Applied Industrial Optics: Spectroscopy, Imaging, and Metrology (AIO)
Digital Holography & 3-D Imaging (DH)
Imaging Systems and Applications (IS)
Laser Applications to Chemical, Security and Environmental Analysis (LACSEA)
Propagation through and Characterization of Distributed Volume Turbulence (pcDVT)
Signal Recovery & Synthesis (SRS)

13–17 July 2014

Seattle, WA, USA

Welcome to the 2014 Imaging and Applied Optics. The Congress has six topical co-located meetings (listed above) for attendees to benefit from exposure to a diverse collection of optical technologies. Three new meetings have joined this year, DH, LACSEA and SRS. 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. In addition to the technical sessions the committees have planned Plenary Speakers, a Welcome Reception, and a Poster Session. We hope that bringing together leaders and experts among the different communications to share information will provide you with a rich experience!

The Applied Industrial Optics (AIO) meeting was an unprecedented success in 2013, and promises to be very exciting this year. Bernard Kress the Optics Lead on the Google Glass Project will deliver the plenary talk. The meeting covers a wide range of applied optical technologies including spectroscopy, lasers, optical fibers, interferometry, imaging and innovative emerging technologies, and a very diverse set of application areas including monitoring in harsh environments, industrial process monitoring, medical, construction and life sciences. Featured this year will be 35 invited speakers from industry, government and academia, all of whom are at the forefront of applied optics from around the globe. Returning to its roots as a forum for discussing real world challenges facing applied optics, we have developed four unique panel discussions relevant to key technologies in presented during the Conference, an information session for students on industrial/governmental careers, and a brainstorming session where industrial researchers and applications specialists will focus on solving hurdles and challenges presented by the attendees when moving a new project into the marketplace.

Digital Holography & 3-D Imaging (DH) is the world's premier forum for disseminating the science and technology geared towards 3-D information processing. Since the meeting's inception in 2007, it has steadily and healthily grown to 116 presentations this year. The four-day program includes a plenary speaker, tutorial presentation, 14 invited speakers, 74 contributed oral presentations, and 26 poster presentations. At this meeting, expect to hear about the latest research on 3-D imaging, digital holographic microscopy, digital/electronic holography, 3-D displays and systems, integral photography and imaging, and holographic interferometry/modulators/filters/materials as well as applications in biomedical imaging, optical processing, and metrology.

Imaging Systems and Applications (IS) is an "all-encompassing" topical meeting specializing in imaging system design and components, imaging modalities and systems, and applications of military, industrial, medical and consumer imaging. Its aim is to highlight how different materials, components, and processing combine to create imaging systems and determine their performance. Invited speakers from the military, academic, and commercial imaging sectors will address the current status and future of imaging technologies and capabilities in their organizations. The conference includes 22 invited, 37 contributed oral presentations, and 3 poster presentations. Features this year include a plenary talk by Ramesh Raskar of *the* Media Lab, MIT, Camera Culture Group., as well as joint sessions with AIO, IS, pcDVT and DH.

The Laser Applications to Chemical, Security and Environmental Analysis (LACSEA) topical meeting is focused on all aspects of spectroscopic sensing in combustion or industrial processes, in environments that may contain chemical or biological agents, and in atmospheric measurements. Sensing of liquids (e.g., aerosols) and solids (e.g., particulates or explosives) are also discussed. The rapid development of laser technologies as well as data analysis tools are paving the way for novel monitoring schemes and even real-time control in various environments. Topics cover the VUV to THz spectra range, and involve exciting new developments in analytical spectroscopy, ultrafast lasers, frequency combs, and miniaturization. This year's program is exceptional! It includes invited talks by 23 well-known international experts spanning 7 countries, 31 contributed speakers, and 17 poster presentations. A plenary talk will be delivered by Prof. Christof Schulz of University Duisburg Essen, Germany on in-situ laser diagnostics in gas-phase synthesis of functional nanomaterials. LACSEA will also feature a joint session with IS and pcDVT.

The Propagation through and Characterization of Distributed Volume Turbulence (pcDVT) meeting discusses the physics of light propagating through distributed volume turbulence. For the meeting's first year it will bring together 12 invited speakers and 18 contributed presentations. pcDVT is grouped into three general areas: experimental results, modeling and simulation, and turbulence-induced photonic orbital angular momentum (POAM). Experimental results will be presented in three areas: beam statistics tied to micrometeorological phenomena, large-scale atmospheric coherent structures and quantification of laser communications channels. Additionally, the program covers both wave optical simulation and micro and mesoscale meteorological models.

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, phase retrieval, optical turbulence characterization, optical signal processing, and more. There are 18 invited and 18 contributed presentations as part of this exciting meeting.

We are pleased to have you join us and look forward to your continued participation in future OSA meetings.

Regards,
Imaging and Applied Optics Meeting Chairs

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Sri Rama Prasanna Pavani, *Arecont Vision, USA,* **Program Chair**

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

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Jess Ford, *Weatherford International Ltd, USA*

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Thank you to all the Imaging and Applied Optics Committee members for contributing many hours to maintain the high technical quality standards of OSA topical meetings.

Special Events

Joint Plenary
Tuesday 15, July, 08:00–10:30
Metropolitan Ballroom A

The Joint Plenary Session will feature three Plenary speakers (one speaker from three of the topical meetings, AIO, IS and LACSEA). For more information on the plenary presentations see page 6 of the program.

Welcome Reception
Monday 14 July, 19:00–20:30
Metropolitan B and Foyer

Join your fellow attendees for the Congress Reception. Enjoy delectable fare while networking. The reception is open to all full conference attendees. Congress attendees may purchase extra tickets for their guest.

Poster Sessions
Tuesday 15, July, 17:00–19:00
Metropolitan Ballroom B

Posters are an integral part of the technical program and offer a unique networking opportunity, where presenters can discuss their results one-to-one with interested parties. Each author is provided with a 4 ft. × 8 ft. (1.22 m × 2.44 m) board on which to display the summary and results of his or her paper.

Exhibit Hall
Metropolitan Ballroom B

Monday, 14 July	10:00–10:30	Exhibit Hall Opening and Coffee Break
	16:00–17:00	Coffee Break with Exhibitors
Tuesday, 15 July	10:30–11:30	Coffee Break with Exhibitors
	17:00–19:00	Poster Session with Exhibitors
Wednesday, 16 July	10:00–10:30	Coffee Break with Exhibitors
	16:00–17:00	Coffee Break with Exhibitors
Thursday, 17 July	10:00–10:30	Coffee Break with Exhibitors
	16:00–17:00	Coffee Break with Exhibitors

Awards

OSA Foundation Travel Grant

We are pleased to announce The OSA Foundation Travel Grant recipient for Imaging and Applied Optics Congress. The OSA Foundation Student Travel Grant Program is designed to provide career development opportunities by assisting students who wish to attend conferences and meetings. The grants are given to students working or studying science in qualifying developing nations so they can attend OSA-managed technical meetings and conferences.

This year's recipient is: Manoj Kumar, *Indian Institute of Technology Delhi (IIT Delhi), India*

During the plenary session, OSA will recognize two recently elected fellow members.

Wolfgang Osten, University of Stuttgart, Germany
For numerous significant contributions to optical metrology and information processing including areas such digital holography, phase retrieval and display, and micro-and nano-optics.

Aydogan Ozcan, *University of California Los Angeles, USA*
For contributions to computational imaging, sensing and holography technologies, and instrumentation impacting bio-photonics and its applications to telemedicine and global health.

Joint Plenary Session

AIO Plenary Speaker

Tuesday, 15 July, 08:00–08:50
Metropolitan Ballroom A

Bernard Kress, *Optics Lead, Advanced Technology Team, Google Glass Project, Google [X], USA*

For over 20 years, Bernard has made significant scientific contributions as researcher, professor, consultant, advisor, instructor, and author, making major contributions to digital micro-optical systems for consumer electronics, generating IP, and teaching and transferring technological solutions to industry. Many of the world's largest producers of optics and photonics products have consulted with him on a wide range of optics and photonics technologies including; laser materials processing, optical security, optical telecom/datacom, optical data storage, optical computing, optical motion sensors, pico- projectors, light emitting diode displays, optical gesture sensing, three dimensional remote sensing, digital imaging processing, and biotechnology sensors. Bernard has generated more than 30 international granted patents. He has published four books, a book chapter, 102 refereed publications and proceedings, and numerous technical publications. He has also been Involved in European Research Projects in Micro-Optics including the Eureka Flat Optical Technology and Applications (FOTA) Project and the Network for Excellence in Micro-Optics (NEMO) Project. Bernard is currently the Optics Lead in the Advanced Technology Team at Google Glass Project.

IS Plenary

Tuesday, 15 July, 8:50 –9:40
Metropolitan Ballroom A

Ramesh Raskar, *Associate Professor of Media Arts and Sciences, The Media Lab, MIT, Camera Culture Group, USA*

Ramesh Raskar is an Associate Professor at MIT Media Lab. Ramesh Raskar joined the Media Lab from Mitsubishi Electric Research Laboratories in 2008 as head of the Lab's Camera Culture research group. His research interests span the fields of computational photography, inverse problems in imaging and human-computer interaction. Recent projects and inventions include transient imaging to look around a corner, a next generation CAT-Scan machine, imperceptible markers for motion capture (Prakash), long distance barcodes (Bokode), touch+hover 3D interaction displays (BiDi screen), low-cost eye care devices (Netra,Catra), new theoretical models to augment light fields (ALF) to represent wave phenomena and algebraic rank constraints for 3D displays(HR3D). In 2004, Raskar received the TR100 Award from Technology Review, which recognizes top young innovators under the age of 35, and in 2003, the Global Indus Technovator Award, instituted at MIT to recognize the top 20 Indian technology innovators worldwide. In 2009, he was awarded a Sloan Research Fellowship. In 2010, he received the Darpa Young Faculty award. Other awards include Marr Prize honorable mention 2009, LAUNCH Health Innovation Award, presented by NASA, USAID, US State Dept and NIKE, 2010, Vodafone Wireless Innovation Project Award (first place), 2011. He holds over 50 US patents and has received four Mitsubishi Electric Invention Awards. He is currently co-authoring a book on Computational Photography.

LACSEA Plenary

Tuesday, 15 July, 9:40–10:30
Metropolitan Ballroom A

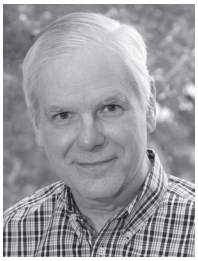
Christof Schulz, *Institute for Combustion and Gas Dynamics–Reactive Fluids,Univ. Duisburg Essen, Germany*

Prof. Dr. Christof Schulz studied Chemistry at the Univ. of Karlsruhe from 1988-94. He received his PhD at the Physical Chemistry Institute at the Univ. of Heidelberg in 1997 with a thesis on the "Development and application of a laser-induced fluorescence method for the quantitative measurement of nitric oxide in internal combustion engines". From 1997-2004 he headed the group on "Laser diagnostics in combustion processes" in the same institute where he also received his Habilitation in 2002. During this time he was for several subsequent research periods at Stanford Univ., from 2000-02 as Visiting Scholar and from 2002-04 as Consulting Associate Professor. In 2004 he assumed the Chair for Combustion and Gas Dynamics at the Univ. of Duisburg-Essen where he currently leads a group of 45 scientists. Christof Schulz was supported by the Studienstiftung des deutschen Volkes from 1991-94. In 2014 he received the Leibniz Prize of the German Research Foundation, DFG. In 1999 he received the Freudenberg Award of the Heidelberg Academy of Sciences and the 1. Prize of the BMW Scientific Award. He is member of the editorial boards of the journals Progress in Energy and Combustion Science, Combustion and Flame, and Proceedings of the Combustion Institute. Since 2007 he is deputy director of the Center for NanoIntegration Duisburg-Essen (CeNIDE). Since 2008 he is a scientific director of the Institute for Energy and Environmental Technology (IUTA) in Duisburg. Since 2009 he is also the director of the NanoEnergyTechnologyCenter (NETZ) in Duisburg. Since 2007 he is member of the board of the German Section of the Combustion Institute and since 2012 he is member of the board of the international Combustion Institute. Since 2010 he is the director of the Center for Nanointegration Duisburg-Essen (CeNIDE). Since 2008 he serves as an elected member of the review board "Energieverfahrenstechnik" of the German Research Foundation, DFG.

DH Special Events

DH Plenary

Monday, 14 July, 08:15–09:15
Ravenna A, B&C



James Fienup, *Robert E. Hopkins Professor of Optics, The Institute of Optices,Univ. of Rochester, USA*

James R. Fienup received his PhD in Applied Physics from Stanford Univ.. He was a Senior Research Engineer at Environmental Research Institute of Michigan (ERIM) and Veridian Systems, Ann Arbor, MI, until 2002, and is the Robert E. Hopkins Professor of Optics at the Univ. of Rochester. He is a member of the National Academy of Engineering, is a Fellow of the Optical Society of America and of the International Society for Optical Engineering (SPIE), and is a Senior Member of IEEE. He was awarded the Rudolf Kingslake Medal and Prize for 1979 by the SPIE, the International Prize in Optics for 1983 by the International Commission for Optics, and the Emmett Leith Medal for 2013 by the OSA. He was a Distinguished Visiting Scientist at the Jet Propulsion Lab in 2009. He was Editor-in-Chief of the Journal of the Optical Society of America A, 1997-2003. He previously served as Division Editor of Applied Optics - Information Processing, and Associate Editor of Optics Letters. Prof. Fienup's research centers on obtaining images with finer resolution. He developed phase retrieval and image reconstruction and restoration algorithms for unconventional imaging, lensless coherent imaging, wavefront sensing, and aberration correction. Application areas spanned nano-imaging with coherent x-ray diffraction, digital holography, correcting astronomical telescopes, imaging through aberrating media, synthetic-aperture radar (SAR), and biomedical imaging. He also contributed to diffractive optical elements, image quality for sparse-aperture systems, SAR moving-target detection, and computer-generated holograms. He has over 220 publications and 5 patents.

DH Tutorial

Tuesday, 15 July, 15:00–16:00
Ravenna A, B&C

Wolfgang Osten, *Institut für Technische Optik, Germany*

Prof. Wolfgang Osten received the Diploma in Physics from the Friedrich-Schiller-University Jena in 1979 and in 1983 the PhD degree from the Martin-Luther-University Halle-Wittenberg for his thesis in the field of holographic interferometry. From 1984 to 1991 he was employed at the Central Institute of Cybernetics and Information Processes in Berlin making investigations in digital image processing and computer vision. In 1991 he joined the Bremen Institute of Applied Beam Technology (BIAS) to establish the Department Optical 3D-Metrology. Since September 2002 he has been a full professor at the University of Stuttgart and director of the Institute for Applied Optics. His research work is focused on new concepts for industrial inspection and metrology by combining modern principles of optical metrology, sensor technology and image processing. Special attention is directed to the development of resolution enhanced technologies for the investigation of micro and nano structures.

Digital Holography & 3-D Imaging (DH) Congress 2015

May 2015
Shanghai, China

Check the OSA website for updates
www.osa.org/DH

General Information

Registration

Metropolitan Ballroom Foyer

Sunday, 13 July	15:00–18:00
Monday, 14 July	07:00–18:00
Tuesday, 15 July	07:00–17:00
Wednesday, 16 July	07:30–19:00
Thursday, 17 July	07:30–18:00

Exhibit Hall

Monday, 14 July–Thursday, 17 July
Metropolitan Ballroom B

The Imaging and Applied Optics exhibit is open to all registered attendees. Visit a diverse group of companies representing every facet of optics. Coffee breaks, poster sessions and exhibits will be held with the exhibit from Monday–Thursday.

Exhibit Hall Hours

Monday, 14 July	10:00–17:00
Tuesday, 15 July	10:30–19:00
Wednesday, 16 July	10:00–17:00
Thursday, 17 July	10:00–17:00

Recorded Presentations

Many of the sessions during this year's Imaging and Applied Optics Congress are being digitally captured for on-demand viewing. Session content will be available within forty-eight hours of being recorded. Recorded content can be accessed by visiting www.osa.org/ImagingOPC and clicking on the "**Access meeting presentations/slidecasts"** under **Essential Links.** Presentations for authors who have indicated they do not wish to be recorded will not be available. Posting of Thursday sessions may be delayed up to a week.

About OSA's Optics InfoBase

Registrants and current subscribers can access all of the conference papers, posters and postdeadline papers on OSA's digital library, Optics InfoBase. The Optics InfoBase is a cutting-edge repository that contains OSA Publishing's content, including 16 flagship, partnered and co-published peer-reviewed journals and 1 magazine. With more than 240,000 articles including papers from over 450 conferences, Optics InfoBase is the largest peer-reviewed collection of optics and photonics.

OSA
OpticsInfoBase
OSA's Digital Library

Early Online Access to the Technical Digest and Postdeadline Papers

Full Technical Attendees have both EARLY and FREE continuous access to the digest papers through Optics InfoBase. To access the papers go to www.osa.org/ImagingOPC and select the **"Access digest papers"** essential link on the right hand navigation. As access is limited to Full Technical Congress Attendees only, you will be asked to validate your credentials by entering the same login email address and password provided during the Congress registration process. If you need assistance with your login information, please use the "forgot password" utility or "Contact Help" link.

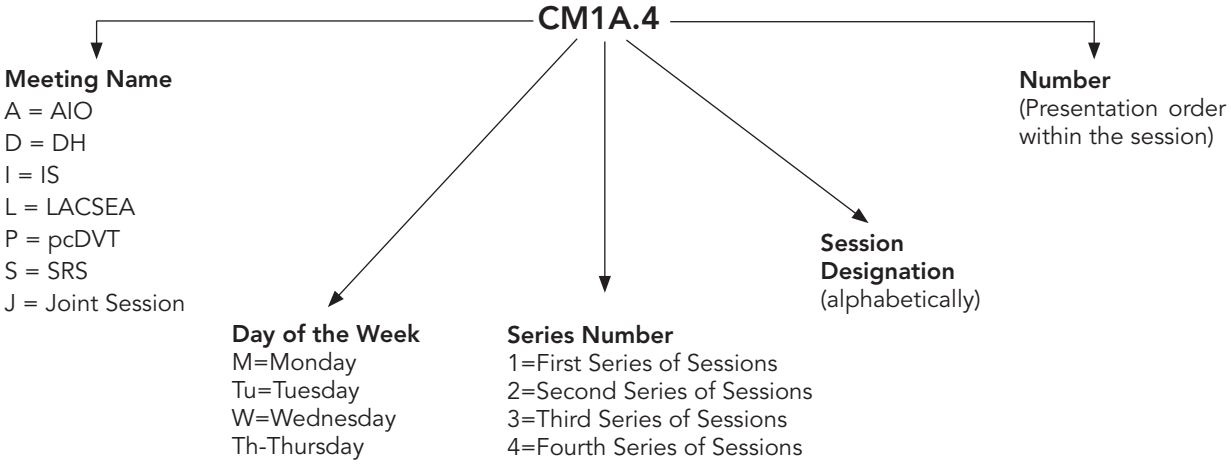
Poster Presentation PDFs

The PDFs of select poster presentations will be available two weeks after the conference. While accessing the papers in Optics Infobase look for the multimedia symbol.

Update Sheet and Postdeadline Papers

All technical program changes will be communicated in the onsite Congress Program Update Sheet. All attendees receive this information with registration materials, and we encourage you to review it carefully to stay informed to changes in the program. Postdeadline papers will also be announced on the update sheet.

Explanation of Session Codes



The first letter of the code designates the meeting (A=AIO, D=DH, I=IS, L=LACSEA, P=pcDVT, S=SRS, J=Joint Session). The second element denotes the day of the week (Monday=M, Tuesday=Tu, Wednesday=W, Thursday=Th). The third element indicates the session series in that day (for instance, 1 would denote the first parallel sessions in that day). Each day begins with the letter A in the fourth element and continues alphabetically through a series of parallel sessions. The lettering then restarts with each new series. The number on the end of the code (separated from the session code with a period) signals the position of the talk within the session (first, second, third, etc.). For example, a presentation coded DTu1B.4 indicates that this paper is part of DH (D) and is being presented on Tuesday (Tu) in the first series of sessions (1), and is the third parallel session (B) in that series and the fourth paper (4) presented in that session.

Invited papers are noted with Invited

Plenary papers are noted with Plenary

Tutorial papers are noted with Tutorial

Panels are noted with Panel

Recorded Presentations are noted with ▶

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Agenda of Sessions — Monday, 14 July

	Issaquah A & B	Ravenna A,B & C	Metropolitan Ballroom A	Ballard Room	Capitol Hill	Greenwood
	AIO	DH	IS	LACSEA	pcDVT	SRS
07:00–18:00	**Registration,** *Metropolitan Ballroom Foyer*					
08:00–10:00	**AM1A • Far and Away We See You** (starts at 08:30)	**DM1B • Digital Holographic Imaging**	**IM1C • Image Quality Inspection and Imaging Systems I** ▶ (ends at 09:45)	**LM1D • Flow Visualization & Imaging**	**PM1E • Atmospheric Characterization I** (ends at 09:45)	**SM1F • Image Reconstruction and Enhancement**
10:00–10:30	**Exhibit Hall Opening,** *Metropolitan Ballroom B*					
10:30–12:30	**AM2A • The Frontier: Applied Spectroscopy**	**DM2B • Advances in Digital Holographic Techniques**	**IM2C • Image Quality Inspection and Imaging Systems II** ▶	**LM2D • Spray Diagnostics & Combustion Imaging**	**PM2E • Atmospheric Characterization II** (ends at 12:15)	**SM2F • Compressive Imaging and Phase Retrieval**
12:30–14:00	**Lunch,** *On Your Own*					
14:00–16:00	**AM3A • Coherent and Diffuse, Light at the Extremes**	**DM3B • Digital Holographic Microscopy**	**IM3C • Biomedical Sensing and Imaging Applications** ▶	**LM3D • Developments in CARS and Other Nonlinear Spectroscopies**	**PM3E • Non-Kolmogorov Turbulence**	**SM3F • Image Perception**
16:00–17:00	**Exhibit Hall & Coffee Break,** *Metropolitan Ballroom B*					
17:00–19:00	**AM4A • Fiber Fiber Everywhere**	**DM4B • Quantitative Phase Imaging and Holography**	**IM4C • Remote Imaging and Sensing** ▶	**LM4D • New Laser Sources & Instrumentation**		**SM4F • Holographic Imaging**
19:00–20:30	**Welcome Reception,** *Metropolitan Ballroom B and Foyer*					

Key to Conference Abbreviations

AIO	Applied Industrial Optics: Spectroscopy, Imaging, and Metrology
DH	Digital Holography & 3-D Imaging
IS	Imaging Systems and Applications
LACSEA	Laser Applications to Chemical, Security and Environmental Analysis
pcDVT	Propagation through and Characterization of Distributed Volume Turbulence
SRS	Signal Recovery & Synthesis

Agenda of Sessions — Tuesday, 15 July

	Issaquah A & B	Ravenna A,B & C	Metropolitan Ballroom A	Ballard Room	Capitol Hill	Greenwood
	AIO	DH	IS	LACSEA	pcDVT	SRS
07:00–17:00	**Registration,** *Metropolitan Ballroom Foyer*					
08:00–10:30	**JTu1A • Joint Opening Plenary ▶,** *Metropolitan Ballroom A*					
10:30–11:30	**Coffee Break and Exhibit Hall,** *Metropolitan Ballroom B*					
11:30–13:30	**ATu2A • The Joy of Measurement, How Low Can We Go**	**DTu2B • Digital Holography**	**JTu2C • Joint Lidar Session ▶ (with LACSEA and IS and pcDVT)**	**see JTu2C**	**see JTu2C**	**STu2F • Novel Image Sensing I** (ends at 13:15)
13:30–15:00	**Lunch,** *On Your Own*					
15:00–17:00	**ATu3A • Trip the Light Body Fantastic**	**DTu3B • Remote Laboratory in Holographic Metrology**	**ITu3C • 3D Sensing and Phase Retrieval and Holography** (ends at 16:45)	**LTu3D • Raman and Absorption-Based Measurements ▶**	**PTu3E • Slope Discrepancy, Hidden Phase, Branch Points and Deep Turbulence** (ends at 16:15)	**STu3F • Novel Image Sensing II** (ends at 16:45)
17:00–19:00	**JTu4A • Joint Poster Session,** *Metropolitan Ballroom B*					

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SRS	Signal Recovery & Synthesis

Agenda of Sessions — Wednesday, 16 July

	Issaquah A & B	Ravenna A,B & C	Metropolitan Ballroom A	Ballard Room	Capitol Hill	Greenwood
	AIO	DH	IS	LACSEA	pcDVT	SRS
07:30–19:00	**Registration,** *Metropolitan Ballroom Foyer*					
08:00–10:00	**AW1A • Measurement Makes Successes** (starts at 08:30)	**DW1B • Special Session in Holographic Lithography**	**IW1C • Computational Optics and Microscopy I**	**LW1D • QCL-Based Measurement**	**PW1E • Quantum Properties of Light in Turbulence** (ends at 09:45)	**SW1F • Tomographic Imaging**
10:00–10:30	**Coffee Break and Exhibit Hall,** *Metropolitan Ballroom B*					
10:30–12:30	**AW2A • QCL Hits the Floor Running**	**DW2B • 3D Imaging and Display Systems**	**IW2C • Computational Optics and Microscopy II**	**LW2D • Stand-off Detection & LIBS**	**PW2E • Imaging in Distributed Volume Turbulence** (ends at 12:00)	
12:30–14:00	**Lunch,** *On Your Own*					
14:00–16:00	**See JW3C**	**DW3B • Biomedical/ Clinical/ Medical Applications**	**JW3C • Imaging Imaging, Wow (with AIO and IS)**	**LW3D • Frequency Combs & Precision Optical Measurements**		
16:00–17:00	**Coffee Break and Exhibit Hall,** *Metropolitan Ballroom B*					
17:00–19:00	**AW4A • Optics, Images, & Field Theory Oh My**	**DW4B • Holographic Imaging** (ends at 18:45)	**IW4C • Digital Image Processing** (ends at 18:30)	**LW4D • New Approaches in Trace Gas Sensing**		

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Agenda of Sessions — Thursday, 17 July

	Issaquah A & B	Ravenna A,B & C	Metropolitan Ballroom A
	AIO	DH	IS
07:30–18:00	**Registration,** *Metropolitan Ballroom Foyer*		
8:00–10:00	**ATh1A • Awesome Optical Materials** (starts at 09:00)	**DTh1B • Metrology and Profilometry** ▶	**JTh1C • Joint Session with DH** (ends at 09:45)
10:00–10:30	**Coffee Break and Exhibit Hall,** *Metropolitan Ballroom B*		
10:30–12:30	**ATh2A • Mathematics in Action** (ends at 12:00)	**DTh2B • Holography and Diffraction** ▶	**ITh2C • Computational Optics and Image Processing**
12:30–14:00	**Lunch,** *On Your Own*		
14:00–16:00		**DTh3B • Digital Holographic Optical Processing** ▶	
16:00–17:00	**Coffee Break and Exhibit Hall,** *Metropolitan Ballroom B*		
17:00–19:00		**DTh4B • Novel Applications of Digital Holography**	

Recorded Presentations

Selected sessions during this year's Imaging and Applied Optics Congress are being digitally captured for on-demand viewing. Session content will be available within forty-eight hours of being recorded. Recorded sessions are indicated by ▶. Recorded content can be accessed by visiting www.osa.org/ImagingOPC and clicking on the "Access meeting presentations/slidecasts" under Essential Links. As access is limited to Full Technical Conference Attendees only, you will be asked to validate your credentials by entering the same login email address and password provided during the Conference registration process. If you need assistance with your login information, please use the "forgot password" utility or "Contact Help" link.

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Issaquah A & B	Ravenna A,B & C	Metropolitan Ballroom A
Applied Industrial Optics: Spectroscopy, Imaging, and Metrology	Digital Holography & 3-D Imaging	Imaging Systems and Applications

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

07:00–18:00 Registration, *Metropolitan Ballroom Foyer*

08:30–10:00
AM1A • Far and Away We See You
Presider: Thomas Haslett; Avo Photonics Inc, USA

AM1A.1 • 08:30 Invited
Quantification and Relative Amounts of Pollutants in Vehicle Exhaust Plumes, Stewart Hager[1]; [1]*Hager Environmental & Atmospheric Techno, USA.* EDAR (Emissions Detection And Reporting) is a portable or permanent down looking roadside system for the detection of exhaust emissions from roadway vehicles. The current version of EDAR uses scanning Lidar to simultaneously measure carbon dioxide, carbon monoxide, nitric oxide and hydrocarbons. Because EDAR scans over the entire plume it can retrieve absolute amounts or grams/mile directly. Results of testing and retrievals of absolute and relative amounts of pollutants in exhaust plumes will be discussed.

AM1A.2 • 09:00 Invited
Detection of Survivors in Fire Scenes by Mid-IR Digital Holography, Vittorio Bianco[1], Melania Paturzo[1], Andrea Finizio[1], Lisa Miccio[1], Pietro Ferraro[1]; [1]*Istituto Nazionale di Ottica, Italy.* We developed two different systems for real-time imaging live humans through smoke and flames. The capabilities of both the devices are discussed showing the possibility to employ them in case of real fire accidents.

08:00–10:00
DM1B • Digital Holographic Imaging
Presider: Yoshio Hayasaki; Utsunomiya Univ., Japan

08:00 • Welcoming Remarks

DM1B.1 • 08:15 Plenary
Phase Error Correction in Digital Holographic Imaging, James R. Fienup[1]; [1]*Univ. of Rochester, USA.* Digital holographic imaging for remote sensing or microscopy may suffer from blur due to aberrating media. This paper reviews phase-error correction algorithms that allow a diffraction-limited image to be reconstructed from the collected data.

DM1B.2 • 09:15
Limits of numerical diffraction methods revisited, Raul Castañeda[1], Diego Hincapie[1,2], Jorge Garcia-Sucerquia[1]; [1]*School of Physics, Universidad Nacional de Colombia, Colombia;* [2]*Facultad de Ingeniería, Instituto Tecnologico Metropolitano, Colombia.* An optical field can be numerical propagated using the method of the angular spectrum and Fresnel transform. The limits of application for these two numerical methods to compute the propagation of optical fields are evaluated.

08:00–09:45
IM1C • Image Quality Inspection and Imaging Systems I
Presider: Zeev Zalevsky, Bar-Ilan Univ., Israel

IM1C.1 • 08:00 Invited
Democratization of Diagnostics and Measurement Tools through Computational Imaging and Sensing, Aydogan Ozcan[1]; [1]*Electrical Engineering and Bioengineering Depts., Univ. of California Los Angeles, USA.* We review our recent results on computational imaging, sensing and diagnostic techniques that can be used for various biomedical applications, even in resource limited and field settings.

IM1C.2 • 08:30 Invited
Two Applications of Vectorial Color: Camera Design and Lighting of Colored Objects, James A. Worthey[1]; [1]*retired, USA.* Color stimuli are described by 3-vectors, which can be added to model color mixing, yet vector diagrams are rare. A set of orthonormal opponent color matching functions leads to better vectors, solving old problems.

IM1C.3 • 09:00
Scan Linearization for Resonant Optomechanical Systems, Christopher M. Brown[1], John T. Melcher[2], Stephan J. Stranick[1]; [1]*Materials Measurement Laboratory, National Inst. of Standards and Technology, USA;* [2]*Physical Measurement Laboratory, National Inst. of Standards and Technology, USA.* Optomechanical characteristics of spiral scanning, Lissajous, and mixed resonant beam scanning systems are reviewed. An optical design for a scan lens that linearizes a fixed amplitude resonant beam scan is presented.

IM1C.4 • 09:15
Mosaic active imaging: direct physical modelling and image reconstruction, Emmanuelle THOUIN[1], Marie-Thérèse Velluet[2], Dominique Hamoir[1], François Malgouyres[3], Laurent Hespel[1], Xavier Briottet[1]; [1]*ONERA - The French Aerospace Lab, France;* [2]*ONERA - The French Aerospace Lab, France;* [3]*Toulouse Mathematics Inst. (IMT), France.* This paper presents a new active imaging sytem. Its performances are evaluated with an end-to-end simulator realistic in terms of turbulence effects. It performs a sequence of synthetic images. Reconstruction methods restore the scene from sequence of images.

Ballard Room	Capitol Hill	Greenwood
Laser Applications to Chemical, Security and Environmental Analysis	Propagation through and Characterization of Distributed Volume Turbulence	Signal Recovery & Synthesis

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

07:00–18:00 Registration, *Metropolitan Ballroom Foyer*

08:00–10:00
LM1D • Flow Visualization & Imaging
Presider: Waruna Kulatilaka; Spectral Energies LLC, USA

LM1D.1 • 08:00 Invited
Thermographic Particle Image Velocimetry, Benoit Fond[1], Christopher Abram[1], Frank Beyrau[1]; [1]*Imperial College London, UK.* Planar high-speed temperature and velocity measurements in gaseous flows can be performed simultaneously using micrometer-sized thermographic phosphor particles as tracers. Validation of this concept and applications in turbulent flows will be presented.

LM1D.2 • 08:30
Spatially-resolved measurements of gas-phase temperature and SiO concentration in a low-pressure nanoparticle synthesis reactor using laser-induced fluorescence, Thomas Dreier[1], Omid Feroughi[1], Andreas Langer[1], Christof Schulz[1]; [1]*Universität Duisburg-Essen, Germany.* Gas-phase temperatures in low pressure premixed hydrogen/oxygen/hexamethyldi-siloxane (HMDSO) flames and SiO concentrations were measured by laser-induced fluorescence imaging. Experimental and simulated excitation spectra of SiO as an intermediate species were compared.

LM1D.3 • 08:45
Laser-Induced Incandescence (LII) Measurements on Gas-Borne Silicon Nanoparticles, Raphael Mansmann[1], Thomas Dreier[1], Christof Schulz[1]; [1]*Universität Duisburg-Essen, Germany.* Particle sizes of silicon nanoparticles were determined by laser-induced incandescence measurements within a microwave-plasma reactor. Literature data of the silicon vapor pressure are compared and analyzed for the suitability towards modeling LII temperature decay curves.

LM1D.4 • 09:00 Invited
Digital In-line Holography (DIH) for 3D Imaging of Aluminum Drop Combustion in Propellant Plumes, Daniel Guildenbecher[1]; [1]. Digital in-line holography (DIH) is an optical technique which allows for numerical refocusing after an experiment. Here we discuss application of DIH for high-fidelity visualization and quantification of aluminum drop combustion in propellant plumes.

08:00–09:45
PM1E • Atmospheric Characterization I
Presider: Darryl Sanchez; US Air Force Research Laboratory, USA

08:00 • Welcoming Remarks

PM1E.1 • 08:15 Invited
Satellite and Radar Measurement of CT2, Cn2, and Cv2, Steven Fiorino[1]; [1]*Air Force Inst. of Technology, USA.* Paper describes novel method to obtain temperature and wind using satellite-based data. Structure functions of temperature, CT2, refractive index, Cn2, and wind velocity, Cv2, are derived over large volumes and compared to radar-derived data.

PM1E.2 • 08:45 Invited
Optical Angle-of-arrival Fluctuations Caused by Turbulent and non-Turbulent Refractive-Index Fluctuations in the Atmosphere, Andreas Muschinski[1]; [1]*NorthWest Research Associates, USA.* Abstract not available.

PM1E.3 • 09:15
Characterizing Earth's Boundary Layer (CEBL)—2014 Update, Thomas Farrell[1], Darryl Sanchez[1], Kelly Patrick[1], Anita Gallegos[2], Alex Duchane[1], William Gibson[1], Denis W. Oesch[2], Eric Aglubat[1], David Spendel[1], Terry Brennan[3]; [1]*US Air Force Research Laboratory, USA;* [2]*Leidos, USA;* [3]*Prime Plexus, USA.* AFRL is developing a model of boundary layer turbulence. A field campaign, correlating meteorological conditions with measured turbulence, is being conducted to anchor the model. We present the 2014 update on the campaign.

08:00–10:00
SM1F • Image Reconstruction and Enhancement
Presider: Christy Fernandez-Cull; MIT Lincoln Lab, USA

SM1F.1 • 08:00 Invited
Uniqueness Results for Reconstruction of Imagery Degraded By Atmospheric Turbulence, Brandoch Calef[1]; [1]*Boeing LTS, USA.* Reconstruction of imagery degraded by atmospheric turbulence is a problem of great practical importance. We discuss conditions for uniqueness in several inverse problems, including phase retrieval, multiframe blind deconvolution, and phase diversity. In each case, the setting considered is incoherent imaging through Kolmogorov turbulence. We show that this model yields strong results, in particular that each problem has a unique solution (up to trivial ambiguities) with probability 1.

SM1F.2 • 08:30 Invited
Tomographic Reconstruction of Atmospheric Turbulence from Microlens Imagery, James G. Nagy[1], Michael Hart[2], Douglas A. Hope[3], Stuart M. Jefferies[4]; [1]*Emory Univ., USA;* [2]*Univ. of Arizona, USA;* [3]*USA Air Force Academy, USA;* [4]*Univ. of Hawaii, USA.* Data acquired from a micro-lens array is used to obtain a 3-D reconstruction of the wave front. The problem is modeled as a large-scale inverse problem, which can be efficiently solved using iterative optimization techniques.

SM1F.3 • 09:00
Blind Deconvolution Of Turbulence-degraded Images Using Natural PSF Priors, Roberto Baena[1,2], Szymon Gladysz[2], Laurent Mugnier[3], Rao Gudimetla[4], Robert L. Johnson[4], Lee Kann[4]; [1]*Real Academia de Ciencias y Artes de Barcelona, Spain;* [2]*Fraunhofer Inst. of Optronics, System Technologies and Image Exploitation, Germany;* [3]*ONERA/DOTA, France;* [4]*Air Force Research Laboratory, USA.* Deconvolution through atmospheric turbulence requires regularization. Many object priors have been proposed but their utility might be limited to one class of real objects. Optical effects of atmospheric turbulence on the PSF form a viable alternative.

SM1F.4 • 09:15 Invited
Cross-Correlation Imaging, Bahaa E. Saleh[1]; [1]*Univ. of Central Florida, CREOL, USA.* Abstract not available.

Issaquah A & B	Ravenna A,B & C	Metropolitan Ballroom A
Applied Industrial Optics: Spectroscopy, Imaging, and Metrology	Digital Holography & 3-D Imaging	Imaging Systems and Applications

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

AM1A • Far and Away We See You—Continued

AM1A.3 • 09:30 Invited

LIBS in the Laband Beyond, Steven G. Buckley[1]; [1]*TSI Inc., USA.* Laser-Induced Breakdown Spectroscopy has seen a surge in interest, evolving from a research topic to a more mainstream analytical solution. This talk covers compelling applications for LIBS in the corporate Laband the evolution of LIBS into a process monitoring and control tool for industrial applications. Emphasis will be placed on analysis methods and system developments that yield rapid results.

DM1B • Digital Holographic Imaging—Continued

DM1B.3 • 09:30

Robust phase-shift estimation method for generalized phase-shifting digital holography using statistical approach, Nobukazu Yoshikawa[1], Takaaki Shiratori[1], Kazuki Kajihara[1]; [1]*Graduate School of Science and Engineering, Saitama Univ., Japan.* We propose a robust phase-shift estimation method for statistical generalized phase-shifting digital holography. A correct object wave is obtained without depending on the statistical property on the Fresnel diffraction field of the object.

DM1B.4 • 09:45

Convergence Characteristics of Nonlinear Phase Retrieval, Jen-Tang Lu[1], Chien-Hung Lu[1], Jason W. Fleischer[1]; [1]*Princeton Univ., USA.* We theoretically and experimentally investigate the convergence characteristics of a phase retrieval algorithm using nonlinear diversity. The nonlinear algorithm has a non-monotonic convergence profile, giving a criterion for minimum phase error in the reconstruction.

IM1C • Image Quality Inspection and Imaging Systems I—Continued

IM1C.5 • 09:30

Fourier Spectral Filter Array Design For Multispectral Image Recovery, Keigo Hirakawa[1], Kenneth J. Barnard[2]; [1]*Intelligent Signal Systems Laboratory, Univ. of Dayton, USA;* [2]*US Air Force Research Laboratory, USA.* A methodology for spectral image acquisition that maintains optimal spatial and spectral resolution while providing video-rate data collection with accurate spatial-spectral registration is defined. The derived sampling approach exploits inherent support of spatial/spectral scene information.

10:00 Exhibit Hall Opening, *Metropolitan Ballroom B*

10:30–12:30 AM2A • The Frontier: Applied Spectroscopy

Presider: Gary Miller; US Naval Research Laboratory, USA

AM2A.1 • 10:30 Invited

Miniature Raman Spectrometers, Peter Höjerback[1]; [1]*Serstech, Sweden.* Raman spectroscopy has since a long time proven its value for the identification of unknown samples, while also serving users in the material verification and process automation areas. With the development of smaller optics, improved and more affordable lasers, detectors and electronics, Raman Spectrometers are becoming smaller, easier to use and more affordable. This trend opens up for a much wider use of the technology, but it also brings about new challenges. Come and listen to Serstech's experiences of this evolving market and how the technology is adapted to meet new user needs.

AM2A.2 • 11:00 Invited

Using a Multimode Fiber as Compact, High-resolution Spectrometer, Brandon Redding[1], Hui Cao[1]; [1]*Applied Physics, Yale Univ., USA.* We demonstrate that a multi-mode fiber can operate as a high-resolution spectrometer after calibrating wavelength-dependent speckle patterns. A 100m fiber provides 1pm resolution and a 4cm fiber enables broadband operation across the visible spectrum.

10:30–12:30 DM2B • Advances in Digital Holographic Techniques

Presider: Gabriel Popescu; Univ of Illinois at Urbana-Champaign, USA

DM2B.1 • 10:30 Invited

Inherently super-resolving FINCH 3D fluorescence microscopy, Gary Brooker[1], Nisan Siegel[1], Joseph Rosen[2,1], Nobuyuki Hashimoto[3], Makoto Kurihara[3], Ayano Tanabe[3]; [1]*Biomedical Engineering, Johns Hopkins Univ., USA;* [2]*Electrical and Computer Engineering, Ben-Gurion Univ., Israel;* [3]*Citizen Holdings Co., Ltd., Japan.* Progress since the invention of Fresnel Incoherent Correlation Holography (FINCH) [1] in 2007 from an idea into a super resolution microscope with resolution about twice the Rayleigh limit will be chronicled.

DM2B.2 • 11:00

New Method for Field of View Extension or Frame-Rate Increase in Low-Coherence Off-Axis Holography, Natan T. Shaked[1], Pinhas Girshovitz[1], Irena Frenklach[1]; [1]*Tel-Aviv Univ., Israel.* We present a new method for obtaining significant extension or frame-rate increase in low-coherence off-axis holography, using which it is possible to image larger and more dynamic samples without resolution or magnification loss.

DM2B.3 • 11:15

Optical Sectioning by Confocal Fresnel Incoherent Correlation Holography, Roy Kelner[1], Barak Katz[1], Joseph Rosen[1]; [1]*Dept. of Electrical and Computer Engineering, Ben-Gurion Univ. of the Negev, Israel.* Fresnel incoherent correlation holography (FINCH) is a method capable of recording spatially incoherent digital Fresnel holograms. We present a confocal configuration of FINCH that is able to suppress out-of-focus information from the recorded hologram.

10:30–12:30 IM2C • Image Quality Inspection and Imaging Systems II

Presider: Michael Kriss, MAK Consultants, USA

IM2C.1 • 10:30 Invited

Color Vision: Cones, Constancy and Categories, Karl Gegenfurtner[1]; [1]*Justus Liebig Universitat Giessen, Germany.* The origin of color categories is still unresolved. Work will be presented linking perceptual and linguistic color categories to several aspects of low-level color processing, such as discrimination and constancy.

IM2C.2 • 11:00 Invited

The Giant Magellan Telescope: Imaging New Worlds, Laird Close[1]; [1]*Astronomy, Univ. of Arizona, USA.* The next generation of adaptive optics systems utilizing adaptive secondary mirrors on today's and tomorrow's giant telescopes will be reviewed. In particular, the promise of directly imaging Earth-like worlds around other stars with the future 24m Giant Magellan Telescope will be highlighted.

Ballard Room	Capitol Hill	Greenwood
Laser Applications to Chemical, Security and Environmental Analysis	Propagation through and Characterization of Distributed Volume Turbulence	Signal Recovery & Synthesis

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

LM1D • Flow Visualization & Imaging—Continued

LM1D.5 • 09:30 Invited

Nonlinear Tomography: a New Imaging Concept, Weiwei Cai[1], Clemens Kaminski[1]; [1]*Univ. of Cambridge, UK.* This work will introduce the concepts of both the so-called linear and nonlinear tomography. Special focuses will be on the latter one and its guidance for developing imaging techniques as applied to flow diagnostics.

PM1E • Atmospheric Characterization I—Continued

PM1E.4 • 09:30

Correlated Satellite-derived Turbulence, Clouds and Aerosol Data, David Meier[1], Steven Fiorino[1]; [1]*Air Force Inst. of Technology, USA.* Paper describes novel methods to obtain winds, turbulence, cloud base and top heights, and aerosol extinction values from polar orbiting satellite data. Comparisons to ground-based LIDAR measurements and enhancements via numerical weather data are discussed.

SM1F • Image Reconstruction and Enhancement—Continued

SM1F.5 • 09:45

Super-resolution of wavefront encoding system by combining bi-cubic interpolation and L-R filtering methods, Haoyuan Du[1], Liquan Dong[1], Ming Liu[1], Wei Jia[1], Yuejin Zhao[1], Xiaohua Liu[1], Hong Wu[1], Xiaoxiao Zhou[1], Xueyan Li[1]; [1]*Beijing Inst. of Technology, China.* In the wavefront encoding optical system, a low-resolution sensor is adopted to capture encoded image. Through bi-cubic interpolation and L-R filtering using the PSF as the deconvolution filter, the super-resolution image is achieved.

10:00 Exhibit Hall Opening, *Metropolitan Ballroom B*

10:30–12:30 LM2D • Spray Diagnostics & Combustion Imaging

Presider: Joakim Bood; Lund Univ., Sweden

LM2D.1 • 10:30 Invited

New spray measurements using ballistic imaging, Mark A. Linne[1]; [1]*Applied Mechanics, Chalmers Univ., Sweden.* Advances in ballistic imaging for spray breakup studies are described, together with measurements in fundamental and applied (e.g. at diesel relevant conditions) spray systems.

LM2D.2 • 11:00 Invited

Investigation of Multiphase Flow Physics Using Synchrotron-Based X-Ray Radiography and Fluorescence, Terrence R. Meyer[1], Benjamin R. Halls[1], Christopher R. Radke[2], Alan L. Kastengren[3]; [1]*Iowa State Univ., USA,* [2]*NASA Johnson Space Center, USA,* [3]*Argonne National Laboratory, USA.* X-ray radiography and fluorescence are used to track mass distribution in the near-field mixing zone of liquid-liquid and liquid-gas spray systems. This enables detailed investigation of parameters affecting multiphase mixing processes under optically complex conditions.

10:30–12:15 PM2E • Atmospheric Characterization II

Presider: Denis Oesch; LEIDOS, USA

PM2E.1 • 10:30 Invited

Propagation through and Characterization of Strongly Inhomogeneous Ionospheric Turbulence, Alex Mahalov[1]; [1]*Arizona State Univ., USA.* I review physics-based predictive modeling and novel multi-nesting computational techniques for propagation through strongly inhomogeneous non-Kolmogorov ionospheric media characterized by sharp gradients of the refractive index at the edges of primary and secondary Rayleigh-Taylor plasma bubbles. The scintillation effects induced by trapping of electromagnetic (EM) waves in parabolic cavities created by the refractive index gradients along propagation path are analyzed.

PM2E.2 • 11:00 Invited

Modifying the Inner Scale Equation of the Boundary Layer Turbulence Model to Account for Non-Kolmogorov Turbulence, Thomas Farrell[1], Darryl J. Sanchez[1], Patrick Kelly[1], Anita Gallegos[2], Eric Aglubat[1], Alex Duchane[1], David Spendel[1], Terry Brennan[3]; [1]*US Air Force Research Laboratory, USA;* [2]*Leidos, USA;* [3]*Prime Plexus LLC, USA.* Previously, we developed a model of the Earth's boundary layer to predict optical turbulence characteristics from environmental parameters. This discusses a generalization made to the inner scale equation to account for non-Kolmogorov turbulence.

10:30–12:30 SM2F • Compressive Imaging and Phase Retrieval

Presider: Lei Tian; UC Berkeley, USA

SM2F.1 • 10:30 Invited

Statistical Methods in Compressive Imaging, Lawrence Carin[1]; [1]*Duke Univ., USA.* This talk will review recent developments in the use of statistical methods for inversion of data that are acquired compressively. A particular focus will be placed on dictionary learning and its connection to mixture models. It will be explained how these methods can be used to achieve very efficient inversion, with state-of-the-art accuracy. The basic framework will be demonstrated as applied to real compressively acquired data. In particular, we will consider compressive measurements with respect to time, spectrum and focus.

SM2F.2 • 11:00

Reducing Basis Mismatch in Harmonic Signal Recovery via Alternating Convex Search, Jonathan Nichols[1], Colin McLaughlin[1], Frank Bucholtz[1]; [1]*US Naval Research Laboratory, USA.* In compressive sampling applications, even small deviations from an exact signal model can result in dramatic increases in estimation error. This work describes an iterative, biconvex search algorithm that solves this problem.

SM2F.3 • 11:15

Compressed Sensing Techniques for Image Reconstruction in Optical Interferometry, Binoy Kurien[1,2], Yaron Rachin[1], Vinay Shah[1], Jonathan Ashcom[1], Vahid Tarokh[2]; [1]*MIT Lincoln Laboratory, USA;* [2]*Harvard Univ. School of Engineering and Applied Sciences, USA.* We develop a novel method of image reconstruction from bispectrum and magnitude observables of an optical interferometer using Compressed-Sensing techniques. We validate our method in simulation and with actual measurements from a Fizeau interferometer.

Issaquah A & B	Ravenna A,B & C	Metropolitan Ballroom A
Applied Industrial Optics: Spectroscopy, Imaging, and Metrology	Digital Holography & 3-D Imaging	Imaging Systems and Applications

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

AM2A • The Frontier: Applied Spectroscopy—Continued

AM2A.3 • 11:30 Invited

Development of Cavity-Enhanced Absorption Spectroscopy Analyzers for Industrial Applications, Manish Gupta[1], Andrew Fahrland[1], J. Brian Leen[1]; [1]*Los Gatos Research Inc, USA.* The advent of cavity-enhanced absorption spectroscopy analyzers has enabled new industrial applications that require sensitive, fast, and accurate measurements. Examples that highlight these capabilities include industrial process control, emissions monitoring, gas quality, and mobile applications.

AM2A.4 • 12:00 Invited

On-chip Random Spectrometer, Brandon Redding[1], Seng Fatt Liew[1], Raktim Sarma[1], Hui Cao[1]; [1]*Applied Physics, Yale Univ., USA.* We utilize multiple-scattering in an on-chip disordered structure to build a compact, high-resolution spectrometer. We demonstrate 0.75 nm resolution with 25 nm bandwidth at λ=1500 nm using a 25 μm radius random scattering structure.

DM2B • Advances in Digital Holographic Techniques—Continued

DM2B.4 • 11:30

Incoherent digital holography with axial localisation by the rotating point spread function, Petr Bouchal[1,2], Zdeněk Bouchal[3], Radim Chmelík[1,2]; [1]*Inst. of Physical Engineering, Brno Univ. of Technology, Czech Republic;* [2]*Central European Inst. of Technology, Czech Republic;* [3]*Dept.of Optics, Palacký Univ. Olomouc, Czech Republic.* In this study, the rotating point spread function, previously demonstrated in optical imaging, is for the first time implemented in incoherent holography. Theoretical concept of defocusing induced rotation supported by the experimental results is presented and used for a precise axial localisation.

DM2B.5 • 11:45

Incoherent off-axis color holographic imaging with digital compensation of chromatic aberrations, Tianlong Man[1], Yuhong Wan[1]; [1]*Beijing Univ. of Technology, China.* Incoherent color holographic three-dimensional (3D) imaging is implemented using off-axis Fourier triangular interferometer. The chromatic aberration resulting from wavelength sensitivity of recording is digitally compensated by employing proper image reconstruction and fusion algorithms.

DM2B.6 • 12:00

X-ray Holographic Microscopy by Self-Interference Incoherent Digital Holography, Myung K. Kim[1], Peter Fischer[2], Weilun Chao[2], Stefano Cabrini[2]; [1]*Univ. of South Florida, USA;* [2]*Lawrence Berkeley National Laboratory, USA.* New approach to full-field soft x-ray holographic microscopy is being developed based on the principle of self-interferencce incoherent digital holography, with simple optical configurations and higher efficiencies. Theorectial and preliminary experimental results will be presented.

DM2B.7 • 12:15

Real-Time Unwrapped Phase-Profile Calculation from Off-Axis Holograms using Conventional Computers, Natan T. Shaked[1], Pinhas Girshovitz[1]; [1]*Tel-Aviv Univ., Israel.* We present a new approach for extracting unwrapped phase profiles from off-axis digital holograms of one megapixel in more than 30 frames per second using a standard single-core personal computer on a Matlab platform.

IM2C • Image Quality Inspection and Imaging Systems II—Continued

IM2C.3 • 11:30 Invited

Intrinsic limits to super-resolution in far-field imaging, Stephen G. Lipson[1]; [1]*Technion Israel Inst. of Technology, Israel.* We show that resolution in optical imaging is limited by available photons and information theory concepts, and can not be expressed directly in terms of wavelength and numerical aperture. We use STORM to illustrate this concept.

IM2C.4 • 12:00

Image Quality Evaluation of High-order Ghost Imaging, Xue-Feng Si[1], WenWen Zhang[1], Qian Chen[1], RuiQing He[1]; [1]*Nanjing Univ of Science & Technology, China.* Image quality evaluating model is set up by considering visible and the standard deviation. The relation between the number of the pixel in the information region and the optimal order is researched by the model.

IM2C.5 • 12:15

An Angled Slit MTF Calculation Technique for Alignment and Characterization of the OSIRIS-REx Camera Suite, Dathon R. Golish[1], Wiley Black[1,2], Stefan O'Dougherty[1], Steve Peterson[1], Lori Harrison[1], Christian Drouet d'Aubigny[1]; [1]*Lunar and Planetary Laboratory, Univ. of Arizona, USA;* [2]*Control Vision, Inc., USA.* We present applications of an angled slit method for calculating MTF with sub-pixel resolution for the OSIRIS-REx Camera Suite. The technique is used for determination of best focus, CCD alignment, and performance characterization.

12:30–14:00 Lunch, *On Your Own*

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Ballard Room	Capitol Hill	Greenwood
Laser Applications to Chemical, Security and Environmental Analysis	Propagation through and Characterization of Distributed Volume Turbulence	Signal Recovery & Synthesis

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

LM2D • Spray Diagnostics & Combustion Imaging—Continued

LM2D.3 • 11:30
Investigation of ps-PFLIF for detection of hydrogen peroxides in laminar flames, Malin Jonsson[1], Kajsa Larsson[1], Jesper Borggren[1], Marcus Aldén[1], Joakim Bood[1]; [1]*Physics, Lund Univ., Sweden*. Using short (5 ns) pump-probe delay times, photochemical interferences due to CO2 photolysis can be virtually eliminated in flame experiments with photofragmentation laser-induced fluorescence (PFLIF), which enables hydrogen peroxides to be measured with higher accuracy.

LM2D.4 • 11:45
OH-Thermometry with Photofragmentation Laser-Induced Fluorescence, Elin Malmqvist[1], Malin Jonsson[1], Marcus Aldén[1], Joakim Bood[1]; [1]*Physics, Lund Univ., Sweden*. A technique that increases the temperature range and the sensitivity of OH-LIF thermometry is proposed. OH-excitation scans, acquired through photofragmentation laser-induced fluorescence of H2O2, are used to determine 2-D-temperatures in H2O2-vapor and in an HCCI-engine.

LM2D.5 • 12:00
Simultaneous Imaging of H2O2 and H2O Concentration Distributions Using Photofragmentation LIF, Kajsa Larsson[1], Marcus Aldén[1], Joakim Bood[1]; [1]*Physics, Lund Univ., Sweden*. Simultaneous imaging of H2O2 and H2O vapor, based on photofragmentation laser-induced fluorescence, is demonstrated. The concentrations are determined from the total OH(A-X) fluorescence (H2O2) and the ratio between the 1-1 and 0-0 emission bands (H2O).

LM2D.6 • 12:15
Temperature Imaging in Low-pressure Flames Using Diode Lasers, Jesper Borggren[1], Iain Burns[2], Anna-Lena Sahlberg[1], Zhongshan Li[1], Marcus Aldén[1]; [1]*Compustion Physics, Lund Univ., Sweden;* [2]*Chemical and Process Engineering, Univ. of Strathclyde, UK*. We present a calibration free technique for spatially resolved imaging of flame temperature. Its application is demonstrated in a low pressure premixed methane flame seeded with indium. Temperature measurements over a range of equivalence ratios are investigated.

PM2E • Atmospheric Characterization II—Continued

PM2E.3 • 11:30 Invited
Quantifying the Dependence of Temperature and Refractive Index Structure Parameters on Atmospheric Stability using Direct and Large-Eddy Simulations, Sukanta Basu[1], Ping He[1]; [1]*North Carolina State Univ., USA*. We report the continuing development of an extensive simulated database of stably stratified turbulence which includes episodic bursting events. Utilizing this database, a few physically-based parameterizations for the structure parameters are being formulated.

PM2E.4 • 12:00
A Quasi-Wavelet Model For The Turbulent Refractive Index, Dario G. Perez[1], Gustavo Funes[2]; [1]*Instituto de Fisica, Pontificia Universidad Catolica de Valparaiso, Chile;* [2]*Centro de Investigaciones Opticas (CIOp), Argentina*. We apply the novel quasi-wavelet model to the turbulent refractive index, then the first-order phase fluctuations are calculated. We explore its potential by estimating the angle-of-arrival variance. We found a good correspondence with previous models.

SM2F • Compressive Imaging and Phase Retrieval—Continued

SM2F.4 • 11:30
Withdrawn

SM2F.5 • 11:45
Mitigating the Effect of Noise in Iterative Projection Phase Retrieval, Russell Trahan[1], David Hyland[1]; [1]*Aerospace Engineering, Texas A&M Univ., USA*. Here the effect of noisy measurement data is explored within the traditional phase retrieval problem with the goal of filtering the noise to obtain an estimate of the true data. The method proposed can be applied to most existing phase retrieval methods.

SM2F.6 • 12:00
Regularized Phase Retrieval from Wavefront Sensor Images and the Importance of Priors, Zhengyun Zhang[1], Zhi Chen[1], Shakil Rehman[1], George Barbastathis[1,2]; [1]*Singapore-MIT Alliance for Res & Tech Ct, Singapore;* [2]*Mechanical Engineering, MIT, USA*. We present a regularized phase retrieval method for recovering high frequency information from wavefront sensor images and discuss the physical basis behind the need for priors whenever phase retrieval is applied to wavefront sensing data.

SM2F.7 • 12:15
Binary Sensing Matrix Design for Compressive Imaging Measurements, Jun Ke[1], Edmund Y. Lam[2], Ping Wei[1]; [1]*School of Optoelectronics, Beijing Inst. of Technology, China;* [2]*Dept.of Electrical and Electronic Engineering, The Univ. of Hong Kong, Hong Kong*. We design a binary sensing matrix in compressive imaging to reduce the capture time while maintaining image reconstruction performance, by minimizing the distance between the binary matrix and a modified principal component analysis sensing matrix.

12:30–14:00 Lunch, *On Your Own*

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Issaquah A & B

Applied Industrial Optics: Spectroscopy, Imaging, and Metrology

Ravenna A,B & C

Digital Holography & 3-D Imaging

Metropolitan Ballroom A

Imaging Systems and Applications

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

14:00–16:00
AM3A • Coherent and Diffuse, Light at the Extremes
Presider: Joseph Dallas; Avo Photonics Inc, USA

AM3A.1 • 14:00 Invited
High Peak and Average Power Near/Mid-IR Femtosecond Laser Sources, Sterling J. Backus[1,3], Susannah Brown[2], Michael Gerrity[2], Xiaoshi Zhang[1], Randy Bartels[3], Jeff Squier[4], Henry Kapteyn[1,2], Margaret Murnane[1,2]; [1]*Research and Development Department, Kapteyn-Murnane Labs, USA;* [2]*Univ. of Colorado, Dept.of Physics, JILA, USA;* [3]*Dept.of Electrical and Computer Engineering, Colorado State Univ., USA;* [4]*Dept.of Physics, Colorado School of Mines, USA.* I will present work on hybrid fiber/bulk systems employing non-linear amplifiers to reach near and mid-IR wavelengths to obtain high peak and average powers, with <100 femtosecond pulse durations. These systems have a wide range of uses from biotech imaging techniques, hard X-ray generation, and industrial/medical micromachining. I will illustrate our specific designs for pushing the limits on femtosecond fiber laser technology, mating it with solid state lasers, and extending these systems to meet the needs of cutting edge science.

AM3A.2 • 14:30 Invited
Current Developments and Future Trends in Diode-driven Solid-state Lighting, Faiz Rahman[1]; [1]*Electrospell Ltd, UK.* This talk will examine on going developments in white lighting generated from the light-emitting diode and laser diode. It will focus on techniques through which the performance metrics of these devices are being improved.

AM3A.3 • 15:00 Invited
Fiber-laser-based Widely-tunable Sources for the Visible, Angus Henderson[1]; [1]*Lockheed Martin Aculight Corp, USA.* Fiber lasers may be frequency converted to the visible via harmonic generation but they do not provide significant wavelength tunability. We have developed widely tunable orange to red fiber lasers using cascaded quasi-phase-matched frequency conversion.

14:00–16:00
DM3B • Digital Holographic Microscopy
Presider: Yasuhiro Takaki; Tokyo Univ of Agriculture and Technology, Japan

DM3B.1 • 14:00 Invited
Image acquisition, processing and reconstruction in holographic and tomographic diffractive microscopy, Olivier Haeberle[1], Jonathan Bailleul[1], Hui Liu[1], Bertrand Simon[1], Matthieu Debailleul[1]; [1]*Laboratoire MIPS EA2332, Universite de Haute-Alsace, France.* Tomographic diffractive microscopy allows for 3-D imaging of unlabelled specimens, giving access to their index of refraction distribution. Principles of the technique, and recent progress towards real-time acquisition/reconstruction/display of the images will be presented.

DM3B.2 • 14:30 Invited
Multispectral digital lensless holographic microscopy: from white light LED to fs-laser, Jorge Garcia-Sucerquia[1]; [1]*Universidad Nacional de Colombia, Colombia.* Multispectral digital lensless holographic microscopy operating with femtosecond laser and white light LED is presented. Both methodologies show the capability of producing spectral analysis and full color imaging of biological specimens at micrometer spatial resolution.

DM3B.3 • 15:00
Holographic Line-Scanning Confocal Microscope, Changgeng Liu[1], Myung K. Kim[1]; [1]*Univ. of South Florida, USA.* A new imaging system is proposed by combining line-scanning confocal microscope with digital holography. By this combination, the proposed system will posses characteristics of these two imaging technologies, such as low coherent noise, optical sectioning and accessibility to complex optical field.

DM3B.4 • 15:15
Phase-shifting interferometry capable of selectively extracting multiple wavelength information and its applications to sequential and parallel phase-shifting digital holography, Tatsuki Tahara[1], Shuhei Kikunaga[1], Yasuhiko Arai[1], Yasuhiro Takaki[2]; [1]*Kansai Univ., Japan;* [2]*Tokyo Univ. of Agriculture and Technology, Japan.* Phase-shifting interferometry capable of selectively extracting multiple wavelength information is presented. Specific phase shifts are introduced to extract wavelength. The proposed technique is applied to sequential and parallel phase-shifting digital holography. Validity is numerically confirmed.

14:00–16:00
IM3C • Biomedical Sensing and Imaging Applications
Presider: Aydogan Ozcan, Univ. of California Los Angeles, USA

IM3C.1 • 14:00 Invited
Raman Scattering: from Laboratories to Clinics, Shan Yang[1]; [1]*Dept.of Mechanical and Aerospace Engineering, Case Western Reserve Univ., USA.* Raman scattering has great application potential in medicine. Recent progress on the development of Raman related spectroscopy and hyperspectral imaging instruments and their feasibilities in arthritis disease diagnosis and dental caries detection are presented.

IM3C.2 • 14:30
Nuclear 3D Gamma and X-Ray Imaging using Variable Pinholes Array System, Ariel Schwarz[1], Amir Shemer[1], Zeev Zalevsky[1]; [1]*Bar-Ilan Univ., Israel.* We present a biomedical imaging technique for gamma/x-rays able to provide depth/3D information with improved SNR, sensitivity efficiency and no resolution degradation. The system is based on time multiplexing method with variable pinholes array.

IM3C.3 • 14:45
Withdrawn

IM3C.4 • 15:00
Non Labeled Tumor Detection via Polarization and Spectral Properties of Gold Nanoparticles, Zeev Zalevsky[1], Dror Fixler[1]; [1]*Bar-Ilan Univ., Israel.* We present a novel concept involving optical properties of gold-nanorods. When the gold-nanorods are located in a tumor the reflected light has low degree of polarization at two specific reflected wavelengths.

IM3C.5 • 15:15
Micro-optical coherence tomography (μOCT) in vivo, Dongyao Cui[1,2], Xinyu Liu[1,2], Ping Shum[1,2], Xiaojun Yu[1,2], Linbo Liu[1,3]; [1]*School of Electrical and Electronic Engineering, Nanyang Technological Univ., Singapore;* [2]*OPTIMUS, Photonics Centre of Excellence, Nanyang Technological Univ., Singapore;* [3]*School of Chemical & Biomedical Engineering, Nanyang Technological Univ., Singapore.* We have developed a Micro- optical coherence tomography (μOCT) for in vivo use. We have achieved a longitudinal resolution of 1.9μm in free space and 1.38μm in tissue. In vivo imaging was conducted using zebra fish larvae and cellular structures can be observed.

Ballard Room

Laser Applications to Chemical, Security and Environmental Analysis

Capitol Hill

Propagation through and Characterization of Distributed Volume Turbulence

Greenwood

Signal Recovery & Synthesis

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

14:00–16:00
LM3D • Developments in CARS and Other Nonlinear Spectroscopies
Presider: Thomas Seeger; Universität Siegen, Germany

LM3D.1 • 14:00 Invited
Hybrid fs/ps Rotational CARS Temperature/Species Detection in Flames at kHz Rate, Sean P. Kearney[1]; [1]*Sandia National Labs, USA.* A hybrid rotational CARS scheme with femtosecond pump/Stokes preparation and a high-energy probe, generated by second-harmonic bandwidth compression (SHBC), is described. The instrument is demonstrated for kHz-rate temperature/oxygen probing in C2H4/air flat flames.

LM3D.2 • 14:30 Invited
Recent Advances in CARS Imaging: New Capabilities for Combustion Diagnostics, Christopher J. Kliewer[1]; [1]*Sandia National Labs, USA.* Single laser pulse methods for 1D and 2D coherent spectral imaging with coherent anti-Stokes Raman spectroscopy have recently been developed for studies of gas phase reacting systems, with particular focus on combustion diagnostics.

LM3D.3 • 15:00
Fs-TALIF imaging of atomic species in non-equilibrium plasmas at moderate pressures, Jacob Schmidt[1], Waruna Kulatilaka[1], Sukesh Roy[1], Kraig Frederickson[2], Walter Lempert[2], James R. Gord[3]; [1]*Spectral Energies, LLC., USA;* [2]*The Ohio State Univ., USA;* [3]*Air Force Research Laboratory, USA.* A femtosecond laser-based TALIF scheme is demonstrated allowing for two-dimensional imaging of atomic hydrogen, oxygen and nitrogen inside a non-equilibrium, pin-to-pin, low pressure discharge cell additionally assisting development of more predictive two-dimensional plasma kinetics models.

LM3D.4 • 15:15 Invited
Ultrafast Time-Resolved Probes for Quenching-Free Detection of Excited-State Species, Hans U. Stauffer[1], Sukesh Roy[1], James R. Gord[2]; [1]*Spectral Energies LLC, USA;* [2]*Aerospace Systems Directorate, Air Force Research Laboratory, USA.* The recent development and application of ultrafast nonlinear optical probes aimed at detection of gas-phase species via electronic excitation will be detailed. The use of femtosecond lasers, in particular, allows measurements to be made on ultrashort timescales that are not susceptible to collisions with species that rapidly quench fluorescence.

14:00–16:00
PM3E • Non-Kolmogorov Turbulence
Presider: Thomas Farrell; US Air Force Research Laboratory, USA

PM3E.1 • 14:00 Invited
Simulating Non-Kolomogorov Phase Screens with Finite Inner and Outer Scales, Michael C. Roggemann[1]; [1]*Michigan Technological Univ., USA.* A method for simulating turbulence-corrupted phase screens for the case of non-Kolmogorov power law and finite inner and outer scales is presented. The sub-harmonic approach of Lane [1] is used. Simulated structure functions are compared to theoretical values where possible with excellent agreement. Some simulated propagation examples are also presented.

PM3E.2 • 14:30 Invited
Intensity and Power Statistics of Laser and Random Beams in Non-Kolmogorov Turbulence, Olga Korotkova[1]; [1]*Univ. of Miami, USA.* Intensity and power statistics including PDF of several beams is investigated after they interact with non-Kolmogorov turbulence. Measurements are taken with help of several SLMs employed for phase perturbation for source and medium.

PM3E.3 • 15:00
Laboratory Investigation of the Spectral Exponent Effect on Scintillation in Non-Kolmogorov Turbulence, Xifeng Xiao[1], Olga Korotkova[2], David G. Voelz[1]; [1]*Klipsch School of Electrical and Computer Engineering, New Mexico State Univ., USA;* [2]*Dept.of Physics, Univ. of Miami, USA.* A Labsetup involving a spatial light modulator is described for examining the dependence of scintillation on the spectral index of non-Kolmogorov turbulence. A comparison of Labresults with simulation and existing theory is discussed.

PM3E.4 • 15:15
Estimating path-averaged Refractive index structure constant) in Non-Kolmogorov deep turbulence using the unwrapped phase variance and correlation information, Venkata S. Gudimetla[1], Jeremy P. Bos[1]; [1]*US Air Force, USA.* In this paper, we will show that path-averaged refractive index structure constant can be estimated in non-Kolmogorov deep turbulence from the unwrapped phase information (phase variance and correlation) at the receiver.

14:00–16:00
SM3F • Image Perception
Presider: Esteban Vera; Duke Univ., USA

SM3F.1 • 14:00 Invited
Optimal Channelized Quadratic Observers for Binary Classification Tasks, Eric Clarkson[1], Meredith Kupinski[1]; [1]*Univ. of Arizona, USA.* A new method is presented for computing optimized channels for channelized quadratic observers utilizing high-dimensional image data. Gaussian statistics are assumed for the image data, but the method is applicable in more general situations.

SM3F.2 • 14:30
Effect of Low SNR on Visual Image Quality, David R. Gerwe[1]; [1]*Boeing - Phantomworks, USA.* The effect of noise and blur on image quality is investigated using human evaluations of images. Below SNR of 10 resolution is limited by noise and is insensitive to blur level. The VIF model is shown to accurately match the human response.

SM3F.3 • 14:45 Invited
Study on Issues of Visual Fatigue of Display Devices, Yongtian Wang[1], Yue Liu[1], Bochao Zou[1], Yi Huang[1]; [1]*Beijing Inst. of Technology, China.* Recent advances in visual fatigue assessment regarding 3D displays are discussed and both subjective and objective measurement methods are examined. A brief introduction of our ongoing effort towards that goal is also presented.

SM3F.4 • 15:15 Invited
Looking Around Corners with Trillion Frames Per Second Imaging and Projects in Eye-diagnostics on a Mobile Phone, Ramesh Raskar[1]; [1]*MIT, USA.* Abstract not available.

Issaquah A & B	Ravenna A,B & C	Metropolitan Ballroom A
Applied Industrial Optics: Spectroscopy, Imaging, and Metrology	Digital Holography & 3-D Imaging	Imaging Systems and Applications

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

AM3A • Coherent and Diffuse, Light at the Extremes—Continued

AM3A.4 • 15:30 Panel
Panel: Next Challenges in Lighting and Laser Sources
Moderator: Joe Dallas, *Avo Photonics, Inc., USA*
Sterling Backus, *KM Labs, USA*
Faiz Rahman, *Electrospell, UK*
Angus Henderson, *Lockheed Martin Aculight, USA*

DM3B • Digital Holographic Microscopy—Continued

DM3B.5 • 15:30
Phase aberration compensation using virtual confocal scheme in digital holographic microscopy, Yang-Kun Chew[1], Min-Tzung Shiu[2], Chi-Ching Chang[1]; [1]*Electro-Optical and Energy Engineering, MingDao Univ., Taiwan;* [2]*School of Defense Science, National Defense Univ., Taiwan.* To improve and avoid difficult alignment in physical compensation of quadratic phase, virtual confocal offset lens enables clear image reconstruction under high degree of magnification by distance changing of CCD to objective lens.

DM3B.6 • 15:45
High-resolution and wide-field phase imaging through lensless digital holographic microscopy, Kazuhiro Hoshino[1], Eriko Watanabe[1]; [1]*Center for Frontier Science and Engineering, The Univ. of Electro-Communictions, Japan.* This paper presents the development of phase-shifting lensless digital holographic microscopy that has high resolution (0.98 μm) and supports wide-field imaging (2 mm × 2 mm) with localized autofocusing.

IM3C • Biomedical Sensing and Imaging Applications—Continued

IM3C.6 • 15:30
Light Field Otoscope, Noah Bedard[1], Ivana Tosic[1], Lingfei Meng[1], Kathrin Berkner[1]; [1]*Ricoh Innovations Corporation, USA.* We introduce a light field otoscope that enables new functionalities for middle ear imaging, such as depth estimation, multi-view extraction, and multispectral rendering of the tympanic membrane. A prototype and experimental results are presented.

IM3C.7 • 15:45
Imaging via Tactile Spatial Stimulation of the Cornea, Zeev Zalevsky[1], Yevgeny Beiderman[1], Michael Belkin[2], Ygal Rotenstreich[2]; [1]*Bar-Ilan Univ., Israel;* [2]*Tel-Aviv Univ., Israel.* We present the first experimental quantification of the tactile spatial responsivity of the human cornea and we teach subjects to recognize spatial tactile shapes that are stimulated on their cornea.

16:00–17:00 Exhibit Hall & Coffee Break, *Metropolitan Ballroom B*

NOTES

Ballard Room	Capitol Hill	Greenwood
Laser Applications to Chemical, Security and Environmental Analysis	Propagation through and Characterization of Distributed Volume Turbulence	Signal Recovery & Synthesis

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

LM3D • Developments in CARS and Other Nonlinear Spectroscopies—Continued

LM3D.5 • 15:45
Analysis of Ultrafast-Saturation Criterion of Electronic-Resonance-Enhanced CARS, Anil K. Patnaik[1,2], Sukesh Roy[3], James R. Gord[1]; [1]*Aerospace Systems Directorate, US Air Force Research Laboratory, USA;* [2]*Dept.of Physics, Wright State Univ., USA;* [3]*Spectral Energies, LLC., USA.* Saturation threshold of a delayed ultrafast probe field in an electronic-resonance-enhanced CARS (ERE-CARS) configuration is calculated for arbitrary pulse duration. Pulse area of the probe can be used to determine the saturation-threshold criterion for ERE-CARS.

PM3E • Non-Kolmogorov Turbulence—Continued

PM3E.5 • 15:30
Simulation of long-path horizontal propagation through a three-layer non-Kolmogorov atmosphere model, Jeremy P. Bos[1], Venkata S. Gudimetla[1]; [1]*AFRL/Maui, USA.* We explore the possibility that a three-layer model including non-Kolmogorov turbulence center section may produce coherent structures in received intensity. Instead, we find that non-Kolmogorov power-law media decreases coherence when log-amplitude variance is fixed.

PM3E.6 • 15:45
Efficiency of adaptive optics correction for Gaussian beams propagating through non-Kolmogorov turbulence, Italo Toselli[1,2], Szymon Gladysz[1]; [1]*Fraunhofer IOSB, Germany;* [2]*University of Miami, USA.* In this paper we investigate theoretically the performance of adaptive-optics correction for Gaussian beams in weak non-Kolmogorov turbulence. Action of adaptive optics is modeled as removal of a certain number of Zernike modes from the aberrated wavefront.

SM3F • Image Perception—Continued

SM3F.5 • 15:45
Nuisance laser pointer detection and geo-location, Trevor A. Wheatley[1], Craig R. Benson[1]; [1]*School of Engineering and Information Technology, UNSW Australia, Australia.* We introduce the new research area of real-time detection and source origin geo-location of nuisance lasers pointers above the horizon. We present initial findings using simple image processing techniques and low-cost sensors.

16:00–17:00 Exhibit Hall & Coffee Break, *Metropolitan Ballroom B*

NOTES

Issaquah A & B

Applied Industrial Optics: Spectroscopy, Imaging, and Metrology

Ravenna A,B & C

Digital Holography & 3-D Imaging

Metropolitan Ballroom A

Imaging Systems and Applications

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

17:00–19:00
AM4A • Fiber Fiber Everywhere
Presider: Jess Ford; Weatherford International Ltd, USA

AM4A.1 • 17:00 Invited
Fiber Optic Sensors for SHM - From Labto Industrial Applications, Katerina Krebber[1]; [1]*8.6, BAM, Germany.* The paper highlights the research activities in Germany and Europe in the development of distributed fiber optic sensor for structural health monitoring (SHM) like the monitoring of geotechnical and civil infrastructures and presents selected results achieved within these projects.

AM4A.2 • 17:30 Invited
ZBLAN Fibers: From Zero Gravity Tests to Orbital Manufacturing, Dmitry S. Starodubov[1], Shelly Mechery[1], David Miller[1], Chris Ulmer[1], Phil Willems[1], Jeff Ganley[2], Dennis Tucker[3]; [1]*Physical Optics Corporation, USA;* [2]*Air Force Research Labs (AFRL/RVSS), USA;* [3]*NASA Marshall Space Flight Center, USA.* The experimental findings of low loss ZBLAN optical fibers fabrication in zero gravity are presented. The mechanisms of the observed phenomena are discussed. The potential challenges of the orbital manufacturing are reviewed in detail.

AM4A.3 • 18:00
Simple Fiber-Optic Current Sensor with Integrated-Optics Polarization Splitter for Interrogation, Georg M. Müller[1], Lin Yang[1], Andreas Frank[1], Klaus Bohnert[1]; [1]*ABB Corporate Research, Switzerland.* A simplified fiber-optic current sensor configuration is presented. Key component is an assembly of a 1x3 integrated-optics splitter with retarder and polarizer platelets that transforms the magneto-optic phase shift into anti-phase signals proportional to current.

AM4A.4 • 18:15
Fiber-Loop Cavity Ring-Down Absorption Spectroscopy, Nicholas L. Andrews[1], Jessica Litman[1], Klaus Bescherer[1], Jack A. Barnes[1], Hans-Peter Loock[1]; [1]*Queen's Univ., Canada.* Cavity ring-down spectroscopy is a multi-pass absorption spectroscopic technique that amplifies the absorption loss of a sample. CRDS can be adapted to absorption measurements on liquid samples using a fiber optic waveguide loop.

AM4A.5 • 18:30 Panel
Panel: Careers in Optics
Moderator: *Hans Peter Loock, Queen's University - Chemistry, Canada*
Georg Müller, *ABB Corporate Research, Switzerland*
Gary Miller, *Naval Research Lab, USA*
Pietro Ferraro, *Consiglio Nazionale delle Ricerche INO, Italy*

19:00–20:30 Welcome Reception,
Metropolitan Ballroom B and Foyer

17:00–19:00
DM4B • Quantitative Phase Imaging and Holography
Presider: Gary Brooker; Johns Hopkins Univ., USA

DM4B.1 • 17:00 Invited
Quantitative Phase Microscopy of Optically Manipulated Objects, Samarendra K. Mohanty[1]; [1]*Univ. of Texas at Arlington, USA.* Abstract not available.

DM4B.2 • 17:30
Quantitative Phase Imaging using Quantum Light, Chien-Hung Lu[1], Jason W. Fleischer[1]; [1]*Princeton Univ., USA.* We experimentally demonstrate quantitative phase imaging using entangled photons. By using transport-of-intensity methods, we show that phase retrieval from quantum illumination is more sensitive and less noisy than that of classical light.

DM4B.3 • 17:45
Coherence-Controlled Holographic Microscopy for Coherence-Gated Quantitative Phase Imaging, Tomas Slaby[1,2], Pavel Kolman[3], Zbynek Dostal[2,3], Martin Antos[2,3], Martin Lostak[1,2], Aneta Krizova[1,2], Jana Collakova[2,3], Vera Kollarova[3], Michala Slaba[2,3], Pavel Vesely[3], Radim Chmelik[2,3]; [1]*TESCAN Brno, s.r.o., Czech Republic;* [2]*Faculty of Mechanical Engineering, Brno Univ. of Technology, Czech Republic;* [3]*Central European Inst. of Technology, Brno Univ. of Technology, Czech Republic.* We show that the use of incoherent illumination in coherence-controlled holographic microscopy (CCHM) enables coherence-gated quantitative phase imaging of objects through turbid media. Also high lateral resolution and strong suppression of coherence noise is demonstrated.

DM4B.4 • 18:00
Three-dimensional fractal structure of a blood clot using quantitative phase imaging, G Rajshekhar[1], Basanta Bhaduri[1], Krishnarao Tangella[2], Gabriel Popescu[1]; [1]*Quantitative Light Imaging Laboratory, Dept.of Electrical and Computer Engineering, Beckman Inst. for Advanced Science and Technology, Univ. of Illinois,Urbana-Champaign, USA;* [2]*Dept.of Pathology, Christie Clinic, USA.* We demonstrate a quantitative phase imaging technique to measure the three-dimensional structure of a blood clot. The technique offers a non-invasive, speckle-free and label-free approach for exploring the fractal characteristics of fibrin network.

DM4B.5 • 18:15
Cylindrical hologram recorder method based on outside-in propagation model, Jun Wang[1], Qionghua Wang[1], Yuhen Hu[2]; [1]*Sichuan Univ., China;* [2]*Univ. of Wisconsin - Madison, USA.* This paper presents a cylindrical hologram recorder method generated by computer based on outside-in propagation model. The hologram recorder method could be used for 3D holographic display with 360° view angle and unlimited object size.

DM4B.6 • 18:30
Polarization holography using the circularly polarized light, An'an Wu[1], Tsutomu Shimura[2], Kazuo Kuroda[3,1]; [1]*School of Optoelectronics, Beijing Inst. of Technology, China;* [2]*Inst. of Industrial Science, Univ. of Tokyo, Japan;* [3]*Center for Optical Research and Education, Utsunomiya Univ., Japan.* The characteristics of the polarization holography of the circularly polarized light are studied based on a tensor theory. The reconstruction wave is disappeared when we use the orthogonal reference wave to reconstruct.

DM4B.7 • 18:45
Method for auto-focusing in digital lensless holographic microscopy, Jorge Garcia-Sucerquia[1], Carlos Trujillo[1]; [1]*School of Physics, Universidad Nacional de Colombia, Colombia.* An auto-focusing method applicable to digital lensless holographic microscopy is presented. The proposed technique has been tested on auto-focusing experimental holograms and contrasted with some reported methods to seek for the best focus plane.

17:00–19:00
IM4C • Remote Imaging and Sensing
Presider: Kathrin Berkner, Ricoh Innovations, Inc., USA

IM4C.1 • 17:00 Invited
Navy Imaging Systems, Dale C. Linne von Berg[1]; [1]*US Naval Research Laboratory, USA.* Naval environments require sensing modalities that span the spectral imaging regime. Recent advances in optics and spectral sensor design, sensor fusion, and image processing techniques are described relevant to unique Navy airborne and maritime applications.

IM4C.2 • 17:30 Invited
Optical Challenges in Super-Resolving Array Cameras, Jacques Duparre[1], Kartik Venkataraman[1]; [1]*R&D group, Pelican Imaging Corp., USA.* We present the optical aspects of an ultra-thin high performance monolithic camera array, that captures light fields and synthesizes high resolution images along with a range image (scene depth) through integrated parallax detection and superresolution. The camera is passive, supporting both stills and video, low light capable, and small enough to be included in the next generation of mobile devices including smartphones.

IM4C.3 • 18:00
Modeling the Performance of Fire Hazard Detection with Thermal Infrared Cameras, Eddie Jacobs[1]; [1]*Univ. of Memphis, USA.* The development of a performance model of fire fighters detecting fire hazards using a thermal infrared camera is explored. The efficacy of a nonlinear statistical approach and a standard infrared model (NV-IPM) are shown.

IM4C.4 • 18:15
Machine Learning Methods for the Analysis of Turbulence- and Extinction-Degraded Imagery, Colin Reinhardt[1], David T. Wayne[1], Kevin McBryde[1], Ana Ascencio[1]; [1]*Atmospheric Propagation Branch, SSC-PAC, USA.* Machine learning methods improve performance of a novel atmospheric parameter estimation algorithm for characterizing local atmospheric propagation channel optical turbulence, extinction, and scattering. Results of lab experiment, field test, and wave-optics propagation simulations are presented.

IM4C.5 • 18:30
Optical Arrangements for Time-Gated Ballistic Imaging, Mattias Rahm[1], Megan Paciaroni[2], Zhenkan Wang[3], Mark A. Linne[1], David Sedarsky[1]; [1]*Applied Mechanics, Chalmers Univ. of Technology, Sweden;* [2]*Physics & Engineering, Fort Lewis College, USA;* [3]*Combustion Physics, Lund Univ., Sweden.* We report on a comparison of two optical setups used in time-gated ballistic imaging simulating monodisperse scattering environments with polystyrene spheres in different sizes and concentrations suspended in water.

IM4C.6 • 18:45
Remote optical sensor of blood coagulation, oximetry and dehydration, Zeev Zalevsky[1], Israel Margalith[1], Nisan Ozana[1], Yevgeny Beiderman[1], Mark Kunin[1], Javier Garcia[2], Vicente Mico[2]; [1]*Bar-Ilan Univ., Israel;* [2]*Universitat de València, Spain.* An optical approach for remote extraction of vibrations has recently been proposed. We demonstrate the method's ability to continuously monitor three biomedical indicators: blood oximetry, blood coagulation and dehydration of the body.

Ballard Room

Laser Applications to Chemical, Security and Environmental Analysis

Greenwood

Signal Recovery & Synthesis

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

17:00–19:00
LM4D • New Laser Sources & Instrumentation
Presider: Thomas Dreier; Universität Duisburg-Essen, Germany

LM4D.1 • 17:00 Invited
Compact Femtosecond Lasers and Applications in Photothermal Spectroscopy, Michelle Y. Sander[1]; [1]*Electrical and Computer Engineering, Photonics Center, Division of Materials Science and Engineering, Boston Univ., USA.* Compact femtosecond fiber lasers and frequency comb technology at telecommunication wavelengths are presented. Integration of such a robust fiber probe laser into photothermal microspectroscopy for chemical and biological samples is demonstrated.

LM4D.2 • 17:30
Coherent quantum cascade laser array at 8.2 µm in extended-cavity system, Raphael Vallon[1], Bertrand Parvitte[1], Gregory Maisons[2], Mathieu Carras[2], Virginie ZENINARI[1]; [1]*GSMA, France;* [2]*III-V lab, France.* In the framework of research program "COCASE", GSMA and III-V lab report the development of a monolithic quantum cascade array emitting at 8.2 µm mounted in an external-cavity system in order to obtain wide tunability.

LM4D.3 • 17:45 Invited
Recent Advances in High-energy, Extended-duration Burst-mode Laser Technology for High-speed Applications in Turbulent Flows, Joseph D. Miller[1], Mikhail Slipchenko[2], Terrence R. Meyer[3], Sukesh Roy[2], James R. Gord[1]; [1]*Air Force Research Laboratory, Aerospace Systems Directorate, USA;* [2]*Spectral Energies, LLC, USA;* [3]*Dept.of Mechanical Engineering, Iowa State Univ., USA.* Burst-mode pulse energies exceeding 1 Joule at 10 kHz along with 100-millisecond tailored burst profiles (1,000-10,000 pulses) are produced using temporally adjustable oscillator and amplifier technology enabling high-fidelity measurements and analyses in turbulent flows.

LM4D.4 • 18:15
All-fiber Homodyne Laser Doppler Vibrometry for Seafloor Topographic Survey, Jianhua Shang[1,2], Fu Yang[1], Yan He[2], Yuan Luo[2], Xiaofeng Jin[3], Wen Xu[3]; [1]*Donghua Univ., China;* [2]*Shanghai Inst. of Optics and Fine Mechanics, Chinese Academy of Sciences, China;* [3]*Zhejiang Univ., China.* An all-fiber compact homodyne laser Doppler vibrometry for the future-generation seafloor topographic survey in turbid water has been developed. By means of this setup, we display the experiment results obtained in the anechoic tank.

LM4D.5 • 18:30 Invited
Photochemistry in Hollow-core Photonic Crystal Fiber Microreactors, Tijmen G. Euser[1], A. M. Cubillas[1,2], X. Jiang[1], S. Unterkofler[1], B.j.M Etzold[2,3], P. Wasserscheid[2,3], A. C. Jones[4], P. J. Sadler[5], P.St.J Russell[1,2]; [1]*Max Planck Inst. for the Science of Light, Germany;* [2]*Excellence Cluster, Germany;* [3]*Lehrstuhl für Chemische Reaktionstechnik, Germany;* [4]*Univ. of Edinburgh, UK;* [5]*Univ. of Warwick, UK.* Hollow-core photonic crystal fiber uniquely allows low-loss propagation of light in liquid-filled microchannels, thus enabling highly efficient photochemistry, photo-switching, and photocatalysis at optical powers that are five orders of magnitude lower than in conventional systems.

17:00–19:00
SM4F • Holographic Imaging
Presider: Lei Tian; UC Berkeley, USA

SM4F.1 • 17:00 Invited
Complex amplitude modulation in real time holographic computation, Juan Liu[1], Xin Li[1]; [1]*Beijing Inst. of Technology, China.* The loss of the amplitude or phase information will lead to the random noise of high frequency in the reconstruction the real object. The complex amplitude modulation in real time are presented theoretically and experimentally.

SM4F.2 • 17:30
High-resolution Section Recovery Using a Configurable Pupil in a Scanning Holographic Microscopy, Haiyan Ou[1], Kenneth Wong[2], Edmund Y. Lam[2]; [1]*Inst. of Applied Physics, Univ. of Electronic Science and Technology of China, China;* [2]*Dept.of Electrical and Electronic Engineering, Univ. of Hong Kong, Hong Kong.* We present a sectioning method in optical scanning holography with enhanced depth resolution using a configurable pupil, which is based on spatial light modulator. A depth resolution of 0.7 µm can be achieved by this method.

SM4F.3 • 17:45 Invited
An Acquisition Method for Holographic Display, Guohai Situ[1]; [1]*Chinese Academy of Sciences, China.* It is well known that holographic display can provide 3D scenes with continuous viewpoints and free of accommodation-convergence conflict. So far most of the research in this area focuses on the display end, leaving the acquisition end merely explored. For holographic content acquisition, one needs to capture the scene in 3D. Ways to do this include the traditional optical holography and integral imaging. However, optical holography suffers from serious speckle while integral imaging has a long march to increase the resolution. In this paper, we propose a technique based on a variation of the transport of intensity equation to calculate the "phase" information of a scene from its defocusd intensity captured by a color camera under white light illumination. With the defocused phase and intensity data at hand, we can calculate the infocused wavefront of the scene, and further encode it into a computer generated hologram for subsequent holographic display. We demonstrate the proposed technique by simulation and experimental results. Compared with existing 3D acquisition techniques for holographic display, our method may provide better viewing experience due to the free of speckle in the acquisition stage, as well as the fact that the resolution does not limited by the microlenslet.

SM4F.4 • 18:15
Reducing the Acquistion Time of Optical Scanning Holography by Compressed Sensing, Antony C.S. Chan[1], Kenneth Wong[1], Kevin Tsia[1], Edmund Y. Lam[1]; [1]*The Univ. of Hong Kong, Hong Kong.* We propose a compressed sensing approach to improve the the acquisition time of optical scanning holography with a spiral trajectory. A two-sectional object is reconstructed with high fidelity by at least 5 speed improvement.

SM4F.5 • 18:30 Invited
Withdrawn

19:00–20:30 Welcome Reception, *Metropolitan Ballroom B and Foyer*

07:00–17:00 Registration, *Metropolitan Ballroom Foyer*

Metropolitan Ballroom A

Joint

08:00–10:30
JTu1A • Joint Plenary

JTu1A.1 • 08:00 Plenary
See Through Optical Architectures for Wearable Displays, Bernard Kress[1]; [1]*Google, USA.* HUDs (Head Up Displays) and HMDs (Helmet Mounted Displays) have been with us for a few decades, providing exceptional optical performances for specialized defense applications. On the other hand, consumer electronics HMDs (Head Mounted Displays) have been lingering as personal gadgets for a mere decade. But recently, major companies have launched consumer compelling head mounted display solutions integrating both hardware, operating system as well as content, unlocking the decade long consumer HMD status-quo. As a result, we are witnessing today a fragmentation of the HMD market into various categories which have their very own specificity in terms of functionality, hardware and content. Such fragmentation is responsible for defining new distinct market segments such as consumer near to eye displays, social smart glasses, gaming headsets, as well as professional (engineering and technical) HMDs, specialized (medical, law enforcement, firefighting) HMDs and of course the previously existing defense market. We will be reviewing the different type of optical hardware used in such devices.

JTu1A.2 • 08:50 Plenary
Looking around Corners with Trillion Frames Per Second Imaging and Projects in Eye-Diagnostics on a Mobile Phone, Ramesh Raskar[1]; [1]*MIT, USA.* Abstract not available.

JTu1A.3 • 09:40 Plenary
In Situ Laser Diagnostics in the Gas-Phase Synthesis of Functional Nanomaterials, Christof Schulz[1]; [1]*CENIDE, Univ. of Duisburg-Essen, Germany.* Laser-based in-situ diagnostics based on laser-induced fluorescence and incandescence are used to characterize reaction conditions such as temperature, species concentration, and particle size with high spatial and temporal resolution to understand and optimize the gas-phase synthesis of functional nanomaterials.

10:30–11:30 Coffee Break and Exhibit Hall, *Metropolitan Ballroom B*

Issaquah A & B

Applied Industrial Optics: Spectroscopy, Imaging, and Metrology

11:30–13:30
ATu2A • The Joy of Measurement, How Low Can We Go
Presider: Dominik Rabus; Burkert Fluid Control Systems, Germany

ATu2A.1 • 11:30 Invited
Static Optical Interferometry: Evolution, Challenges and Opportunities, Dominic F. Murphy[1]; [1]*Pie Photonics, Ltd, Ireland.* Static optical interferometry has continued to evolve over recent decades into increasingly compact and portable forms, for example, from Twyman-Green and Lloyd's mirrors type configurations to Young's Interferometer and multi-core fiber forms. This evolution has seen developments from multi-component, bulk-optic configurations to single optical fiber and optical waveguide circuits and extreme miniaturisation in the form of multi-mode and multi-core fibers. Here, we consider advantages, challenges and opportunities that this evolution presents across a selection of metrology and spectroscopy applications.

ATu2A.2 • 12:00 Invited
Challenges for Optical Metrology in the Aerospace Industry, Jonathan M. Saint Clair[1]; [1]*Boeing Company, USA.* This paper will examine a brief history of optical metrology technologies utilized within the aerospace industry. We will identify the unique challenges aerospace industry requirements impose, present a view of the technical trends in the driving requirements, and take a look at the corresponding trends in measurement technology evolutions likely to have a positive impact.

Ravenna A,B & C

Digital Holography & 3-D Imaging

11:30–13:30
DTu2B • Digital Holography
Presider: TBD

DTu2B.1 • 11:30 Invited
Computational Sectioning and Resolution Enhancement in Optical Scanning Holography, Edmund Y. Lam[1]; [1]*Univ. of Hong Kong, Hong Kong.* This paper overviews recent computational imaging techniques to increase the axial resolution and sectioning performance of optical scanning holography, including the use of a dual-wavelength source, double scanning, and configurable pupils.

DTu2B.2 • 12:00
Optical Scanning Holography in the Coherent Mode, Chia-Hao Guo[1], Wei-Ren Siao[1], Jung-Ping Liu[1]; [1]*Feng Chia Univ., Taiwan.* The recording of a hologram of a diffusive object by optical scanning holography in the coherent mode is a challenge because the optical signal is extremely weak. We successfully achieved this kind of recording.

Metropolitan Ballroom A

Joint LACSEA / IS / pcDVT

11:30–13:30
JTu2C • Joint Lidar Session (with LACSEA , IS and pcDVT)
Presider: Julie Smith; US Air Force Research Laboratory, USA

JTu2C.1 • 11:30 Invited
Development of a lidar technique for profiling optical turbulence, Gary G. Gimmestad[1], David Roberts[1], John Stewart[1], Jack Wood[1]; [1]*Georgia Tech Research Inst., USA.* A fielded lidar system for remote sensing of the strength of atmospheric refractive turbulence is described, along with the history of development of the instrument and the data analysis algorithms. Measured turbulence profiles are presented.

JTu2C.2 • 12:00
Range-Gated Intensified-CCD Imager for Atmospheric Characterization, Colin Reinhardt[1], David T. Wayne[1], Stephen Hammel[1]; [1]*Atmospheric Propagation Branch, SSC-PAC, USA.* Real-time measurement of local atmospheric propagation channel conditions with range-gated intensified-CCD imager applied to optical turbulence and atmospheric extinction and scattering characterization. Results of lab experiment, field test, and wave-optics propagation simulations are presented

Greenwood

Signal Recovery & Synthesis

11:30–13:15
STu2F • Novel Image Sensing I
Presider: David Gerwe; Boeing, USA and Esteban Vera; Duke Univ., USA

STu2F.1 • 11:30 Invited
Optical Imaging with the Use of a Scattering Lens, Wonshik Choi[1], Seungwon Jeong[1], Sungsam Kang[1]; [1]*Korea Univ., Korea.* We developed an experimental system that records the transmission matrix of a scattering medium and demonstrated resolution enhancement by the use of the scattering medium and endoscopic imaging with just a single multimode fiber.

STu2F.2 • 12:00
Complete reflectance function measurement of translucent object using compressive sensing, Yusuke TAMPA[1], Ryoichi Horisaki[1], Jun Tanida[1]; [1]*Osaka Univ., Japan.* The eight-dimensional reflectance field(RF) function of translucent object is acquired using a framework of compressive sensing. We demonstrate that the proposed method can observe the RF with the half number of measurements required by conventional method.

Issaquah A & B

Applied Industrial Optics: Spectroscopy, Imaging, and Metrology

ATu2A • The Joy of Measurement, How Low Can We Go—Continued

ATu2A.3 • 12:30 Invited

Advanced Nanoparticle Measurement using Near Field Light, Robert Hart[1]; [1]*OptoFluidics, USA.* Optofluidics' NanoTweezer is the first commercial system capable of directly optically trapping and analyzing nano and microscale objects in solution, ranging from plastics, to metals to oxides and which are already in wide use throughout medicine, energy and industrial materials. Our system offers the ability to analyze shape and surface properties of large numbers of individual nanoparticles without electron microscopy. Unlike traditional free space optical traps which are light diffraction limited and thus can only influence dielectric objects larger than a hundreds of nanometers in size, the NanoTweezer technology is powered by proprietary nanophotonic waveguides engineered to exert stronger optical forces via light confinement and resonance, enabling a technological leap in trapping and analysis capability. We will cover the technology's working principles and discuss specific applications of the technology, emphasizing the system's capabilities in nanoparticle analysis.

ATu2A.4 • 13:00 Invited

The State of the Art in Interference Microscopy: Modern Techniques for Geometric Form, Surface Texture and Areal Structure Analysis, Peter J. de Groot[1]; [1]*Zygo Corporation, USA.* Optical interference microscopy has evolved from a tool for 3D surface roughness to a multi-functional platform for complete surface structure analysis. This review paper considers the evolution, current state of the art and future prospects for this technology.

Ravenna A,B & C

Digital Holography & 3-D Imaging

DTu2B • Digital Holography—Continued

DTu2B.3 • 12:15

Viewing-zone scanning-type horizontally scanning holography, Keisuke Fujii[1], Yasuhiro Takaki[1]; [1]*Tokyo Univ of Agriculture and Technology, Japan.* We propose a viewing-zone scanning-type horizontally scanning holography that enlarges both screen size and viewing area. The reduced viewing zones created by magnifying images generated by a MEMS SLM are scanned by a horizontal scanner.

DTu2B.4 • 12:30

Phase retrieval for multiple-wavelength in-line holography, Yan Li[1], Wen Xiao[1]; [1]*Beihang Univ., China.* A phase retrieval method imposing the appropriate constraints on object plane for multiple-wavelength in-line digtial holography is presented. Experimental results demostrate a better elimination effect and less number of wavelengths compared with previously reported approaches.

DTu2B.5 • 12:45

Compressive imaging through turbid media combining two axially Bragg-filtered digital holograms, Wensheng Chen[1,2], Zhi Chen[2,3], Shakil Rehman[2], George Barbastathis[2,4]; [1]*Dept. of Mechanical Engineering, National Univ. of Singapore, Singapore;* [2]*Singapore-MIT Alliance for Research and Technology, Singapore;* [3]*Dept. of Biomedical Engineering, National Univ. of Singapore, Singapore;* [4]*Dept.of Mechanical Engineering, MIT, USA.* We combine the zero and first order of light diffracted from a volume hologram in the framework of compressive sensing to reconstruct the object through turbid media.

DTu2B.6 • 13:00

Joint Object Reference Digital Interferometer (JORDI): A Single Spatial Light Modulator Based Design, Roy Kelner[1], Joseph Rosen[1]; [1]*Dept.of Electrical and Computer Engineering, Ben-Gurion Univ. of the Negev, Israel.* The joint object reference digital interferometer (JORDI) is a single-channel apparatus for recording coherent holograms. Normally, two spatial light modulators (SLMs) are required for its realization. Presented here is a new design that uses only a single SLM.

DTu2B.7 • 13:15

Performance of the Switch-Back Technique for Fast Hidden-Surface Removal in Computer Holography, Kyoji Matsushima[1], Sachio Masuda[1], Sumio Nakahara[2]; [1]*Dept.of Electrical and Electronic Engineering, Kansai Univ., Japan;* [2]*Dept.of Mechanical Engineering, Kansai Univ., Japan.* A novel technique for hidden-surface removal, called switch-back technique, is proposed for fast generation of full-parallax CGHs. The basic theory based on Bibinet's law as well as the performances are presented with the reconstruction of CGHs.

Metropolitan Ballroom A

Joint LACSEA / IS / pcDVT

JTu2C • Joint Lidar Session (with LACSEA , IS and pcDVT)—Continued

JTu2C.3 • 12:15

Ultra-Narrow Line Tunable Semiconductor Lasers for Coherent LIDAR Applications, Elijah Dale[1], Wei Liang[1], Danny Eliyahu[1], Anatoliy Savchenkov[1], Vladimir Ilchenko[1], Andrey B. Matsko[1], David Seidel[1], Lute Maleki[1]; [1]*OEwaves Inc, USA.* A compact diode laser with 2nm thermal tunability, 100kHz flat modulation frequency response range and 100Hz linewidth is demonstrated. A turn-key-style packaged device suitable for LIDAR applications is created and tested.

JTu2C.4 • 12:30

Impact of dust particle shape and water coating on multiwavelength lidar signals, Pierre Lafrique[1], Laurent Hespel[1], Alain Dabas[2], Xavier Briottet[1], Thierry Huet[1]; [1]*ONERA, France;* [2]*Météo France, France.* We model an atmospheric multiwavelength lidar in a dust aerosols layer, where optical properties are calculated for different shapes and with or without an overlay of water. Results show significant effects on multiwavelength lidar signals.

JTu2C.5 • 12:45

Volume component analysis for feature extraction in LiDAR point cloud objects, Nina Varney[1], Vijayan Asari[1]; [1]*Dept.of Electrical and Computer Engineering- Vision Lab, Univ. of Dayton, USA.* This approach describes a method for using adapted Principal Component Analysis (PCA) in order to extract a set of reduced dimensionality features for use in classification of a 3D object, represented by a LiDAR point cloud.

JTu2C.6 • 13:00

Shoreline Extraction from 2-D and 3-D LiDAR Images, Prakash Duraisamy[1], Amr Hussein Yousef[1], Khan M. Iftekharuddin[1], Steve Jackson[2]; [1]*Old Dominion Univ., USA;* [2]*Univ. of North Texas, USA.* In this paper, we introduce a novel approach for extraction of shoreline in 2-D intensity and 3-D LiDAR images obtained during the same or different time periods. The method involves computing coarse registration of the images , and subsequent refinement of extracted shoreline using homography information. The proposed approach utperforms the limitations of current shoreline extraction algorithms in literature.

JTu2C.7 • 13:15

CALIBRATION METHOD FOR PARTICLE CONCENTRATION MAPPING BASED ON LIDAR INVERSION, Simon Turbide[1], Daniel Cantin[1], François Châteauneuf[1]; [1]*INO, Canada.* A new calibration method for aerosol mapping from lidar is proposed. The method relies on a fit over signal using input transmission from a reference direction. The accuracy is about 80% according to validation tests.

Greenwood

Signal Recovery & Synthesis

STu2F • Novel Image Sensing I—Continued

STu2F.3 • 12:15 Invited

Sampling and Inference Problems for Spatiotemporal Single-Photon Imaging, Yue Lu[1]; [1]*Havard Univ., USA.* Recent advances in materials, devices and fabrication technologies have led to an emerging class of solid-state sensors with single photon sensitivity. Thanks to their sub-nanosecond time resolution, and rapidly increasing spatial resolutions, these new single-photon sensors (SPS) have been a key enabling technology behind recent breakthroughs in several domains, including fluorescence-based bio-imaging, time-of-flight 3D computer vision, LIDAR, and astronomy. In this talk, I will present results in signal sampling and inference to address several challenges associated with the SPS. In particular, I will present our recent work on establishing the performance bounds of the SPS in acquiring light intensity fields; on time-sequential adaptive sensing schemes that allow one to push the imaging capabilities of SPS systems beyond the nominal limit imposed by current hardware; and on new image formation algorithms that can efficiently "decode" the massive bitstreams generated by the SPS.

STu2F.4 • 12:45

Image Reconstruction from Sparse Interferometric Data, Zachary DeSantis[1], James R. Fienup[1]; [1]*Univ. of Rochester, USA.* Imaging geosynchronous satellites from the ground using imaging interferometry and multiple spectral channels has an unknown linear phase across each set of measurements, caused by the atmosphere. We demonstrate the successful image reconstructions of this particular type of phase-corrupted data.

STu2F.5 • 13:00

Simultaneous Dynamic Pupil Coding with On-chip Coded Aperture Temporal Imaging, Christy Fernandez-Cull[1], R. Hamilton Shepard[1], Brian M. Tyrrell[1], Richard D'Onofrio[1]; [1]*Massachusetts Inst of Tech Lincoln Lab, USA.* We describe a new sensor that combines dynamic pupil coding with a digital readout integrated circuit (DROIC) capable of modulating a scene with a global or per-pixel time-varying, pseudo-random, and duo-binary signal (+1-1,0).

13:30–15:00 Lunch, *On Your Own*

Issaquah A & B

Applied Industrial Optics: Spectroscopy, Imaging, and Metrology

Ravenna A,B & C

Digital Holography & 3-D Imaging

Metropolitan Ballroom A

Imaging Systems and Applications

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

15:00–17:00
ATu3A • Trip the Light Body Fantastic
Presider: Arlene Smith; Univ. of Michigan, USA

ATu3A.1 • 15:00 Invited
Smartphone Biosensors for Health, Environment, and Food Safety, Brian T. Cunningham[1]; [1]*Univ of Illinois at Urbana-Champaign, USA.* This talk will summarize recent developments in the utilization of an integrated smartphone camera as a high resolution spectrophotometer capable of performing ELISA assays, label-free photonic crystal biosensor assays, thin film chromatography, and fluorescence spectroscopy.

ATu3A.2 • 15:30 Invited
Spatially Resolved Diffuse Reflectance Measurements for Oximetry, Kate L. Bechtel[1], Kim Shultz[1], Sophia Berger[1], Mark Lonsinger[2], Scott Coleridge[2]; [1]*Triple Ring Technologies, Inc., USA;* [2]*ViOptix, Inc., USA.* Measurement of tissue oxygenation is confounded by optical scattering, the effects of which can be mitigated through spatially resolved measurements. The principles of operation of a handheld tissue oximeter will be presented, including Monte Carlo optical modeling, manufacturing reproducibility, and instrument calibration.

ATu3A.3 • 16:00 Invited
Multimodal Coherent Nonlinear Optical Microscopy: From Biophotonics to Geophotonics, Albert Stolow[1,2]; [1]*SDTech, National Research Council Canada, Canada;* [2]*Chemistry, Univ. of Ottawa, Canada.* Simplified, robust approaches to label-free Coherent Raman Microscopy allow for applications ranging from cellular imaging and disease progression, to biomaterials, to microimaging of mining ore distributions.

15:00–17:00
DTu3B • Remote Laboratory in Holographic Metrology
Presiders: Wolfgang Osten; Institut für Technische Optik, Germany and Yoshio Hayasaki; Utsunomiya Univ., Japan

DTu3B.1 • 15:00 Tutorial
Remote Labs - A Challenge for Digital Holography and Modern Metrology, Wolfgang Osten[1]; [1]*Inst. for Applied Optics, Univ. Stuttgart, Germany.* The tutorial reviews the idea of remote Labs and illustrates the potential of the approach on selected examples with special focus on the field of optical metrology. The concept of remote metrology is extended beyond the simple exchange of data between distant Labs and the remote access to experimental facilities embedded in modern educational concepts. An an architecture that provides the opportunity to communicate with and eventually control the physical set-up of a remote metrology system is described. It is shown that such a concept can be implemented within cloud computing environments, and may extend their current performance by the access to experimental facilities.

DTu3B.2 • 16:00 Invited
Intellectual Property and Business Aspects of Digital Holography, Nadya Reingand[1], Yan Hankin[1]; [1]*Patent Hatchery LLC, USA.* This paper presents an overview of intellectual property in the field of digital holography and highlights the possibilities revealed by patent searching and analysis. Over one thousand and five hundred patent documents relevant to digital holography were uncovered by this study. The search was performed using the following databases: U.S. Patent Office, European Patent Office, and Japanese Patent Office, for the time frame of 1971 through April 2014. The patent analysis unveils trends in patent temporal distribution, leading IP portfolios, competition among companies within the digital market, and other interesting insights.

15:00–16:45
ITu3C • 3D Sensing and Phase Retrieval and Holography
Presider: Pietro Ferraro, Istituto Nazionale di Ottica, Italy

ITu3C.1 • 15:00 Invited
Digital Holographic Imaging in Microscopy and Tomography, Chau-Jern Cheng[1], Yu-Chih Lin[1], Xin-Ji Lai[1]; [1]*National Taiwan Normal Univ., Taiwan.* This work describes the digital holographic imaging techniques and recent progress in microscopy and tomography. Studies both on theoretical analysis and experimental results are presented and discussed.

ITu3C.2 • 15:30 Invited
Capture and processing of light ray field for three-dimensional information acquisition and hologram synthesis, Jae-Hyeung Park[1]; [1]*Inha Univ., Korea.* Light ray field contains distribution of the light rays from a three-dimensional object scene. The light ray field can be captured using integral imaging principle and used for the acquisition and the processing of the three-dimensional information of the scene. In this report, we present a method to capture and process the light ray field, focusing on its application to synthesize the hologram of the scene.

ITu3C.3 • 16:00 Invited
Lab on Chip 3D Holographic Imaging, Pietro Ferraro[1]; [1]*Istituto Nazionale di Ottica, Italy.* 3D imaging approaches based on holographic modality have been developed for Lab-on-Chip devices. Exploiting Digital Holography features a number of applications are illustrated thus demonstrating its great potentialities as coherent imaging tool for bio-microfluidic platform.

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

15:00–17:00
LTu3D • Raman and Absorption-Based Measurements

Presider: Scott Sanders; Univ. of Wisconsin-Madison, USA

LTu3D.1 • 15:00 Invited

Raman Analytics for Complex Liquid Phase Systems, Kristina Noack[1], Johannes Kiefer[2], Alfred Leipertz[1]; [1]*Chemical and Bioengineering, Inst. of Engineering Thermodynamics, Germany;* [2]*Inst. of Engineering Thermodynamics, Germany.* The development of evaluation models for Raman signals of processes in the liquid phase is a nontrivial and crucial step. This is qualitatively and quantitatively demonstrated by means of ionic liquids and an algae cultivation.

LTu3D.2 • 15:30

Dual-Resolution Raman Spectroscopy for Measurements in DME-Air Flames, Gaetano Magnotti[1], Robert S. Barlow[1]; [1]*Sandia National Labs, USA.* The paper describes a dual-resolution Raman spectroscopy instrument for simultaneous measurements of major species and major combustion intermediates in DME-air flames. Measurements in a laminar flame from a Tsuji burner are used to characterize the instrument accuracy and precision.

LTu3D.3 • 15:45

Open-path TDLAS for in-situ detection of water isotopes in ice clouds down to 190 K, Benjamin Kuehnreich[1,2], Steven Wagner[2], Jan C. Habig[3], Harald Saathoff[3], Elisabeth J. Moyer[4], Volker Ebert[1,2]; [1]*Chemical Physics and Explosion Protection, Physikalisch Technische Bundesanstalt, Germany;* [2]*Reactive Flows and Diagnostics, Technische Universität Darmstadt, Germany;* [3]*Inst. for Meteorology and Climate Research, Karlsruhe Inst. of Technology, Germany;* [4]*Dept.of Geophysical sciences, Univ. of Chicago, USA.* A time-multiplexed isotope-selective open-path TDLAS spectrometer was developed for the AIDA cloud chamber as part of the ISOCLOUD project and achieves detection limits of 4ppb for H216O and 170ppt for H218O.

LTu3D.4 • 16:00 Invited

Distributed Feedback Interband Cascade Lasers and their Spectroscopic Applications in Gas Sensing, Lars Hildebrandt[1], Michael von Edlinger[1], Julian Scheuermann[1], Lars Nähle[1], Marc Fischer[1], Johannes Koeth[1], Martin Kamp[2], Robert Weih[2], Sven Höfling[2]; [1]*nanoplus GmbH, Germany;* [2]*Univ. Wuerzburg, Technische Physik, Germany.* A general overview of application-grade distributed feedback interband cascade laser devices operating at specific, industrially relevant, wavelengths between 3 and 6 µm are presented. Continuous wave operation up to 80°C with tuning ranges above 20 nm was achieved.

15:00–16:15
PTu3E • Slope Discrepancy, Hidden Phase, Branch Points and Deep Turbulence

Presider: Denis Oesch; LEIDOS, USA

PTu3E.1 • 15:00 Invited

Modal Identification and Characterization of Strong Turbulence Propagation, Terry Brennan[1], Darryl J. Sanchez[2], Patrick Kelly[2], Thomas Farrell[2], Denis W. Oesch[3]; [1]*Prime Plexus, USA;* [2]*Starfire Air Force Research Laboratory, USA;* [3]*Leidos, USA.* An identifying mode associated with strong turbulence measured by a Hartmann wavefront sensor is described and validated with field data from the Starfire Optical Range Turbulence Sensor. Rytov dependence is illustrated with wave optics simulation.

PTu3E.2 • 15:30

Measurement of Creation Pairs by Shack-Hartmann Wavefront Sensors, Darryl J. Sanchez[1], Denis W. Oesch[2], Pat Kelly[1]; [1]*Starfire Optical Range, USA;* [2]*Leidos, USA.* Shack-Hartmann wavefront sensors have long been used to measure phase. Here, we consider measurement of creation pair phase.

PTu3E.3 • 15:45

LSPV+7, A branch-point-tolerant reconstructor for strong turbulence adaptive optics, Michael Steinbock[1], Milo W. Hyde[1], Jason D. Schmidt[2]; [1]*ENG, Air Force Inst. of Technology, USA;* [2]*MZA Associates Corporation, USA.* Least squares, complex-exponential, and post-processing congruence operation reconstructors are compared for closed-loop adaptive optics in temporally evolving strong turbulence. Utilizing a self-referencing interferometer, an average improvement of 120% is seen over traditional least-squares.

PTu3E.4 • 16:00

An Initial Investigation of a Fried Parameter for Rotational Phase, Darryl J. Sanchez[1], Denis W. Oesch[2], Pat Kelly[1]; [1]*Starfire Optical Range, USA;* [2]*Leidos, USA.* The Fried parameter is the standard measure for phase of its characteristic scale length. Here, we consider the Fried parameter in the presence of rotational phase.

15:00–16:45
STu3F • Novel Image Sensing II

Presider: Edmund Lam; Univ. of Hong Kong, Hong Kong and Christy Fernandez-Cull; MIT Lincoln Lab, USA

STu3F.1 • 15:00 Invited

Deblurring Compressive Spectro-Polarimetric Images Taken Trough Atmospheric Turbulence, Robert J. Plemmons[1], Sudhakar Prasad[2], Qiang Zhang[3]; [1]*Computer Science, Wake Forest Univ., USA;* [2]*Physics and Astronomy, Univ. of New Mexico, USA;* [3]*independent consultant, USA.* We consider an approach for identifying non-resolvable space objects such as satellites or debris using compressive spectro-polarimetric imaging. In particular, deblurring algorithms are described for mitigating the effects of atmospheric turbulence blurring on such images.

STu3F.2 • 15:30

Moiré Effect Provides 10x Spectral Resolution Boost on Mt. Palomar NIR Triplespec Spectrograph, David J. Erskine[1,2], Jerry Edelstein[2], Ed Wishnow[2], Martin Sirk[2], Eliza McDonald[2], Yuzo Ishikawa[2], William V. Shourt[2]; [1]*Lawrence Livermore National Laboratory, USA;* [2]*Space Sciences Lab, Univ. of California, USA.* We demonstrate a 10x boost in spectral resolution of the NIR Triplespec spectrograph at Mt. Palomar using a moire effect created by an interferometer, reversing the heterodyning numerically, and assembling information from multiple exposures.

STu3F.3 • 15:45 Invited

Image Processing for Fiber-coupled Monocentric Imagers, Joseph E. Ford[1]; [1]*Univ. of California San Diego, USA.* We describe theoretical and experimental investigation of "cascade imaging processing," the recovery of high-resolution spherical images formed by monocentric lenses, sampled by quasi-period optical fiber bundles, transferred and resampled by multiple conventional CMOS focal planes.

STu3F.4 • 16:15 Invited

3-D Statistical Characterization of the Heterogeneity of Biological Macromolecular Complexes by Electron Microscopy, Peter C. Doerschuk[1], Nan Xu[1], Yunye Gong[1], Yili Zheng[2], Qiu Wang[1, 3]; [1]*Cornell University, USA;*[2]*Lawrence Berkeley National Laboratory, USA;* [3]*Siemens Corporate Research, USA.* Electron microscopy provides images of macromolecular complexes from which the 3-D structure of the complex can be computed when all instances of a complex are identical. An algorithm for characterizing the 3-D spatial statistics of the complex is described and demonstrated for the important case when different instances are not identical.

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

ATu3A • Trip the Light Body Fantastic—Continued

ATu3A.4 • 16:30 Invited

Development of Wide-field Quantitative Multispectral Fluorescence-Reflectance Imaging Using an Ultrathin and Flexible Scanning Fiber Endoscope, Chenying Yang[1], Eric Seibel[2]; *[1]Bioengineering, Univ. of Washington, USA; [2]Mechanical Engineering, Univ. of Washington, USA.* Molecular imaging has great potential for personalized diseases diagnosis and treatment. We present technologies developed using an ultrathin and flexible multispectral Scanning Fiber Endoscope for wide-field, high-resolution and quantitative fluorescence molecular imaging.

DTu3B • Remote Laboratory in Holographic Metrology—Continued

DTu3B.3 • 16:30

Looking around the corner and through a diffuser: different approaches, Alok K. Singh[1], Dinesh N. Naik[1], Giancarlo Pedrini[1], Mitsuo Takeda[1], Wolfgang Osten[1]; *[1]Institut für Technische Optik, Universität Stuttgart,, Germany.* Retrieving the information of an object which is obscured by a diffuser or hidden around the corner has vast range of applications. Here we propose two different techniques based on digital holography and intensity correlation to retrieve 3-D object from the scattered field.

DTu3B.4 • 16:45

Partially occluded 3D reconstruction by using off-axially distributed sensing structure, Yongri Piao[1], Miao Zhang[2], Donghak Shin[3]; *[1]School of Information and Communication Engineering, Dalian Univ. of Technology, China; [2]Dept.of Game and Mobile Contents, Keimyung Univ., Korea; [3]Inst. of Ambient Intelligence, Dongseo Univ., Korea.* In this paper, we present a partially occluded 3D reconstruction by using off-axially distributed sensing structure. This method utilizes both lateral and longitudinal perspectives for 3D reconstruction. We present the preliminary experimental results to show the feasibility of the proposed system.

ITu3C • 3D Sensing and Phase Retrieval and Holography—Continued

ITu3C.4 • 16:30

High dynamic range three-dimensional measurement using fringe projection technique, Shijie Feng[1], Qian Chen[1], Chao Zuo[1], Yuzhen Zhang[1]; *[1]Nanjing Univ. of Science and Technology, China.* This paper presents an approach to high dynamic range shape measurement for scenario of largely varying range of surface reflectivity, e.g. simultaneously containing very dark and bright surfaces.

Metropolitan Ballroom B

17:00–19:00
JTu4A • Joint Poster Session

JTu4A.1

Advanced detection methods of spaceborne laser altimeter, Fu Yang[1], Jianhua Shang[1], Yan He[2], Yage Zhan[1], Weibiao Chen[2]; *[1]Donghua Univ., China; [2]Shanghai Inst. of Optics and Fine Mechanic, Chinese Academy of Science, China.* Three advanced detection methods are proposed to realize high spatial resolution detection. Compared with the parameters of the GLAS, all of the three methods are superior in terms of spatial resolution, power consumption, and sensitivity.

JTu4A.2

Optical Design Considerations for Chemical Species Tomography in a Jet Exhaust Plume, Paul Wright[1], Edward Fisher[2], Hugh McCann[2]; *[1]School of Electrical & Electronic Engineering, The Univ. of Manchester, UK; [2]School of Engineering, The Univ. of Edinburgh, UK.* We describe the optical design considerations for an optical tomography system operating in a jet exhaust plume. We identify the limitations of existing literature and describe Laband engine tests intended to address these.

JTu4A.3

A Comparison of Classical and Modulated Raman Spectroscopy for Multicomponent Measurement, Bryan M. Hennelly[1], Sinead Barton[1], Tomas Ward[1], John Lowry[1]; *[1]National Univ. of Ireland, Maynooth, Ireland.* In this study we perform a basic experimental comparison of Raman and wavelength modulated Raman Spectroscopy for analysis of Labprepared solutions to determine whether WMRS may offer an improvement over classical Raman for multicomponent analysis.

JTu4A.4

Microfluidics and Solid-phase Microextraction Effects in SERS Chips for Rapid and Sensitive Malathion Detection, Yan Deng[1], Qiuming Yu[2]; *[1]Precision Instruments, Tsinghua Univ., China; [2]Chemical Engineering, Univ. of Washington, USA.* Coupled Microfluidics and SPME effects in PDMS-gold nanostructure SERS chips were modeled and simulated to reveal that high flow rate increases the mass transfer efficiency and uncovered PDMS concentrates malathion molecules around SERS hot spots.

JTu4A.5

Scalable directional-view display and contents acquisition approach, Youngmin Kim[1], Sunghee Hong[1], Hoonjong Kang[1], Soon-gi Park[2], Jong-Young Hong[2], Jonghyun Kim[2], Chang-Kun Lee[2], Byoungho Lee[2]; *[1]Realistic Media Platform Research Center, Korea Electronics Technology Inst., Korea; [2]School of Electrical Engineering, Seoul Natioanl Univ., Korea.* We proposed a contents acquisition method based on a computer generated method for directional-view display. The proposed method can be incorporated in scalable directional-view display and integral imaging.

JTu4A.6

Fourier hologram synthesis from two photographic images captured at different focal planes, Ni Chen[1], Jae-Hyeung Park[2], Jiwoon Yeom[1], Jonghyun Kim[1], Gang Li[1], Byoungho Lee[1]; *[1]School of Electrical Engineering, Seoul National Univ., Korea; [2]School of Information and Communication Engineering, Inha Univ., Korea.* We propose a hologram synthesis method from two photographic images captured under sunlight illumination. The hologram is calculated from the orthographic images which are extracted using the light field moment imaging technique. The experiment verified the feasibility of the method.

JTu4A.7

Fish embryo multimodal imaging by laser Doppler digital holography, Michel Gross[1], Nicolas Verrier[1], Pascal Picart[2]; *[1]Laboratoire Charles Coulomb - UMR 5221 CNRS-UM2, Université Montpellier II Place Eugène Bataillon, France; [2]LUNAM, Université du Maine, CNRS UMR 6613, LAUM, Avenue Olivier Messiaen, France.* A laser Doppler imaging scheme combined to an upright microscope is proposed. Quantitative Doppler imaging in both velocity norm and direction, as well as amplitude contrast of either zebrafish flesh or vasculature is demonstrated.

JTu4A.8

Mobile autostereoscopic 3D display using a diamond pixel structured OLED pentile display panel, Wonjun Lee[1], Junghoon Yoon[1], Yooncheol Shin[1], Jonghyun Kim[2], Chang-Kun Lee[2], Youngmo Jeong[2], Changwon Jang[2], Jong-Young Hong[2], Byoungho Lee[2]; *[1]Digital Media & Communications R&D Center, Samsung Electronics, Korea; [2]School of Electrical Engineering, Seoul National Univ., Korea.* An auto-stereoscopic three-dimensional (3D) display, which has a diamond pixel structured pentile display panel and selectively operates in both landscape and portrait mode, is composed by using the detachable parallax barrier film.

JTu4A.9

Effects of Spatial Extensions in Computer Generated Holograms on Reconstruction Quality in Multi-Focal Imaging Systems, Alkan Gulses[1], B. Keith Jenkins[1]; *[1]Univ. of Southern California, USA.* Phase-only computer generated holograms are investigated under possible spatial extension in lateral and longitudinal dimensions. Design methods and effects on noise removal are described.

JTu4A.10

Fabrication of Computer Generated Holograms Constituted from Sub-Micrometer Pixel for Wide Viewing Angle Using Laser Lithography, Sumio Nakahara[1], Kyoji Matsushima[2]; *[1]Dept. of Mechanical Engineering, Kansai Univ., Japan; [2]Dept. of Electrical Engineering, Kansai Univ., Japan.* CGH was made using a laser lithography system to display true 3D reconstruction images. In order to give a large viewing angle, CGH of the giga-pixel pattern constituted from a pixel of submicron size was fabricated.

JTu4A.11

Complex amplitude-modulated data page recording in coaxial holographic data storage with phase-shifting digital holography, Teruyoshi Nobukawa[1], Takanori Nomura[2]; *[1]Graduate School of Systems Engineering, Wakayama Univ., Japan; [2]Faculty of Systems Engineering, Wakayama Univ., Japan.* The retrieving method of a complex amplitude-modulated data page by the generalized phase-shifting method is proposed in coaxial holographic data storage. The numerical simulation shows the feasibility of the proposed coaxial system.

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

LTu3D • Raman and Absorption-Based Measurements—Continued

LTu3D.5 • 16:30
VCSEL-based laser hygrometer using rapidly time division multiplexed direct absorption and wavelength modulation spectroscopy, Alexander Klein[1], Volker Ebert[1,2]; [1]*Analytics and Thermodynamic State Behaviour of Gases, Physikalisch-Technische Bundesanstalt, Germany;* [2]*Center of smart interfaces, TU Darmstadt, Germany.* A newly developed spectroscopic modulation scheme enables absolute gas concentration measurements with enhanced precision and dynamic range by time multiplexing calibration-free direct tunable diode laser absorption (dTDLAS) and wavelength modulation spectroscopy (WMS).

LTu3D.6 • 16:45
Catalytic reactions of the fuel cells Visualized by THz Chemical Microscope, Tetsuya Kusaka[1], Kazuki Koiso[1], Kenji Sakai[1], Toshihiko Kiwa[1], Keiji Tsukada[1]; [1]*Okayama Univ., Japan.* A terahertz chemical microscope has been developed to visualize the electric potential shift of the catalytic electrodes in fuel cells. The potential shift due to the catalytic reactions of the supplied gases could be visualized.

STu3F • Novel Image Sensing II—Continued

Tuesday, 15 July

Metropolitan Ballroom B

JTu4A • Joint Poster Session—Continued

JTu4A.12
Experimental Tomography and 3D Imaging of Vortex Beams, Bohumil Stoklasa[1], Libor Motka[1], Jaroslav Rehacek[1], Zdenek Hradil[1], Luis L. Sánchez-Soto[2]; [1]*Dept.of Optics, Univerzita Palackeho v Olomouci, Czech Republic;* [2]*Departamento de Optica, Universidad Complutense, Spain.* We experimentally show that wavefront detection combined with tomography processing can be used for the complete characterization of the second-order coherence and hence 3D imaging of partially coherent vortex beams.

JTu4A.13
Characteristics of Reflective Spatial Light Modulator on Glass Substrate, Yong-Hae Kim[1]; [1]*ETRI, Korea.* We fabricated the reflective spatial light modulator on a glass substrate. The size of the SLM are 4 cm x 3 cm. The SLM shows the phase modulation of 2.8 π according to the voltage.

JTu4A.14
Virtual-image Disk-type Multiplex Holography with Diverging Object Wave, Yih-Shyang Cheng[1], Kai-Chun Chen[1]; [1]*Dept.of Optics and Photonics, National Central Univ., Taiwan.* The possibility of fabricating multiplex hologram with diverging object wave, with which the viewing point for individual hologram is missing, is demonstrated. The aspect ratio and the wavelength bandwidth of the reconstructed images are investigatedd.

JTu4A.15
Measurement of the Rotating Flow Fields by Digital Holography Particle Image Velocimetry, Yan Yang[1], Hong Yang[1], Guangyong Li[1]; [1]*Chongqing Univ. of Technology, China.* The digital holography image velocimetry (DHPIV) is presented to accurately measure the rotating flow fields. Several methods are applied in the process of measurement and the results demonstrate this technique works well.

JTu4A.16
A study on Fresnel and Fourier holographic images reconstructed by tilted plane wave, Byng Gyu Chae[1]; [1]*Electronics and Telecommunications Research Inst., Korea.* We investigate the shape of the Fresnel and Fourier holographic images reconstructed by a tilted plane wave. The reconstructed images of both holograms are well described as Affine transformation.

JTu4A.17
Influence of Deconvolution PSF on Particle Image Reconstruction in Digital Holography, Yuto Asai[1], Shigeru Murata[2], Yohsuke Tanaka[2]; [1]*Graduate School of Science and Technology, Kyoto Inst. of Technolgy, Japan;* [2]*Dept.of Mechanical and System Engineering, Kyoto Inst. of Technology, Japan.* This paper investigates the influence of deconvolution PSF on particle image reconstruction in digital holography for multiple particles. A part of reconstructed particle images is employed as the PSF to reduce the noise in reconstructed images.

JTu4A.18
Digital Holographic Projection Tomography for Micrometric Vegetal Fibers: Limiting Factors, Pascal Picart[1], Haithem Khelfa[1], Mokrane Malek[1], Christophe Poilane[3], Denis Mounier[2]; [1]*LAUM CNRS Université du Maine, France;* [2]*IMMM CNRS Université du Maine, France;* [3]*CIMAP CNRS Université de Caen, France.* This paper discusses a method for optical projection tomography of micrometric vegetal fibers, based on digital holographic microscopy. Experimental results obtained with a flax fiber are provided. The main limiting factors are discussed.

JTu4A.19
High Efficient Reflective Dammann Grating, Jin Wang[1], Changhe Zhou[1], Jianyong Ma[1], Feng Zhu[1], Wei Huang[1]; [1]*Shanghai Inst. of Optics and Fine Mechanics, China.* A 1×2 reflective Dammann grating with efficiency of 97% higher than the traditional scalar one is designed. We fabricate the reflective gratings with period of 1879nm at wavelength of 1064nm by direct laser writing.

JTu4A.20
The Measurement of the Refractive Index of Transparent Liquids by Using Holographic Grating, Chun-Wei Liu[1], Lee Chi-Hung[2], Shih-Chieh Lin[1], Chia-Jen Ting[3], Tsung-Hsin Lin[3], Chun-Fa Lan[3]; [1]*National Tsing Hua Univ., Taiwan;* [2]*Feng Chia Univ., Taiwan;* [3]*Industrial Technology Research Inst., Taiwan.* A novel refractometer with high precision, low cost and a wide measurement range is presented. This proposed design adopted the diffraction phenomenon of holographic grating for the purpose of the biological/medical field.

JTu4A.21
A Fast Stereo Matching Method in Three-Dimensional Shape Measurement, Kun Liu[1], Changhe Zhou[1], Shaoqing Wang[1], Shengbin Wei[1], Jianyong Ma[1], Wei Jia[1]; [1]*Labof Information Optics and Optoelectronics Techniques, Shanghai Inst. of Optics and Fine Me, China.* A fast matching method is proposed to avoid plenty of unnecessary calculations in binocular 3D measurement. Experiments show that the method greatly improves computational efficiency of stereo matching for obtaining 3D imaging of object.

JTu4A.22
Comparison of perceived resolution between a parallax barrier and a lenticular array, Minyoung Park[1], Hee-Jin Choi[1]; [1]*Dept.of Physics, Sejong Univ., Korea.* The perceived resoltuions of the parallax barrier and the lenticular array are compared using a mirror stereoscope. Although the physical number of pixels consisting the 3D images are same for the two methods, the observer perceived them differently.

JTu4A.23
Bidirectional Visual and Thermal 3D Information Display by Use Crossed-Mirror Array, Ryosuke Kujime[1], Shiro Suyama[1], Hirotsugu Yamamoto[1,2]; [1]*Univ. of Tokushima, Japan;* [2]*Utsunomiya Univ., Japan.* We have investigated composition of crossed-mirror array in order to realize composite aerial information display that provides different visual information for two different directions and the same thermal 3D information for the two directions.

JTu4A.24
Modulo Wavelets for Interferometric Phase Data, David Blinder[1,2], Tim Bruylants[1,2], Heidi Ottevaere[3], Ann Dooms[1,2], Adrian Munteanu[1,2], Peter Schelkens[1,2]; *[1]ETRO, Vrije Universiteit Brussel, Belgium; [2]Multimedia Technologies, iMinds, Belgium; [3]B-PHOT, Vrije Universiteit Brussel, Belgium*. A newly proposed modulo wavelet transform incorporated in a JPEG 2000 architecture allows for efficient compression of interferometric phase maps. Coding gains of over 0.5 bpp are reported over the state-of-the-art.

JTu4A.25
Effective CGH calculation algorithm with low memory usage using compressed look-up table based on separation of light modulation variable, Jia Jia[1,2], Yongtian Wang[1], Juan Liu[1], Xin Li[1], Yijie Pan[1], Guofan Jin[2]; *[1]Beijing Inst. of Technology, China; [2]Tsinghua Univ., China*. A fast algorithm with low memory usage is proposed for computer generated hologram calculation based on compressed look up table. The memory usage and the calculation time of the new C-LUT are both reduced.

JTu4A.26
Phase Reconstruction with Automatic Angular-Spectrum Filtering in Dual-Wavelength Digital Holography, Zhe Wang[1,2], Zhuqing Jiang[1,2], Yifei Chen[1,2], Yuhong Wan[1,2]; *[1]College of Applied Sciences, Beijing Univ. of Technology, China; [2]Inst. of Information Photonics Technology, Beijing Univ. of Technology, China*. We present an automatic angular-spectrum filtering algorithm for phase reconstruction in dual-wavelength off-axis digital holography with a common path configuration. The reconstructed object phase map of a surface-relief grating is achieved by using it.

JTu4A.27
Direct laser writing of computer-generated hologram using pulse laser system, Yeonsu Im[1], Woonchan Moon[1], Jinyoung Roh[2], Hwi Kim[2], Joonku Hahn[1]; *[1]Electronics Engineering, Kyungpook National Univ., Korea; [2]Electronics and Information Engineering, Korea Univ., Korea*. We suggest a novel method for recording computer-generated hologram with pulse laser system to improve the diffraction efficiency. With this method, a transmittive hologram with square-shaped pixel structure is demonstrated.

JTu4A.28
Implementation of Projection of Three-Dimensional Binary Patterns Using Programmable Fresnel Lenslet Arrays, Wei-Feng Hsu[1], Po-Kai Hsieh[1]; *[1]National Taipei Univ. of Technology, Taiwan*. A pseudo-scanning projection method for three-dimensional binary patterns using a liquid-crystal-on-silicon spatial light modulator was presented to rapidly display a sequence of programmable Fresnel lenslet arrays. The advantages include low power consumption and high stability.

JTu4A.29
Simulated Tempering Markov Chain Monte Carlo for Full Waveform LIDAR signal Analysis, Weiji He[1], Wenye Yin[1], Lei Zhang[1], Guohua Gu[1], Qian Chen[1]; *[1]Nanjing Univ of Science and Technology, China*. A new approach of Simulated Tempering Markov Chain Monte Carlo (STMCMC) for full waveform LIDAR signal analysis was proposed and demonstrated. We present the theory, algorithm as well as the practical examples.

JTu4A.30
Variance of Weak Fluctuations of Orbital Angular Momentum of Gaussian Laser Beam Induced by Atmospheric Turbulence, Valerii P. Aksenov[1], Cheslav E. Pogutsa[1]; *[1]Inst. of Atmospheric Optics, Russia*. The variance of fluctuations of the orbital angular momentum (OAM) of Gaussian laser beam in a turbulent medium is estimated asymptotically. It is shown that atmospheric turbulence induces OAM fluctuations in a beam initially not carrying OAM.

JTu4A.31
Static Magnetic Faraday Rotation Spectroscopy for OH Radical Detection at 2.8 μm, Weixiong Zhao[1], Lunhua Deng[2], Xuezhe Xu[1], Weidong Chen[3], Xiaoming Gao[1], Wei Huang[1], Weijun Zhang[1]; *[1]Anhui Inst. of Optics and Fine Mechanics, Chinese Academy of Sciences, China; [2]State Key Labof Precision Spectroscopy, East China Normal Univ., China; [3]Labof Physical-Chemistry of the Atmosphere, Univ. of the Littoral Opal Coast, France*. We report on the development of a Faraday rotation spectrometer operating at 2.8 μm for OH radical detection with a static magnetic (DC) field in combination with wavelength modulation spectroscopy.

JTu4A.32
Complete characterization of trace gas photoacoustic sensors using a finite element method, Bertrand Parvitte[1], Christophe Risser[1], Raphael Vallon[1], Virginie ZENINARI[1]; *[1]GSMA, France*. GSMA laser team reports simulations and optimization of a differential Helmholtz resonant photoacoustic gas sensor using a finite element method. The sensor characteristics and gas detection limit are estimated and compared to the experimental ones.

JTu4A.33
Frequency-Stabilized Cavity Ring-Down Spectroscopy in the Mid-Infrared, Adam J. Fleisher[1], David Long[1], Qingnan Liu[1], Joseph T. Hodges[1]; *[1]National Inst of Standards & Technology, USA*. We report progress towards an ultrasensitive mid-infrared frequency-stabilized cavity ring-down spectrometer designed for CO2 sensing below the pmol/mol (parts-per-trillion) level.

JTu4A.34
Instantaneous Multiplex Imaging in Reacting Flows with Planar Coherent Raman Spectroscopy, Alexis Bohlin[1], Christopher J. Kliewer[1]; *[1]Combustion Chemistry, Sandia National Labs, USA*. We develop planar coherent Raman spectroscopy for instantaneous two-dimensional diagnostic imaging in chemically reactive flows. Spatially correlated spectra from N2, O2, and H2 are detected within a single-laser-shot, and temperature contour maps are derived.

JTu4A.35
Direct measurements of collisionally broadened Raman linewidths of C2H2 S-branch transitions by time-resolved picosecond RCARS, Paul S. Hsu[1], Hans U. Stauffer[1], Naibo Jiang[1], Sukesh Roy[1], James R. Gord[2]; *[1]Spectral Energies LLC, USA; [2]AFRL, USA*. We report direct linewidth measurement of self- and N2-broadened Raman S-branch transition of C2H2 using time-resolved picosecond-CARS spectroscopy. The results will provide accurate temperature and species-concentration information from rotational-CARS measurements.

JTu4A.36
RAM-free Wavelength Modulated Off-Axis Integrated Cavity Output Spectroscopy to OH Radical Monitoring, Christophe Lengignon[1], Xiaojuan Cui[1,2], Weixiong Zhao[1,2], Tao WU[1,3], Eric Fertein[1], Weidong Chen[1]; *[1]Universite du Littoral, France; [2]Anhui Inst. of Optics and Fine Mechanics, Chinese Academy of Sciences, China; [3]Nanchang Hangkong Univ., China*. Elimination of residual amplitude modulation in wavelength modulated off-axis integrated cavity output spectroscopy allows achieving a noise equivalent absorption sensitivity of 4.5×10-12 cm-1/Hz1/2, yielding a 1σ detection limit of 5.7×109 OH radicals/cm3 at ~1435 nm.

JTu4A.37
Real time monitoring of chemical reaction of NO2 + O3 -> NO3 and NO3 + NO2 <--> N2O5 in smog chamber by long optical pathlength absorption spectroscopy, Hongming Yi[1,2], Tao Wu[3], Amélie Lauraguais[1], Vladimir Semenov[4], Cecile Coeur[1], Eric Fertein[1], Xiaoming Gao[2], Weidong Chen[1]; *[1]Universite du Littoral, France; [2]Anhui Inst. of Optics and Fine Mechanics, Chinese Academy of Sciences, China; [3]Nanchang Hangkong Univ., China; [4]A.M. Prokhorov General Physics Inst., RAS, Russia*. Real time concentration monitoring of NO3, NO2, O3 and N2O5 for study of chemical kinetic process in smog chamber by open-path LED-IBBCEAS operating near 662 nm and QCL absorption spectroscopy at ~8 μm.

JTu4A.38
Nonlinear Tomography with Multiplexed Wavelength Modulation Spectroscopy in Harsh Combustion Environments, Weiwei Cai[1], Clemens Kaminski[1]; *[1]Dept.of Chemical Engineering, Univ. of Cambridge, UK*. This work numerically demonstrate a tomographic method with frequency-multiplexed calibration-free wavelength modulation spectroscopy (WMS) to simultaneously reconstruct the distributions of temperature and species concentration in harsh combustion environments.

JTu4A.39
Development of a Pressure Imaging Technique with Nonlinear Absorption Tomography for Flow Diagnostics, Weiwei Cai[1], Clemens Kaminski[1]; *[1]Dept.of Chemical Engineering, Univ. of Cambridge, UK*. This work aims to use the recent advances in rapid sweeping lasers and develop an absorption technique for pressure imaging in reactive flows. This paper provides the mathematical formulation and numerical demonstration.

JTu4A.40
Distributed Feedback Interband Cascade Laser at 3550 nm for Formaldehyde Measurements, Michael von Edlinger[1], Julian Scheuermann[1], Lars Nähle[1], Lars Hildebrandt[1], Marc Fischer[1], Johannes Koeth[1], Robert Weih[2], Sven Höfling[2], Martin Kamp[2]; *[1]nanoplus GmbH, Germany; [2]Technische Physik and Wilhelm-Konrad-Röntgen-Research-Center for Complex Material Systems, Universität Würzburg, Germany.* Distributed feedback Interband Cascade Laser devices operating around 3.55 μm for formaldehyde sensing are presented. Continuous wave operation up to 50°C with tuning ranges above 20 nm, covering several absorption features of formaldehyde, was achieved.

JTu4A.41
Experimentally implementable double-image optical encryption based on Gerchberg-Saxton algorithm, Wei-Na Li[1], Nam Kim[1]; *[1]Chungbuk National Univ., Korea*. A novel double-image optical encryption scheme based on Gerchberg-Saxton algorithm (GSA) is proposed in this paper. It maximally eliminates the crosstalk problem and no decryption sequence is involved. In addition, this system can be easily implemented by optical experiment.

JTu4A.42
Channel Drop Filter by using Tetragonal Photonic Crystal Ring Resonator by FDTD Method, Mayur Kumar Chhipa[1]; *[1]Electronics and Communication Engineering, Government Engineering College, Ajmer Raj, India*. Channel drop filter based on 2-D PCRR is proposed. The structure is made up of a hexagonal lattice of silicon rods with the refractive index n1=3.2634 which are perforated in air with refractive index n2=1.

JTu4A.43
Development of a Cavity-Enhanced Albedometer for Simultaneous Measurement of Aerosol Extinction and Scattering Coefficients, Weixiong Zhao[1], Xuezhe Xu[1], Meili Dong[1], Weidong Chen[2], Xiaoming Gao[1], Wei Huang[1], Weijun Zhang[1]; *[1]Anhui Inst. of Optics and Fine Mechanics, Chinese Academy of Sciences, China; [2]Labof Physical-Chemistry of the Atmosphere, Univ. of the Littoral Opal Coast, France*. We report on the development of a cavity-enhanced albedometer incorporating broad-band cavity-enhanced spectroscopy approach and an integrating sphere for simultaneous in-situ measurements of aerosol scattering and extinction coefficients on the exact same sample volume.

JTu4A.44
Simulations and developments of Si-integrated photoacoustic cells for the optical sensing of the atmosphere, Virginie Zeninari[1], Justin Rouxel[1,2], Bertrand Parvitte[1], Raphael Vallon[1], Mickael Brun[2], Sergio Nicoletti[2], Alain Gliere[2]; *[1]GSMA, France; [2]CEA-LETI, France*. In the framework of research program "MIRIADE", GSMA and CEA-LETI report simulations and developments of Si-integrated resonant photoacoustic cells developed for the optical sensing of the atmosphere when associated with mid-infrared sources such as QCLs.

JTu4A.45
Application of a cavity enhanced UV-LED spectrometer for measurements of atmospheric HONO and NO2 in Hong Kong, Tao WU[1], Qiaozhi Zha[2], Weidong Chen[3], Zheng Xu[2], Tao Wang[2], Xingdao He[1]; [1]*Key Labof Nondestructive Test, Nanchang Hangkong Univ., China;* [2]*Dept.of Civil and Environmental Engineering, The Hong Kong Polytechnic Univ., China;* [3]*Laboratoire de Physicochimie de l'Atmosphère, Université du Littoral Côte d'Opale, France.* A cavity enhanced UV-LED spectrometer was applied to measure ambient HONO and NO2 during field intercomparison campaign in HK. Detection limits of 0.3 ppbv for HONO and 1 ppbv for NO2 were achieved over 120s.

JTu4A.46
Measurements of Liquid Film Thickness and Solute Concentration of Aqueous NaCl Solution by Absorption Spectroscopy, Rongchao Pan[1], Jay B. Jeffries[2], Thomas Dreier[1], Christof Schulz[1]; [1]*Universität Duisburg-Essen, Germany;* [2]*Stanford Univ., USA.* A diode-laser absorption sensor with three near-infrared distributed-feedback diode lasers at ~1.4 μm is used for simultaneous measurement of liquid film thickness and concentration in aqueous NaCl solution.

JTu4A.47
Sensing of Alkanes in Water by Using Optical Microring Resonators with Hydrophobic and Hydrophilic Surfaces, Rozalia Orghici[1,3], Wolfgang Schade[1,2], Björn M. Reinhard[3]; [1]*Fiber Optical Sensor Systems, Fraunhofer Heinrich Hertz Inst., Germany;* [2]*Inst. for Energy Research and Physical Technologies, Clausthal Univ. of Technology, Germany;* [3]*Dept.of Chemistry and The Photonics Center, Boston Univ., USA.* The use of optical microring resonators with hydrophobic and hydrophilic surfaces for the sensitive and selective detection of alkanes in water is presented. In the case of octane, for example, a detection limit in the range of 0.7 μg/L has been achieved.

JTu4A.48
2D/3D imaging screen using spatially multiplexed holographic optical elements, Chang-Kun Lee[1], Changwon Jang[1], Keehoon Hong[1], Jiwoon Yeom[1], Byoungho Lee[1]; [1]*Electrical Engineering, Seoul National Univerisy, Korea.* 2D/3D imaging screen using a spatially multiplexed holographic optical element is proposed. We record simple mirror for 2D imaging and lens-array for 3D imaging in a holographic material. 2D and 3D images are displayed simultaneously.

JTu4A.49
Expansion of an Exit Pupil of the Projection Lens in a Multi-projection 3D System, Soon-gi Park[1], Matheus Miranda[1], Jong-Young Hong[1], Youngmin Kim[2], Byoungho Lee[1]; [1]*School of Electrical Engineering, Seoul National Univ., Korea;* [2]*Realistic Media Platform Research Center, Korea Electronics Technology Inst., Korea.* We propose an expansion method of exit pupil of projectors in a multi-projection 3D display. With the expansion of the exit pupil, the expansion of the system with tiling method is effectively enabled.

JTu4A.50
Lossless Compression of Elemental Images in Photon Counting Three-dimensional Integral Imaging, Inkyu Moon[1], Samarjit Das[1], Mingu Han[1], Jonggob We[1]; [1]*Chosun Univ., Korea.* This paper provides an overview of a method for a compression of elemental images in the photon counting three-dimensional (3D) integral imaging.

NOTES

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

07:30–19:00 Registration, *Metropolitan Ballroom Foyer*

08:30–10:00
AW1A • Measurement Makes Successes
Presider: Hans-Peter Loock; Queen's Univ. - Chemistry, Canada

AW1A.1 • 08:30 Invited

Paper Parameter Estimation Using Time-domain Terahertz Spectroscopy, J. Steven Dodge[1], Payam Mousavi[1], Ian Bushfield[1], Stéphane Savard[2], David Jez[2], Frank Haran[2]; [1]*Simon Fraser Univ., Canada;* [2]*Honeywell Process Solutions, Canada*. We demonstrate a technique for determining the thickness, moisture, and basis weight of paper, using time-domain terahertz spectroscopy. The fundamental uncertainty limits on all three paper processing parameters are competitive with existing sensor technology.

AW1A.2 • 09:00 Invited

Industrial Applications of Terahertz Technology: From Layer Thickness Measurements to Mail Screening, Rene Beigang[1]; [1]*Univ. of Kaiserslautern, Germany.* Terahertz time domain spectroscopy is used for industrial nondestructive testing and sensing applications including quality control, security applications and chemical analysis. Depending on the method of evaluation different properties of objects under investigation can be determined.

08:00–10:00
DW1B • Special Session in Holographic Lithography
Presider: Alan Purvis; Univ. of Durham, UK

DW1B.1 • 08:00 Invited

Holographic Lithography, Alan Purvis[1], Hesus Toriz-Garcia[2], Joshua Cowling[1], Gavin Williams[2], Luke Seed[2], Richard McWilliam[1], Florian Soulard[1], Peter Ivey[3]; [1]*School of Engineering and Computing Sciences, Durham Univ., UK;* [2]*Dept.of Electronic and Electrical Engineering, Univ. of Sheffield, UK;* [3]*Independent Consultant, UK*. This review summarises the work of the Durham-Sheffield, UK team working on Holographic Lithography over the last decade. It collates progress in 3D resolution and overall scale of the substrate wiring patterns designed and considers a range of approaches and applications.

DW1B.2 • 08:30 Invited

LC-based Phase-modulating Spatial Light Modulators, Andreas Hermerschmidt[1], Grigory Lazarev[1], Oleg V. Rozhkov[2], [1]*HOLOEYE Photonics AG, Berling, Germany,* [2]*Bauman Moscow State Technical University, Russia*. LCOS-technology is grown from display applications from one side and scientific applications from other side. The successful transition to commercial non-display applications imposes new criteria on design, production and characterization of phase-only LCOS SLM products.

DW1B.3 • 09:00 Invited

Maskless Photolithography By Holographic Optical Projection, Timothy D. Wilkinson[1]; [1]*Electrical Engineering, Univ. of Cambridge, UK*. We present an inexpensive novel rapid prototyping approach to a maskless and fully adaptive photolithographic process. Using holographic projection allows diffraction-limited performance within the given parameters of the optical system, adaptive software refocusing, and a continuous, pixel-free pattern.

08:00–10:00
IW1C • Computational Optics and Microscopy I
Presider: Byoungho Lee, Seoul National Univ., South Korea

IW1C.1 • 08:00 Invited

Addressing The Inverse Problem of Imaging With 'Heavy Atom' Optics, Aaron Lewis[1], Danielle Honigstein[2], Jacques Weinroth[1], Michael Werman[1]; [1]*Hebrew Univ. of Jerusalem, Israel;* [2]*Nanonics Imaging Ltd, Har Hotzvim Hi-Tech Park, Israel*. A solution for inverse problems in imaging is experimentally demonstrated using a nanoscopically controllable delta function reference source to solve the phase problem of far-field imaging exactly with super-resolution potential.

IW1C.2 • 08:30 Invited

Design of Complex Light Modulation Macro-pixel, Hwi Kim[1], Jinyoung Roh[1]; [1]*ICT Convergence Technology for Health & Safety, Dept.of Electronics and Information Engineering, Korea Univ., Korea*. Complex modulation architectures for holographic three-dimensional display are investigated. The two contrasted device-level architectures for complex light modulation are analyzed with numerical simulations. The first one takes the form consisting of in-plane amplitude-only pixels, while the second one is made by super-posed pixel structure. The advantage and limitations of the complex light modulation is discussed.

IW1C.3 • 09:00

Total Variation Regularized Deconvolution of Extended Depth of Field Microscope Images, Ramzi N. Zahreddine[1], Carol Cogswell[1]; [1]*Univ. of Colorado at Boulder, USA*. Total variation regularized deconvolution provides a highly accurate reconstruction of extended depth of field microscopy images. Several versions of the deconvolution problem, tailored for specific noise distributions, are presented. Results are compared with linear filters.

IW1C.4 • 09:15

An ultra-high-speed compressive multi-aperture CMOS image sensor, Futa Mochizuki[1], Taishi Takasawa[1], Keiichiro Kagawa[1], Min-Woong Seo[1], Keita Yasutomi[1], Shoji Kawahito[1]; [1]*Shizuoka Univ., Japan*. To achieve subnano-second temporal resolution imaging, we have proposed a compressive multi-aperture high-speed image sensor. We designed a CMOS image sensor with 5×3 apertures and 64×54 pixels aperture. Temporal resolution of 10ns was confirmed experimentally.

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

07:30–19:00 Registration, *Metropolitan Ballroom Foyer`*

08:00–10:00
LW1D • QCL-Based Measurement

Presider: Weidong Chen; Universite du Littoral, France

LW1D.1 • 08:00
Recent Advances in Chemical Detection with Chirped Laser Dispersion Spectroscopy, Gerard Wysocki[1], Genevieve Plant[1], Andreas Hangauer[1], Michal Nikodem[1]; [1]*Princeton Univ., USA.* Resent progress in implementations and performance improvements of chirped laser dispersion spectroscopy will be presented.

LW1D.2 • 08:15 Invited
On Recent Progress Applying Quantum Cascade Lasers in Plasma Diagnostics, Jean-Pierre H. van Helden[1], Paul Davies[2], Marko Hübner[1], Nobert Lang[1], Antoine Rousseau[3], Stephan Welzel[4], Jürgen Röpcke[1]; [1]*Process Monitoring, Leibniz Inst. for Plasma Science & Technology (INP Greifswald), Germany;* [2]*Dept. of Chemistry, Univ. of Cambridge, UK;* [3]*LPP, Ecole Polytechnique, Université Paris Sud-11, France;* [4]*FOM Inst. DIFFER, Netherlands.* Over the last decade, diverse phenomena in molecular plasmas in which many short-lived and stable species are produced have been successfully studied with quantum cascade laser absorption spectroscopy (QCLAS) in the mid-infrared spectral range.

LW1D.3 • 08:45
Applications of cw Quantum Cascade Laser near 8 μm in Gas Sensing Research, Muhammad Bilal Sajid[1], Aamir Farooq[1]; [1]*Clean Combustion Research Center, Division of Physical Sciences and Engineering, King Abdullah Univ. of Science and Technology, King Abdullah Univ of S&T (KAUST), Saudi Arabia.* Quantum cascade laser based sensors operating near 8 μm to detect H2O2, C2H2, CH4, N2O and H2O are discussed and demonstrated for applications in chemical kinetics, combustion and spectroscopic measurements.

LW1D.4 • 09:00
Quantum cascade laser based tetrafluoromethane and nitrogen oxide measurements for emission monitoring applications, Peter Geiser[1], Peter Kaspersen[1]; [1]*Norsk Elektro Optikk A/S, Norway.* Mid-infrared measurements of tetrafluoromethane at ambient temperature and nitric oxide at elevated temperatures have been performed using continuous-wave room-temperature quantum cascade lasers and second harmonic detection.

LW1D.5 • 09:15 Invited
Multiplexed Pulsed Quantum Cascade Laser Based Hypertemporal Real-time Headspace Measurements, Charles C. Harb[1]; [1]*Univ. of New South Wales, Australia.* Recent advances in digital signal processing have made it possible to make real-time hypertemporal spectroscopic measurements over several wavelength bands simultaneously. This talk will outline the progress made in this area of research and present a view of future application for this technology.

08:00–09:45
PW1E • Quantum Properties of Light in Turbulence

Presider: Darryl Sanchez; US Air Force Research Laboratory, USA

PW1E.1 • 08:00 Invited
Exploiting Strong Turbulence in Quantum Communications, Paolo Villoresi[1]; [1]*Universita degli Studi di Padova, Italy.* A protocol for Quantum-Key-Distribution over long links in realistic conditions including daylight exploiting strong-atmospheric-turbulence is studied. The secret-key-generation occurs in a selected fraction of the link duration, even when the average-conditions are below secure-communication limits.

PW1E.2 • 08:30
Vortex stabilization of the direction of laser beam propagation in randomly inhomogeneous medium, Valerii P. Aksenov[1], Cheslav E. Pogutsa[1], Valeriy V. Kolosov[1]; [1]*Inst. of Atmospheric Optics, Russia.* It is found that if a laser beam has vortex properties, then its random wandering in a turbulent medium decreases. The higher the orbital angular momentum (topological charge) carried by the beam, the higher the beam stability. The most stable vortex beam occupies the largest volume in space.

PW1E.3 • 08:45
Turbulence-induced Optical Vortex Trails in Light from HR 1577, Denis W. Oesch[1], Darryl Sanchez[2], Patrick Kelly[2]; [1]*Leidos, USA;* [2]*AFRL, USA.* The 2011 SOR observations of HR 1577 were reanalyzed using projections of the helicity spectrum. The method demonstrated optical vortex trails in each of the HR 1577 observations.

PW1E.4 • 09:00
Alignment Considerations for Optical OAM Detection, Nadeepa I. Jayasundara[1], David G. Voelz[1], Mazen Nairat[1]; [1]*New Mexico State Univ., USA.* We simulated the detection of OAM in the presence of sensor misalignment. Our results indicate that the OAM mode can be detected if the alignment is within a reasonable faction of the overall beam size.

PW1E.5 • 09:15
Using quantum operators to describe orbital angular momentum of Hermite Gaussian modes, Mazen Nairat[1], David G. Voelz[1]; [1]*New Mexico State Univ., USA.* Orbital angular momentum of Hermite Gaussian modes is determined using algebraic quantum operators. A vortex profile of the corresponding modes is clearly defined. Our approach is applicable in vacuum as well as in homogenous turbulence.

08:00–10:00
SW1F • Tomographic Imaging

Presider: Edmund Lam; Univ. of Hong Kong, Hong Kong

SW1F.1 • 08:00 Invited
Compressive Millimeter Wave and X-Ray Tomography, David J. Brady[1]; [1]*Duke Univ., USA.* Compressive tomography consists of estimation of high dimensional objects from measurements distributed over lower dimensions. Examples include reconstruction of 3D spectral data cubes from 2D focal planes and reconstruction of 3D volumes from 2D x-ray projections or holograms. Compressive tomographic estimation is improved if projections are structured to randomize the sampling phase space. To illustrate this principle, we show that structured x-ray illumination enables improvements in reconstructed image quality for compressed measurements relative to full Radon sampling and that structured millimeter wave illumination improves estimation of 3D surfaces.

SW1F.2 • 08:30
Effect of Projection Access Ordering in Algebraic Reconstruction Technique towards Rapidly Convergent CT Reconstruction from Simultaneous Projections, Murat Tahtali[1], Sajib Saha[1], Andrew Lambert[1], Mark Pickering[1]; [1]*Univ. of New South Wales, Canberra, Australia.* In this paper, we systematically evaluate the effect of different projections access ordering in algebraic reconstruction technique (ART) towards rapidly convergent CT reconstruction, for the newly proposed simultaneous CT capture method by Tahtali et. al.

SW1F.3 • 08:45
CT Reconstruction from Simultaneous Projections, Sajib Saha[1], Murat Tahtali[1], Andrew Lambert[1], Mark Pickering[1]; [1]*Univ. of New South Wales, Canberra, Australia.* This paper focuses on reconstructing CT from simultaneous X-ray projections. We propose amendment(s) for the simultaneous CT capture method by Tahtali, Saha et. al. to ensure better reconstruction.

SW1F.4 • 09:00 Invited
Metamaterial Apertures for Computational Imaging Schemes, David R. Smith[1]; [1]*Duke Univ., USA.* We describe efforts to develop a versatile, metamaterial-based aperture for use at millimeter wavelengths. With a greater emphasis on signal recovery and estimation techniques, metamaterial apertures offer a low-cost route to powerful, advanced imaging devices.

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

AW1A • Measurement Makes Successes—Continued

AW1A.3 • 09:30
Study of Influence of Experimental Technique on Measured Particle Velocity Distributions in Fluidized Bed, Balaji Gopalan[1,2], Frank Shaffer[1,2]; [1]*West Virginia Univ. Research Corporation, USA;* [2]*National Energy Technology Laboratory, USA.* High speed imaging with particle tracking data has demonstrated that the observational volume in the measurement technique will greatly influence the higher order statistics of particle velocity distribution in fluidized bed processes.

AW1A.4 • 09:45
Undisturbed imaging through a dynamic gas-liquid boundary by wavefront manipulation, Christoph Leithold[1], Lars Büttner[1], Moritz Stürmer[2], Ulrike Wallrabe[2], Jürgen Czarske[1]; [1]*Faculty of Electrical and Computer Engineering, Labfor Measurement and Testing Technique, Univ. of Technology Dresden, Germany;* [2]*Dept. of Microsystems Engineering - IMTEK, Labfor Micro Actuators, Univ. of Freiburg, Germany.* We present a technique for distortion-free laser-based measurements through a dynamic gas-liquid interface. Suitable components, methods and applications of the adaptive interferometric technique will be discussed by accomplished experiments and simulations.

DW1B • Special Session in Holographic Lithography—Continued

DW1B.4 • 09:30 Invited
Exploiting photochromism for optical nanopatterning, Rajesh Menon[1]; [1]*Univ. of Utah, USA.* This paper reports the application of photochromic molecules to optical subwavelength nanopatterning. Two distinct approaches will be described.

IW1C • Computational Optics and Microscopy I—Continued

IW1C.5 • 09:30
Multiplexed coded illumination in Fourier Ptychography, Lei Tian[1], Laura Waller[1]; [1]*Univ. of California Berkeley, USA.* Fourier Ptychography recovers high-resolution phase and amplitude from low-resolution images taken at varying illumination angles. Here, we describe multiplexing methods for reduction of the acquisition time and data size requirements for this method.

IW1C.6 • 09:45
Fourier Ptychography - Towards Perfect Microscope, xiaoze ou[1], Changhuei Yang[1]; [1]*Caltech, USA.* We illustrate the principle of Fourier ptychography, a super-resolution imaging scheme, and demonstrated its capability to achieve high resolution, large field-of-view, aberration free, magnitude and quantitative phase images using LED matrix and conventional microscope.

10:00–10:30 Coffee Break and Exhibit Hall, *Metropolitan Ballroom B*

NOTES

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

LW1D • QCL-Based Measurement—Continued

LW1D.6 • 09:45
Differential Faraday Rotation Spectrometer for Detection of Nitric Oxide Isotopes, Eric J. Zhang[1], Gerard Wysocki[1]; [1]*Electrical Engineering, Princeton Univ., USA.* We present a differential dual-modulation Faraday rotation spectrometer for real-time detection of nitric oxide isotopologues. The prototype system provides > 27 dB signal cancellation for optical subtraction of the sample and calibration gas spectra.

PW1E • Quantum Properties of Light in Turbulence—Continued

PW1E.6 • 09:30
A First Look at Starfire Optical Range Atmospheric Monitor Data for Photonic Orbital Angular Momentum, Denis W. Oesch[1], Darryl J. Sanchez[2], Earl Spillar[2], Patrick Kelly[2]; [1]*LEIDOS, USA;* [2]*AFRL, USA.* A first look for photonic orbital angular momentum in five years of atmospheric profiling data from the Starfire Optical Range Atmospheric Monitor is presented.

SW1F • Tomographic Imaging—Continued

SW1F.5 • 09:30 Invited
Cellular Imaging Without Fluorescence, Shan S. Kou[1]; [1]*Univ. of Melbourne, Australia.* This talk will provide an overview of recent projects in quantitative cellular imaging using intrinsic optical signatures, such as phase, bi-refringence and refractive index, and present several novel techniques that will underpin the final goal of label-free "super-resolved" three-dimensional (3D) microscopy.

10:00–10:30 Coffee Break and Exhibit Hall, *Metropolitan Ballroom B*

NOTES

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

10:30–12:30
AW2A • QCL Hits the Floor Running
Presider: Thomas Haslett; Avo Photonics Inc, USA

AW2A.1 • 10:30 Invited
Monolithic Tuning of Quantum Cascade Lasers for Compact Infrared Spectroscopy Applications: From Design Considerations to Results, Mark F. Witinski[1], Christian Pfluegl[1], Laurent Diehl[1]; [1]*Eos Photonics, USA*. Eos Photonics manufactures DFB QCL arrays, with each element unique wavelength. In spectroscopy systems, such as standoff detectors and gas analyzers, this enables broad coverage and fast, all-electronic wavelength tuning with no moving parts.

AW2A.2 • 11:00 Invited
High power and single mode Quantum Casade lasers for industrial applications, Mariano Troccoli[1]; [1]*Adtech Optics Inc, USA*. We present our state-of-the-art results on distributed feedback and high power quantum cascade (QC) lasers. Application issues and perspectives of single mode and high power QCLs will also be discussed.

AW2A.3 • 11:30 Invited
Tunable QCLs with Intra Cavity MEMS Filters for Spectroscopic Applications, Chip Marshall[1], Don Kuehl[1], Eugene Ma[1], Jinhong Kim[1], Richard Sharp[1]; [1]*RedShift Systems Corporation, USA*. Quantum cascade lasers (QCLs) are an emerging solution for molecular spectroscopy applications. We describe the development and application of a new tunable external cavity QCL platform utilizing MEMS fabricated tunable thin film filters which achieve both a broad tuning range and precise wavelength control.

AW2A.4 • 12:00 Panel
Panel: QCL Commercial Challenges
Moderator: Thomas Haslett, *Avo Photonics Inc., USA*
Mark Witinski, *EOS Photonics, USA*
Mariano Troccoli, *AdTech Optics, USA*
Richard Sharp, *RedShift Systems, USA*

10:30–12:30
DW2B • 3D Imaging and Display Systems
Presider: Byoungho Lee; Seoul National Univ., South Korea

DW2B.1 • 10:30 Invited
Recent Progress in Updatable Holographic 3D Display Systems Using Monolithic Organic Compounds, Naoto Tsutsumi[1], Kenji Kinashi[1], Kanako Ogo[1], Takahiro Fukami[1], Yuuki Yabuhara[1], Kazuhiro Tada[2], Yutaka Kawabe[2]; [1]*Kyoto Inst. of Technology, Japan;* [2]*Chitose Inst. of Science and Technology, Japan*. We present here recent progress of updatable holographic stereogram 3D display systems using monolithic organic compound film device. Current system promises full color updatable holographic 3D display system.

DW2B.2 • 11:00 Invited
Standardization Activities for 3D Display and Devices, Nam Kim[1]; [1]. 3D displays are becoming part of our life. There are several technologies to achieve the 3D effects. We briefly introduced the 3D display, their more reasonable technology classification, the standardization measurements and the activities of international standardization organizations, companies, and research Inst.s.

DW2B.3 • 11:30
Progress on a low-cost holographic video monitor, Drew Henrie[1], Benjamin Haymore[1], M. Zhang[1], Dunia Alrabidi[1], Daniel Smalley[1], Sundeep Jolly[2], V. Michael Bove[2]; [1]*Brigham Young Univ., USA;* [2]*MIT Media Lab, MIT, USA*. Abstract: In this presentation we report improvements to the supporting geometry of the low-cost MIT/BYU mark IV holographic video monitor and invite broader participation in this research effort by providing design equations and prototyping data.

DW2B.4 • 11:45
Projection-type Integral Imaging Using Pico-projector, Yucheol Yang[1], Sung-Wook Min[1]; [1]*Dept.of Information Display, Kyung, Korea*. A pico-projector is applied to projection-type integral imaging in real mode. And using the matrix analysis, a pixel mapping algorithm is processed. The experiments are carried out to confirm the validity of proposed pixel mapping.

DW2B.5 • 12:00
Floated integral imaging display viewable from surrounding area, Daisuke Miyazaki[1], Go Miyazaki[1], Yuki Maeda[1], Takaaki Mukai[1]; [1]*Graduate School of Engineering, Osaka City Univ., Japan*. A full-parallax auto-stereoscopic display method that enables formation of a floating three-dimensional image viewable from a surrounding area is proposed. This method utilizes integral imaging, a rotating mirror scanner, and a hemisphere concave mirror.

DW2B.6 • 12:15
3D Amplitude and Phase Imaging Using Flow-scanning Tomography, Nicolas C. Pegard[1], Marton L. Toth[2], Monica Driscoll[2], Jason W. Fleischer[1]; [1]*Electrical Engineering, Princeton Univ., USA;* [2]*Biology and Biochemistry, Rutgers Univ., USA*. We combine a microfluidic channel and hybrid space-angle measurement to observe live biomaterial in motion. We experimentally demonstrate the technique by co-registering 3D absorption and 3D differential-phase-contrast images on live, freely swimming C.elegans nematodes.

10:30–12:30
IW2C • Computational Optics and Microscopy II
Presider: Laura Waller, Univ. of California Berkeley, USA

IW2C.1 • 10:30 Invited
Computational imaging for 3D Fluorescence Microscopy, Chrysanthe Preza[1]; [1]*Univ. of Memphis, USA*. Computational imaging approaches have been developed to address depth variability in 3D fluorescence microscopy of imaging of thick samples, using depth-variant restoration and/or point-spread function engineering. Results from simulated and experimental data are presented.

IW2C.2 • 11:00 Invited
Arbitrary Optical Transformations Without Calculations, David A. B. Miller[1]; [1]*Stanford Univ., USA*. We show how to perform any linear transformation on a coherent light field, without fundamental efficiency limits, trained, adaptive approach based on singular value decomposition mathematics and suitable for integrated optics implementations in simple cases.

IW2C.3 • 11:30 Invited
Absolute shape measurements at high resolution using digital holographic microscope, Tomasz Kozacki[1], Kamil Lizewski[1], Julianna Kostencka[1], Michal Jozwik[1]; [1]*Politechnika Warszawska, Poland*. We review holographic methods for measurement of three-dimensional deep and high gradient topographies. The special attention is paid to illumination schemes (spherical and multidirectional plane wave illumination) as well as to algorithms for shape calculation.

IW2C.4 • 12:00
Axial Scanning and Phase Retrieval based Geometric Super Resolved Imager, Amikam Borkowski[1], Emanuel Marom[1], Zeev Zalevsky[2]; [1]*Tel Aviv Univ., Israel;* [2]*Bar-Ilan Univ., Israel*. We propose a new geometric super resolving approach that overcomes the geometric resolution reduction caused by the spatially large pixels of the detector array. The improvement process is obtained by applying an axial scanning procedure.

IW2C.5 • 12:15
Coded Time-of-Flight Imaging for Calibration Free Fluorescence Lifetime Estimation, Ayush Bhandari[1], Christopher Barsi[1], Refael Whyte[2], Achuta Kadambi[1], Anshuman J. Das[1], Adrian Dorrington[2], Ramesh Raskar[1]; [1]*MIT, USA;* [2]*School of Engineering, Univ. of Waikato, New Zealand*. We present a novel, single-shot, calibration-free, framework within which Time-of-Flight cameras can be used to estimate lifetimes of fluorescent samples. Our technique relaxes the high time resolution or the multi-frequency measurement requirements in conventional systems.

12:30–14:00 Lunch, *On Your Own*

Ballard Room

Laser Applications to Chemical, Security and Environmental Analysis

Capitol Hill

Propagation through and Characterization of Distributed Volume Turbulence

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

10:30–12:30
LW2D • Stand-off Detection & LIBS
Presider: Aamir Farooq; Stanford Univ., USA

LW2D.1 • 10:30 Invited

Flow Imaging and Standoff Detection by Dissociation of Air Molecules, Richard B. Miles[1], Arthur Dogariu[1]; [1]*Princeton Univ., USA.* This talk will discuss new diagnostics in air based on laser dissociation of oxygen and nitrogen. Three concepts will be highlighted: FLEET, backward lasing in air, and double pulse Radar REMPI trace detection of xenon.

LW2D.2 • 11:00

Standoff real-time detection and hyperspectral imaging using coherent Raman, Arthur Dogariu[1]; [1]*Princeton Univ., USA.* We demonstrate real-time standoff detection and identification of explosives and chemicals using backscattered collinear CARS. Nanograms of explosives are detected in milliseconds from many meters away. Standoff hyperspectral imaging of trace explosives is demonstrated.

LW2D.3 • 11:15

Backwards nitrogen double lasing in air for remote trace detection, Arthur Dogariu[1], Richard B. Miles[1]; [1]*Princeton Univ., USA.* We demonstrate remote lasing of atomic nitrogen in air, and investigate the backward coherent stimulated emission. We propose a scheme for remote trace detection using double air lasing and resonant pumping.

LW2D.4 • 11:30 Invited

Improvised explosives and precursor identification with LIBS, Amy Bauer[1]; [1]*Applied Research Associates, Inc, USA.* Improvised explosive materials (IE) present a potent measurement/detection challenge. Some materials are well-identified with traditional instrumentation; those mixed with metal powders are not. Laser-induced breakdown spectroscopy adds needed capability to the detection arsenal of first-responders.

LW2D.5 • 12:00

Laser induced breakdown spectroscopy for gas phase measurements of alkaline species, Peter Kutne[1], Wolfgang Meier[1]; [1]*German Aerospace Center (DLR), Germany.* An experimental setup to produce a preheated air flow, seeded with reproducible amounts of earth alkaline or alkaline species is described. Results from the first measurements with Laser induced breakdown spectroscopy are presented.

LW2D.6 • 12:15

Advantages of shortwave infrared LIDAR entomology, Mikkel B. Sørensen[1,2]; [1]*Dept.of Physics, Lund Univ., Sweden;* [2]*Hyspex, Norsk Elektro Optikk, Norway.* Challenges of insect monitoring is revised. I present our new lidar, and use remote dark-field monitoring as well as hyperspectral push-broom imaging to argue why lidar entomology is significantly improved when implemented at telecom wavelengths.

10:30–12:00
PW2E • Imaging in Distributed Volume Turbulence
Presider: Thomas Farrell; US Air Force Research Laboratory, USA

PW2E.1 • 10:30 Invited

Target-in-the-loop Atmospheric Turbulence Characterization Based on Remote Sensing Invariants, Mikhail A. Vorontsov[1,2], Svetlana L. Lachinova[2]; [1]*Univ. of Dayton, USA;* [2]*Optonicus, LLC, USA.* We discuss a target-in-the-loop atmospheric sensing concept that offers a possibility for the development of a new type of scintillometer that does not require precise transmitter/receiver alignment and can operate over extended-range distances.

PW2E.2 • 11:00 Invited

Wave Optics Modeling and LabGeneration of "Exotic" Partial Coherent Beams, David G. Voelz[1], Xifeng Xiao[1]; [1]*New Mexico State Univ., USA.* A wave optics-based design method is described for random screens to produce a partial spatial coherent beam with an arbitrary far-field intensity pattern. The approach is demonstrated with computer simulations and Labresults.

PW2E.3 • 11:30

Atmospheric Turbulence Compensation and Coherent Beam Combining over a 7 km Propagation Path Using a Fiber-Array System with 21 Sub-apertures, Thomas Weyrauch[1], Mikhail Vorontsov[1,2], Vladimir Ovchinnikov[2], Ernst Polnau[1], Guimin Wu[2], Thomas Ryan[2], Morris Maynard[2]; [1]*Univ. of Dayton, USA;* [2]*Optonicus, USA.* Piston phase control based on SPGD maximization of the target-return optical power resulted in compensation of turbulence-induced wavefront distortions in coherent beam combining experiments over a near horizontal path under various turbulence conditions.

PW2E.4 • 11:45

Laboratory Investigation of Schell's Theorem, Troy Ellis[1], Michael Flanagan[1]; [1]*US Air Force, USA.* This work explores Schell's Theorem and its potential for removing effects of partial coherence from the optical transfer function of aberrated images collected in a Labexperiment.

12:30–14:00 Lunch, *On Your Own*

Ravenna A,B & C

Digital Holography & 3-D Imaging

14:00–16:00
DW3B • Biomedical/Clinical/ Medical Applications

Presider: Nam Kim; Chungbuk National Univ., South Korea

DW3B.1 • 14:00 Invited

High-speed Digital Holography in Middle-ear Mechanics: From Labto Clinical Use, Cosme Furlong[1,2], Ivo Dobrev[1,2], Jeffrey Tao Cheng[3,4], Morteza Khaleghi[1,2], John J. Rosowski[3,4]; *[1]) Center for Holographic Studies and Laser Micro-mechaTronics (CHSLT), USA; [2]Mechanical Engineering Department, Worcester Polytechnic Inst., USA; [3]Eaton-Peabody Laboratory, , Massachusetts Eye and Ear Infirmary, USA; [4]Dept.of Otology and Laryngology, Harvard Medical School, USA.* We present holographic methodologies for characterization of shape and nanometer scale motions of the human tympanic membrane, including measurements at rates > 40 kfps. Our efforts are to bring advanced metrology tools to the clinic.

DW3B.2 • 14:30

Studying cell-material interaction by new particle tracking in digital holography, Lisa Miccio[1], Pasquale Memmolo[1,2], Francesco Merola[1], Pietro Ferraro[1]; *[1]CNR, National Inst. of Optics -INO, Italy; [2]IIT, Center for Advanced Biomaterials for Health Care - CRIB, Italy.* A method for 3D tracking is implemented exploiting Digital Holography features in Lab on Chip. The procedure avoids phase unwrapping occurring in traditional processes and extends holographic potentiality measuring sample properties by monitoring probe's displacements

DW3B.3 • 14:45

Biovolume calculation and three-dimensional imaging of bovine spermatozoa by digital holography, Francesco Merola[1], Lisa Miccio[1], Pasquale Memmolo[1,3], Giuseppe Di Caprio[2], Giuseppe Coppola[2], Paolo Netti[3], Pietro Ferraro[1]; *[1]INO-CNR, Italy; [2]IMM-CNR, Italy; [3]IIT-CRIB, Italy.* Optical tweezers and digital holography are used for the purpose of trapping and analyze bovine spermatozoa in microfluidic devices. 3D imaging and estimation of volume of the cells are provided.

DW3B.4 • 15:00

High-Resolution Tomographic Imaging of Living Tissue using Lens-Less Holographic Microscopy, Kunihiro Sato[1], Yuta Futsuki[1]; *[1]Univ. of Hyogo, Japan.* High-resolution tomographic microscopy is developed for optical measurement of living tissue by using the lens-less reflection-type holographic microscopy. Tomographic images with a resolution of about one micron are reconstructed for complex biological structures.

DW3B.5 • 15:15

Characterization of inclusions in a water droplet using Digital In-line Holography, Wisuttida Wichitwong[1], Sébastien Coëtmellec[1], Denis Lebrun[1], Daniel Allano[1], Gérard Gréhan[1], Marc Brunel[1]; *[1]CNRS UMR 6614 CORIA, France.* Glass inclusions in a water droplet are visualized using digital in-line holography. The sizes and 3D locations of the inside-particles are obtained. A long exposure scheme is tested to determine the trajectories of the inclusions.

Metropolitan Ballroom A

Joint AIO / IS

14:00–16:00
JW3C • Imaging Imaging, Wow

Presider: Gary Miller; US Naval Research Laboratory, USA

JW3C.1 • 14:00

High-speed and high-resolution phase-space imaging with digital micromirror devices, Hsiou-Yuan Liu[1], Lei Tian[1], Laura Waller[1]; *[1]Electrical Engineering and Computer Sciences, Univ. of California Berkeley, USA.* We describe an imaging system for capturing 4D phase-space distributions of partially coherent and scattered light. The capture comprises a fast aperture coding in the Fourier space of the object, which is done by a digital micromirror device (DMD).

JW3C.2 • 14:15

Spectral Optics Simulation for Rapid Image Systems Prototyping: Ray-tracing, Diffraction and Chromatic Aberration, Andy Lin[1], Joyce E. Farrell[1], Brian A. Wandell[1]; *[1]Stanford Univ., USA.* We describe a software tool that models multicomponent spherical lenses, and calculates the spectral irradiance and depth maps for three-dimensional scenes. Combined with image systems simulations, this tool allows for the rapidly prototyping of imaging systems.

JW3C.3 • 14:30 Invited

Standards and Methods for the Evaluation of Hyperspectral Imaging System Performance, David W. Allen[1]; *[1]National Inst of Standards & Technology, USA.* Hyperspectral imaging is being adopted for a wide range of applications including those related to industrial and manufacturing processes. The ability to spectrally discriminate differences between materials depends on a wide range of variables in the imaging system. Evaluating the performance of the system allows for the estimation of the probability of detection and false alarm rates. The performance of the hyperspectral imaging system can often be tied directly to costs, safety, and quality. This talk will cover both basic standards (such as reference diffusers and wavelength standards) and advanced methods (including microscene generation and the NIST Hyperspectral Image Projector) that can facilitate how well a hyperspectral imaging system performs.

JW3C.4 • 15:00

Broadband Diffractive Optics for Enhancing the Efficiency of Solar Cells, Rajesh Menon[1], Peng Wang[1], Nabil Mohammed[1]; *[1]Univ. of Utah, USA.* We propose a broadband diffractive optics based spectrum splitting approach to enhance the efficiency of solar cells. Numerical simulations indicate ~27% and ~45% increase in output power of two and three bangap solar cells respectively.

JW3C.5 • 15:15

Improvement of the correlation speed in an optical correlation system using a holographic disc, Kanami Ikeda[1], Eriko Watanabe[1]; *[1]Univ. of Electro-Communications, Japan.* We developed an optical correlation system that has a potential to achieve data transfer speed higher than 110 Gbps. An equal error rate of 0% with a 2-μm recording pitch and a disc rotation speed of 900 rpm were obtained.

Ballard Room

Laser Applications to Chemical, Security and Environmental Analysis

14:00–16:00
LW3D • Frequency Combs & Precision Optical Measurements

Presider: Adam Fleisher; National Inst of Standards & Technology, USA

LW3D.1 • 14:00 Invited

Near-Infrared Dual-Comb Spectroscopy of Gases, Nathan R. Newbury[1]; *[1]National Inst of Standards & Technology, USA.* Coherent dual-frequency comb spectroscopy provides a means to probe molecular spectra with the full accuracy and precision of frequency combs. We will discuss our dual comb spectrometer for precision Labmeasurement and recent outdoor measurements.

LW3D.2 • 14:30 Invited

Coherent Raman Spectroscopy with Femtosecond Laser Frequency Combs, Ming Yan[1,2], Takuro Ideguchi[2], Simon Holzner[1,2], Birgitta Bernhardt[1,2], Guy Guelachvili[3], Theodor W. Hänsch[1,2], Nathalie Picqué[1,2]; *[1]Physics department, Ludwig-Maximilians-Universitä t München, Germany; [2]Max-Plank-Inst. for Quantum Optics, Germany; [3]Institut des Sciences Molé culaires d'Orsay, France.* Two femtosecond laser frequency combs are harnessed for coherent Raman spectroscopy and spectro-imaging, which simultaneously measure, on the microsecond timescale, all spectral elements over a wide bandwidth and with high resolution on a single photodetector.

LW3D.3 • 15:00

Mode-Resolved Absorption and Dispersion Measurements in High-Finesse Cavities, Joseph T. Hodges[1], David Long[1], Adam Fleisher[1], Katarzyna Bielska[1,2], Wojtewicz Szymon[1,2]; *[1]National Inst of Standards & Technology, USA; [2]Univ. of Nicolaus Copernicus, Poland.* We discuss a precise method for measuring mode widths and positions in an optical resonator. This technique quantifies absorption and dispersion of light caused by an absorbing gas or by losses in the resonator optics.

LW3D.4 • 15:15

An Optical Parametric Oscillator Based On Two PPNL Crystals for Mid-Infrared Dual-Comb Spectroscopy, Julien Mandon[1], Yuwei Jin[1], Simona M. Cristescu[1], Frans J. Harren[1]; *[1]Inst. of Molecules and Materials, Radboud Universiteit Nijmegen, Netherlands.* We present a mid-infrared optical-parametric-oscillator (OPO) based on two PPNL crystals for dual-comb spectroscopy. The OPO cavity offers several advantages to generate two mid-infrared beams for high resolution spectra between 2.5 and 4.5 μm.

Ravenna A,B & C

Digital Holography & 3-D Imaging

DW3B • Biomedical/Clinical/ Medical Applications—Continued

DW3B.6 • 15:30
Spectroscopic measurement for fruit using spectral estimation digital holography, Peng Xia[1], Yasuhiro Awatsuji[1], Shogo Ura[1], Kenzo Nishio[2], Osamu Matoba[3]; [1]*Graduate School of Science and Technology, Kyoto Inst. of Technology, Japan;* [2]*Advanced Technology Center, Kyoto Inst. of Technology, Japan;* [3]*Graduate School of System Informatics, Kobe Univ., Japan.* We present a digital holography using spectral estimation technique, which can measure spectral reflectance of 3D objects. We experimentally succeed in estimating the spectral reflectance of a lemon by using the technique.

DW3B.7 • 15:45
Stochastic Digital Holography for Visualizing Strongly Refracting Transparent Objects, Jean-Michel Desse[2], Pascal Picart[1]; [1]*LAUM CNRS Université du Maine, France;* [2]*ONERA, France.* This paper presents a digital holographic method to visualize inside a strongly refracting object. The proof of principle is provided through the visualization of refractive index variation inside a lighting ampoule.

Metropolitan Ballroom A

Joint AIO / IS

JW3C • Imaging Imaging, Wow—Continued

JW3C.6 • 15:30 Invited
Observing Optically Challenging Objects with Structured Light, Christoph Mertz[1]; [1]*Carnegie Mellon Univ., USA.* Structured light is a common tool to observe the 3D shape of objects. However, most of these sensor systems assume that the objects scatter light diffusely and that there is only a moderate amount of ambient light. They are not able to deal with specular or transparent objects or with the ambient lighting from direct sunlight. We have built a scanning laser line striper that works even in bright sunlight and is able to observe optically challenging objects. In this paper we will show how the sensor can be used to measure the 3D shape of reflective objects and objects behind a semi-transparent plane.

Ballard Room

Laser Applications to Chemical, Security and Environmental Analysis

LW3D • Frequency Combs & Precision Optical Measurements—Continued

LW3D.5 • 15:30 Invited
Counting Atoms in a Magneto-Optic Trap, Guo-Min Yang[1], Le-Yi Tu[1], Cun-Feng Cheng[1], Yu R. Sun[1], Shui-Ming HU[1]; [1]*Hefei National Labfor Physical Sciences at Microscale, Univ Sci & Tech China, China.* A laser-based atom counter is built to detect rare noble-gas isotopes which are ideal tracers for environmental samples. It reveals million-year-old groundwater by measuring radio-krypton abundances at the ppq level.

16:00–17:00 Exhibit Hall & Coffee Break, *Metropolitan Ballroom B*

NOTES

Issaquah A & B

Applied Industrial Optics: Spectroscopy, Imaging, and Metrology

17:00–19:00
AW4A • Optics, Images, & Field Theory Oh My

Presider: Dominik Rabus; Burkert Fluid Control Systems, Germany

AW4A.1 • 17:00 Invited

Reducing Measurement Error in the MacAdam Ellipses, Jeff Throckmorton[1]; [1]*Ocean Optics Inc., USA*. Color measurements are integral to almost all consumer goods and bulk material supply. This presentation focuses on the design criteria for the development of a spectrometer that reduces variability in measurement of the MacAdam ellipse.

AW4A.2 • 17:30 Invited

Roadmap for Commercial Gigapixel Cameras, David J. Brady[1,2]; [1]*Duke Univ., USA;* [2]*Duke Univ., Aqueti, USA*. Multiscale array cameras allow 10-100x improvements in commercial camera resolution. This talk discussed the optical manufacturing, electronic processing and communications and cloud software ecosystem that enables economical multiscale cameras.

Ravenna A,B & C

Digital Holography & 3-D Imaging

17:00–18:45
DW4B • Holographic Imaging

Presider: Pascal Picart; LAUM CNRS Université du Maine, France

DW4B.1 • 17:00

Image-readout optical system for large size electronic holography using multiple spatial light modulators, Hisayuki Sasaki[1], Kenji Yamamoto[1], Koki Wakunami[1], Yasuyuki Ichihashi[1], Ryutaro Oi[1], Takanori Senoh[1]; [1]*Universal Communication Research Inst., National Inst. of Information and Communications Technology, Japan.* The electronic holographic three-dimensional images produced by reflection-type multiple spatial light modulators have limited scalability. We propose latitude enhancement method with a newly devised space-saving image-readout optical system to produce large color full-parallax images.

DW4B.2 • 17:15

Imaging of 2D objects in diffuse media by coherence-controlled holographic microscope, Vera Kollarova[1], Martin Lostak[2], Michala Slaba[1,2], Tomas Slaby[2], Jana Collakova[1,2], Zbynek Dostal[1,2], Aneta Krizova[1,2], Lenka Strbkova[1], Radim Chmelik[1,2]; [1]*Central European Inst. of Technology, Brno Univ. of Technology, Czech Republic;* [2]*Faculty of Mechanical Engineering, Brno Univ. of Technology, Czech Republic*. Coherence-controlled holographic microscope (CCHM) is a tool for quantitative phase imaging. Coherence-gating effect enables to observe samples through diffuse media. Numerical simulations of imaging of 2D objects through scattering layer is presented in the paper.

DW4B.3 • 17:30

Recovery of Partially Occluded Object Image in Digital Holography Based on Image Inpainting, Shuming JIAO[1], Wai Ming Tsang[1]; [1]*City Univ. of Hong Kong, Hong Kong*. This paper proposes a method for recovering partially occluded object image from a digital hologram. The method is based on restoring the missing fringe patterns on the occluding wavefront plane by image inpainting algorithm.

DW4B.4 • 17:45

Experimental validation of Fourier Interferometric Imaging (FII): a new simple and powerful model to measure cloud of droplets, Sawitree Saengkaew[1], Gérard Gréhan[1], Marc Brunel[1], Daniel Allano[1]; [1]*Optics and Laser, UMR CNRS 6614\CORIA, France*. Experimental validation of the FII approach on a line of monodispersed droplets is presented. Good agreement between both the numerical and experimental behavior is obtained. The droplet location is measured with an accuracy better than 1 µm for a droplet distance as large as 1.2 mm.

Metropolitan Ballroom A

Imaging Systems and Applications

17:00–18:30
IW4C • Digital Image Processing

Presider: Khan Iftekharuddin, Old Dominion Univ., USA

IW4C.1 • 17:00 Invited

Scene Radiance Estimation from Human Corneal Reflections, Shoji Tominaga[1], Ryo Otera[2], Shogo Nishi[3]; [1]*Graduate School of Advanced Integration Science, Chiba Univ., Japan;* [2]*Graduate School of Information Technology, Kobe Inst. of Computing, Japan;* [3]*Dept.of Engineering Informatics, Osaka Electro-Communication Univ., Japan*. A method is proposed for estimating spectral radiances of the surrounding scene from a reflected image on the corneal surface. A color camera and the human eyeball are used to develop a simple imaging system.

IW4C.2 • 17:30

Super-Resolution Based Demosaicking For Full Motion Video SWIR Multi-Spectral Sensor, Andrey Kanaev[1], Michael Yetzbacher[1], Mary Kutteruf[1], Michael DePrenger[2], Kyle Novak[2], Cory Miller[2], Trijntje Downes[1]; [1]*US Naval Research Laboratory, USA;* [2]*Tekla Research Inc., USA*. We present novel demosaicking algorithm for the first full motion video SWIR 9-band sensor based on pixel size filter array. Spatial resolution enhancement of each spectral band is achieved using modified super-resolution technique.

IW4C.3 • 17:45

Shadow Removal for Illumination Invariant Face Detection in Hyperspectral Imagery, Yakov Diskin[1], Paheding Sidike[1], Saibabu Arigela[1], Vijayan Asari[1]; [1]*Univ. of Dayton, USA*. We present an adaptive visibility improvement technique that leverages the hyperspectral-bands to improve the local contrast and spatial resolution of shadow regions. The proposed technique is evaluated by determining the face-detection rate under various illuminations.

Ballard Room

Laser Applications to Chemical, Security and Environmental Analysis

17:00–19:00
LW4D • New Approaches in Trace Gas Sensing

Presider: Grant Ritchie; Univ. of Oxford, UK

LW4D.1 • 17:00 Invited

Photoacoustic Spectroscopy with Micro-Tuning Forks - A Versatile Tool for Gas Sensing, Michael Köhring[1], Ulrike Willer[2], Wolfgang Schade[1,2]; [1]*Fiber Optical Sensor Systems, Fraunhofer Heinrich-Hertz-Inst., Germany;* [2]*Inst. for Energy Research and Physical Technologies, Clausthal Univ. of Technology, Germany.* An overview on micro-tuning fork based gas detection is presented. Fundamentals of QEPAS are discussed; however the focus is on recent developments in the field of all optical sensing. New applications and perspectives are shown.

LW4D.2 • 17:30

Chirped laser dispersion spectroscopy in dual side-band frequency-shifted-carrier arrangement, Michal P. Nikodem[1], Karol Krzempek[2], Krzysztof Abramski[2]; [1]*Wroclaw Research Centre EIT+, Poland;* [2]*Wroclaw Univ. of Technology, Poland*. New configuration for near-infrared chirped laser dispersion spectroscopy (CLaDS) is presented. Signal enhancement with respect to previously demonstrated CLaDS configuration is shown experimentally.

LW4D.3 • 17:45

Multi-species detection using mid-infrared Multi-Mode Absorption Spectroscopy, MUMAS, Paul Ewart[1], Henry Northern[1], Seamus O'Hagan[1], Benjamin Metcalf[1], Chul S. Kim[2], Mijin Kim[3], Charles D. Merritt[1], William W. Bewley[1], Chadwick L. Canedy[1], Joshua Abell[1], Igor Vurgaftman[1], Jerry R. Meyer[1]; [1]*Univ. of Oxford, UK,* [2]*Code 5604, Naval Research Lab, Washington, DC, USA;* [3]*Soetra Defense Solutions, Inc., Columbia, USA*. Multi-mode absorption spectroscopy has been used to detect CH4, NH3 and N2O individually or simultaneously in mixtures using multi-mode radiation generated by difference frequency generation at 3.3 microns or interband cascade lasers at 3.7 microns

Issaquah A & B

Applied Industrial Optics: Spectroscopy, Imaging, and Metrology

AW4A • Optics, Images, & Field Theory Oh My—Continued

AW4A.3 • 18:00
Full-field Interferometric Confocal Microscopy using a VCSEL Array, Brandon Redding[1], Yaron Bromberg[1], Michael Choma[2,3], Hui Cao[1]; [1]*Applied Physics, Yale Univ., USA;* [2]*Diagnostic Radiology, Yale School of Medicine, USA;* [3]*Biomedical Engineering, Yale Univ., USA.* We present an interferometric confocal microscope using a low-spatial-coherence VCSEL array. Spatial coherence gating provides continuous virtual pinholes allowing an entire en face plane to be imaged in a snapshot at camera limited frame rate.

AW4A.4 • 18:15
Influence of Magnetic Field on Gaseous Flames using Digital Speckle Pattern Interferometry (DSPI) and Riesz Transform, Manoj Kumar[1], Varun Kumar[1], Shilpi Agarwal[1], Gufran S Khan[1], Chandra Shakher[1]; [1]*IDD Centre, Indian Inst. of Technology Delhi, India.* An experimental investigation on temperature profile of gaseous flames in the presence of uniform and non-uniform magnetic fields by using DSPI is presented. Phase has been extracted by application of Riesz transform and monogenic signal.

AW4A.5 • 18:30 Panel
Panel: Bring Us Your Problems
Moderator: Jess Ford, *Weatherford International Ltd, USA*
Dominik Rabus, *Burkert Fluid Control Systems, Germany*
David Allen, *NIST, USA*
Arlene Smith, *Univ. of Michigan, USA*

Ravenna A,B & C

Digital Holography & 3-D Imaging

DW4B • Holographic Imaging—Continued

DW4B.5 • 18:00
Classical and Digital Holography of Singlet Oxygen in Water, Irina Semenova[1], Andrey Belashov[1], Dina Maksimova[1,3], Nickolai Petrov[2], Oleg Vasyutinskii[1,3]; [1]*Ioffe Physical Technical Inst., Russia;* [2]*St.Petersburg National Research Univ. ITMO, Russia;* [3]*St.Petersburg State Polytechnic Univ., Russia.* A novel approach to detect and monitor singlet oxygen in solution by means of holographic registration of thermal disturbances produced by its radiationless deactivation is presented and realized experimentally both in classical and digital arrangements.

DW4B.6 • 18:15
Directivity of Floating LED formed with Aerial Imaging by Retro-Reflection (AIRR), Hirotsugu Yamamoto[1,2], Yuka Tomiyama[2], Shiro Suyama[2]; [1]*Center for Optical Research and Education (CORE), Utsunomiya Univ., Japan;* [2]*Dept. of Optical Science and Technology, Univ. of Tokushima, Japan.* We have proposed an aerial imaging by retro-reflection (AIRR). This paper reports directivity of AIRR by use of retro-reflective sheeting of micro-beads type. A floating LED image was observed over 90 degrees.

DW4B.7 • 18:30
Shack-Hartmann Tomography and 3D Imaging of Partially Coherent Vortex Beams, Jaroslav Rehacek[1], Zdenek Hradil[1], Bohumil Stoklasa[1], Libor Motka[1], Luis L. Sánchez-Soto[2]; [1]*Dept.of Optics, Palacky Univ., Czech Republic;* [2]*Departamento de Óptica, Universidad Complutense, Spain.* We reinterpret the operation of wavefront sensors as a simultaneous unsharp measurement of position and momentum. Utilizing quantum tomography techniques we report the experimental characterization and 3D imaging of partially coherent vortex fields.

Metropolitan Ballroom A

Imaging Systems and Applications

IW4C • Digital Image Processing—Continued

IW4C.4 • 18:00
Enhanced Extended Depth-of-Field Microscopy via Modeling of SLM Effects on the Applied Phase Mask, Md Shohag Hossain[1], Sharon V. King[1], Chrysanthe Preza[1]; [1]*Univ. of Memphis, USA.* To represent the imaging model precisely for wavefront encoded systems, we modified our forward model to take into consideration the diffraction inefficiency of spatial light modulator response and its effect on the ideal phase mask.

IW4C.5 • 18:15
Multifractal Detrended Fluctuation Analysis Shows Promise For Brain Tumor Grading, Syed Reza[1], Randall Mays[1], Khan M. Iftekharuddin[1]; [1]*Old Dominion Univ., USA.* This work proposes a novel non-invasive method for brain tumor grading using magnetic resonance imaging (MRI). Multifractal Detrended Fluctuation Analysis (MFDFA) [1] provides features that are useful for classification (grading) of brain tumors such as High Grade (HG) or Low Grade (LG) in MRI.

Ballard Room

Laser Applications to Chemical, Security and Environmental Analysis

LW4D • New Approaches in Trace Gas Sensing—Continued

LW4D.4 • 18:00
Fast and wideband supercontinuum absorption spectroscopy in the mid-IR range, Nicolas Cezard[1], Guillaume Canat[1], Alexandre Dobroc[1], Mathieu Duhant[1], William Renard[1], Claudine Besson[1]; [1]*Office National d'Etudes et Recherches Aerospatiales, France.* We report on our new test bench dedicated to Supercontinuum Absorption Spectroscopy in the mid-infrared (3.3 µm). It delivers fast (<0.1 s) and wideband spectra (200 nm) at 0.8 cm-1 resolution. Gas concentrations are retrieved using a DOAS-inspired algorithm.

LW4D.5 • 18:15 Invited
Nested Cavity Optical Parametric Oscillator (NesCOPO) - A unique approach for gas sensing, Michel Lefebvre[1], Hélène Coudert-Alteirac[1], Quentin Clement[1], Dominique Mammez[1], Myriam Raybaut[1], Jean-Baptiste Dherbecourt[1], Jean-Michel Melkonian[1], Antoine Godard[1], Guillaume Aoust[1], Jessiace Barrientos Barria[1]; [1]*ONERA, France.* Gas sensing applications have promoted huge developments of tunable lasers in the mid-infrared. This presentation will brighten the high potential of NesCOPO devices both for local photoacoustic spectroscopy and for remote detection using lidar instruments.

LW4D.6 • 18:45
Quantitative measurement of the volatile anesthetic agents and respiratory gases during anesthesia by a compact, robust and mobile sensor based on linear Raman scattering, Sebastian Schlueter[1,2], Frederick Krischke[4], Nadejda Popovska-Leipertz[2], Thomas Seeger[1,3], Georg Breuer[4], Christian Jeleazcov[4], Jürgen Schüttler[4], Alfred Leipertz[1,5]; [1]*Erlangen Graduate School in Advanced Optical Technologies, Univ. of Erlangen-Nuremberg, Germany;* [2]*Esytec GmbH, Germany;* [3]*Inst. of Engineering Thermodynamics, Univ. of Siegen, Germany;* [4]*Dept.of Anaesthesiology and Intensive Care,, Univ. of Erlangen-Nuremberg, Germany;* [5]*Inst. of Engineering Thermodynamics, Univ. of Erlangen-Nuremberg, Germany.* This study presents a fully functional optical sensor for anesthetic agents based on spontaneous Raman scattering which offers several advantages in comparison to established systems. The system performance is compared to a conventional monitoring system.

07:30–18:00 Registration, *Metropolitan Ballroom Foyer*

09:00–10:00
ATh1A • Awesome Optical Materials
Presider: Joe Dallas, AVO Photonics, Inc., USA

ATh1A.1 • 9:00 Invited
Motion-less Adaptive Optical Systems Based on Liquid Crystals: From fundamentals to mobile applications, Tigran V. Galstian[1,2], Karen Asatryan[2], Peter Clark[2]; [1]*Physics, Universite Laval, Canada;* [2]*Research and Development, Lensvector, USA.* Miniaturization of optical cameras tightens the manufacturing and operation tolerances and increases the complexity of integration of mechanically moving elements for auto focus, image stabilization and zoom. Liquid crystals enable those functions without mechanical movements.

08:00–10:00
DTh1B • Metrology and Profilometry
Presider: TBD

DTh1B.1 • 08:00 Invited
Measuring phase derivatives in digital holographic interferometry, G Rajshekhar[2], Pramod K. Rastogi[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland;* [2]*Electrical and Computer Engineering, Univ. of Illinois,Urbana-Champaign, USA.* We discuss pseudo Wigner-Ville distribution based phase derivative estimation techniques in digital holographic interferometry. These techniques address the major challenges associated with measuring phase derivatives, and have great potential in non-destructive testing and precision metrology.

DTh1B.2 • 08:30
Wide-field diffraction phase microscope for precision metrology, G Rajshekhar[1], Basanta Bhaduri[1], Chris Edwards[2], Renjie Zhou[2], Lynford Goddard[2], Gabriel Popescu[1]; [1]*Quantitative Light Imaging Laboratory, Dept.of Electrical and Computer Engineering, Beckman Inst. for Advanced Science and Technology, Univ. of Illinois,Urbana-Champaign, USA;* [2]*Photonic Systems Laboratory, Dept.of Electrical and Computer Engineering, Micro and Nanotechnology Laboratory, Univ. of Illinois at Urbana-Champaign, USA.* We demonstrate a wide-field diffraction phase microscope for large field of view quantitative phase imaging. The instrument provides an extremely stable, single-shot, full-field and robust imaging modality for nanoscale metrology and SLM characterization.

DTh1B.3 • 08:45
Holographic Behavior in Ultrashort Pulse-pair 2d-Velocimetry, David J. Erskine[1], Raymond F. Smith[1], Suzanne Ali[1], Peter M. Celliers[1], Cynthia A. Bolme[2,1]; [1]*Lawrence Livermore National Laboratory, USA;* [2]*Los Alamos Nat Lab, USA.* Two-dimensional velocity interferograms of shocked silicon surface illuminated by a pair of 3ps pulses separated by 260 ps can be treated as holograms to numerically refocus narrow cracks otherwise blurred in ordinary image.

DTh1B.4 • 09:00
Velocity Filtering Method for Moving Particles Based on Doppler Phase-Shifting Digital Holography, Daisuke Barada[1], Nao Ninomiya[1], Shigeo Kawata[1], Toyohiko Yatagai[1]; [1]*Utsunomiya Univ., Japan.* The velocity filtering is achieved utilizing the beat frequency dependence of particle velocity. The principle of the velocity filtering is numerically verified. This method confirmed a spherical wave with a certain velocity can be extracted.

DTh1B.5 • 09:15
High-Accuracy Shape Measurement for Moving Objects by One-Shot Digital Holography, Kunihiro Sato[1]; [1]*Univ. of Hyogo, Japan.* A technology is developed for shape measurement of moving objects by one-shot digital holography. The method is based on calculation of depth from focus. Accuracy better than 0.0001 is obtained in the measurement of depth.

08:00–09:45
JTh1C • Joint Session with DH
Presider: Stephen Lipson, Technion Israel Institute of Technology, Israel

JTh1C.1 • 08:00 Invited
Precise Intensity Modulation in 3D Dynamic Holographic Display, Xin Li[1], Juan Liu[1], Zhao Zhang[1], Jia Jia[1], Yijie Pan[1], Yongtian Wang[1]; [1]*Beijing Inst. of Technology, China.* The intensity of 3D image is modulated precisely in holographic 3D display by complex amplitude modulation and non-uniform sampling. Simulated and experimental results show the image quality is improved noticeably.

JTh1C.2 • 08:30
Reflection- type three-dimensional screen, Byoungsub Song[1], Hyunsik Sung[1], Sung-Wook Min[1]; [1]*Information Display, Kyung Hee Univ., Korea.* Two kinds of reflection-type three-dimensional (3D) screens are analyzed how to improve 3D image visibility. In the projection-type integral imaging, the 3D screen using retroreflector is applied and compared with that using mirror.

JTh1C.3 • 08:45
Two-step phase shifting interferometry based in two coupled Sagnac interferometers, Luis García Lechuga[1], Noel-Ivan Toto-Arellano[1], Belen Lopez-Ortiz[1], Victor-Hugo Flores-Muñoz[2], Juan Carlos Seck-Tuoh-Mora[3], Gustavo Rodríguez Zurita[4], Juan Carlos González-Islas[1]; [1]*Electromecanica Industrial, Univ. Tecnológica de Tulancingo, Mexico;* [2]*Centro de Investigaciones en Óptica, A.C., Mexico;* [3]*Universidad Autónoma del Estado de Hidalgo, Mexico;* [4]*Benemérita Universidad Autónoma de Puebla, Mexico.* In this work, we present a two-step phase shifting interferometer based on two-coupled interferometers. The system generates two-interferograms, we analyzed the cases of four-pattern captured in two steps; the results obtained for transparent samples are presented.

JTh1C.4 • 09:00
Phase profile analysis of phase objects through the use of a common path interferometer based on a one beam splitter configuration, Luis García Lechuga[1], Jonathan Martínez Lozano[1], Belen Lopez-Ortiz[1], Victor Flores-Muñoz[2], Noel-Ivan Toto-Arellano[1], Juan Carlos Seck-Tuoh-Mora[3], Juan Carlos González-Islas[1], Gustavo Rodríguez Zurita[4]; [1]*Universidad Tecnológica de Tulancingo, Mexico;* [2]*Centro de Investigaciones en Óptica, A.C., Mexico;* [3]*Universidad Autónoma del Estado de Hidalgo, Mexico;* [4]*Benemérita Universidad Autónoma de Puebla, Mexico.* In this research we implemented a common-path interferometer based on polarization phase shifting and grating interferometry techniques in order to retrieve the phase data of the object in a single capture.Experimental results are also given.

JTh1C.5 • 09:15
Integration for Phase Retrieving by Quantitative Differential Interference Contrast Microscopy, Sheng-Kang Yu[1,2], Shih-Chieh Lin[1], Carol J. Cogswell[2]; [1]*Dept.of Power Mechanical Engineering, National Tsing Hua Univ., Taiwan;* [2]*Dept.of Electrical, Computer, and Energy Engineering, Univ. of Colorado Boulder, USA.* A quantitative differential interference contrast technique is adopted for measuring object thickness or refractive index. We propose a modified integration method to improve measurement and to reduce effects of noise on reconstructing phase from gradient.

Issaquah A & B

Applied Industrial Optics: Spectroscopy, Imaging, and Metrology

ATh1A • Awesome Optical Materials—Continued

ATh1A.2 • 09:30 Invited
Tailoring Metallic Nanostructures for Surface-Enhanced Spectroscopy, Alexandre Brolo[1]; [1]*Univ. of Victoria, Canada.* Abstract not available.

Ravenna A,B & C

Digital Holography & 3-D Imaging

DTh1B • Metrology and Profilometry—Continued

DTh1B.6 • 09:30
Multi-scale digital holographic interferometry for studying a thermoacoustic resonator, Pascal Picart[1], Mathieu Leclercq[1], Thibault Wassereau[1], Guillaume Penelet[1]; [1]*LAUM CNRS Université du Maine, France.* This paper proposes a digital holographic set-up with two wavelengths and two image sensors, having different acquisition frame rates, to characterize the acoustic auto-oscillations generated in a standing-wave thermo-acoustic generator.

DTh1B.7 • 09:45
Application of two-frequency method to optical frequency comb profilometry for a long-depth object measurement, Quang Pham[1], Yoshio Hayasaki[1]; [1]*Utsunomiya Univ. CORE, Japan.* Using two-frequency method, a profilometer composed of an ultra-stabilized mode-locked frequency comb laser and a single pixel camera based on compressive sensing technique was demonstrated to measure profile of a more than 1 meter object.

Metropolitan Ballroom A

Joint DH / IS

JTh1C • Joint Session with DH—Continued

JTh1C.6 • 09:30
Interferometric Localization Microscopy, Amihai Meiri[1], Rajesh Menon[1], Zeev Zalevsky[2]; [1]*Univ. of Utah, USA;* [2]*Bar-Llan Univ., Israel.* Interference of signal in Fourier space, emitted from single probes, is used to localize it by recording and computing the phase of the fringes. Such system has applications in super resolution localization microscopy.

10:00–10:30 Coffee Break and Exhibit Hall, *Metropolitan Ballroom B*

NOTES

Issaquah A & B

Applied Industrial Optics: Spectroscopy, Imaging, and Metrology

10:30–12:00
ATh2A • Mathematics in Action
Presider: Arlene Smith; Univ. of Michigan, USA

ATh2A.1 • 10:30 Invited
Multivariate Analysis of Vibrational Spectra in Industrial Research, Douglas L. Elmore[1]; [1]*Corporate Research Analytical Labs, 3M, USA.* Interpreting large and complex data sets in relatively short periods of time is a significant challenge in vibrational spectroscopy. We will show some of the multivariate analysis approaches that our lab uses to manage this problem in the context of industrial research.

ATh2A.2 • 11:00 Invited
Fourier Ptychographic Microscopy: Large Field-of-View and High Resolution Microscopy Imaging, Changhuei Yang[1]; [1]*EE, BE, MedE, California Inst. of Technology, USA.* Fourier Ptychographic Microscopy enables a microscope to push past its physical limitations to provide gigapixel imaging capability and outperform the best available microscope. It is a novel computational approach for high-throughput microscopy imaging.

ATh2A.3 • 11:30 Invited
Fourier ptychography (FP): a computational framework for high-resolution, high-throughput imaging, Guoan Zheng[1]; [1]*Univ. of Connecticut, USA.* Fourier ptychography is recently developed computational approach for high-resolution, high-throughput imaging. In this talk, we will report our recent developments of the FP approach for gigapixel microscopy, phase imaging, 3D imaging, spectrum-multiplexing, and super-resolution imaging.

Ravenna A,B & C

Digital Holography & 3-D Imaging

10:30–12:30
DTh2B • Holography and Diffraction
Presider: Hoonjong Kang; Korea Electronics Technology Inst., South Korea

DTh2B.1 • 10:30
Phase Imaging with X-ray Digital Holography and Compressive Sensing Approach, Shakil Rehman[1], Yubo Duan[1], Wensheng Chen[1], Kiyofumi Matsuda[2], George Barbastathis[3,4]; [1]*BioSym/CENSAM, Singapore-MIT Alliance for Research and Technology, Singapore;* [2]*National Inst. of Advanced Industrial Science and Technology (AIST), Japan;* [3]*Mechanical Engineering, MIT, USA;* [4]*Univ. of Michigan-Shanghai Jiao Tong Univ. Joint Inst., China.* Digital holographic method is used to record X-ray inline holograms and a numerical reconstruction method is proposed to reconstruct such holograms with compressive sensing approach.

DTh2B.2 • 10:45
Continuous-wave Terahertz Digital Holography on Biological Specimen, Lu Rong[1], Dayong Wang[1], Tatiana Latychevskaia[2], Xun Zhou[3], Yunxin Wang[1]; [1]*Collge of Applied Sciences, Beijing Univ. of Technology, China;* [2]*Physics Inst., Univ. of Zurich, Switzerland;* [3]*Reserach Center of Laser Fusion, CAEP, China.* We report here terahertz digital holography on biological specimen. In-line holograms were recorded with terahertz waves of 118.83 μm. Absorption and phase distributions were reconstructed from extrapolated hologram resolving features of 35 μm in size.

DTh2B.3 • 11:00
Phase Retrieval for Terahertz Digital Holography, Dayong Wang[1], Lu Rong[1], Xun Zhou[2], Tatiana Latychevskaia[3], Yunxin Wang[1]; [1]*Beijing Univ. of Technology, China;* [2]*Reserach Center of Laser Fusion, CAEP, China;* [3]*Physics Inst., Univ. of Zurich, Switzerland.* Pre-reconstruction protocol and phase retrieval algorithm are proposed for continuous-wave Terahertz in-line digital holography. Experimental results demonstrated the feasibility of the proposed method to obtain both amplitude and phase-shifting distributions of opaque objects.

DTh2B.4 • 11:15
Computer Generated Holographic Dual Storage Concept for Long Term Data Archiving, Christophe Martinez[1], Fabien Laulagnet[1], Frederic Petit[2], Philippe Carre[2], Pascal Boulitreau[3], Nathaniel Oving[3]; [1]*DOPT/SCOOP, CEA-LETI, France;* [2]*XLIM SIC, CNRS Poitiers Univ., France;* [3]*Arnano, France.* Complementary CGH is used to embed a digital compressed version of a raw image in the micro-pattern halftone structure of the image microform. Impact on image quality recovery is evaluated.

DTh2B.5 • 11:30
Design and demonstration of diffractive fan-out elements generating an array of sub-diffraction-limit spots, Yusuke Ogura[1], Masahiko Aino[1], Jun Tanida[1]; [1]*Graduate School of Information Science and Technology, Osaka Univ., Japan.* This paper reports on diffractive fan-out elements that generate an array of sub-diffraction-limit spots. We construct a new iterative algorithm to design the elements and demonstrate generation of various arrangements of small spots.

DTh2B.6 • 11:45
Three-dimensional Profilometry Using Active Laser Array and Binocular Camera, Shengbin Wei[1], Changhe Zhou[1], Shaoqing Wang[1], Kun Liu[1]; [1]*Labof Information Optics and Optoelectronics Techniques, SIOM, China.* A 3D measurement method using a grating which generates square laser array is proposed. A new method for stereo matching is proposed and verified by experiments.

Metropolitan Ballroom A

Imaging Systems and Applications

10:30–12:00
ITh2C • Computational Optics and Image Processing
Presider: K. Vijayan Asari, Univ. of Dayton, USA

ITh2C.1 • 10:30 Invited
Title to Be Determined, Arun Ross[1]; [1]*Michigan State Univ., USA.* Abstract not available.

ITh2C.2 • 11:00 Invited
Remotely Acquired Human Signatures for Tactical Biometrics and Medical Diagnosis, Kevin Leonard, Keith K. Krapels, Jide Familoni; *US Army Night Vision and Electronic Sensors Directorate, USA.* The Modeling and Simulation Division at the U.S. Army's RDECOM CERDEC Night Vision Electronic Sensors Directorate (NVESD) is exploring ways to exploit human signatures for both tactical and medical applications. The current operating environment that the Army faces is characterized by uncertainty and surprise, with threats coming from increasingly non-traditional sources. Tactically relevant biometrics needs to be conducted at longer ranges, at night, and in degraded environments. In this work we discuss some of the challenges and potential solutions to conducting human identification and recognition in non-ideal conditions. In addition, the asymmetric nature of warfare has also led to a need for novel medical diagnostic tools. We discuss ways that EO/IR sensors could be used for remote triage and in the diagnosis and treatment of mTBI and PTSD. The ultimate goal of our work is to look at novel applications that utilize existing sensors in order to provide our Soldiers with the tools they need to best accomplish their mission, and when home, have the best medical care possible.

ITh2C.3 • 11:30 Invited
Design of Superior Lenses Assuming 4D Light Field Capture and Processing, Ren Ng[1]; [1]*Lytro, Inc., USA.* This talk will demonstrate how 4D light field imaging enables the design of new, superior lenses by counting on computational correction of aberrated light ray trajectories in post processing.

Applied Industrial Optics: Spectroscopy, Imaging, and Metrology

Digital Holography & 3-D Imaging

Imaging Systems and Applications

DTh2B • Holography and Diffraction—Continued

DTh2B.7 • 12:00
Wide-field, Non-mechanical Beam Steering with Space-Variant Wavefront Correction, Abbie T. Watnik[1], James R. Lindle[1], Vincent A. Cassella[1]; [1]*US Naval Research Laboratory, USA.* Parallel Stochastic Gradient Search optimization is used to optimize and improve degraded beam quality in a holographic beam steering experiment for various steering angles.

DTh2B.8 • 12:15
Near-field Fresnel Reconstruction of Digital Holograms, Logan Williams[1], Georges Nehmetallah[2], Rola Aylo[3], Partha P. Banerjee[1]; [1]*Electro-Optics, Univ. of Dayton, USA;* [2]*Electrical Engineering and Computer Science, Catholic Univ. of America, USA;* [3]*Electrona Engineering LLC, USA.* Fresnel transform implementation methods are explored which dramatically reduce the minimum reconstruction distance requirements and allow maximal signal recovery with numerically improved resolution scaling at any distance. Methods are illustrated using experimental results.

ITh2C • Computational Optics and Image Processing—Continued

ITh2C.4 • 12:00 Invited
Seeing Is Believing, Matthew Siegal[1]; [1]*Cinematographer, USA.* News Flash: Palm-sized digital still cameras shoot big time 4K motion pictures! Yes, it is true, and we are paying $12.00 a ticket to see the resulting images at our local movie theater. The motion picture industry is at a point where digital cinema cameras of all shapes and sizes achieve incredible low light sensitivity and excellent skin tone reproduction, while benefiting from vastly improved dynamic range. Seeing is Believing, a short 30 min multi-media presentation, focuses on the applied use of these digital cameras (big and small), along with their remarkable sensor technology and cinema lenses for motion picture production. In the context of making movies, the presentation introduces and explains the industry standards for camera ergonomics, imager size, resolution and ISO. Using a high-end digital cinema camera alongside a pint sized 4K still camera the audience will be taken through the daily considerations of cinematographers and professional image makers.

12:30–14:00 Lunch, *On Your Own*

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Digital Holography & 3-D Imaging

14:00–16:00
DTh3B • Digital Holographic Optical Processing
Presider: Marc Georges; Universite de Liege, Belgium

DTh3B.1 • 14:00
Color holographic wave-front printing method based on partitioned elemental hologram, Hoonjong Kang[1], Youngmin Kim[1], Joosup Park[1], Elena Stoykova[1,2], Sunghee Hong[1]; [1]*1Digital Holography Research Team, Korea Electronics Technology Inst., Korea;* [2]*2Inst. of Optical Materials and Technologies, Bulgarian Academy of Sciences, Bulgaria.* A color holographic wave-front printing method which used sub-partitioning of each elemental hologram in the holographic plane is proposed to make color fringe pattern. By this method, a printed hologram can provide a better color hologram without color mosaic pattern.

DTh3B.2 • 14:15
Full Color White Light Transmission Hologram by Monochromatic Recording, Dinesh Padiyar[1], Stephen Hart[2], Joy Padiyar[1], Daniel Burman[2]; [1]*Triple Take Holographics, USA;* [2]*Holorad, USA.* We have created full color holograms recorded monochromatically and reconstructed with a white light source in transmission using dichroics. Three holograms are individually recorded with RGB data and interleaved with dichroic filters as a stack.

DTh3B.3 • 14:30
Suppression of daytime sky light in artificial satellite detection using volume hologram filters, Zhi Chen[1,2], Hanhong Gao[3], George Barbastathis[2,4]; [1]*Dept.of Biomedical Engineering, National Univ. of Singapore, Singapore;* [2]*Singapore-MIT Alliance for Research and Technology, Singapore;* [3]*Dept.of Electrical Engineering and Computer Science, MIT, USA;* [4]*Dept.of Mechanical Engineering, MIT, USA.* We design an experiment of using volume hologram filters with telephoto objectives to detect solar-illuminated artificial satellite under strong daylight background noise. Results verify the suppression of background noise and enhancement in overall signal-to-noise ratio(SNR).

DTh3B.4 • 14:45
Time-resolved digital holographic imaging of two interacting filaments in sapphire, Nerijus Šiaulys[1], Audrius Dubietis[1], Andrius Melninkaitis[1]; [1]*Laser Research Center, Vilnius Univ., Lithuania.* Induced refractive index changes and nonlinear interaction between two parallel femtosecond filaments in sapphire is studied in situ by means of time-resolved digital holographic microscopy.

DTh3B.5 • 15:00
Visual measurement of pulse laser ablation process by use of digital holographic interferometry, Jianlin Zhao[1]; [1]*Northwestern Polytechnical Univ., China.* We introduce digital holographic interferometry (DHI) to the visual and quantitative measurement of the ablation process induced by pulsed paler. Two different approaches and the corresponding experimental results will be presented in this paper.

DTh3B.6 • 15:15
Resolution enhancement in synthetic aperture digital holographic microscopy, Xin-Ji Lai[1], Chau-Jern Cheng[1], Han-Yen Tu[2], Li-Chien Lin[3]; [1]*Inst. of Electro-Optical Science, National Taiwan Normal Univ., Taiwan;* [2]*Dept.of Electrical Engineering, Chinese Culture Univ., Taiwan;* [3]*Dept.of Communications Engineering, Feng Chia Univ., Taiwan.* This study presents a resolution enhancement technique in synthetic aperture digital holographic microscopy based on nonlinear scanning mechanism. Experimental results show the frequency coverage and phase sensitivity of the synthesized reconstructed image are improved simultaneously.

DTh3B.7 • 15:30
Hyperspectral Holographic Fourier-Microscopy, Georgy Kalenkov[1], Sergey Kalenkov[2], Alexander Shtanko[3]; [1]*Moscow Inst. of Physics and Technology, Russia;* [2]*Univ. of mechanical engineering (MAMI), Russia;* [3]*Moscow State Univ. of Technology (Stankin), Russia.* New lens free holographic image acquisition method in polychromatic, unpolarized light is presented. Hyperspectral amplitude and average-phase profile images of standard microscope samples obtained experimentally are presented, speckle noise reduction is discussed.

DTh3B.8 • 15:45
Full-field Angle-deviation Optical Microscope with Reflectivity-Height Transformation, Ming-Hung Chiu[1], Chen-Tai Tan[1], Ming-Hung Tsai[1], Ya-Hsin Yang[1]; [1]*Electro-Optical Engineering, National Formosa Univ., Taiwan.* This full-field three-dimensional (3D) optical microscope is based on the reflectivity-height transformation. Using a parallelogram prism and two CCDs to detect the reflectivity at the critical angle nearby can achieve the angle deviation and surface height.

16:00–17:00 Exhibit Hall & Coffee Break,
Metropolitan Ballroom B

17:00–19:00
DTh4B • Novel Applications of Digital Holography
Presider: Changhe Zhou; Shanghai Inst of Optics and Fine Mech, China

DTh4B.1 • 17:00
Size measurement of nanostructure using digital super-resolution interference microscopy, Shinji Ishikawa[1], Yoshio Hayasaki[1]; [1]*Utsunomiya Univ., Japan*. We demonstrate a super-resolved imaging based on a complex-amplitude pattern matching method. The accuracy in a size measurement of a nanostructured object is estimated by a computer simulation.

DTh4B.2 • 17:15
An Iterative Algorithm for Improving Resolution and Signal-to-Noise Ratio of Captured Noisy Low-Resolution Diffraction Fields, Gokhan B. Esmer[1]; [1]*Dept.of Electrical and Electronics Engineering, Marmara Univ., Turkey.* An iterative super-resolution algorithm, based on capturing multiple noisy low-resolution diffraction fields, is proposed. It performs windowing on the reconstructed object to improve resolution and decrease noise level on captured fields. It provides satisfactory results.

DTh4B.3 • 17:30
Analytical brightness compensation algorithm for traditional polygon-based method, Yijie Pan[1,2], Yongtian Wang[1], Juan Liu[1], Xin Li[1], Jia Jia[3], Zhao Zhang[1]; [1]*Beijing Engineering Research Center for Mixed Reality and Advanced Display, School of Optoelectronics, Beijing Inst. of Technology, China;* [2]*Bradley Dept.of Electrical and Computer Engineering, Virginia Tech, USA;* [3]*State Key Labof Precision Measurement Technology and Instruments, Tsinghua Univ., China*. An analytical brightness compensation method is proposed for the traditional polygon-based method, where a flat power spectral density and the paraxial approximation were used. The proposed method separates the brightness compensation from the fabrication process.

DTh4B.4 • 17:45
Withdrawn

DTh4B.5 • 18:00
Simultaneous measure of refractive integral index and nexine thickness of a pollen grain by digital holographic microscopy, Freddy A. Monroy Ramirez[1]; [1]*Universidad Nacional de Colombia, Colombia.* we have implemented a decoupling method to obtain simultaneously measures of integral refractive index and size of a pollen grain membrane with spherical symmetry by microscopy digital holography (MHD) techniques

DTh4B.6 • 18:15
Phase-space Measurement for Depth Estimation and Image Recovery through Scattering Media, Kevin Takasaki[1], Jason W. Fleischer[1]; [1]*Electrical Engineering, Princeton Univ., USA.* We use windowed Fourier transforms (spatial spectrograms) to image objects obscured by a thin scattering layer. Such phase-space methods can improve the resolution of the recovered object and allow for estimation of source depth.

DTh4B.7 • 18:30
Suppression of Speckle Noise with Spatial Light Modulator in Digital Holography, Yunxin Wang[1], Dayong Wang[1], Lu Rong[1], Yuhong Wan[1]; [1]*Beijing Univ. of Technology, China*. A speckle noise suppression method based on spatial light modulator is proposed by angular diversity. The influence of experimental parameters on the minimal angular difference is analyzed, and experimental results demonstrate its effectiveness and practicability.

DTh4B.8 • 18:45
Vibration Analysis By Speckle Interferometry With CO2 Lasers And Microbolometers Arrays, Jean-François Vandenrijt[1], Cédric Thizy[1], Marc P. Georges[1]; [1]*Centre Spatial de Liege, Universite de Liege, Belgium*. Speckle interferometry in the time-average mode at long infrared wavelengths is shown for observing the mode shapes of vibrating objects. The long wavelength allows observing larger vibration displacements than what is achieved with visible wavelengths.

Key to Authors and Presiders

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