay[1], Christina N. Hsu[1], Qiang Ji[2,1], Shaun Bell[4,1], Wu Zhang[5], Jianping Huang[5], Zhanqing Li[3,2], Hong-Bin Chen[6]; [1]NASA Goddard Space Flight Center, USA; [2]ESSIC - University of Maryland College Park, USA; [3]Department of Atmospheric and Oceanic Sciences, University of Maryland, USA; [4]Science Systems and Applications, Inc., USA; [5]College of Atmospheric Sciences, Lanzhou University, China; [6]Institute of Atmospheric Physics, Chinese Academy of Sciences, China.* Longwave direct radiative effects of mineral dust are investigated during previous field campaigns. Surface measurements and radiative transfer modeling are employed for probing dust radiative impacts for regions frequented by dust aerosol.

JWA22
Spectral Calibration of CrIS Instrument On-Orbit, *Denise Hagan[1]; [1]Northrop Grumman Corp., USA.* We describe a method for atmospheric spectral validation of the NPP CrIS, based on MetOp IASI data as proxy for CrIS and OSS forward model calculations.

JWA23
Comparison of IASI AND AVHRR CLOUD Properties in High Latitudes with Coregistered CALIOP AND CPR PRODUCTS, *Lydie Lavanant[1]; [1]MétéoFrance, France.* This paper presents the comparisons of cloud retrievals of IASI and AVHRR with independent CALIOP and CPR measurements. The coregistration period comprises the Antartica ConcordIasi campaign with dropsonde providing in-situ information.

JWA24
Evaluation of Cloud Contamination of Infrared Radiances using Simulated AIRS and IASI Observations, *Sylvain Heilliette[1], Yves Rochon[1], Jacek Kaminski[1]; [1]Environment Canada, Canada.* Simulations performed during the preparation of on Observing System Simulation Experiment are used to estimate quantitatively cloud contamination of AIRS and IASI radiances assimilated in Environment Canada Numerical Weather Prediction System.

JWA25
Validation of IASI Temperature and Water Vapor Retrievals with Global Radiosonde Measurements and Model Forecasts, *Murty G. Divakarla[1], Antonia Gambacorta[2], Christopher Barnet[3], Mitchell D. Goldberg[3], Eric Maddy[2], Tom King[2], Walter Wolf[3], Kexin Zhang[2]; [1]I.M. Systems Group., Inc., USA; [2]Dell, USA; [3]STAR, NOAA/NESDIS, USA.* Atmospheric temperature and water vapor profiles retrieved from the MetOp-IASI instrument were evaluated with global radiosonde measurements and ECMWF analysis. Analysis of information content embedded in these retrievals was also attempted.

JWA26
Solar Adaptive Optics System and Observations at the Hida Observatory, *Noriaki Miura[1]; [1]Computer Sciences, Kitami Institute of Technology, Japan.* We develop a solar adaptive optics system at the Hida Observatory in Japan. We report the details of the system and observation results. Solar images observed with the system demonstrate better contrast and finer structures.

JWA27
Halo Suppression using Phase-Sorting Interferometry, *Johanan L. Codona[1], Matthew Kenworthy[2,1], Michael Hart[1]; [1]Steward Observatory, University of Arizona, USA; [2]Leiden Observatory, Leiden University, Netherlands.* Interferometric measurements of an AO-corrected diffraction halo enables an antihalo servo. Simultaneous WFS measurements and fast speckle images allow measurement and suppression of the underlying complex halo, including non-common-path aberrations.

JWA28
Bilateral Cone Density Distribution Analyzed with a Compact Adaptive Optics Ophthalmoscope, *Marco Lombardo[1], Giuseppe Lombardo[2,3], Domenico Schiano Lomoriello[1], Pietro Ducoli[1], Sebastiano Serrao[1]; [1]IRCCS Fondazione G.B. Bietti, Italy; [2]LiCryL Laboratory, CNR-IPCF Unit of Support Cosenza, Italy; [3]Vision Engineering, Italy.* Parafoveal photoreceptor packing distribution was evidenced to be correlated between fellow eyes in 12 subjects. The systematic mirror symmetric cone packing distribution may be involved in the first step of binocular visual signal processing

JWA29
A/V Ratio as Predicted by Full Width at Half Maximum and by Blood Vessel Tracking in Presence of Ocular Aberrations, *Varis Karitans[1,2], Maris Ozolinsh[1,2], Sergejs Fomins[1,2], Nikita Iroshnikov[3], Andrey Larichev[3]; [1]Department of Ferroelectrics, Institute of Solid State Physics, University of Latvia, Latvia; [2]Department of Optometry and Vision Science, University of Latvia, Latvia; [3]Department of Medical Physics, M.V.Lomonosov Moscow State University, Russian Federation.* Aberrations impact A/V ratio calculated from full width at half maximum. We investigated whether aberrations affect A/V ratio calculated by tracking the vessels. Aberrations changed the A/V ratio. We conclude that aberrations impact A/V ratio.

JWA30
High Resolution Hartmann Wavefront Sensor for EUV Lithography System, *Alessandro Polo[1], Florian Bociort[1], Silvania Pereira[1], Urbach Paul[1]; [1]Imaging Science & Technology, Delft University of Technology, Netherlands.* We discuss the use of a Hartmann Wavefront Sensor as an instrument to measure the aberration in an Extreme Ultraviolet Lithography system. Simulations demonstrate the feasibility and advantages in terms of dynamic range and accuracy.

JWA31
The High-order Mode Conversion Based on Optimization-translation Adaptive Optics, *Hai C. Zhao[1], Xiao Wang[1], Hao Ma[1], Pu Zhou[1], Yan Ma[1], San H. Wang[1], Xiao J. Xu[1]; [1]National University of Defense Technology, China.* We present research on high-order Gaussian laser beam transformation by using adaptive optics (AO) technique. The numerical simulation and experimental results indicate the feasibility of blind-optimization AO in mode transformation system.

12:30–14:00 Lunch
(On Your Own)

Application of Lasers for Sensing & Free Space Communication

Joint AIO / IS

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

14:00–15:40
LWC • Laser Communication/Atmosphere I
Linda Thomas; Office of Naval Research, United States, Presider

LWC1 • 14:00 Invited
The Lunar Laser Communications Demonstration, *Bryan Robinson[1], Don Boroson[1], D. A. Burianek[1], D. V. Murphy; [1]Massachusetts Inst of Tech Lincoln Lab, USA.* The Lunar Laser Communications Demonstration (LLCD) will demonstrate high-rate duplex lasercom between a lunar spacecraft and a ground terminal. We describe the LLCD system architecture and provide an overview of the space- and ground-terminal designs.

LWC2 • 14:40 Invited
Mobile Lasercom Systems Using Modulating Retro-reflectors, *Peter G. Goetz[1], William S. Rabinovich[1], Rita Mahon[1], Mike Ferraro[1], James L. Murphy[1], Michele R. Suite[2], Christopher I. Moore[2], Harris R. Burris[2], Walter R. Smith[2], Warren W. Schultz[3], [1]Optical Sciences Division, [2]Naval Center for Space Technology, [3]Chemistry Division, Naval Research Laboratory, USA.* The use of lasercom on mobile platforms is complicated by the pointing precision required. Modulating retro-reflectors greatly relax pointing requirements, enabling lasercom on a variety of mobile platforms not possible with traditional lasercom.

LWC3 • 15:20
Propagation of a General Multi-Gaussian Schell-Model Beam in Turbulent Atmosphere, *Mehdi Sharifi[1], Bin Luo[1], Yongxiong Ren[1], Anhong Dang[1], Hong Guo[1]; [1]Institute of Quanum Electronics, Peking University, China.* The investigations on propagation of a multi-Gaussian Schell-model beam in turbulent atmosphere reveal that, under certain condition, initial coherence width can be a knob for changing the average intensity profile at the receiver plane.

14:00–15:40
JWB • Joint AIO/IS Session I: Biophotonics
Sean Christian; Optrology, Inc., United States, Presider

JWB1 • 14:00 Invited
Optofluidic Microscopy: Chip-scale imaging cell cytometry, *Changhuei Yang[1], Guoan Zheng[1], Seung Ah Lee[1], Sean Pang[1], Lapman Lee[1], Changhuei Yang; [1]Caltech, USA.* We will discuss our recent work on chip-scale microscopy, including fluorescence and laser-scanning imaging techniques.

JWB2 • 14:40 Invited
Autonomous Hyperspectral Imaging in Real-Time, *Patrick Treado[1], Matthew Nelson[1], Robert C. Schweitzer[1]; [1]ChemImage Corporation, USA.* Hyperspectral imaging sensors for the detection of challenging targets in complex environments are maturing. Hyperspectral imaging sensors generate significant volumes of data that need to be reduced to a manageable form on a timescale that's relevant to its intended use.

JWB3 • 15:20
A Compact Probe for β+-Emitting Radiotracer Detection in Surgery, Biopsy and Medical Diagnostics based on Silicon Photomultipliers, *Christian Mester[1], Claudio Bruschini[1,2], Patricia Magro[1], Nicolas Demartines[2], Vincent Dunet[2], Eugene Grigoriev[4], Anatoli Konoplyannikov[4], Maurice Matter[2], John O. Prior[2], Edoardo Charbon[1,3]; [1]EPFL, Switzerland; [2]CHUV, Switzerland; [3]TU Delft, Netherlands; [4]Forimtech SA, Switzerland.* We present a new probe for radiotracer detection in vivo. The device is based on silicon photomultipliers coupled with a scintillator and wirelessly compensated for supply voltage and temperature variations. The probe is positron sensitive.

16:00–16:30 Coffee Break/ Exhibits Open, *Ballroom Foyer, Convention Level*

Salon A

Fourier Transform Spectroscopy

Pier 7/8

Hyperspectral Imaging and Sounding of the Environment

Salon C

Computational Optical Sensing and Imaging

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

14:00–16:00
FWB • Static Spectrometers and New Developments II
Juliet Pickering; Imperial College London, United Kingdom, Presider

FWB1 • 14:00
Doppler Asymmetric Spatial Heterodyne (DASH) Interferometer from Flight Concept to Field Campaign, *David D. Babcock[1], John Harlander[2], Christoph R. Englert[3], Frederick Roesler[4], Andrew N. Straatveit[1]; [1]Artep Inc., USA; [2]Dept. of Physics, Astronomy and Engineering Science, St. Cloud State University, USA; [3]Space Science Division, US Naval Research Laboratory, USA; [4]Department of Physics, University of Wisconsin-Madison, USA.* Reviewed will be a flight concept for a DASH optical interferometer to passively measure upper atmospheric Doppler winds, a completed laboratory DASH prototype instrument, and current field campaign results.

FWB2 • 14:20
Laboratory and Field Tests of a Doppler Asymmetric Spatial Heterodyne (DASH) Spectrometer for Thermospheric Wind Observations, *John Harlander[1], Christoph R. Englert[2], David Babcock[3], Frederick Roesler[4]; [1]Physics, St Cloud State University, USA; [2]US Naval Research Laboratory, USA; [3]Artep, Inc., USA; [4]University of Wisconsin-Madison, USA.* We describe laboratory and field tests of a Doppler Asymmetric Spatial Heterodyne (DASH) interferometer for upper atmospheric wind observations of the O[1D] 630 nm emission.

FWB3 • 14:40
Miniaturized Mars Methane Monitor (M4): An Ongoing Study of an Instrument Concept, *Christoph R. Englert[1], John Harlander[2], Robert DeMajistre[3], Michael H. Stevens[1]; [1]Space Science Division, Naval Research Laboratory, USA; [2]Dept. of Physics, Astronomy and Engineering Science, St. Cloud State University, USA; [3]Space Department, The Johns Hopkins University Applied Physics Laboratory, USA.* We present a compact, high resolution SHS spectrometer concept to observe methane, water vapor, and carbon dioxide on Mars. It is based on direct viewing of the sun to measure atmospheric, mid-wavelength infrared absorption.

FWB4 • 15:00
A Second Generation Tunable Spatial Heterodyne Spectrometer for Ground-Based Observations of Diffuse Emission Line Targets, *Walter Harris[1], Sona Hosseini[1], Jason Corliss[1]; [1]University of California, Davis, USA.* We report construction and testing of a tunable spatial heterodyne spectrometer that has been installed at the Coudé Auxiliary Telescope on Mt. Hamilton. The instrument combines high sensitivity and resolving power with broadband capability.

FWB5 • 15:20
Development and Field Tests of Narrowband All-Reflective Spatial Heterodyne Spectrometers, *Jason B. Corliss[1,2], Frederick Roesler[1], Walter Harris[2], Edwin Mierkiewicz[1], John Harlander[3]; [1]University of Wisconsin-Madison, USA; [2]University of California Davis, USA; [3]St. Cloud State University, USA.* We describe the design, development and performance tests of a narrow-band, high-resolution all-reflection Spatial Heterodyne Spectrometer tuned to 630nm as a step towards a FUV design that will operate at the 121nm Lyman-alpha line.

FWB6 • 15:40
CoBiSS: Compact Bidimensional Sampling Spectrometer, *Hadjar Yassine[1], Renault Mikael[1], Blaize Sylvain[1], Bruyant Aurélien[1], Arnaud Laurent[1], Lerondel Gilles[1], Royer Pascal[1]; [1]UTT, France.* Novel technology for static Fourier spectrometer based on 2D angle-tilted array of nanostructured glass surface on which light beams interfere in total internal reflection. Near field subwavelength spatial sampling is achieved by tilt angle control.

14:00–16:00
HWB • Spectral Analyses
Martin Mlynczak; NASA Langley Research Center, United States, Presider

HWB1 • 14:00 Invited
Improving Estimates of the Earth's Radiation Budget with Multispectral and Hyperspectral Satellite Observations, *Tristan L'Ecuyer[1], Greg McGarragh[1], Philip Gabriel[1], David Henderson[1]; [1]Atmospheric Science, Colorado State University, USA.* This presentation explores the potential benefits of combining satellite-based hyperspectral radiances with active measurements for refining estimates of the many factors that influence the Earth's radiation budget.

HWB2 • 14:40 Invited
NASA's Future HyspIRI Mission and the EO-1 Hyperion Collections, *Betsy Middleton[1]; [1]NASA Goddard Space Flight Ctr., USA.* NASA's Hyperspectral Infrared Imager (HyspIRI) concept for a global survey mission with two instruments, a visible-shortwave infrared imaging spectrometer (380-2500 nm) and an 8-band multispectral thermal imager, will be described. Also, the ten years (2001-present) of a global sampling mission by a heritage sensor, the Hyperion instrument on Earth Observing-1 satellite, will be summarized.

HWB3 • 15:20 Invited
Quantifying the Information Content of Hyperspectral Cloud Data, *Odele M. Coddington[1], Peter Pilewskie[1], Tomislava Vukicevic[2]; [1]Laboratory for Atmospheric and Space Physics, University of Colorado Boulder, USA; [2]NOAA Atlantic Oceanographic and Meteorological Laboratory, USA.* We quantify the information content of hyperspectral cloud measurements at over 300 narrow spectral bands from the near-ultraviolet to the near-infrared. We use this to evaluate the retrieval wavelengths and their impact on cloud retrievals.

14:00–16:00
CWB • Computational Holography
Demetri Psaltis; EPFL, Switzerland, Presider

CWB1 • 14:00
Gigapixel Synthetic-Aperture Digital Holography: Sampling and Resolution Considerations, *Abbie E. Tippie[1], James Fienup[1]; [1]Institute of Optics, University of Rochester, USA.* A gigapixel array is used for synthetic-aperture digital holography. Considering propagation and sampling requirements, a high-resolution image is reconstructed using sharpness metrics in combination with speckle-averaging independent realizations.

CWB2 • 14:20
High Pixel Count Holography, *Sehoon Lim[1], Daniel L. Marks[1], David J. Brady[1]; [1]ECE, Duke University Fitzpatrick Center for Photonics and Communications Systems, USA.* Relatively low cost focal arrays and the availability of high performance digital processing enable computational holographic imaging on unprecedented scale. This talk describes recent progress in registration and optimization algorithm.

CWB3 • 14:40
Conceptual Basis for Designing Holographic Synthetic Aperture Telescope, *Barak Katz[1], Joseph Rosen[1]; [1]Electrical and Computer Engineering, Ben-Gurion University of the Negev, Israel.* A scheme of Synthetic aperture with Fresnel elements (SAFE) which may be used as a basis for designing synthetic aperture telescopes is proposed. Laboratory indoor experiments provide the proof of concept for such a design.

CWB4 • 15:00
Resolution Analysis of In-line Digital Holography, *Hao Yan[1], Anand Asundi[1]; [1]NANYANG TECHNOLOGICAL UNIVERSITY, Singapore.* Resolution of in-line digital holography limited by pixel averaging effect within the pixel finite detection size, finite CCD aperture size, sampling effect and object extent is investigated by Wigner distribution for the first time.

CWB5 • 15:20
Digital Holographic Imaging of Multi-Phase Flows, *Lei Tian[1], Hanhong Gao[1], George Barbastathis[1,2]; [1]MIT, USA; [2]Singapore-MIT Alliance for Research and Technology (SMART) Centre, Singapore.* In-line digital holography is applied to study multi-phase flows. Caustic formed by bubbles are studied and used to sort different phases in the flows.

CWB6 • 15:40
What is the Reconstruction Range for Compressive Fresnel Holography?, *Yair Rivenson[1], Stern Adrian[1]; [1]Ben-Gurion University of the Negev, Israel.* We discuss some basic guidelines for using the Fresnel transform as a compressive sensing operator. We show that when practicing the compressive Fresnel transform, the reconstruction distance affects the reconstruction result.

16:00–16:30 Coffee Break/ Exhibits Open, *Ballroom Foyer, Convention Level*

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

16:30–18:30
LWD • Laser Communication/ Atmosphere II
Linda Thomas; Office of Naval Research, United States, Presider

LWD1 • 16:30 Invited
A Transportable Atmospheric Testing Suite, *Rita Mahon[1], Christopher I. Moore[2], Harris R. Burris[2], Mike Ferraro[1], Wiliam S. Rabinovich[1], Michel R. Suite[2], Linda Thomas[2]; [1]Code 5654, Naval Research Laboratory, USA; [2]Code 8123, Naval Research Laboratory, USA.* A Transportable Atmospheric Testing Suite (TATS) consisting of sensors to monitor atmospheric turbulence and meteorological parameters over both direct and retroreflected free space optical links is described.

LWD2 • 17:10 Invited
Robust Fiber-to-fiber Free-Space Optical Communications under Strong Atmospheric Turbulences, *Yoshinori Arimoto[1]; [1]Space Communication Systems Laboratory, National Institute of Information and Communications Technology, Japan.* This paper describes the SMF-coupled FSO terminals which use mutual beacon tracking, diffraction limited signal beam pointing and advanced initial beacon acquisition system to provide robust link operation under strong atmospheric turbulences.

LWD3 • 17:50
Free Space Quantum Communication using Continuous Polarization Variables, *Bettina Heim[1,2], Christian Peuntinger[1,3], Christoffer Wittmann[1,3], Christoph Marquardt[1,2], Gerd Leuchs[1,2]; [1]Max Planck Institute for the Science of Light, Germany; [2]Institute of Optics, Information and Photonics and Erlangen Graduate School in Advanced Optical Technologies (SAOT), University of Erlangen-Nuremberg, Germany; [3]Institute of Optics, Information and Photonics, University of Erlangen-Nuremberg, Germany.* We experimentally investigate atmospheric influences on quantum communication using continuous polarization variables. Signal and local oscillator are combined in one spatial mode, which leads to excellent interference at the homodyne detection.

LWD4 • 18:10
Diffraction-Attenuation Resistant Beams, *Leonardo A. Ambrosio[1], Michel Zamboni-Rached[1], Hugo E. Hernández-Figueroa[1]; [1]Department of Microwaves and Optics, DMO, FEEC, Unicamp, University of Campinas, Brazil.* Diffraction-Attenuation Resistant Beams are generated by suitably superposing Bessel beams. We report theoretical results revealing that they can be used not only for short-range applications, but also to overcome atmospheric attenuation in FSO.

16:30–18:30
JWC • Joint AIO/IS Session II: 3D Imaging
Sri Rama Prasanna Pavani; Ricoh Innovations, United States, Presider

JWC1 • 16:30 Invited
SIM and Deflectometry: New Tools to Acquire Beautiful, SEM-like 3D Images, *Gerd Haeusler[1], Markus Vogel[1], Zheng Yang[1], Alexander Kessel[1], Christian Faber[1]; [1]Institute of Optics, Univ. of Erlangen-Nuremberg, Germany.* Structured-illumination microscopy and microdeflectometry acquire the shape of microscopic objects with a noise level down to 1 nanometer, a depth of field 100 times larger than the Rayleigh depth, and slope angles up to 80°.

JWC2 • 17:10 Invited
An Algorithm for High-Speed 3-D Profilometry, *Benjamin Braker[1], Eric Moore[1]; [1]Chiaro Technologies, USA.* Structured light profilometers measure static object shapes but their measurement of moving objects is limited. We present a decoding algorithm which, when used with high-speed hardware, produces high-speed profilometry of general objects.

JWC3 • 17:50 Invited
3D Far-field Optical Nanoscopy and Aperiodic Volume Optics, *Rafael Piestun[1]; [1]Univ. Colorado, USA.* Abstract Not Available

NOTES

Salon A

Joint Fourier Transform Spectroscopy/
Hyperspectral Imaging and Sounding of the Environment

Salon C

Computational Optical Sensing
and Imaging

These concurrent sessions are grouped across two pages. Please review both pages for complete session information.

16:30–18:30
Joint FTS/HISE Postdeadline Session

16:30–18:10
CWC • Other Sensing Modalities
Sapna Shroff, Digital Optics Research group at Ricoh Innovations Inc., United States, Presider

CWC1 • 16:30 Invited
Radiometric Consistency in Source Specifications for Photolithography, *Alan E. Rosenbluth[1], Jaione Tirapu Azpiroz[2], Kafai Lai[2], Kehan Tian[2], David Melville[1]; [1]IBM T.J. Watson Research Center, USA; [2]IBM Semiconductor Research and Development Center, USA.* Mask simulations are made consistent with the brightness theorem if the source map is rescaled by pixel-solid-angle. Standard radiometry factors preserve consistency during propagation, and are derivable from rigorous vector diffraction integrals.

CWC2 • 17:10 Invited
Reconstruction Strategies for Modulated Polarimeters, *Charles F. LaCasse[1], Scott Tyo[1], Russell A. Chipman[1]; [1]University of Arizona, USA.* Modulated polarimeters measure the polarimetric information in an optical field by modulating the intensity in a polarization-dependent way. This modulation creates side bands in Fourier transform space that carry the desired information.

CWC3 • 17:50
Dynamic 3D Measurement for Specular Reflecting Surface with Monoscopic Fringe Reflectometry, *Lei Huang[1], Chiseng Ng[1], Anand Asundi[1]; [1]Nanyang Technological Univerisity, Singapore.* Dynamic full-field 3D measurement of specular surfaces can be conveniently implemented with fringe reflection technique. An experimental study on measuring water wave variations is carried out to demonstrate the feasibility of the proposed approach.

NOTES

Pier 4

Application of Lasers for Sensing & Free Space Communication

08:00–10:00
LThA • Ladar I
Edward Watson; AFRL/RYM, United States, Presider

LThA1 • 08:00 Invited
Haiti 3D Ladar Flights, *Rick Heinrich[1]; [1].* Abstract Not Available

LThA2 • 08:30 Invited
Real-Time 3D Intelligence Products Using the Total Sight™ LiDAR System, *R. Patrick Earhart[1], Roy Nelson[1]; [1]Ball Aerospace and Technologies, USA.* Ball Aerospace has developed Total Sight™, a real-time 3D video-LiDAR system capable of collecting, processing, and streaming color fused digital elevation maps. These maps include basic classification to support various time-critical missions.

LThA3 • 09:00 Invited
Geiger-mode Avalanche Photodiode Focal Plane Arrays for 3D LIDAR Imaging, *Mark A. Itzler[1], Entwistle M. Owens[1], K. Patel[1], X. Jiang[1], K. Slomkowski[1], K. Slomkowski[1], S. Rangwala[1]; [1]Princeton Lightwave, USA.* We describe FPAs based on planar-geometry Geiger-mode avalanche photodiodes designed for single-photon 3D LIDAR imaging systems. We compare new 32x128x50µm format FPAs with 32x32x100µm FPAs for dark count rate, crosstalk performance, and overall pixel yield.

LThA4 • 09:30 Invited
Single Photon Imaging Cameras for 3D Imaging Applications, *Rengarajan Sudharsanan[1,2], Ping Yuan[1], Joseph Boisvert[1]; [1]Boeing Spectralab, USA; [2]Boeing Directed Energy Systems, USA.* Boeing Spectrolab has demonstrated 3D imaging using single photon Geiger-mode cameras operating at 1060 nm wavelength. In this conference we will present status of detector array performance, camera design and performance, and 3D imaging data.

Salon A

Fourier Transform Spectroscopy

08:20–10:20
FThA • Laboratory Spectroscopy
Jerome Genest, Université Laval, Canada, Presider

FThA1 • 08:20 Invited
Optical Multidimensional Fourier Transform Spectroscopy of Atomic Vapors and Semiconductors, *Steven T. Cundiff[1], Galan Moody[1], Hebin Li[1], Alan D. Bristow[1], Mark E. Siemens[1]; [1]JILA, NIST and Univ. of Colorado, USA.* Optical multidimensional Fourier transform spectroscopy excites a sample with a sequence of ultrafast pulses. A spectrum is constructed by taking Fourier transforms with respect to pulse delays, which are interferometrically controlled.

FThA2 • 09:00
High Resolution Molecular Spectroscopy with the Imperial College UV FT spectrometer, *Douglas Blackie[1], Juliet C. Pickering[1], James Rufus[1], Anne P. Thorne[1], Glenn Stark[2], James Lyons[3], Richard Blackwell-Whitehead[4], Peter L. Smith[5]; [1]Physics, Imperial College London, United Kingdom; [2]Department of Physics, Wellesley College, USA; [3]Department of Earth and Space Sciences, Instit. Geophysics and Planetary Physics, UCLA, USA; [4]Lund Observatory, Sweden; [5]Harvard-Smithsonian Center for Astrophysics, USA.* We present high resolution molecular spectroscopy measurements performed at Imperial College: the first high resolution absorption cross sections of the xSO2 isotopologues; and completion of a multi-temperature study of the UV spectrum of SO2.

FThA3 • 09:20
New Atomic Data for Astrophysics by High Resolution Fourier Transform Spectrometry, *Matt Ruffoni[1], Juliet C. Pickering[1], Anne P. Thorne[1], Charlotte Holmes[1], Richard Blackwell-Whitehead[2]; [1]Physics, Imperial College London, United Kingdom; [2]Lund Observatory, Sweden.* New measurements, by high resolution IR-VUV Fourier Transform spectrometry, of accurate atomic data (wavelengths, energy levels, transition probabilities) for astrophysics applications are presented.

FThA4 • 09:40
Spectrum and Energy Levels of Cr II Based On FT Spectra from the VUV to mid-IR, *Craig J. Sansonetti[1], Gillian Nave[1]; [1]Atomic Physics Division, National Institute of Standards and Technology, USA.* We are preparing a precise line list and re-optimized energy levels for the astrophysically important spectrum of singly-ionized chromium (Cr II) based principally on Fourier transform spectra spanning the region 1552 Å to 5.5 µm.

10:00–10:30 Coffee Break/Exhibits Open, *Ballroom Foyer, Convention Level*

10:30–12:15
LThB • Ladar II
Timothy Carrig; Lockheed Martin, United States; Paul McManamon; Exciting Technology, LLC, United States, Presiders

LThB1 • 10:30 Invited
Next Generation Infrared Imaging Sensors, *Andrew Sarangan[1], Josh Duran[1]; [1]Electro-Optics, University of Dayton, USA.* We will describe the advances being made in the different modalities of InSb-based infrared sensors for active imaging, such as avalanche detection, polarimetric and multispectral capabilities using manufacturable technologies.

LThB2 • 11:00 Invited
Considerations for Remote Sensing of Atmospheric Particles, *Tahllee Baynard[1]; [1]Lockheed Martin, USA.* This article discusses remote sensing of atmospheric particles for general monitoring applications which includes detection, mapping, characterization, discrimination, and identification. Details regarding the architecture for real-time information are also included.

LThB3 • 11:30 Invited
Stand-off Biometric Identification using Fourier Transform Profilometry for 2D+3D Face Imaging, *Brian C. Redman[1], Steve J. Novotny[1], Taylor Grow[1], Van Rudd[1], Nathan Woody[1], Michael Hinckley[1], Paul McCumber[1], Nathan Rogers[1], Michael Hoening[1], Kelli Kubala[1], Scott Shald[1], Radoslaw Uberna[1], Tiffanie D'Alberto[1], Thomas Hoft[2], Russell Sibell[3], Frederick W. Wheeler[4]; [1]Lockheed Martin Coherent Technologies, USA; [2]Mathematics, Tufts University, USA; [3]SIBELLOPTICS, USA; [4]GE Global Research, USA.* We developed and tested a Fourier Transform Profilometry, 2D+3D face imager operating with subjects moving at ≤1.5 m/s at ≤25-m range with <1.4-mm resolution and range precision at 1-Hz capture rate using low cost components.

LThB4 • 12:00
NFADs as Single Photon SSPMs, *Mark A. Itzler[1], K. Slomkowski[1], X. Jiang[1]; [1]Princeton Lightwave, USA.* We present results for negative feedback avalanche diodes (NFADs), which are InPbased SWIR solid-state photomultipliers with single-photon sensitivity operated with just a DC bias. We demonstrate photon number resolution for a matrix of NFAD elements.

10:30–12:30
FThB • Comb Techniques
Steven Cundiff; JILA, NIST and University of Colorado, United States, Presider

FThB1 • 10:30 Invited
Fourier Transform Spectroscopy with Laser Frequency Combs, *Birgitta Bernhardt[1], Takuro Ideguchi[1], Antonin Poisson[1], Theodor Hänsch[1], Nathalie Picqué[1], Guy Guelachvili[1]; [1]Max-Planck-Institut für Quantenoptik, Germany; [2]Université Paris-Sud, Mfür Quantenoptik, France; [3]Ludwig-Maximilians-Universität München, Germany.* The millions of precisely controlled laser comb lines produced with a train of ultrashort laser pulses can be harnessed for highly-multiplexed molecular spectroscopy. Fourier transform spectroscopy with frequency combs is emerging as a powerful new tool.

FThB2 • 11:10 Invited
Performance of a Coherent Dual Frequency Comb Spectrometer, *Nathan R. Newbury[1], Esther Baumann[1], Ian Coddington[1], Fabrizio Giorgetta[1], William Swann[1], Alex Zolot[1]; [1]NIST, USA.* We discuss the performance of a coherent dual frequency comb spectrometer in terms of signal-to-noise ratio, resolution, and accuracy based on experimental data in the near and short-wave infrared centered at 1.5 and 3.4 micrometers.

FThB3 • 11:50
Active Fourier-Transform Spectroscopy for Spectral Ranging, *Jérôme Genest[1], Boudreau Sylvain[1], Jean-Daniel Deschênes[1], Martin Godbout[1], Roy Simon[2]; [1]Centre d'optique, photonique et laser, Université Laval, Canada; [2]Tactical Surveillance and Reconnaissance Section, DRDC Valcartier, Canada.* This work reports range-resolved Fourier-transform spectroscopy using stabilized short pulse lasers. Using the proposed approach, one can retrieve the spectral reflectance as well as the distance of diffuse reflectors in a laser ranging experiment.

FThb4 • 12:10
Fourier Transform Multiple-Correlation Spectroscopy with a Frequency Comb in the Presence of Dispersion, *Mounir G. Zeitouny[1], Augustus Janssen[2], Nandini Bhattacharya[1], Stefan Persijn[3], Steven van den Berg[3], Urbach Paul[1]; [1]Imaging science and technology, Delft University of Technology, Netherlands; [2]EE and EURANDOM, Technical University Eindhoven, Netherlands; [3]VSL, Netherlands.* We present a Fourier Transform Infrared spectrometer for use with a frequency comb laser as source. The spectrometer can completely resolve the modes of the frequency comb at 100 MHz.

Key to Authors and Presiders

(**Bold** denotes Presider or Presenting Author)

Imaging and Applied Optics: OSA Optics & Photonics Congress

Postdeadline Papers

ISBN 978-1-55752-929-9

Pier 5
AO Postdeadline Session
Tuesday, July 12, 2011 16:30 - 18:30
Gordon Love; University of Durham, UK, Presider

APDP1 • 16:30

Inverse Problem Approach to the detection of Exoplanets in Multi-Wavelength Data , N. Devaney[1,2], É. Thiébaut[2], [1]*School of Physics, National University of Ireland, Ireland* [2]*Université de Lyon, France.* Images obtained at different wavelengths may be used to discriminate faint exoplanets from residual speckle in the stellar PSF. We have developed an inverse problem approach to fit multi-wavelength data which shows improved detection limits.

APDP2 • 16:50

Practical Implementation of Natural Guide Star Adaptive Optics Point Spread Function Reconstruction on Gemini/Altair & Keck II Systems, *Laurent Jolissaint[1], Julian Christou[2], Chris Neyma[3,] Peter Wizinowich[3], [1]aquilAOptics, Switzerland; [2]Gemini Observatory, USA; [3] W.M. Keck Observatory, USA.* We present the results of the implementation of an Adaptive Optics (AO) Point Spread Function Reconstruction (PSF-R) algorithm on the Gemini-North (Altair) and W.M. Keck systems, for the simplest mode: on-axis bright natural guide star (NGS). We find that unknown telescope, instrument and non-common path aberrations - that are not accounted for in the current model - are as important as the residual turbulence aberrations. We discuss these limitations here and describe our plans to measure and include these unknown aberrations in our model.

APDP3 • 17:10

The Gemini Multi-Conjugate Adaptive System Sees Star Light, *F. Rigaut[1], B. Neichel[1], M. Bec[1], M. Boccas[1], C. D'Orgeville[1], V. Fesquet [1], R. Galvez[1], G.Gausachs[1], G. Trancho[1], C.Trujillo[1], M.Edwards[1], R.Carrasco[1], [1]Gemini Observatory, Chile.* The Gemini Multi-Conjugate Adaptive Optics system (GeMS) has been in commissioning in the first 5 months of 2011. In this paper we present the first results of this commissioning period and plans for the future.

APDP4 • 17:30

Phase Sensor for Solar Adaptive-Optics, *Agla´e Kellerer, [1]Big Bear Solar Observatory, USA.* A new wavefront sensor for solar adaptive optics is presented. The measured quantity is directly proportional to the wavefront phase – no additional computation is required. The method is now being tested on an optical bench.

APDP5 • 17:50

Wavefront sensing in XUV: HHG beam profile measurement, *P. Homer, [1]B. Rus, J. Hrebicek, [1]J.Nejdl; Department of Ultraintense Lasers Physics v.v.i. / PALS Centre, Academy of Sciences of the Czech Republic, Czech Republic.* We will present results of an experiment dedicated to the XUV wavefront profile measurement of the HHG (High-order Harmonic Generation) beam, carried at the PALS laser center. The wavefront sensing has been achieved by using the PDI (Point Diffraction Interferometer) technique. The performance of the developed PDI sensor has been tested with 10-Hz XUV source emitting at the wavelength λ=30nm, generated in Ar gas cell by 300 mJ, 40-fs IR laser pulses. The design and development of this XUV wavefront sensor will also be discussed, showing advantages and limitations of applicability of the PDI technique in the XUV and soft-x-ray spectral region

APDP6 • 18:10

The Use of Adaptive Optics in Imaging the Eyes of Small Animals, *Melanie C. W. Campbell[1,2,3], Marsha L.Kisilak[1,2], Mark Bird[1,2,3], Elizabeth Irving[1,2], [1]Physics & Astronomy, and [2]School of Optometry, University of Waterloo, [3]Guelph Waterloo Physics Institute, Waterloo, Ontario, Canada.* High resolution imaging of a wide variety of animals is important to understanding their vision and to imaging retinal details in animal models of human disease. We discuss the differing requirements and advantages of AO correction across species.

Salon B
Joint FTS/HISE/AO/COSI Poster Session
Wednesday, July 13, 2011 10:30 -- 12:30

JWA32 Postdeadline Poster - AO

Kalman and H-infinity Controllers for GeMS, *I. Rodriguez[1], B. Neichel[2], A. Guesalaga[1], F. Rigaut2, D. Guzman[1], [1]Center for Astro-Engineering, Department of Electrical Engineering, Pontificia Universidad Catolica, Chile; [2]Gemini Observatory, Chile*. GeMS is the Gemini Multi-conjugate System. The system includes 5 Laser Guide Stars, 3 Natural Guide Stars, 3 Deformable Mirrors 1 Tip-Tilt Mirror. In this paper we focus on the control of the Tip-Tilt loop. Two new controllers have been implemented and tested, namely Kalman and H-infinity. We demonstrate that these controllers provide the means to efficiently attenuate vibration or certain frequency bands for GeMS.

Salon C
COSI Postdeadline Session
Wednesday, July 13, 2011 10:30 -- 11:30

Micheal Gehm, University of Arizona, USA, Presider

CPDP1 • 10:30

Adaptive Periodic-Correlation Algorithm for Extended Scene Shack-Hartmann Wavefront Sensing, *Erkin Sidick, Jet Propulsion Laboratory, California Institute of Technology, USA*. We present an adaptive periodic-correlation algorithm for large dynamic range extended-scene Shack-Hartmann wavefront sensing. We show that it accurately measures very fine image shifts over many pixels under a variety of practical imaging conditions.

CPDP2 • 10:50

Lensless Tomographic Microscopy on a Chip, *Serhan O. Isikman[1], Waheb Bishara[1], Sam Mavandadi[1], Frank Yu[1], Steve Feng[1], Randy Lau[1], Aydogan Ozcan[1,2], [1]Electrical Engineering Department, University of California, USA,[2]California NanoSystems Institute (CNSI), University of California, USA.* A lensless optical tomography platform is demonstrated for use in high throughput 3D imaging applications. Through the use of pixel super-resolution techniques in partially-coherent digital in-line holography and tomographic reconstruction, this computational microscope achieves <1μm × <1μm × <3μm spatial resolution along the x, y and z directions, respectively, over a large imaging volume of ~15mm3.

CPDP3 • 11:10

Field Test of PANOPTES-Based Adaptive Computational Imaging System Prototype, *Manjunath Somayaji1, Marc P. Christensen[1], Esmaeil Faramarzi[1], Dinesh Rajan[1], Juha-Pekka Laine[2], Domhnull Granquist-Fraser[2, 3], Peter Sebelius[2], Arthur Zachai[2], Murali Chaparala[2], Gregory Blasche[2], Keith Baldwin[2], Babatunde Ogunfemi[2, 4], [1]Department of Electrical Engineering, Southern Methodist University, USA; [2]The Charles Stark Draper Laboratory, USA; [3]Department of Biomedical Engineering, Worcester Polytechnic Institute, USA; [4]Department of Electrical and Computer Engineering, Northeastern University, USA.* We describe the design and prototype development of a visible-band, multi-resolution, steerable computational imager in a flat profile, based on the PANOPTES architecture. We present this imager's superresolution capabilities via field test results.

Salon A
Joint FTS/HISE Postdeadline Session
Wednesday, July 13, 2011 16:30 -- 18:10
Felix Friedl-Vallon; Karlsruher Institut fuer Technologie Germany; Pierre Tremblay, University Laval, Canada, Presiders

JPDP1 • 16:30 FTS - INVITED

GOSAT/TANSO: Instrument Design and Level 1 Product Processing Algorithms, *Jun Yoshida[1], Takahiro Kawashima[1], Juro Ishida[1], Akihiko Kuze[2], Hiroshi Suto[2], Kei Shiomi[2], Masakatsu Nakajima[2]; [1]NEC TOSHIBA Space Systems, Ltd, Japan; [2]Japan Aerospace Exploration Agency, Japan.* The Greenhouse gases Observing SATellite (GOSAT) has acquired mainly carbon dioxide (CO2) and methane (CH4) absorption spectra globally from space since early 2009. TANSO-FTS (Thermal And Near infrared Sensor for carbon Observation Fourier Transform Spectrometer) is a space-born FTS which has 3 SWIR bands (0.76, 1.6 and 2.0 um) and 1 TIR band (5.5 - 14.3 um) for observation of scattering light and thermal radiation from the earth. In order to improve the GOSAT data quality, the level 1 product processing algorithms has been developed for several years. The instrument design of the GOSAT/TANSO-FTS and the overview of the level 1 product processing algorithms are described.

JPDP2 • 17:10 HISE

Spectrometers for Ocean and Atmospheric Sensing, *Tim Valle[1], James Leitch[1], Chuck Hardesty[1], Curtiss O. Davis[2] and Nicholas Tufillaro[2], Kelly Chance[3], Xiong Liu[3], Scott Janz[4], Ken Pickering[4], Jun Wang[5], [1]Ball Aerospace, USA; [2]College of Oceanic and Atmospheric Sciences/ Oregon State University, USA; [3]Smithsonian Institution/Smithsonian Astrophysical Observatory, USA, [4]NASA/Goddard Space Flight Center, USA; [5]University of Nebraska, USA.* Describe the motivation, goals, and plans for MOS and GeoTASO, two NASA Instrument Incubator Program sponsored technology development projects directed at supporting the NASA GEO-CAPE ocean and atmospheric science mission.

JPDP3 • 17:30 FTS

On-Orbit Absolute Radiance Standard for Future IR Remote Sensing Instruments – Overview of Recent Technology Advancements, *Claire Pettersen[1], Fred A. Best[1], Douglas P. Adler[1], Henry E. Revercomb[1], P. Jonathan Gero[1], Joseph K. Taylor[1], Robert O. Knuteson[1], and John H. Perepezko[2], [1]University of Wisconsin, Space Science and Engineering Center, USA ,[2]University of Wisconsin, Materials Science and Engineering, USA.* A summary of the development and recent advancements of the On-Orbit Absolute Radiance Standard at the University of Wisconsin Space Science and Engineering Center. This work is funded under the NASA Instrument Incubator Program.

JPDP4 • 17:50 FTS

Spectroscopic Interferometric Method of Revealing Spectral Features from Extra-Solar Planets, *Eyal Schwartz, Stephen G. Lipson, Physics department, Technion – Israel Institute of Technology, Haifa, Israel*. The signal contrast in a light source between an Earth-like extra-solar planet and a parent star (typical sun-like) is a difficult obstacle in imaging and spectroscopic analysis of a distant light source observed on earth. We suggest a method of using parts of an interferogram of the combined light sources (both planet and sun) in order to increase the signal to noise ratio and identify the specific spectral features from the planet in the background of the parent star.

Imaging and Applied Optics Congress 2011
Update Sheet

Withdrawals

The following poster and papers were withdrawn after the program guide went to print: JTuB2; JTuB5; JTuB8; JTuB9; JWA4; JWA18; JWA23. LMA1; LMA2; LMC4; LWC3; JPDP2; LTuA2

Presenter Changes

CWC3 will be presented by Yan Hao Nanyang Technological University, Singapore. **JWB2** will be presented by Shona Steward, ChemImage Corporation, USA. **AMB1** will be presented by Robert Wilson, UKATC, Royal Observatory Edinburgh, UK.

HTuC1 will be presented by Allen Huang **GeoMetWatch-STORM: Global Constellation of Next-generation Ultraspectral Geostationary Observatorie** in lieu of Margaret Kalacska. His paper is included in this update sheet.

Presider Updates

Ping Yang will preside over HWB 14:00-16:00 in Pier 7/8.

Author Updates

The author block for **AIMB4** should read ElfedLewis[1]; [1]University of Limerick, Ireland.

Networking over Lunch

Tuesday, 12 July 12:30 – 14:00
Sponsored by the OSA Information Acquisition, Processing and Display Technical Division

David Brady, Division Chair, and Chris Dainty, OSA President, invite you to join them over lunch for some lively net-working with your colleagues. OSA is pleased to offer complimentary sandwiches and beverages to all who attend.

Student Awards

Vyas Akondi, Indian Inst. Of Astrophysics, India has been named the recipient of the 2011 Robert S. Hilbert Memorial Student Travel Grant. Please help us congratulate him on this prestige award.

Postdeadline Papers

Postdeadline Papers are appended to the back of the program guide. Key to postdeadline authors is below.

Web Access

To access the internet in the meeting area use this wireless access code:

SSID: DATAVALET_MR
Login: IMA61
Password: wusyki

Postdeadline Papers: Key to Authors and Presiders

Important Program Changes

LS&C

Monday, July 11th, LMA Hybrid Laser/RF Communications
Session from 8:40-10:00 in Pier 4 has been cancelled

The talks have been moved to the Tuesday, July 12th, 10:30-12:10
LTuB - Network Technologies
Juan Juarez, John Hopkins, United States, Presider

LTuB1 10:30
Diversity Rateless Round Robin for Networked FSO Communications
Roger Hammons

LTuB2 11:10
Optical Automatic Gain Controller for High-Bandwidth Free-Space Optical Communication Links
Juan Juarez

LTuB3 11:30
Customized Bit Error Rate (cBERT) Tester for Characterizing Frequent Fade Communications Channels
James Riggins

AIO

AIMD1 at 16:30 has been moved to AIWB at 12:30
Process Analytical Technology: Bringing Solutions to the Plant Floor
Katherine Bakeev