

**SPIE.** OPTICAL  
METROLOGY

**SPIE.** DIGITAL OPTICAL  
TECHNOLOGIES

# OPTICAL METROLOGY

The latest research in measurement systems, modeling,  
videometrics, and inspection.

and

# DIGITAL OPTICAL TECHNOLOGIES

A conference focused on the components, systems design,  
and applications of emerging digital optical technologies.

## Co-located Events

**24-27 June 2019**

Internationales Congress Center  
Munich, Germany

**JUNE 23-27, 2019, MESSE MÜNCHEN**

24th International Congress on Photonics in Europe—  
collocated with LASER World of PHOTONICS 2019

**WORLD OF PHOTONICS CONGRESS** 

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SPIE is pleased to offer two technical meetings and three courses in Munich. We look forward to an exciting week of sharing, networking, and learning.

24-27 June 2019 · Internationales Congress Center, Munich, Germany

## **SPIE.** OPTICAL METROLOGY

The premier European conference to meet with scientists, engineers, researchers, and product developers to discuss the latest research in measurement systems, modeling, videometrics, and inspection.

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**WT** **LiM** 2019

## **SPIE.** DIGITAL OPTICAL TECHNOLOGIES

A conference focused on the components, systems design, and applications of emerging digital optical technologies in all social, academic, medical, and industrial areas.

The conference reflects trends in recent technologies such as 3D sensors, immersive multimedia, novel displays, light sources and imaging systems. Digital optical technologies include optics designed by digital means, fabricated by digital means, with functionalities enhanced or altered by digital techniques (computational optics or dynamic optics).

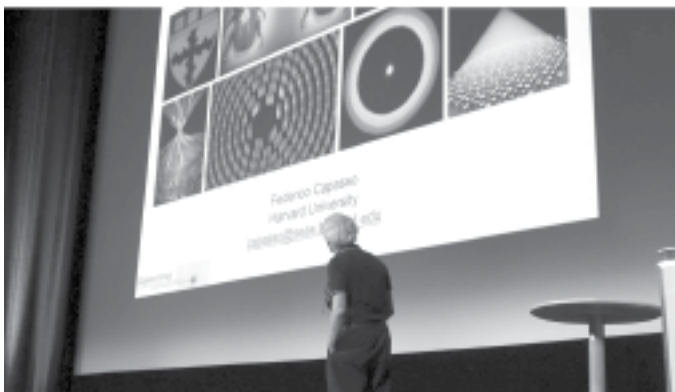
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In addition to providing membership services, SPIE Europe Ltd. organises and manages internationally recognised conferences, education programmes, and technical exhibitions featuring emerging technologies in optics and photonics.

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### SPIE OPTICAL METROLOGY TECHNICAL CONFERENCES

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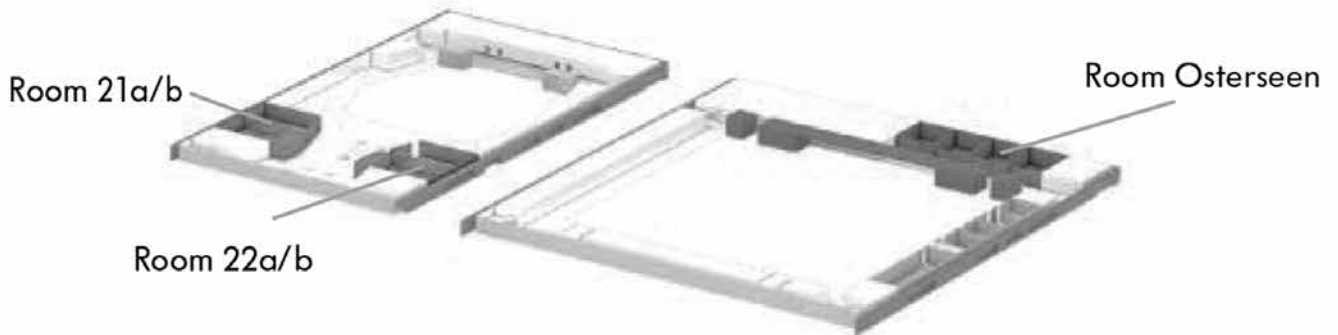
**EOS** OPTICAL  
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**2019**

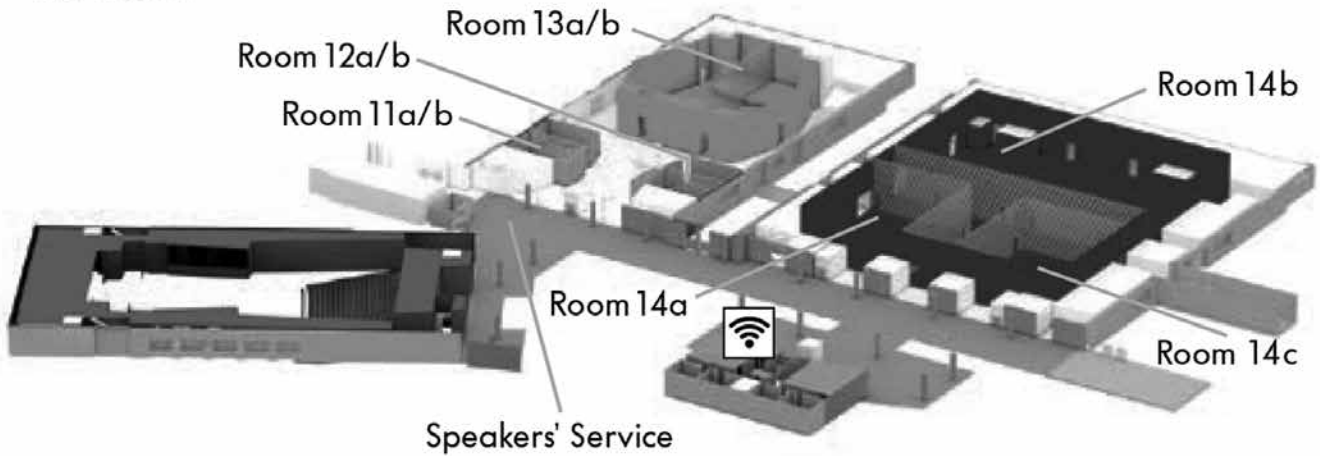
# INTERNATIONALES CONGRESS CENTER FLOOR PLANS

## ROOMS AT THE ICM AND B0

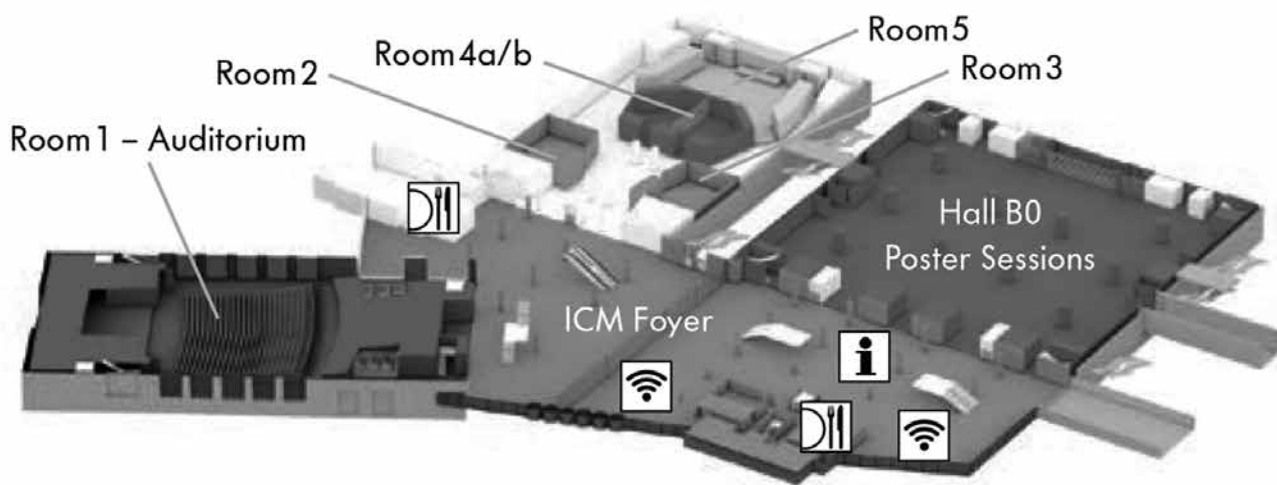
### 2nd Floor



### 1st Floor

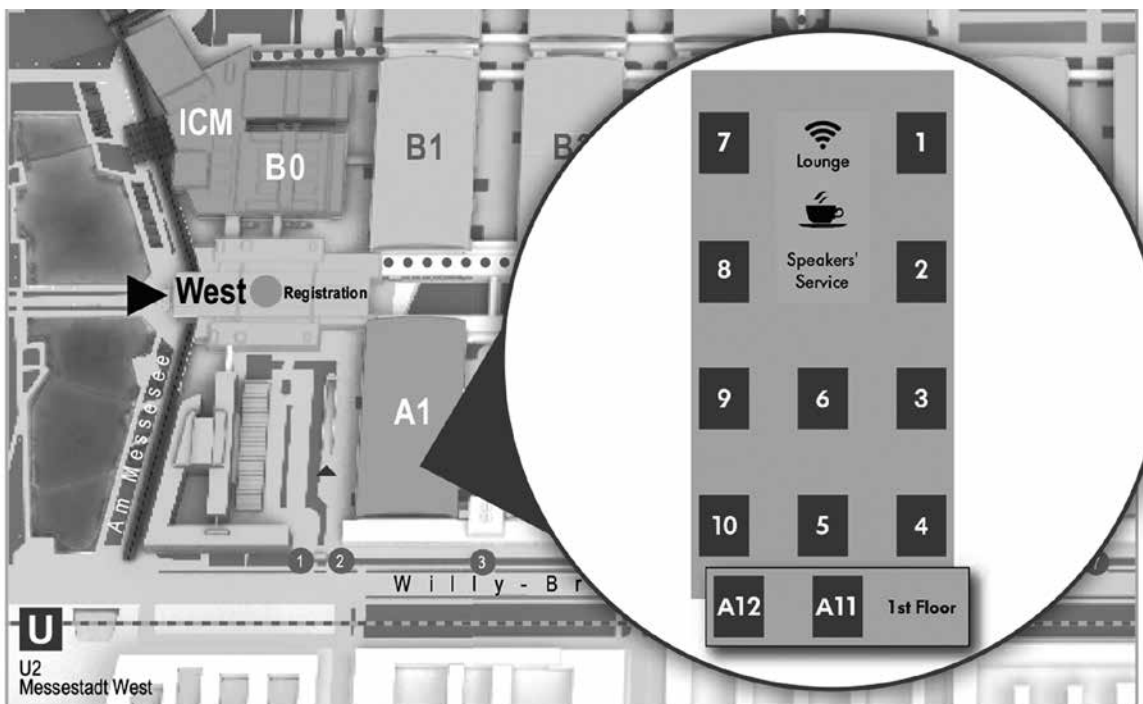


### Ground Floor

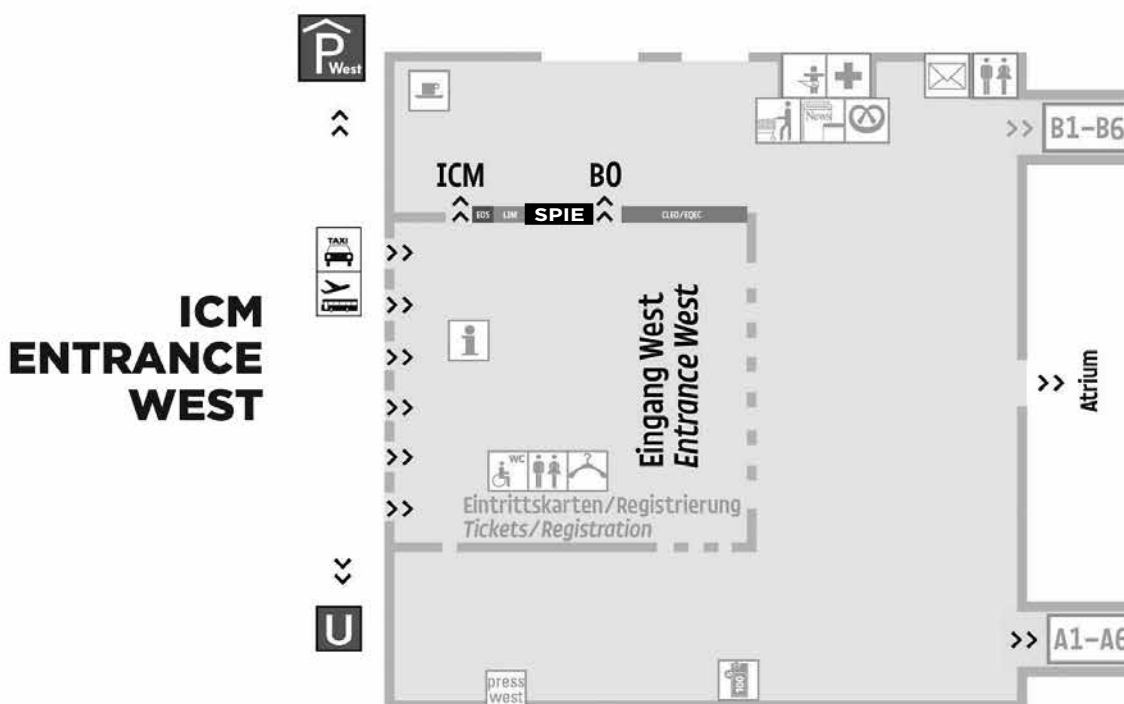




# ROOMS AT THE EXHIBITION HALL A1



- |          |   |            |  |
|----------|---|------------|--|
| <b>1</b> | Room 1 <b>"Albert Einstein"</b> , Ground Floor, Hall A1 | <b>7</b>   | Room 7 <b>"Dennis Gábor"</b> , Ground Floor, Hall A1     |
| <b>2</b> | Room 2 <b>"Emmy Noether"</b> , Ground Floor, Hall A1    | <b>8</b>   | Room 8 <b>"Gustav Hertz"</b> , Ground Floor, Hall A1     |
| <b>3</b> | Room 3 <b>"Theodore Maiman"</b> , Ground Floor, Hall A1 | <b>9</b>   | Room 9 <b>"Arthur Schawlow"</b> , Ground Floor, Hall A1  |
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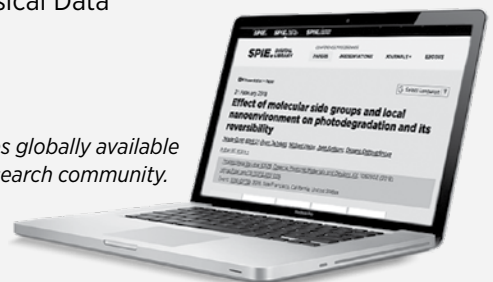
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# DAILY EVENT SCHEDULE

Sunday 23 June      Monday 24 June      Tuesday 25 June      Wednesday 26 June      Thursday 27 June

OPTICAL METROLOGY CONFERENCES	
Conf. 11056: <b>Optical Measurement Systems for Industrial Inspection</b> ( <i>Lehmann</i> ), p. 13	
Conf. 11057: <b>Modeling Aspects in Optical Metrology</b> ( <i>Bodermann</i> ), p. 20	
Conf. 11058: <b>O3A: Optics for Arts, Architecture, and Archaeology</b> ( <i>Liang, Groves</i> ), p. 24	
	Conf. 11059: <b>Multimodal Sensing and Artificial Intelligence: Technologies and Applications</b> ( <i>Stella</i> ), p. 28
Conf. 11060: <b>Optical Methods for Inspection, Characterization and Imaging of Biomaterials</b> ( <i>Ferraro, Grilli, Ritsch-Martel, Hitzenberger</i> ), p. 31	Conf. 11061: <b>Automated Visual Inspection and Machine Vision</b> ( <i>Beyerer, Puente León</i> ), p. 35

DIGITAL OPTICAL TECHNOLOGIES CONFERENCE
Conf. 11062 <b>Digital Optical Technologies II</b> ( <i>Kress, Schelkens</i> ), p. 45

COURSES
SC1218 <b>Optical Technologies and Architectures for Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) Head-Mounted Displays (HMDs)</b> ( <i>Kress</i> ), 8:30 to 12:30, p. 9
SC1217 <b>Design, Modeling and Fabrication Techniques for Micro-Optics: Applications to Display, Imaging, Sensing and Metrology</b> ( <i>Kress</i> ), 13:30 to 17:30, p. 10
SC1275 <b>An Introduction to Deep Learning</b> ( <i>Kruithof</i> ), 13:30 to 17:30, p. 11
Register for these courses separately.

SPECIAL EVENTS			
<i>World of Photonics Congress-wide Plenary Session: Listening to the universe with gravitational waves</i> ( <i>Danzmann</i> ), 10:00 to 11:00, p. 6	<b>Poster Session 1: Optical Metrology, Conf. 11060</b> , 12:10 to 12:40; <b>Conf. 11058</b> , 12:30 to 13:10; <b>Conf. 11056</b> , 13:00 to 14:20, p. 8	<i>Optical Metrology Plenary Session: Towards a complete framework for calibration of optical surface and coordinate measuring instruments</i> ( <i>Leach</i> ), 10:40 to 11:25, p. 7	<b>Poster Session 3: Optical Metrology, Conf. 11061</b> , 11:40 to 12:40, p. 8
<b>Students and SPIE Fellows Luncheon</b> , 12:30 - 14:00, p. 8		<b>Poster Session 2: Optical Metrology, Conf. 11057 and Conf. 11059</b> , 11:30 to 12:40; <b>Digital Optical Technologies, Conf. 11062</b> , 13:00 to 14:00, p. 8	
<i>Digital Optical Technologies Plenary Session: Light field image processing: overview and research problems</i> ( <i>Guillemot</i> ), 13:15 to 14:00, p. 6		<b>Optical Metrology and Digital Optical Technologies Welcome Reception</b> , 19:00 - 21:30, p. 8	
<i>World of Photonics Congress-wide Nobel Plenary Session: Passion for Extreme Light</i> ( <i>Mourou</i> ), 18:10 to 19:00, p. 7			
<b>Bier &amp; Brezel Reception</b> , 19:00 - 21:00, p. 8			

## PLAN YOUR WEEK

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# PLENARY EVENTS

## WORLD OF PHOTONICS CONGRESS-WIDE PLENARY SESSION

Monday 24 June 2019 · 10:00 - 11:00 · Location: ICM, Saal 1

### Listening to the universe with gravitational waves



#### Karsten Danzmann

Max Planck Institute for Gravitational Physics and Leibnitz Univ. Hannover (Germany)

*Biography:* **Prof. Karsten Danzmann** is director at Max Planck Institute for Gravitational Physics (Albert Einstein Institute) and head of the division Laser Interferometry and Gravitational Wave Astronomy. He is Director of the Institute of Gravitation Physics at Leibniz Universität Hannover.

Prof. Danzmann is one of the most important scientists in the study of gravitational waves: His groundbreaking work has enabled the direct detection of gravitational waves, thus ushering in a new era of astrophysical research. For his merits he was honoured with the Edison Volta Prize of the European Physical Society and the Stern-Gerlach Medal of the German Physical Society (DPG) in 2018.

Karsten Danzmann has already been presented with the Fritz Behrens Foundation Science Prize 2016, the Lower Saxony Science Award 2016, the Körber European Science Prize 2017, and the Otto Hahn Prize 2017. As a member of the LIGO Scientific Collaboration he was awarded the Special Breakthrough Prize in Fundamental Physics, the Gruber Cosmology Prize, and the Princess of Asturias Award.

## DIGITAL OPTICAL TECHNOLOGIES PLENARY SESSION

Monday 24 June 2019 · 13:00 - 14:00

Location: Hall A1, Arthur Schawlow

13:00 to 13:15

### Welcome

**Jim M. Oschmann**, SPIE President

Ball Aerospace & Technologies Corp. (Retired), (USA)

### Welcome and Introduction

**Bernard C. Kress**, Microsoft Corp. (USA)

**Peter Schelkens**, Vrije Univ. Brussel (Belgium)

13:15 to 14:00

### Light field image processing: overview and research problems



#### Christine Guillemot

INRIA, France

Light field imaging is becoming increasingly popular thanks to recent advances in acquisition devices. By capturing light rays emitted along different directions, light fields yield a rich description of the scene, enabling post-capture processing capabilities that can be appealing for a variety of

applications. However, the huge volume of high-dimensional light field data is an obvious issue for storage, transmission but also for

fast processing. In addition, acquisition devices designed so far to capture light fields come with some technological limitations that translate into trade-offs between angular and spatial resolution. This talk will review fundamentals in light field imaging, the main capturing devices and will present fundamental problems in light field image processing.

*Biography:* **Christine Guillemot** is currently Director of Research at INRIA (Institut National de Recherche en Informatique et Automatique) in France. She holds a PhD degree from ENST (Ecole Nationale Supérieure des Telecommunications) Paris (1992). From 1985 to 1997, she has been with France Telecom working in the areas of image and video compression for multimedia and digital television. From 1990 to mid 1991, she has worked as visiting scientist at Bellcore Bell Communication research) in the USA. Her research interests are signal and image processing, and in particular 2D and 3D image and video processing for various problems (compression, super-resolution, inpainting, classification). She has co-authored 25 patents, has published 80 journal publications and 190 publications in peer reviewed international conferences. She received an ERC advanced grant for a project on computational imaging (2016-2021).

She has served in both the IEEE MMSP technical committee (2005-2008), and the IEEE IVMSM technical committee (2013-2016). She has been Associate Editor for IEEE Trans. on Image Processing (from 2000 to 2003 and from 2014 to 2016), for IEEE Trans. on Circuits and Systems for Video Technology (2004-2006), IEEE Trans. on Signal Processing (2007-2009), for the Eurasip journal on image communication (2010-2016), and member of the IEEE journal on selected topics in signal processing (2013-2016). She is currently senior area editor for IEEE Trans. on Image Processing and senior member of the steering committee of IEEE Trans. on Multimedia. She is IEEE fellow since January 2013.

## World of Photonics Congress-wide Nobel Plenary Session

Monday 24 June 2019 · 18:00 - 19:00 · Location: ICM, Saal 1

### Passion for Extreme Light



#### Gerard Mourou

École Polytechnique (France); 2018 Physics Nobel Prize Laureate

The Nobel Prize in Physics 2018 was awarded to Arthur Ashkin, Gérard Mourou and Donna Strickland. Strickland and Mourou received the award "for their method of generating high-intensity, ultra-short optical pulses".

Prof. Gérard Mourou was the founding Director of the Center for Ultrafast Optical Science at the University of Michigan. For forty

years, he has pioneered the field of ultrafast lasers and their applications in scientific, engineering and medical disciplines. He is also the initiator of the Extreme Light Infrastructure (ELI) in Europe. He is a fellow of The Optical Society and a fellow of the Institute of Electrical and Electronics Engineers and SPIE. Prof. Mourou is a member of the National Academy of Engineering. Currently he is Distinguished Professor Emeritus from the University of Michigan and the Ecole polytechnique in Palaiseau, France.

He has been the recipient of the Wood Prize from The Optical Society, the Edgerton Prize from the SPIE, the Sarnoff Prize from the IEEE, the 2004 IEEE/LEOS Quantum Electronics Award, 2005 Willis E. Lamb Award for Laser Science and Quantum Optics, the 2009 Charles Hard Townes Award, the 2016 Berthold Leibinger Zukunftspreis and the 2016 Frederic Ives Meda./Jarvis Quinn Prize.





## OPTICAL METROLOGY PLENARY SESSION

Wednesday 26 June 2019 · 10:30 - 11:25

Location: ICM, Saal 1

10:30 to 10:40

### Welcome and Awards Presentation

**Jim M. Oschmann**, SPIE President

Ball Aerospace & Technologies Corp. (Retired), (USA)

### SPIE Harold E. Edgerton Award

presented to **John Dudley**, Univ. de Franche-Comté, Besançon, France in recognition of pioneering applications of ultrashort-pulse measurement techniques in nonlinear fiber optics and specifically for studies of ultrafast self-similarity, supercontinuum generation, and novel classes of optical soliton and optical rogue waves.

### Presentation of SPIE Fellowship

to **Steffen Reichel**, Pforzheim Univ Germany

### Welcome Address and Plenary Speaker Introduction

**Marc P. Georges**, Liège Univ. (Belgium)

**Jörg Seewig**, Technische Univ. Kaiserslautern (Germany)

2019 Symposium Chairs

10:40 to 11:25

### Towards a complete framework for calibration of optical surface and coordinate measuring instruments



**Richard Leach**

University of Nottingham, United Kingdom

The optics and semiconductor manufacturing industries have well-established calibration infrastructures for optical measurements of surface geometry. These infrastructures are less developed for many precision manufacturing industries that rely on machining of complex surface geometries. Highly complex freeform geometries and textures, as found for example in the

automotive, aerospace and medical parts industries, mean that many of the established calibration techniques for optical surface measurements may not be directly relevant. In addition, with the industrial uptake of additive manufacturing techniques, the complexity of the resulting surfaces is leading to new measurement challenges.

It is commonplace in many manufacturing industries to hear users expressing alarm about the incompatibility of optical instruments with contact methods of measuring surface texture and geometry, and these concerns are often borne out in formal comparisons. In many cases, the difference between the results from optical and contact instruments can be explained after critical assessment of the measurement conditions and sample geometries, but the damage has already been done: take up of optical instruments in many manufacturing industries has been slowed.

Why the disconnect, why the lack of trust? One of the primary reasons for this disconnect with complex surfaces is the lack of a calibration framework for optical instruments, where calibration is the process of comparing a measurement result to a reference result in order to es-

tablish traceability. It is relatively simple to understand and model the physical interaction of a contact probe tip with a surface, but it is not so simple to model the equivalent optical interaction – it is a more complex physics problem.

To try to address this issue in the surface texture measurement community, a framework is being developed that attempts to simplify the problem by introducing a number of common or instrument-independent metrological characteristics – instrument parameters that can be determined with a suitable material measure and procedure, and the resulting parameter values can then be propagated through a measurement model to give an estimate of measurement uncertainty. The framework only applies if certain well-defined assumptions about the measurement scenario are adhered to, but it is a solid start and will significantly enhance the kudos of optical instruments in manufacturing industry.

In the world of optical coordinate measurement, for example with laser triangulation or fringe projection systems, there is work in the standards committees to bring optical instruments into the performance verification framework that has been developed for contact coordinate measuring systems. However, with the exception again of the optics industry, there seems to be little research into how to apply the same equivalence to calibration of such instruments – calibration of optical coordinate measuring systems is not currently being addressed in the standardisation committees but is clearly needed in manufacturing industry. In the contact coordinate measuring system world, substitution can be applied in simple cases and virtual instruments can be used in more complex measurement scenarios, but such virtual instrument models are not widely available for optical instruments nor is it completely obvious how to develop them. The presentation will discuss the philosophy and positive advances that have been made in the development of a metrological characteristics framework for surface texture measuring instruments, research work to plug the gaps in situations when the usual assumptions do not apply and will take a forward look at how the framework might be applied to optical coordinate measuring systems. As Professor Wolfgang Osten once said: “...the transfer of technologies from the laboratory to the industrial environment is often an adventure” – I hope I can present a new chapter in this adventure and give some useful hints about the content of the chapters to come.

**Biography:** Professor Richard Leach currently holds the Chair in Metrology in the Faculty of Engineering at the University of Nottingham where he has established The Manufacturing Metrology Team to investigate information-rich metrology of surfaces, to support next-generation manufacturing technologies. Drawing on concepts such as machine learning and sensor fusion, his research is changing the approach to quality control in manufacturing.

Prior to his current position, he spent 25 years at the National Physical Laboratory and led a team in surface and nanometrology. He is an internationally recognised researcher in the field of surface topography measurement, particularly in the area of traceability for areal surface metrology, including optical instruments. Richard has developed a range of instruments over his 30 years of metrology research, including both theory and practical developments. Some instruments developed include Fizeau, Michelson, Twyman-Green, homodyne and low coherence interferometers; fringe projection, photogrammetry, and contact stylus systems; and co-ordinate measuring machine probes.

He has over 400 publications, including five textbooks. He is the European Editor-in-Chief for Precision Engineering journal. He is a Fellow of the Institute of Physics, the Institution of Engineering & Technology, the Institute of Measurement & Control, the International Society of Nanomanufacturing, a Sustained Member of the American Society of Precision Engineering and a Council Member of the European Society of Precision Engineering & Nanotechnology. Richard is a visiting professor at Loughborough University and the Harbin Institute of Technology.

# SPECIAL EVENTS

## Students and SPIE Fellows Luncheon

Monday 24 June 2019 · 12:30 to 14:00

Location: Am See Restaurant, Level 1 ICM

Students: Advance sign-up required onsite; seating is limited.

Student conference attendees and SPIE Fellows are invited to this engaging networking opportunity. This event gives students an opportunity to network with SPIE Fellows who will share their insights into career paths in optics and photonics. Lunch is complimentary but students must sign up at the SPIE registration desk onsite.

## Bier & Brezel Reception

Monday 24 June 2019 · 19:00 - 21:00

Location: Main Foyer, ICM and Hall B0

SPIE invites all attendees to a Bier & Brezel reception. All registered congress attendees are welcome; please remember to wear your conference registration badges. Dress is casual.

## Optical Metrology and Digital Optical Technologies Welcome Reception

Wednesday 26 June 2019 · 19:00 - 21:30

Location: Ratskeller Muenchen, Marienplatz

All attendees are invited to relax, socialise, and enjoy light refreshments. Please remember to wear your conference registration badges. Dress is casual.



## AR VR MR Headset Demos

Tuesday 25 June 2019 · 9:00 - 17:00

Location: Hall A1, Room 10 Wilhelm Röntgen

Try out the latest virtual reality hardware (from Microsoft HoloLens, DigiLens, Dispelix, LightSpace Technologies, SCHOTT, and others). Plus, see the latest in computer-generated holograms (CGH) for 3D displays from the Univ. of Japan.

Go online to reserve a time at [spie.org/demos](http://spie.org/demos)

You must have a technical or exhibition-only badge to access the demos. Max 2 sessions per person, per day.

Questions? Email [innovation@spie.org](mailto:innovation@spie.org)

## SPIE Optical Metrology and SPIE Digital Optical Technologies Joint Poster Sessions

Tuesday - Thursday 25 - 27 June 2019 · 12:00 - 12:40

Location: ICM, Hall B0

All symposium attendees are invited to attend Digital Optical Technologies and Optical Metrology Joint Poster Sessions provided as an opportunity to enjoy networking while reviewing poster papers.

Please note that the Digital Optical Technologies Conference Poster Session (Conf. 10335) has been scheduled as part of the Wednesday Poster Session 2, and will run from 12:50 to 13:50 hrs.

**TUESDAY POSTER SESSION 1:** Conf. 11056, 11058, 11060 (Optical Metrology)

**WEDNESDAY POSTER SESSION 2:** Conf. 11057, 11059 (Optical Metrology), 11062 (Digital Optical Technologies)

**THURSDAY POSTER SESSION 3:** Conf. 11061 (Optical Metrology)

Attendees are encouraged to review the high-quality papers and interact with the poster authors. Poster authors must be present at their posters at the Poster Session times designated for their conference to answer questions and interact with the poster session audience. Attendees are requested to wear their conference registration badges to the poster sessions.

**Please see below for specific conference poster session timing.**

### Tuesday 25 June · Poster Session 1

**Optical Metrology, Conf. 11056** (Opt. Measurement Systems-Industrial Inspection): 13:00 to 14:20

**Optical Metrology, Conf. 11058** (Optics for Arts, Architecture, and Archaeology): 12:30 to 13:10

**Optical Metrology, Conf. 11060** (Opt. Methods for Inspection, Characterization, and Imaging of Biomaterials): 12:10 to 12:40

### Wednesday 26 June · Poster Session 2

**Digital Optical Technologies, Conf. 11062:** 12:50 to 13:50

**Optical Metrology, Conf. 11057** (Modeling Aspects in OM): 11:30 to 12:40

**Optical Metrology, Conf. 11059** (Multimodal Sensing and Artificial Intelligence: Technologies and Applications): 11:30 to 12:40

### Thursday 27 June · Poster Session 3

**Optical Metrology, Conf. 11061** (Automated Visual Inspection and Machine Vision): 11:30 to 12:30

Poster Authors, please note the following:

### Set up and removal times for each of the Poster Session days.

Your poster may be displayed any time after setup time and must be removed by the break-down time noted below.

**Tuesday 27 June** - Conf. 11056, 11058, 11060  
Setup—Monday, 13:00 hrs; Break-down—Tuesday, 17:00 hrs

**Wednesday 28 June** - Conf. 11057, 11059, 11062  
Setup—Wednesday, 10:00 hrs; Break-down—Wednesday, 17:00 hrs

**Thursday 29 June** - Conf. 10334  
Setup—Thursday, 9:30 hrs; Break-down—Thursday, 16:30 hrs

Poster presenters may post their poster papers starting at the announced times for each conference, and present them during their respective conference Poster Session. Any papers left on the boards following the poster removal time will be considered unwanted and will be discarded. SPIE assumes no responsibility for posters left up after the end of the Poster Session. Poster authors should be at their papers during their assigned times to answer questions from attendees.

# COURSES

Get focused, effective training that you can apply directly to your work.

## INSTRUCTOR SPOTLIGHT



### Bernard Kress

Over the past two decades Bernard Kress has made significant scientific contributions as an engineer, researcher, associate professor, consultant, instructor, and author. He has been instrumental in developing numerous optical sub-systems for consumer electronics and industrial products, generating IP, teaching and transferring technological solutions to industry.

What attendees have said about his courses:

- The instructor is very knowledgeable in AR/VR and presented an extremely interesting course.
- Excellent course. Bernard has a lot of energy and enthusiasm!!
- Excellent presentation. Very thorough and generous at answering questions.

## Optical Technologies and Architectures for Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) Head-Mounted Displays (HMDs)

### SC1218

Course Level: Intermediate

CEU: 0.4 €370 Members | €255 Student Members |

€420 Non-Members

Sunday 8:30 to 12:30

The course provides an extensive overview of the current product offerings as well as the various optical architectures, as in:

- Smart Glasses and Digital Eyewear
- Augmented Reality (AR) and Mixed Reality (MR) headsets
- Virtual Reality (VR) and Merged Reality headsets

The course describes the optical backbone of existing systems, as well as the various optical building blocks, as in:

- Display engines including microdisplay panel architectures, scanner based light engines and phase panels
- Optical combiners integrated either in free space or waveguide platforms
- Depth mapping sensors either through structured illumination or time of flight
- Head tracking, gaze tracking and gesture sensors

Emphasis is set on the design and fabrication techniques to provide the best display immersion and comfort:

- Wearable comfort (size/ weight, CG)
- Visual comfort (eye box size and IPD coverage, angular resolution, FOV, distortion, dynamic range, contrast,...)
- Passive and active foveated rendering and peripheral displays
- VAC (Vergence Accommodation Conflict) mitigation through varifocal, multifocal, spatial and temporal light fields and per pixel depth holographic displays.

The features and limitations of current optical technologies addressing such specifications are reviewed.

## MONEY-BACK GUARANTEE

We are confident that once you experience an SPIE course for yourself you will look to us for your future education needs. However, if for any reason you are dissatisfied, we will gladly refund your money. We just ask that you tell us what you did not like; suggestions for improvement are always welcome.

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SPIE reserves the right to cancel a course due to insufficient advance registration.

# COURSES

In order to design next generation head worn systems, one needs to fully understand the specifics and limitations of the human visual system, and design the optics and the optical architecture around such. Challenges for next generation systems are reviewed, where immersion and comfort need to be addressed along with consumer level costs requirements.

Finally, the course reviews market analysts' expectations, projected over the next 5 to 10 years, and lists the main actors (major product design companies, start-ups and optical building block vendors, and current investment rounds in such). Demonstration of some of the state of the art AR, MR and VR headsets will be offered to attendees at the end of the course.

## LEARNING OUTCOMES

This course will enable you to:

- identify the various consumer and enterprise head worn systems available in industry today, defined as smart glasses, digital eyewear, AR, MR and VR HMDs, and understand their fundamental differences and specifics
- explain the current optical technologies and sub-systems, their advantages and limitations.
- describe the relations and implications between FOV, resolution, MTF, eyebox size, effective IPD coverage, screen door effects, pupil swim, vergence/accommodation disparity, foveated rendering, peripheral displays,
- examine the human visual system, its specifics and limitations.
- identify the limitations of current optical architectures and how some can be overcome by designing the optics around the human visual system.
- describe the feature and functionality requirement for next generation systems, and review the key enabling technologies.
- examine the current AR/VR market status as well as the upcoming market expectations for each field (smart glasses, AR and VR)

## INTENDED AUDIENCE

Optical, mechanical and electrical engineers involved in the design and development of Enterprise and Consumer HMDs in all their declinations. Product and project managers involved in defining current and next generation HMD products, technology product roadmaps and next generation optical sub-systems.

## INSTRUCTOR

**Bernard Kress** Over the past two decades, Bernard Kress has made significant scientific contributions as an engineer, researcher, associate professor, consultant, instructor, and author. He has been instrumental in developing numerous optical sub-systems for consumer and industrial products, generating IP, teaching and transferring technological solutions to industry. Application sectors include laser materials processing, optical anti-counterfeiting, biotech sensors, optical telecom devices, optical data storage, optical computing, optical motion sensors, digital displays systems, and eventually HUD and HMD displays (smart glasses, AR/MR/VR). Bernard has been specifically involved in the field of micro-optics, wafer scale optics, holography and nanophotonics. He has published half a dozen books and has more than 35 patents granted. He is a short course instructor for the SPIE and has been chair of various SPIE conferences. He is an SPIE fellow since 2013 and has been elected to the board of Directors of SPIE (2017-19). Bernard has joined Google [X] Labs. in 2011 as the Principal Optical Architect on the Google Glass project, and is since 2015 the Partner Optical Architect at Microsoft Corp. on the HoloLens project.

## Design, Modeling and Fabrication Techniques for Micro-Optics: Applications to Display, Imaging, Sensing and Metrology

### SC1217

Course Level: Intermediate

CEU: 0.4 €370 Members | €255 Student Members |

€420 Non-Members

Sunday 13:30 to 17:30

This course provides an overview of the various design and fabrication techniques available to the optical engineer for micro / nano optics, diffractive optics and holographic optics. Emphasis is put on DFM (Design For Manufacturing) for wafer scale fabrication, Diamond Turning Machining (DTM) and holographic exposure. The course shows how design techniques can be tailored to address specific fabrication techniques' requirements and production equipment constraints. The course will also address various current application fields such as display, imaging, sensing and metrology.

The course is built around 4 points: (1) design, (2) modeling, (3) fabrication/mass production and (4) application fields.

We will also review in details the basic micro-optics building blocks and the overall architecture of the iPhone X IR human face sensor.

1) The course will review various design techniques used in standard optical CAD tools such as Zemax and CodeV to design Diffractive Optical Elements (DOEs), Micro-Lens Arrays (MLAs), hybrid optics and refractive micro-optics, Holographic Optical Element (HOE), as well as the various numerical design techniques for Computer Generated Holograms (CGHs).

2) Modeling single micro optics or complex micro-optical systems including MLAs, DOEs, HOEs, CGHs, and other hybrid elements can be a difficult or nearly impossible task when using classical ray tracing algorithms. We will review techniques using physical optics propagation to model not only multiple diffraction effects and their interferences, but also systematic and random fabrication errors, multi-order propagation and other effects which cannot be modeled accurately through ray tracing.

3) Following the design (1) and modeling tasks (2), the optical engineer usually needs to perform a DFM process so that his/her design can be fabricated by the target manufacturing partner/vendor on specific equipment. We will review such DFM for wafer fab via optical lithography (tape-out process), single point diamond turning (SPDT), or holographic optics recording specification. The course also reviews fracturing techniques to produce GDSII layout files for specific lithographic fabrication techniques and manufacturing equipment.

4) In order to point out the potential of such micro-optics for consumer products, this section reviews current application fields for which such elements are providing an especially good match, impossible to implement with traditional optics, such as depth mapping sensing (structured illumination based sensor) and augmented reality display (waveguide grating combiner optics). We will also review applications in high resolution incremental/absolute optical encoders. Design and modeling techniques will be described for such applications fields, and optical hardware sub-system implementations and micro-optics elements will be shown and detailed.



**LEARNING OUTCOMES**

This course will enable you to:

- review the various micro-optics / diffractive optics design techniques used today in popular optical design software such as Zemax and CodeV
- decide which design software would be best suited for a particular micro-optics design task
- evaluate the various constraints linked to either ray tracing or physical optics propagation techniques, and develop custom numerical propagation algorithms
- model systematic and random fabrication errors, especially for lithographic fabrication
- compare the various constraints linked to mask layout generation for lithographic fabrication (GDSII)
- review the different GDSII fabrication layout file architectures, and how to adapt them to various lithographic fabrication techniques such as the ones described in SC454
- discuss current application fields and products using such optics, as in Augmented and Mixed Reality headsets, and high resolution hybrid incremental/absolute diffractive optical encoders.

**INTENDED AUDIENCE**

Scientists, engineers, technicians, or managers who wish to learn more about how to design, model, fabricate and test micro-optics, diffractive optics and hybrid micro-optics, and how such optics can be integrated effectively in consumer products. Basic knowledge in optics is assumed.

**INSTRUCTOR**

**Bernard Kress** Over the past two decades, Bernard Kress has made significant scientific contributions as an engineer, researcher, associate professor, consultant, instructor, and author. He has been instrumental in developing numerous optical sub-systems for consumer and industrial products, generating IP, teaching and transferring technological solutions to industry. Application sectors include laser materials processing, optical anti-counterfeiting, biotech sensors, optical telecom devices, optical data storage, optical computing, optical motion sensors, digital displays systems, and eventually HUD and HMD displays (smart glasses, AR/MR/VR). Bernard has been specifically involved in the field of micro-optics, wafer scale optics, holography and nanophotonics. He has published half a dozen books and has more than 35 patents granted. He is a short course instructor for the SPIE and has been chair of various SPIE conferences. He is an SPIE fellow since 2013 and has been elected to the board of Directors of SPIE (2017-19). Bernard has joined Google [X] Labs. in 2011 as the Principal Optical Architect on the Google Glass project, and is since 2015 the Partner Optical Architect at Microsoft Corp. on the HoloLens project.

**An Introduction to Deep Learning****New****SC1275**

Course Level: Introductory

CEU: 0.4 €370 Members | €255 Student Members |

€420 Non-Members

Sunday 13:30 to 17:30

This course explains basic principles and applications of deep learning. In the first half the principles and history of deep learning and neural networks are explained, followed by many examples of applications of deep neural networks from image classification to deep fakes. In the second half of the course we will build our own basic networks using Google Collaboratory notebooks and will examine some more advanced options such as data augmentation and transfer learning. Anyone who wants to learn more about what deep learning is and how it can be used will benefit from this course.

**LEARNING OUTCOMES**

This course will enable you to:

- list the basic types of deep learning networks
- list the basic uses that deep networks are currently used for
- list the advantages and disadvantages of using neural networks
- construct a simple neural network using python
- use data augmentation to decrease the amount of data needed for training a neural network
- use transfer learning to make use of pre trained models to train on less data

**INTENDED AUDIENCE**

Scientists, engineers, technicians, or managers who wish to learn more about deep learning and its applications. Undergraduate training in engineering or science is assumed. To join in the second half of the course a laptop with Chrome browser, a Google account, and some rudimentary python knowledge is needed.

**INSTRUCTOR**

**Maarten Kruithof** has worked at TNO in the computer vision group since 2008 and primarily in neural networks and deep learning since 2015. He currently leads a group that applies deep neural network technology to real world problems such as transport and mobility, health care, and industrial and infrastructure inspection. Together with his colleagues, he developed an introductory course on deep learning to teach the basic principles of deep neural networks to new employees, and teaches this course in and outside of TNO.

**Attendees will need their laptop with Chrome browser and a Google account.**

- **Optical Measurement Systems for Industrial Inspection**
- **Modeling Aspects in Optical Metrology**
- **O3A: Optics for Arts, Architecture, and Archaeology**
- **Multimodal Sensing and Artificial Intelligence: Technologies and Applications**
- **Optical Methods for Inspection, Characterization and Imaging of Biomaterials**
- **Automated Visual Inspection and Machine Vision**

## Symposium Chairs



**Marc P. Georges**  
Liège Univ. (Belgium)



**Jörg Seewig**  
Technische Univ.  
Kaiserslautern (Germany)



*Honorary Chair:*  
**Wolfgang Osten**  
Univ. Stuttgart (Germany)

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- Piotr Targowski**, Nicolaus Copernicus Univ. (Poland)

# CONFERENCE 11056

LOCATION: ICM, 14C

Monday–Thursday 24–27 June 2019 • Proceedings of SPIE Vol. 11056

# Optical Measurement Systems for Industrial Inspection XI

Conference Chair: **Peter Lehmann**, Univ. Kassel (Germany)

Conference Co-Chairs: **Wolfgang Osten**, Univ. Stuttgart (Germany); **Armando Albertazzi Gonçalves Jr.**, Univ. Federal de Santa Catarina (Brazil)

Programme Committee: Oleg V. Angelsky, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine); Anand Krishna Asundi, Nanyang Technological Univ. (Singapore); Partha P. Banerjee, Univ. of Dayton (USA); Ralf B. Bergmann, Bremer Institut für angewandte Strahltechnik GmbH (Germany); Harald Bosse, Physikalisch-Technische Bundesanstalt (Germany); Jan Burke, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany); Chau-Jern Cheng, National Taiwan Normal Univ. (Taiwan); Jürgen W. Czarske, Technische Univ. Dresden (Germany); Peter J. de Groot, Zygo Corporation (USA); Chris J. Evans, The Univ. of North Carolina at Charlotte (USA); Pietro Ferraro, CNR-Institute of Applied Sciences and Intelligent Systems “Eduardo Caianiello” (Italy); Andreas Fischer, Bremer Institut für Messtechnik, Automatisierung und Qualitätswissenschaft (BIMAQ) (Germany); Cosme Furlong, Worcester Polytechnic Institute (USA); Marc P. Georges, Univ. de Liège (Belgium); Christophe Gorecki, FEMTO-ST (France); Sen Han, Univ. of Shanghai for Science and Technology (China); Yoshio Hayasaki, Utsunomiya Univ. (Japan); Xiangqian Jiang, Univ. of Huddersfield (United Kingdom); Myung K. Kim, Univ. of South Florida (USA); Tomasz Kozacki, Warsaw Univ. of Technology (Poland); Richard K. Leach, The Univ. of Nottingham (United Kingdom); Eberhard Manske, Technische Univ. Ilmenau (Germany); Andrew John Moore, Heriot-Watt Univ. (United Kingdom); Gunther Notni, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany); Yukitoshi Otani, Utsunomiya Univ. (Japan); Xiang Peng, Shenzhen Univ. (China); Pascal Picart, Univ. du Maine (France); Christian Rembe, TU Clausthal (Germany); Robert Schmitt, RWTH (Germany); Jörg Seewig, Technische Univ. Kaiserslautern (Germany); Cristina Trillo, Univ. de Vigo (Spain); Rainer Tutsch, Technische Univ. Braunschweig (Germany); Eriko Watanabe, The Univ. of Electro-Communications (Japan); Toyohiko Yatagai, Utsunomiya Univ. (Japan); Changhe Zhou, Shanghai Institute of Optics and Fine Mechanics (China)

## MONDAY 24 JUNE

### SESSION 1

LOCATION: ICM, 14C ..... MON 8:30 TO 10:00

### Interferometry I

Session Chairs: **Peter Lehmann**, Univ. Kassel (Germany); **Wolfgang Osten**, Institut für Technische Optik (Germany)

8:30: **Hot topics in classical interferometry (Invited Paper)**, Peter J. de Groot, Zygo Corporation (USA) .....[11056-1]

9:00: **Bessel fringes modulation determination by directional spatial carrier phase shifting**, Adam R. Styk, Helena Dziubecka, Warsaw Univ. of Technology (Poland) .....[11056-2]

9:20: **Comparison of algorithms determining sign of Bessel function in time averaging interferometry**, Helena Dziubecka, Adam R. Styk, Institute of Micromechanics and Photonics, Warsaw Univ. of Technology .....[11056-3]

9:40: **Analysis of measurement error caused by swing motion for determining the physical thickness and group refractive index of a large glass panel**, Jonghan Jin, Korea Research Institute of Standards and Science (Korea, Republic of) and Univ. of Science and Technology (Korea, Republic of); Jaeseok Bae, Univ. of Science and Technology (Korea, Republic of); Jungjae Park, Korea Research Institute of Standards and Science (Korea, Republic of) and Univ. of Science and Technology (Korea, Republic of) .....[11056-4]

### WORLD OF PHOTONICS CONGRESS-WIDE PLENARY SESSION

LOCATION: ICM, SAAL 1 ..... MON 10:00 TO 11:00

### Listening to the universe with gravitational waves

**Karsten Danzmann**, Max Planck Institute for Gravitational Physics and Leibnitz Univ. Hannover (Germany)

Coffee Break ..... Mon 11:00 to 11:15

### SESSION 2

LOCATION: ICM, 14C ..... MON 11:20 TO 12:40

### Digital Holography

Session Chair: **Pietro Ferraro**, Istituto di Scienze Applicate e Sistemi Intelligenti “Eduardo Caianiello” (Italy)

11:20: **Digital holographic imaging for optical inspection in learning-based pattern classification**, Han-Yen Tu, Kuang-Che Chang Chien, Chinese Culture Univ. (Taiwan); Chau-Jern Cheng, National Taiwan Normal Univ. (Taiwan) .....[11056-5]

11:40: **High-NA lensless coherent imager as a building block for a synthetic aperture interferometry array**, Jorge Garcia Armenta, Pablo D. Ruiz, Charles R. Coggrave, Ian S. Park, Jeremy Coupland, Loughborough Univ. (United Kingdom) .....[11056-6]

12:00: **Compact dual-wavelength digital holography using VCSEL technology**, Daniel Claus, Igor Alekseenko, Raimund Hibst, Institut für Lasertechnologien in der Medizin und Messtechnik, Univ. Ulm (Germany) .....[11056-7]

12:20: **Digital holography for quantification of semiconductor structures**, Vismay Trivedi, Nimit Patel, HICS Co. (Korea, Republic of); Mugdha Joglekar, Vani Chhaniwal, The Maharaja Sayajirao Univ. of Baroda (India); Seonoh Lee, HICS Co. (Korea, Republic of); Arun Anand, The Maharaja Sayajirao Univ. of Baroda (India) .....[11056-8]

Lunch Break ..... Mon 12:40 to 13:45

### SESSION 3

LOCATION: ICM, 14C ..... MON 13:45 TO 15:45

### Interferometry II

Session Chair: **Ralf B. Bergmann**, Bremer Institut für angewandte Strahltechnik GmbH (Germany)

13:45: **Topography measurement of glass disk substrates with sub-nanometer resolution**, Klaus Freischlad, Chris Koliopoulos, InterOptics, LLC (USA) .....[11056-9]

14:05: **Three-dimensional shape measurement of fine structure by detecting phase distribution of only zeroth order diffraction beam based on speckle interferometry**, Yasuhiko Arai, Kansai Univ. (Japan) . . .[11056-10]

14:25: **Two-dimensional remote interferometric stage encoder through a single access port using range-resolved interferometry**, Kieran B. Wiseman, Thomas Kissinger, Ralph P. Tatam, Cranfield Univ. (United Kingdom)[11056-11]

14:45: **Absolute distance measurement of optical path length of non-contact three-dimensional nanop profiler based on normal vector tracing method by tandem white-light interferometer**, Jungmin Kang, Takao Kitayama, Ryo Kizaki, Yui Toyoshi, Kota Hashimoto, Osaka Univ. (Japan); Agustinus Winarno, Kiyoshi Takamasu, The Univ. of Tokyo (Japan); Kazuya Yamamura, Endo Katsuyoshi, Osaka Univ. (Japan) .....[11056-12]

15:05: **Differential displacement measurements along a single beam using range-resolved interferometry**, Thomas Kissinger, Ralph P. Tatam, Cranfield Univ. (United Kingdom) .....[11056-13]

15:25: **Demodulation for sinusoidal frequency/phase modulation interferometer using artificial harmonic series signal and phase-locked loop**, Masato Aketagawa, Masato Higuchi, Dong Wei, Nagaoka Univ. of Technology (Japan) .....[11056-14]

Coffee Break ..... Mon 15:45 to 16:15

## SESSION 4

LOCATION: ICM, 14C ..... MON 16:15 TO 17:55

### Speckle and Shearing Interferometry

Session Chair: **Marc P. Georges**, Liège Univ. (Belgium)

16:15: **Thermography-inspired processing strategy applied on shearography towards nondestructive inspection of composites**, Murielle Kirkove, Yuchen Zhao, Pascal Blain, Jean-François Vandenrijt, Marc Georges, Liège Univ. (Belgium). ..... [11056-15]

16:35: **A robust integration algorithm for out-of-plane displacement field measurements applied to multiple images of shearography**, Estiven Sánchez Barrera, Univ. Federal de Santa Catarina (Brazil); Analucia Vieira Fantin, Daniel P. Willemann, Univ. do Estado de Santa Catarina (Brazil); Mauro E. Benedet, Armando Albertazzi Gonçalves Jr., Univ. Federal de Santa Catarina (Brazil) ..... [11056-16]

16:55: **Shearography inspection of monolithic CFRP composites: finite element modeling approach for assessing an adequate strategy of artificial defects representing delamination**, Jean-François Vandenrijt, Ctr. Spatial de Liège (Belgium); Hu Xiong, Cédric Lequesne, Samtech (Belgium); Pascal Blain, Marc Georges, Ctr. Spatial de Liège (Belgium) ..... [11056-17]

17:15: **Extreme shearography: high-speed shearography instrument for in-plane surface strain measurements during an impact event**, Andrei G. Anisimov, Roger M. Groves, Technische Univ. Delft (Netherlands) . [11056-18]

17:35: **Absolute angle measurement using dual-wavelength laser speckle for robotic manufacturing**, Sam J. Gibson, Thomas O. H. Charrett, Ralph P. Tatam, Cranfield Univ. (United Kingdom) ..... [11056-19]

## SESSION 6

LOCATION: ICM, 14C ..... TUE 10:30 TO 12:00

### Resolution Enhancement Techniques

Session Chair: **Eberhard Manske**, Technische Univ. Ilmenau (Germany)

10:30: **Advanced methods for optical nanometrology (Invited Paper)**, Bernd Bodermann, Physikalisch-Technische Bundesanstalt (Germany). . . . [11056-24]

11:00: **Light-sample interaction in microsphere enhanced 2D super-resolution imaging**, Göran Maconi, Ivan Kassamakov, Univ. of Helsinki (Finland); T. Vainikka, Nanojet Inc. (Finland); Timo Arstila, Nanijet Inc (Finland); Edward Hæggsström, Univ. of Helsinki (Finland) ..... [11056-25]

11:20: **Microsphere-assisted imaging of sub-diffraction-limited features**, Sébastien Marbach, Stéphane Perrin, Paul Montgomery, Manuel Flury, Sylvain Lecler, Lab. des sciences de l'Ingénieur, de l'Informatique et de l'Imagerie (France) ..... [11056-26]

11:40: **Label-free 3D super-resolution nanoscope**, Ivan Kassamakov, Göran Maconi, Univ. of Helsinki (Finland); Miiikka Järvinen, Nanojet Inc (Finland); Anton Nolvi, Univ. of Helsinki (Finland); Tuomas Vainikka, Pekka Raatikainen, Timo Arstila, Tuomo Ylitalo, Nanojet Inc (Finland); Ilona Ninca, Univ. of Helsinki (Finland); Kristian Ahlers, Nanojet Inc (Finland); Edward Hæggsström, Univ. of Helsinki (Finland) ..... [11056-27]

Lunch Break ..... Tue 12:00 to 13:00

## POSTERS-TUESDAY

LOCATION: ICM, HALL BO ..... TUE 13:00 TO 14:20

Conference attendees are invited to attend the Optical Metrology Poster Session 1 on Tuesday. Come view the posters and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Posters will be available for viewing starting at 13:00 through 14:20 hrs on Thursday. Poster authors, view poster presentation guidelines and set-up instructions on page 6, and at <http://spie.org/x6513.xml> . (Follow the Special Events link)

**Wavelength-switchable Fizeau interferometry and its applications**, Shijie Liu, Qi Lu, You Zhou, Xueke Xu, Jianda Shao, Shanghai Institute of Optics and Fine Mechanics (China); Zhoulun Wu, Jian Chen, Ming Huang, ZC Optoelectronic Technologies, Ltd. (China) and Anhui Province Key Lab. of Non-Destructive Evaluation (China). ..... [11056-75]

**Light field three-dimensional measurement**, Zewei Cai, Xiaoli Liu, Meihua Liao, Wenqi He, Shenzhen Univ. (China); Giancarlo Pedrini, Wolfgang Osten, Univ. Stuttgart (Germany); Xiang Peng, Shenzhen Univ. (China) . . . . [11056-76]

**Measurement of wavefront curvature using computer-generated Fourier holograms**, George Krasin, Michael Kovalev, Sergey Odinkov, Nikita Stsepuro, Bauman Moscow State Technical Univ. (Russian Federation); Yuriy Glukhov, ELTA, Ltd. (Russian Federation). ..... [11056-77]

**Physical-optics investigation of light coupling into fiber and micro-optical sensors**, Huiying Zhong, Friedrich-Schiller-Univ. Jena (Germany); Site Zhang, LightTrans International UG (Germany); Wenxiu Wang, Friedrich-Schiller-Univ. Jena (Germany); Christian Hellmann, Wyrowski Photonics UG (Germany); Frank Wyrowski, Friedrich-Schiller-Univ. Jena (Germany) ..... [11056-78]

**Surface roughness measurement accuracy analysis of grinded silicon wafer by white light scanning interferometry (WLSI)**, Linjie Zhao, Ping Zhou, Ying Yan, Qian Bai, YiQi Wang, Dongming Guo, Dalian Univ. of Technology (China) ..... [11056-80]

**Non-destructive and real-time optical inspection for lens size using swept source optical coherence tomography**, Pingping Jia, hong zhao II, Xi'an Jiaotong Univ. (China); Jinlei zhao III, No.203 Research Institute of China Ordnance Industries (China); Meiqi Fang IV, Yuwei qin V, Xi'an Jiaotong Univ. (China) ..... [11056-81]

**Optical form measurement system using a line-scan interferometer and distance measuring interferometers for run-out compensation of the rotational object stage**, Joerg Riebeling, Univ. Kassel (Germany); Gerd Ehret, Physikalisch-Technische Bundesanstalt (Germany); Peter Lehmann, Univ. Kassel (Germany) ..... [11056-83]

**Dynamic speckle inspection with raw data compression**, Elena V. Stoykova, Branimir Ivanov, Institute of Optical Materials and Technologies (Bulgaria); Kwan-Jung Oh, Joong Ki Park, Electronics and Telecommunications Research Institute (Korea, Republic of) ..... [11056-84]

**Study of the errors of stereoscopic optical-electronic system for railroad track position**, Ngoc Tuan Pham, Alexander Timofeev, Ivan S. Nekrylov, ITMO Univ. (Russian Federation). ..... [11056-85]

## WORLD OF PHOTONICS CONGRESS: NOBEL PLENARY SESSION

LOCATION: ICM, SAAL 1 ..... MON 18:00 TO 19:00

### Passion for Extreme Light

Gerard Mourou, École Polytechnique (France)

2018 Physics Nobel Prize Laureate

For details, please see page 6.

## TUESDAY 25 JUNE

### SESSION 5

LOCATION: ICM, 14C ..... TUE 8:30 TO 10:00

### Topography Sensors and Measuring Systems

Session Chair: **Jörg Seewig**, Technische Univ. Kaiserslautern (Germany)

8:30: **Scale spanning subnanometer metrology up to ten decades (Invited Paper)**, Eberhard Manske, Thomas Fröhlich, Roland Füssl, Rostyslav Mastlyo, Ulrike Blumröder, Technische Univ. Ilmenau (Germany); Paul Köchert, Physikalisch-Technische Bundesanstalt (Germany); Oliver Birli, Ingo Ortlepp, Technische Univ. Ilmenau (Germany); Christof Pruss, Univ. Stuttgart (Germany); Folker Schwesinger, Andreas Meister, Technische Univ. Ilmenau (Germany) ..... [11056-20]

9:00: **Concept for a highly miniaturized endoscopic point distance sensor**, Korbinian Prause, Hochschule Kempten (Germany); Simon Thiele, Alois Herkommer, Harald Giessen, Univ. Stuttgart (Germany); Bernd Pinzer, Michael Layh, Hochschule Kempten (Germany). ..... [11056-21]

9:20: **Evaluation of the optical performance of a novel high speed focal distance-modulated fibre coupled confocal sensor**, Andreas Gröschl, Janik Schaude, Tino Hausotte, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany) ..... [11056-22]

9:40: **Roundness measurement by employing laser Doppler distance sensor and error separation techniques**, Shengyu Shi, South China Univ. of Technology (China) and TU Dresden (Germany); Hao Zhang, TU Dresden (Germany); Jinping Qu, Gang Jin, South China Univ. of Technology (China); Robert Kuschmierz, Jürgen Czarske, TU Dresden (Germany) ..... [11056-23]

Coffee Break ..... Tue 10:00 to 10:30



**Motionless and fast measurement technique for obtaining the spectral diffraction efficiencies of a grating**, Shenghao Wang, Jianda Shao, Shijie Liu, Shanghai Institute of Optics and Fine Mechanics (China); Zhoulung Wu, Jian Chen, Ming Huang, ZC Optoelectronic Technologies, Ltd (China). . . . . [11056-86]

**Influence of test bench parameters on determination of CMOS -cameras feature**, Ba Minh Dinh, Valery V. Korotaev, Sergey N. Yarishev, Anton A. Maraev, Ivan Hekrylov, Anna Vasileva, ITMO Univ. (Russian Federation) . . . . . [11056-87]

**Near real-time digital holographic imaging on conventional central processing unit**, Vira R. Besaga, Anton V. Saetchnikov, Nils C. Gerhardt, Andreas Ostendorf, Martin R. Hofmann, Ruhr-Univ. Bochum (Germany) . . . . . [11056-88]

**Optic-electronic multi-matrix system for measuring the positions of the reflecting panels on the main mirror of the large radio-telescope**, Igor A. Konyakhin, Minh Hoa Tong, ITMO Univ. (Russian Federation) . . . . . [11056-89]

**Design and fabrication of opto-mechanical micro polymeric cantilever based optical fiber sensor**, Omid Reza Ranjbar Naeini, Mohammad Reza Salehi Moghadam, Ali Barandak, Hamid Latifi, Shahid Beheshti Univ. (Iran, Islamic Republic of) . . . . . [11056-90]

**Investigation of the device for limiting the turn of the converter case**, Alexander Semenov, ITMO Univ. (Russian Federation) . . . . . [11056-91]

**Bright high harmonic generation around 30 nm and 10 nm for seeding full coherent XFEL**, Zhiyuan Lou, Yinghui Zheng, Luyao Zhang, Jiaqi Wu, Zhinan Zeng, Ruxin Li, Zhizhan Xu, Shanghai Institute of Optics and Fine Mechanics (China) . . . . . [11056-92]

**Impact damage characterization in CFRP plates using PCA and MEEMD decomposition methods in optical lock-in thermography phase images**, Bernardo Cassimiro Fonseca de Oliveira, Herberth Birck Fröhlich, Estiven Sánchez Barrera, Univ. Federal de Santa Catarina (Brazil); Christian R. Baldo, Federal Univ. of ABC (Brazil); Armando Albertazzi Gonçalves Jr., Univ. Federal de Santa Catarina (Brazil); Robert H. Schmitt, RWTH Aachen Univ. (Germany) . . . . . [11056-93]

**Turning a machine vision camera into a high precision position and angle encoder: nanoGPS-OxyO**, Olivier Acher, Than Liem Nguyen, HORIBA FRANCE SAS (France) . . . . . [11056-94]

**Improving the accuracy of detail positioning using machine vision methods and the use of preprocessing algorithms**, Evgeny A. Semenishchev, Viacheslav Voronin, Moscow State Univ. of Technology "Stankin" (Russian Federation); Sos Agaian, College of Staten Island, The City Univ. of New York (USA) . . . . . [11056-95]

**Nonlinear noise analysis in a long-haul fiber-optic sensing system**, Chunyan Cao, Hu Chen, National Univ. of Defense Technology (China); Zaibo Liao, Sichuan Univ. (China); Qiyong Tang, Shuidong Xiong, Weihua Zhang, Changxiang Linghu, National Univ. of Defense Technology (China). [11056-96]

**Wafer-level inspection platform on high-volume photonic integrated circuits for drastic reduction of testing time**, Toru Miura, NTT Device Technology Labs. (Japan); Yoshiho Maeda, Shinji Matsuo, Hiroshi Fukuda, Nippon Telegraph and Telephone Corp. (Japan) . . . . . [11056-97]

**Ultra-large dynamic signal detection method based on combined 3x3 optical fiber interferometer**, Shuidong Xiong, Chunyan Cao, Qiong Yao, Fuyin Wang, Qingkai Hou, Hu Chen, Changxiang Linghu, National Univ. of Defense Technology (China) . . . . . [11056-98]

**Comparative analysis of feedback methods in reconstruction algorithms for multiple-scattering holographic tomography**, Julianna Winnik, Damian Suski, Tomasz Kozacki, Warsaw Univ. of Technology (Poland) . . . . . [11056-99]

**A conceptual study of infrared and visible-light image fusion methods for three-dimensional object reconstruction**, Guilherme Canarin Marcellino, Bernardo Cassimiro Fonseca de Oliveira, Vicente Borges, Tiago Loureiro Figaro da Costa Pinto, Univ. Federal de Santa Catarina (Brazil) . . . . . [11056-100]

**Study of the non-uniformity of sensitivity distributed over photomultiplier active area influence on the operation of the photometric module for separate x-ray luminous diamond**, Ivan S Nekrylov, Sergey V. Mednikov, Aleksander N. Chertov, ITMO Univ. (Russian Federation); Joel J. P. C. Rodrigues, ITMO Univ. (Russian Federation) and National Institute of Telecommunications (Brazil); Valery V. Korotaev, Timofeev N. Alexander, ITMO Univ. (Russian Federation). . . . . [11056-101]

**Optimization of a geometrical calibration procedure for stereoscopic endoscopy systems**, Alexey Gorevoy, Alexander S. Machikhin, Demid Khokhlov, Vladislav Batshev, Scientific and Technological Ctr. of Unique Instrumentation RAS (Russian Federation) . . . . . [11056-102]

**Optic-electronic system for measurement the position of Millimetron's space telescope segments of main mirror**, Gleb Vasilev, Igor A. Konyakhin, ITMO Univ. (Russian Federation). . . . . [11056-103]

**Measurement and calculation of solid-state matrix photomultiplier's polarization parameters**, Anastasiya Lobanova, Daria Drozdova, Victoria Ryzhova, ITMO Univ. (Russian Federation) . . . . . [11056-104]

**Optical laser reflection borometry**, Jan Hošek, Czech Technical Univ. in Prague (Czech Republic) . . . . . [11056-105]

**Characterization the effect of acetone gas concentration on polymeric tapered optical fiber sensor**, Omid Reza Ranjbar Naeini, Ali Barandak, Mohamad Mehdy Tahmasebi, Hamid Latifi, Shahid Beheshti Univ. (Iran, Islamic Republic of) . . . . . [11056-107]

**Spectrally-resolved white-light phase-shifted interferometry for 3D measurements of multilayer films**, Young-Sik Ghim, Hyug-Gyo Rhee, Korea Research Institute of Standards and Science (Korea, Republic of) . [11056-108]

**Optical methods of on-line diagnostics of processes of the Nickel alloy powder consolidation in the layer-by-layer laser melting technology**, Yuri N. Zavalov, Alexander V. Dubrov, Vladimir D. Dubrov, Institute of Laser and Information Technologies of the RAS (Russian Federation) . . . . . [11056-109]

**Optical method of on-line temperature monitoring on the melt surface in laser metal deposition technology**, Yuri N. Zavalov, Institute of Laser and Information Technologies of the RAS (Russian Federation); Alexander V. Dubrov, Institute of Laser and Information Technologies of the RAS (Russian Federation); Vladimir D. Dubrov, Institute of Laser and Information Technologies of the RAS (Russian Federation) . . . . . [11056-110]

**3D shape measurement of specular objects by phase measuring deflectometry with polarizers**, Juan Zhao, Zhan Song, Feifei Gu, Shenzhen Institutes of Advanced Technology (China). . . . . [11056-111]

**Camera calibration method of optical system for large field measurement of hot forgings in heavy industry**, Jakub Hurnik, Aneta Zatočilová, David Paloušek, Brno Univ. of Technology (Czech Republic). . . . . [11056-112]

**Original methods of aberration correction in optical systems of autocollimators**, Dmitrii I. Egorov, ITMO Univ. (Russian Federation) [11056-113]

**Micro- and nanofabrication technologies using the nanopositioning and nanomeasuring machines**, Laura Weidenfeller, Martin R. Hofmann, Johannes Kirchner, Shraddha Supreeti, Ivo W. Rangelow, Stefan Sinzinger, Eberhard Manske, Technische Univ. Ilmenau (Germany) . . . . . [11056-114]

**Removal of monotonically increasing or decreasing phase ambiguity in retrieved phase by Riesz transform method in digital interferometric techniques**, Yassine Tounsi, Univ. Chouaib Doukkali (Morocco); Manoj Kumar, Kobe Univ. (Japan); Abdelkrim Nassim, Univ. Chouaib Doukkali (Morocco); Fernando Mendoza-Santoyo, Centro de Investigaciones en Óptica, A.C. (Mexico). . . . . [11056-115]

**Optoelectronic autocollimator as a tool for monitoring load-carrying structure**, Anton A. Nogin, Igor A. Konyakhin, Aigany M. Sakhariyanova, ITMO Univ. (Russian Federation). . . . . [11056-117]

**Automatic control system of combustion processes based on the methods of contactless optical spectroscopy**, Mikhail A. Vaganov, Oleg D. Moskaletz, Vasily I. Kazakov, Saint-Petersburg State Univ. of Aerospace Instrumentation (Russian Federation) . . . . . [11056-118]

**High-accuracy piston error measurement with a large capture range based on coherent diffraction**, Weirui Zhao, Lu Zhang, Yuejin Zhao, Liqun Dong, Mei Hui, Beijing Institute of Technology (China) . . . . . [11056-119]

**Analysis of the method errors of monitoring the parameters of the subanometer level roughness of an optical component's surface based on scattered laser radiation measurement**, Dmitry Denisov, Bauman Moscow State Technical Univ. (Russian Federation); Magomed A. Abdulkadyrov, Peter Luy, "Lytkarino Optical Glass Factory", JSC (Russian Federation); Nikolay Baryshnikov, Tamara Kuznetsova, Bauman Moscow State Technical Univ. (Russian Federation) . . . . . [11056-120]

**Adaptive optics test bench for predictive wavefront correction**, Lidia A. Bolbasova, V. E. Zuev Institute of Atmospheric Optics (Russian Federation); Alexey N. Gritsuta, V. E. Zuev Institute of Atmospheric Optics (Russian Federation) and Tomsk State Univ. (Russian Federation); Vitaly V. Lavrinov, Vladimir P. Lukin, Anton A. Selin, Egor L. Soin, V. E. Zuev Institute of Atmospheric Optics (Russian Federation). . . . . [11056-121]

**All-weather pulse laser altimeter for measuring low altitudes above the sea surface**, Nguyen Tung, Evgeny Lebedko, ITMO Univ. (Russian Federation) . . . . . [11056-122]

**Reliability results of a fully automated robust x-y stage measurement unit for precise light distribution measurement**, Steffen Reichel, Daniel Aichert, Thomas Schaeufele, Burak Oezdemir, Hamza Soeylemez, Daniel Stankic, Hochschule Pforzheim (Germany). . . . . [11056-123]

**Noise reduction of digital holography using speckle correlation properties in longitudinal direction**, Hideki Funamizu, Muroan Institute of Technology (Japan); Jun Uozumi, Hokkai-Gakuen Univ. (Japan); Yoshihisa Aizu, Muroan Institute of Technology (Japan) . . . . . [11056-124]

# CONFERENCE 11056

- Characterization of thermal absorption and nonlinear absorption in KDP/DKDP crystals with different orientations.** Xiaocong Peng, Yuan'an Zhao, Dawei Li, Guohang Hu, Long Zhang, Jianda Shao, Shanghai Institute of Optics and Fine Mechanics (China) . . . . . [11056-125]
- High resolution topography sensors in a multisensor measuring setup.** Sebastian Hagemeyer, Peter Lehmann, Univ. Kassel (Germany) . . . [11056-126]
- Measurement of the refractive index of a transparent film using interferometry.** Hyo Jin Lee, Seung Ho Han, Sung Yup An, Wooyong Song, Ohchul Shin, Soo-Bang Kim, KMAC (Korea, Republic of) . . . . . [11056-127]
- Multi degree-of-freedom position sensing by combination of laser speckle correlation and range-resolved interferometry.** Thomas O. H. Charrett, Thomas Kissinger, Ralph P. Tatam, Cranfield Univ. (United Kingdom) . . . . . [11056-128]
- Measuring method and standard system for retroreflective traffic marking's photometric characteristic.** Huayang He, Yishu Zhou, Jinning Zhang, Jinjin Cao, Zhengwei Leng, Wenying Su, Research Institute of Highway Ministry of Transport (China) . . . . . [11056-129]
- Automatic and accurate full-view registration method for 3D scanning system.** Pei Xu, Guilin Univ. of Electronic Technology (China); Feifei Gu, Zhan Song, Juan Zhao, Shenzhen Institutes of Advanced Technology (China); Jun Li, School of Electronic Engineering and Automation (China) . . . . . [11056-130]
- 3D shape measurement in the presence of interreflections by light stripe triangulation with additional geometric constraints.** Yang Xu, Huijie Zhao, Hongzhi Jiang, Yunfan Wang, Xudong Li, Beihang Univ. (China) . . . [11056-131]
- Analysis of sub-pixel laser spot detection in laser triangulation systems.** Patrick Kienle, Elif Nallar, Michael H. Köhler, Martin Jakobi, Alexander W. Koch, Technische Univ. München (Germany) . . . . . [11056-132]
- Digital holographic microscopy for thickness characterization using synthesized partially coherent holograms.** Marta Mikula, Juan Martínez-Carranza, Tomasz Kozacki, Warsaw Univ. of Technology (Poland) . [11056-133]
- Nonlocal means variants filtering methods for speckle noise reduction in digital speckle pattern interferometric fringes.** Yassine Tounsi, Univ. Chouaib Doukkali (Morocco); Manoj Kumar, Kobe Univ. (Japan); Abdelkrim Nassim, Univ. Chouaib Doukkali (Morocco); Fernando Mendoza-Santoyo, Centro de Investigaciones en Óptica, A.C. (Mexico) . . . . . [11056-134]
- Polarization analysis of the object wave using FMCW-digital holography.** Masayuki Yokota, T. Ishikawa, N. Aoki, Shimane Univ. (Japan) . . . [11056-135]
- A hybrid method for velocity field of fluid flow estimation based on optical flow.** Grzegorz Glomb, Grzegorz Swirniak, Wrocław Univ. of Science and Technology (Poland) . . . . . [11056-136]
- Interferometer for large convex optical aspheric surfaces testing.** Alexandra E. Gavilina, STC UI RAS (Russian Federation); Vladislav I. Batshev, Scientific and Technological Ctr. of Unique Instrumentation RAS (Russian Federation) and Bauman Moscow State Technical Univ. (Russian Federation); Denis A. Novikov, All-Russian Scientific Research Institute for Optical & Physical Measurements (Russian Federation); Maria V. Sergeeva, Scientific and Technological Ctr. of Unique Instrumentation RAS (Russian Federation) . . . . . [11056-137]
- A demodulation method with high stability for interferometric type vector fiber hydrophone.** Qingkai Hou, Fuyin Wang, Qiong Yao, Shuidong Xiong, National Univ. of Defense Technology (China) . . . . . [11056-138]
- Determination of paraxial focal length of lens using Strehl definition measurement.** Antonín Mikš, Jirí Novák, Pavel Novák, Petr Pokorný, Filip Šmejkal, Czech Technical Univ. in Prague (Czech Republic) . . . . . [11056-139]
- Contactless optical spectroscopy methods in the tasks of monitoring physical and technological processes in extreme conditions.** Vasily I. Kazakov, Oleg Moskaletz, Arthur Paraskun, Mikhail A. Vaganov, Saint-Petersburg State Univ. of Aerospace Instrumentation (Russian Federation) . . . . . [11056-140]
- Experimental light scattering by optical fibers: system design and testing.** Grzegorz Swirniak, Grzegorz Glomb, Wrocław Univ. of Science and Technology (Poland) . . . . . [11056-141]
- Alignment analysis and verification plan of freeform mirrors in linear astigmatism-free three-mirror system (LAF-TMS).** Yunjong Kim, Jihun Kim, Jeong-Yeol Han, Korea Astronomy and Space Science Institute (Korea, Republic of); Woojin Park, Soojong Pak, Kyung Hee Univ. (Korea, Republic of); Seunghyuk Chang, Ctr. for Integrated Smart Sensors (Korea, Republic of); Byeongjoon Jeong, Hwan-Jin Choi, Geon-Hee Kim, Korea Basic Science Institute (Korea, Republic of) . . . . . [11056-142]
- Direct monochromatic optic control system of the thickness of thin-film interference coatings applied in vacuum.** Yuriy Prosovskiy, Dmitriy Denisov, Bauman Moscow State Technical Univ. (Russian Federation); Oleg Prosovskiy, Aleksandr Budnev, Technologiya (Russian Federation) . . . . . [11056-143]
- Development of absolute angular encoder design on coordinate photodetectors.** Kirill S. Povarov, Sergey Mitrofanov, ITMO Univ. (Russian Federation) . . . . . [11056-144]
- Adaptive windowed Fourier transform filtering method for speckle fringe patterns.** Jing Liu, Weinan Normal Univ. (China); Guoqing Zhou, Beibei Liu, Northwestern Polytechnical University (China) . . . . . [11056-145]
- Coordinate mapping of the primary mirror vertex in a space telescope by using a CGH and theodolites.** Hagiyoung Kihm, Ho-Soon Yang, Ji-Won Kang, Korea Research Institute of Standards and Science (Korea, Republic of) . . . . . [11056-146]
- A new method for measuring target reflectivity.** Hongfei Wu, Huazhong Univ. of Science and Technology (China); Fei Hu, Huazhong Univ. of Science and Technology (China) and National Key Lab. of Science and Technology on Multi-Spectral Information Processing (China); Jinlong Su, Yan Hu, Peng Fu, Huazhong Univ. of Science and Technology (China) . . . . . [11056-147]
- Highly repetitive low-coherence interferometry with time-stretch technique.** Masaharu Hoshikawa, Katsuhiro Ishii, The Graduate School for the Creation of New Photonics Industries (Japan); Takeshi Makino, Takahiro Hashimoto, Hideaki Furukawa, Naoya Wada, National Institute of Information and Communications Technology (Japan) . . . . . [11056-148]
- Contrast determination in phase-shifting algorithms for interferograms with arbitrary steps and additive noise.** Gastón A. Ayubi, Univ. de la República Uruguay (Uruguay) . . . . . [11056-149]
- Two-shot fringe pattern phase demodulation using the extreme value of interference with Hilbert-Huang per-filtering.** Hanguyng Zhang, Hong Zhao, Xi'an Jiaotong Univ. (China); Jinlei Zhao, No.203 Research Institute of China Ordnance Industries (China); Zixin Zhao, Chen Fan, Xi'an Jiaotong Univ. (China) . . . . . [11056-151]
- High resolution measurement of freeform wavefront by using self-imaging based sensor.** Lalit Mohan Pant, Instrument Design and Development Ctr. (India) and Indian Institute of Technology Delhi (India); Kamal K. Pant, Dali Ramu Burada, Instrument Design and Development Ctr. (India); Amitava Ghosh, Instruments Research & Development Establishment (India); Gufran Sayeed Khan, Chandra Shakher, Instrument Design and Development Ctr. (India) . . . . . [11056-152]
- Development of an illumination module for stroboscopic phase-shift interferometry on MEMS devices.** Luiz Guilherme de Medeiros Ventura, Steffen Wolschke, Fraunhofer-Institut für Photonische Mikrosysteme (Germany); Christoph Skupsch, Fraunhofer-Institut für Photonische Mikrosysteme (Germany) and Robert Bosch Kft. (Hungary); Dirk Berndt, Fraunhofer-Institut für Photonische Mikrosysteme (Germany) . . . . [11056-153]
- Sensitivity of an image-plane digital holography interferometer for the measurement of pile-up.** Matias R. Viotti, Armando Albertazzi Gonçalves Jr., Univ. Federal de Santa Catarina (Brazil); Denis Boing, Rodrigo Blödorn, Centro Univ. de Brusque - UNIFEBE (Brazil) . . . . . [11056-154]
- Measurement system of characteristics of compensation devices by the autocollimation method.** Valeria Portnova, Николай Смирнов, ITMO Univ. (Russian Federation) . . . . . [11056-155]
- Freeform optics alignment strategy and its effect on development of precision freeform optics.** Vinod Mishra, CSIR - Central Scientific Instruments Organisation (India); Dali Ramu Burada, Kamal K. Pant, Indian Institute of Technology Delhi (India); Vinod Karar, CSIR - Central Scientific Instruments Organisation (India); Sunil Jha, Gufran Sayeed Khan, Indian Institute of Technology Delhi (India) . . . . . [11056-156]
- Application of immersion method for measuring freeform surfaces.** Ksenia Lvova, Bauman Moscow State Technical Univ. (Russian Federation) and P. N. Lebedev Physical Institute of the RAS (Russian Federation); Victoria Kaidarakova, Bauman Moscow State Technical Univ. (Russian Federation); Anastasia Perevoznikova, Bauman Moscow State Technical Univ. (Russian Federation) and P. N. Lebedev Physical Institute of the RAS (Russian Federation); Vladislav Druzhin, Bauman Moscow State Technical Univ. (Russian Federation) . . . . . [11056-160]

SESSION 7

LOCATION: ICM, 14C ..... TUE 14:20 TO 15:20

High-speed Techniques

Session Chair: **Peter J. De Groot**, Zygo Corporation (USA)

14:20: **Double pulse LED illumination for phase detection in RGB-interferometry**, Markus Schake, Peter Lehmann, Univ. Kassel (Germany) ..... [11056-28]

14:40: **Full-field, high-frequency, heterodyne interferometry for dynamic metrology based on phase detection using a modified time-of-flight camera**, John B. Mitchell, Compass Optics Ltd. (United Kingdom) and Glyndwr Innovations Ltd. (United Kingdom); Gareth W Roberts, Mathcyf Cyf Ltd (United Kingdom); Paul C.T. Rees, Wrexham Glyndwr University (United Kingdom) ..... [11056-29]

15:00: **GPU-based digital image correlation system for real-time strain-controlled fatigue and strain field measurement**, Andreas Blug, Fraunhofer-Institut für Physikalische Messtechnik (Germany); David J. Regina, Stefan Eckmann, Melanie Senn, Chris Eberl, Fraunhofer-Institut für Werkstoffmechanik (Germany); Alexander Bertz, Daniel Carl, Fraunhofer-Institut für Physikalische Messtechnik (Germany) ..... [11056-30]

Coffee Break ..... Tue 15:20 to 16:00

SESSION 8

LOCATION: ICM, 14C ..... TUE 16:00 TO 18:00

3D Microscopy

Session Chair: **Paul Montgomery**, Lab. des sciences de l'Ingénieur, de l'Informatique et de l'Imagerie (France)

16:00: **Active illumination focus variation**, Carlos Bermudez, Pol Martínez, Cristina Cadevall, Roger Artigas, Sensofar-Tech, S.L. (Spain) ..... [11056-31]

16:20: **Optical measurement of ground cylinder lead angle**, Peter J. de Groot, Michael Schmidt, Leslie L. Deck, Zygo Corporation (USA) ..... [11056-32]

16:40: **User-oriented evaluation of the metrological characteristics of areal surface topography measuring instruments**, Matthias Eifler, Felix Ströer, Julian Hering, Georg von Freymann, Jörg Seewig, Technische Univ. Kaiserslautern (Germany) ..... [11056-33]

17:00: **Correction of surface error occurring in microlenses characterization performed by optical profilers**, Jeremy Béguelin, SUSS MicroOptics SA (Switzerland); Torald Scharf, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Wilfried Noell, Reinhard Voelkel, SUSS MicroOptics SA (Switzerland) ..... [11056-34]

17:20: **The use of parabolic mirrors in combined low-coherence and confocal refractive index measurement**, Daniel Francis, Helen D. Ford, Jonathan M. Hallam, Ralph P. Tatam, Cranfield Univ. (United Kingdom) ..... [11056-35]

17:40: **Novel chromatic confocal differential interference contrast prototype**, Johannes Belkner, National Taiwan Univ. (Taiwan) and Technische Univ. Ilmenau (Germany); Hsiu-Wen Liu, National Taiwan Univ. (Taiwan); Eberhard Manske, Technische Univ. Ilmenau (Germany); Liang-Chia Chen, National Taiwan Univ. (Taiwan) ..... [11056-36]

WEDNESDAY 26 JUNE

SESSION 9

LOCATION: ICM, 14C ..... WED 8:30 TO 10:00

Structured Illumination Techniques I

Session Chair: **Gunther Notni**, Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany)

8:30: **Deflectometry (Invited Paper)**, Jan Burke, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung IOSB (Germany) ..... [11056-37]

9:00: **Hybrid telecentric triangulation sensor system with real-time field-dependent deconvolution**, Andreas Faulhaber, Univ. Stuttgart (Germany); Marc Gronle, Tobias Haist, Institut für Technische Optik, Univ. Stuttgart (Germany); Christof Pruß, Institut für Technische Optik (Germany); Yousef Baroud, Univ. Stuttgart (Germany); Wolfgang Osten, Institut für Technische Optik, Univ. Stuttgart (Germany); Sven Simon, Univ. Stuttgart (Germany) ..... [11056-38]

9:20: **Structured light sensor with telecentric stereo camera pair for measurements through vacuum windows**, Rüdiger Beermann, Lorenz Quentin, Markus Kästner, Eduard Reithmeier, Institut für Mess- und Regelungstechnik, Leibniz Univ. Hannover (Germany) ..... [11056-39]

9:40: **3D shape from thermal patterns: investigation of projection parameters in simulation and experiment**, Martin Landmann, Stefan Heist, Institut für Angewandte Physik, Friedrich-Schiller-Univ. Jena (Germany) and Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany); Peter Kühmstedt, Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany); Gunther Notni, Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany) and Technische Univ. Ilmenau (Germany) ..... [11056-40]

Coffee Break ..... Wed 10:00 to 10:30

SPIE OPTICAL METROLOGY PLENARY SESSION  
LOCATION: ICM, SAAL 1 ..... WED 10:30 TO 11:25

Towards a complete framework for calibration of optical surface and coordinate measuring instruments

Richard Leach, Univ. of Nottingham (United Kingdom)

For details, please see page 7.

SESSION 10

LOCATION: ICM, 14C ..... WED 11:30 TO 12:50

Structured Illumination Techniques II

Session Chair: **Jan Burke**, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung IOSB (Germany)

11:30: **Automatic camera calibration and sensor registration of a multi-sensor fringe measurement system using hexapod positioning**, Sebastian Metzner, Tino Hausotte, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany) ..... [11056-41]

11:50: **Extrinsic calibration of a 3D sensor based on an array projector and a single camera**, Eugene Wong, Stefan Heist, Christian Bräuer-Burchardt, Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany); Andreas Stark, Institute of Applied Optics, Friedrich-Schiller-Univ. Jena (Germany); Holger Babovsky, Richard Kowarschik, Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany) ..... [11056-42]

12:10: **3D multispectral imaging system for contamination detection**, Chen Zhang, Maik Rosenberger, Technische Univ. Ilmenau (Germany); Gunther Notni, Technische Univ. Ilmenau (Germany) and Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany) ..... [11056-43]

12:30: **Full-field deflectometry for optical characterization of high-precision mirrors**, Philippe Antoine, Arno Bouwens, Luc Boussemaere, LAMBDA-X sa (Belgium); Vincent Moreau, Benoît Borguet, Ksenia Sharshavina, AMOS Ltd. (Belgium) ..... [11056-44]

Lunch Break ..... Wed 12:50 to 13:50

SESSION 11

LOCATION: ICM, 14C ..... WED 13:50 TO 15:30

Light Scattering Techniques

Session Chair: **Jürgen W. Czarske**, TU Dresden (Germany)

13:50: **Heterodyne detection system for nanoparticle detection using coherent Fourier scatterometry**, Dmytro Kolenov, Roland C. Horsten, Silvana F. Pereira, Technische Univ. Delft (Netherlands) ..... [11056-45]

14:10: **Determination of optical fiber layer parameters by inverse evaluation of lateral scattering patterns**, Gunnar Claussen, Werner Blohm, Jade Hochschule (Germany) ..... [11056-46]

14:30: **High-resolution Czerny-Turner scatterometer for BRDF measurements**, Felix Koch, Carl Zeiss Jena GmbH (Germany); Matthias Zilk, Friedrich-Schiller-Univ. Jena (Germany); Mike Schnabel, Tilman Glaser, Carl Zeiss Jena GmbH (Germany) ..... [11056-47]

14:50: **Recent development in BTDF/BRDF metrology on large-scale lambertian-like diffusers, application to on-board calibration units in space instrumentation**, Emmanuel Mazy, Céline Michel, Sara Marcotte, Lionel Clermont, Benoît Marquet, Jérôme Jacobs, Isabelle Domken, Yvan Stockman, Ctr. Spatial de Liège (Belgium) ..... [11056-48]

15:10: **Spatially resolved optical strain measurements on high-speed fiber reinforced polymer rotors**, Julian Lich, Tino Wollmann, Angelos Filippatos, Maik Gude, Robert Kuschnierz, Jürgen Czarske, TU Dresden (Germany) ..... [11056-49]

Coffee Break ..... Wed 15:30 to 16:00

# CONFERENCE 11056

## SESSION 12

LOCATION: ICM, 14C ..... WED 16:00 TO 18:00

### Measurement of Optical Components I: Asphere and Freeform Measurement

Joint Session between SPIE Conference 11056 and EOS.

Session Chairs: **Oliver W. Föhnle**, FISBA AG (Switzerland); **Sven Schröder**, Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany)

16:00: **Approaches for a destructive measurement method of subsurface damages**, Michael Seiler, Ernst-Abbe-Hochschule Jena (Germany) [11056-161]

16:20: **Grazing incidence interferometry for testing rough aspherics**, Sergej Rothau, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Klaus Mantel, Max-Planck-Institut für die Physik des Lichts (Germany); Johannes Schwider, Norbert Lindlein, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany) ..... [11056-50]

16:40: **Investigation of non-uniformity of classically polished fused silica elements via laser-induced breakdown spectroscopy**, Christoph Gerhard, HAWK Hildesheim Holzminden Göttingen (France) ..... [11056-162]

17:00: **Tilted wave interferometer in common path configuration: challenges and realization**, Rolf Beisswanger, Christof Pruss, Institut für Technische Optik, Univ. Stuttgart (Germany); Christian Schober, TU Dresden (Germany); Antonia Harsch, Wolfgang Osten, Institut für Technische Optik, Univ. Stuttgart (Germany) ..... [11056-51]

17:20: **Measurement and correction of two-sided freeform optical elements with combined tactile-optical metrology equipment**, Nils Heidler, Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany) ..... [11056-163]

17:40: **Measurement of mid-spatial frequency errors on freeform optics using deflectometry**, Todd F. Blalock, Brittany D. Cox, Brian Myer, Optimax Systems, Inc. (USA) ..... [11056-52]

## THURSDAY 27 JUNE

### SESSION 13

LOCATION: ICM, 14C ..... THU 8:30 TO 10:00

### Measurement of Optical Components II

Session Chair: **Wolfgang Osten**, Institut für Technische Optik (Germany)

8:30: **Testing highly-sophisticated aspheric and cylindric surfaces** (*Invited Paper*), Rainer Schuhmann, Berliner Glas KGaA Herbert Kubatz GmbH & Co. (Germany) ..... [11056-53]

9:00: **Self calibrating Hartmann-type wavefront sensor**, Jean-Michel Asfour, Andreas Vogler, Dioptric GmbH (Germany) ..... [11056-54]

9:20: **Precise measurement of known and unknown freeform surfaces using Experimental Ray Tracing**, Tobias Binkele, David Hilbig, Mahmoud Essameldin, Thomas Henning, Friedrich Fleischmann, Hochschule Bremen Univ. of Applied Sciences (Germany); Walter Lang, University of Bremen (Germany) ..... [11056-55]

9:40: **Interferometric measurement of local radii of curvature for aspheric surface using an IDP**, María Elizabeth Percino-Zacarias, Fermín-Salomón Granados-Agustín, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico); Daniel Aguirre-Aguirre, Brenda Villalobos-Mendoza, Univ. Nacional Autónoma de México (Mexico); Alejandro Cornejo-Rodríguez, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico) ..... [11056-56]

Coffee Break ..... Thu 10:00 to 10:30

## SESSION 14

LOCATION: ICM, 14C ..... THU 10:30 TO 12:30

### Hyperspectral Imaging and Spectroscopic Techniques

Session Chair: **Peter Lehmann**, Univ. Kassel (Germany)

10:30: **Setup and evaluation of a static imaging Fourier transform spectrometer for the mid-infrared spectral range**, Michael H. Köhler, The-Thien Nguyen, Patrick Kienle, Xingchen Dong, Alexander W. Koch, Technische Univ. München (Germany) ..... [11056-57]

10:50: **An approach to combined multispectral reflectorless distance measurement and material probing**, David Salido-Monzú, Andreas Wieser, ETH Zurich (Switzerland) ..... [11056-58]

11:10: **Precise thickness measurement and comparison of step-shaped microfluidic channel mold using optical interferometry**, Jungjae Park, Korea Research Institute of Standards and Science (Korea, Republic of) and Univ. of Science and Technology (Korea, Republic of); Jaeseok Bae, Univ. of Science and Technology (Korea, Republic of); Jonghan Jin, Korea Research Institute of Standards and Science (Korea, Republic of) and Univ. of Science and Technology (Korea, Republic of) ..... [11056-59]

11:30: **Hyperspectral imaging microscopy for thickness measurement and surface characterization of layered MoS<sub>2</sub>**, Xingchen Dong, Michael H. Köhler, Martin Jakobi, Alexander W. Koch, Technische Univ. München (Germany) ..... [11056-60]

11:50: **Realization of a LIBS-based, temporally and spatially resolved welding control**, Max Neumann, Tobias Baselt, Fraunhofer-Institut für Werkstoff- und Strahltechnik (Germany) and Westsächsische Hochschule Zwickau (Germany); Alexander Kabardiadi-Virkovski, Fraunhofer-Institut für Werkstoff- und Strahltechnik (Germany); Yves Winkler, Peter Hartmann, Fraunhofer-Institut für Werkstoff- und Strahltechnik (Germany) and Westsächsische Hochschule Zwickau (Germany) ..... [11056-61]

12:10: **Rotational Raman spectroscopy for in situ temperature and composition determination in reactive flows**, Leo Bahr, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany) and Technische Univ. Bergakademie Freiberg (Germany); Franz J. T. Huber, Stefan Will, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Andreas S. Braeuer, Technische Univ. Bergakademie Freiberg (Germany) ..... [11056-62]

Lunch Break ..... Thu 12:30 to 13:40

## SESSION 15

LOCATION: ICM, 14C ..... THU 13:40 TO 15:40

### In-process and In-situ Measurements

Session Chair: **Xiang Peng**, Shenzhen Univ. (China)

13:40: **Automated pump-probe microscope to observe laser ablation on a picosecond scale**, Fabian Meyer, Mario Böhrer, Andreas A. Brand, Jan F. Nekarda, Fraunhofer-Institut für Solare Energiesysteme (Germany) ..... [11056-63]

14:00: **Significances and challenges of the innovative emerging metrology methodologies to the newest technology nodes**, Hong Chen, XTAL Inc. (USA) ..... [11056-64]

14:20: **Fluorescence laser scanner for in-line inspection of functional coatings in metal processing industries**, Philipp Holz, Albrecht Brandenburg, Fraunhofer-Institut für Physikalische Messtechnik (Germany) ..... [11056-65]

14:40: **Automated inline visual inspection and 3D measuring in electrode manufacturing**, Andreas Frommknecht, Martin Schmauder, Laura Boonen, Carsten Glanz, Fraunhofer-Institut für Produktionstechnik und Automatisierung (Germany) ..... [11056-66]

15:00: **Innovative system for automated measurement of the distribution of the length of natural fibres**, Stefan J. Rinner, Michael Kahl, Carsten Ziolek, NTB Interstaatliche Hochschule für Technik Buchs (Switzerland); Hubert Schmid, IST AG (Switzerland) ..... [11056-67]

15:20: **Imaging detection and classification of particulate contamination on structured surfaces**, Jan Schütz, Alexander Blättermann, Peter Kozłowski, Albrecht Brandenburg, Fraunhofer-Institut für Physikalische Messtechnik (Germany) ..... [11056-68]

Coffee Break ..... Thu 15:40 to 16:00



SESSION 16

LOCATION: ICM, 14C ..... THU 16:00 TO 18:00

**Nondestructive Testing and Fault Detection**

Session Chair: **Armando Albertazzi Gonçalves Jr.**, Univ. Federal de Santa Catarina (Brazil)

16:00: **Development of an experimental setup and a study for the comparison between optical properties and the subjective perception of a quality of a display surface**, Theresa Puder, Fraunhofer-Institut für Werkstoff- und Strahltechnik (Germany); Florian Rudek, Fraunhofer-Institut für Werkstoff- und Strahltechnik (Germany) and Westsächsische Hochschule Zwickau (Germany); Christopher Taudt, Alexander Kabardiadi-Virkovski, Peter Hartmann, Westsächsische Hochschule Zwickau (Germany) and Fraunhofer-Institut für Werkstoff- und Strahltechnik (Germany) ..... [11056-69]

16:20: **Diameter quantification of through holes in pipelines hidden by protective layers of composite materials using instantaneous shearography simultaneously in three shearing directions**, Tiago Bortoli, Analucia V. Fantin, Estiven S Barrera, Mauro E. Benedet, Daniel P. Willemann, Armando Albertazzi Gonçalves Jr., Univ. Federal de Santa Catarina (Brazil) ..... [11056-70]

16:40: **Photoacoustic inspection of CFRP using an optical microphone**, Janez Rus, Ctr. Baustoffe und Materialprüfung, Technische Univ. München (Germany); Balthasar Fischer, XARION Laser Acoustics GmbH (Austria); Christian U. Grosse, Ctr. Baustoffe und Materialprüfung, Technische Univ. München (Germany) ..... [11056-71]

17:00: **Development of a convolutional autoencoder using deep neuronal networks for defect detection and generating ideal references for cutting edges**, Abdullah Karatas, Dorothea Kölsch, Samuel Schmidt, Matthias Eifler, Jörg Seewig, Technische Univ. Kaiserslautern (Germany) ..... [11056-72]

17:20: **SS-OCT for automated composite manufacturing quality control**, Guy Lamouche, National Research Council Canada (Canada); Gil Lund, Fives Lund LLC (USA); Steven Roy, Bruno Gauthier, Marc Palardy-Sim, Maxime Rivard, Christian Padioleau, Jihua Chen, Jean-Pierre Monchalain, Ali Yousefpour, National Research Council Canada (Canada) ..... [11056-73]

17:40: **An automatic visual inspection system to scan outer lenses of automotive rear lamps**, Tommaso Fontanot, Univ. degli Studi di Trieste (Italy) and Automotive Lighting Rear Lamps Italia (Italy); Denis Ermacora, Giulio Simonetti, Sebastian Raducci, DataMind S.r.l. (Italy); Erik Vesselli, Univ. degli Studi di Trieste (Italy) and Istituto Officina dei Materiali (Italy); Sara Paroni, Automotive Lighting Rear Lamps Italia (Italy) ..... [11056-74]

# CONFERENCE 11057

LOCATION: MONDAY-WEDNESDAY AM: ICM, 12B; WEDNESDAY PM: ICM, 12A

Monday-Wednesday 24-26 June 2019 • Proceedings of SPIE Vol. 11057

## Modeling Aspects in Optical Metrology VII

Conference Chair: **Bernd Bodermann**, Physikalisch-Technische Bundesanstalt (Germany)

Conference Co-Chairs: **Karsten Frenner**, Institut für Technische Optik (Germany); **Richard M. Silver**, National Institute of Standards and Technology (USA)

Programme Committee: Markus Bär, Physikalisch-Technische Bundesanstalt (Germany); Jörg Bischoff, Osires Optical Engineering (Germany); Sven Burger, Konrad-Zuse-Zentrum für Informationstechnik (Germany); Peter Evanschitzky, Fraunhofer-Institut für Integrierte Systeme und Bauelemententechnologie IISB (Germany); Liwei Fu, Univ. Stuttgart (Germany); Wolfgang Holzapfel, DR. JOHANNES HEIDENHAIN GmbH (Germany); Norbert Kerwien, Carl Zeiss AG (Germany); Rainer Köning, Physikalisch-Technische Bundesanstalt (Germany); Stefanie Kroker, Physikalisch-Technische Bundesanstalt (Germany); Johannes Ruoff, Carl Zeiss SMT GmbH (Germany); Thomas Siefke, Physikalisch-Technische Bundesanstalt (Germany); Frank Wyrowski, Friedrich-Schiller-Univ. Jena (Germany)

### MONDAY 24 JUNE

#### WORLD OF PHOTONICS CONGRESS-WIDE PLENARY SESSION

LOCATION: 1ICM, SAAL 1 ..... MON 10:00 TO 11:00

#### Listening to the universe with gravitational waves

**Karsten Danzmann**, Max Planck Institute for Gravitational Physics  
and Leibnitz Univ. Hannover (Germany)

See details page 6.

Coffee Break ..... Mon 11:00 to 11:15

#### JOINT SESSION

LOCATION: ICM, ROOM 2 ..... MON 11:15 TO 12:45

#### SPIE Optical Metrology-EQEC 2019

Session Chair: **Bernd Bodermann**, Physikalisch-Technische  
Bundesanstalt (Germany)

#### Joint Session between SPIE Conference 11057 and CLEO EQEC 2019

11:15: **Numerical optimization of resonant photonic devices** (*Invited Paper*),  
Martin Hammerschmidt, Lin Zschiedrich, Philipp-Immanuel Schneider, Felix  
Binkowski, JCMwave GmbH (Germany); Sven Burger, Konrad-Zuse-Zentrum  
für Informationstechnik Berlin (Germany) .....[11057-101]

11:45: **Lensless metrology for semiconductor lithography at EUV** (*Invited  
Paper*), Iacopo Mochi, Paul Scherrer Institut (Switzerland) .....[11057-102]

12:15: **Metrology for and with nanooptics** (*Invited Paper*), Thomas Pertsch,  
Friedrich-Schiller-Univ. Jena (Germany) and Fraunhofer Institute for Applied  
Optics and Precision Engineering IOF (Germany) and Max Planck School of  
Photonics (Germany) .....[11057-103]

Lunch Break ..... Mon 12:45 to 13:50

LOCATION: ICM, 12B ..... 13:50 TO 14:00

#### Welcome and Introduction

#### SESSION 1

LOCATION: ICM, 12B ..... MON 14:00 TO 15:50

#### Interferometry I

Session Chair: **Wolfgang Holzapfel**, DR. JOHANNES HEIDENHAIN  
GmbH (Germany)

14:00: **Modeling the misalignment error in a solar system simulator for  
rotationally shearing interferometer** (*Invited Paper*), Marija Strojnik Scholl,  
Centro de Investigaciones en Óptica, A.C. (Mexico) .....[11057-1]

14:30: **Fractional Fourier ridges for demodulation of interferograms with  
quadratic phase**, Jinmin Wu, Mingfeng Lu, Chenchen Ji, Pei-Hang Li, Feng  
Zhang, Ran Tao, Beijing Institute of Technology (China) .....[11057-2]

14:50: **Suppression of nonlinear optical frequency sweeping in frequency-  
scanning interferometry for absolute distance measurement**, Zhongwen  
Deng, Zhigang Liu, Wen Deng, Xingyu Jia, Xi'an Jiaotong Univ.  
(China) .....[11057-3]

15:10: **Intrinsic surface feature-based subaperture stitching of freeform  
wavefront**, Kamal K. Pant, Instruments Research & Development Establishment  
(India); Dali R. Burada, Indian Institute of Technology Delhi (India); Vinod Mishra,  
CSIR - Central Scientific Instruments Organisation (India); Amitava Ghosh,  
Instruments Research & Development Establishment (India); Gufran S. Khan,  
Chandra Shaker, Indian Institute of Technology Delhi (India) .....[11057-4]

15:30: **Adjustable accurate phase shifter for phase-shifting interferometry**,  
Cruz Meneses-Fabian, Benemérita Univ. Autónoma de Puebla (Mexico);  
Rosaura Kantun-Montiel, Gildardo Pablo Lemus-Alonso, Univ. de Monterrey (Mexico) .....[11057-5]

Coffee Break ..... Mon 15:50 to 16:20

#### SESSION 2

LOCATION: ICM, 12B ..... MON 16:20 TO 18:10

#### Optical Materials/Imaging and Microscopy

Session Chair: **Stefanie Kroker**, Physikalisch-Technische  
Bundesanstalt (Germany)

16:20: **Modeling of bulk materials and nanostructures for applications  
in high-precision optical metrology** (*Invited Paper*), Stefanie Kroker,  
Physikalisch-Technische Bundesanstalt (Germany) and Technische Univ.  
Braunschweig (Germany); Florian Bruns, Johannes Dickmann, Physikalisch-  
Technische Bundesanstalt (Germany); Walter Dickmann, Jan Meyer, Technische  
Univ. Braunschweig (Germany); Carol B. Rojas Hurtado, Physikalisch-  
Technische Bundesanstalt (Germany) .....[11057-6]

16:50: **Modeling aspects for high-precision absorption measurements**,  
Walter Dickmann, Technische Univ. Braunschweig (Germany); Johannes  
Dickmann, Florian Bruns, Stefanie Kroker, Physikalisch-Technische  
Bundesanstalt (Germany) .....[11057-7]

17:10: **Large area metasurface lenses in the NIR region**, Mitchell Kenney,  
James Grant, Danni Hao, Univ. of Glasgow (United Kingdom); Kevin Docherty,  
Gordon Mills, Kelvin Nanotechnology Ltd. (United Kingdom); Graham Jeffrey,  
Leonardo MW Ltd. (United Kingdom); Donald Macleod, David Henry, UK  
Astronomy Technology Ctr. (United Kingdom); Peter MacKay, Gooch &  
Housego PLC (United Kingdom); Marc Sorel, Univ. of Glasgow (United  
Kingdom); Robert Lamb, Leonardo MW Ltd. (United Kingdom); David Cumming,  
Univ. of Glasgow (United Kingdom) .....[11057-8]

17:30: **Systematic approach on illustrating the challenges represented by  
optical bidirectional measurements using rigorous simulations**, Jan Krüger,  
Rainer Köning, Bernd Bodermann, Physikalisch-Technische Bundesanstalt  
(Germany) .....[11057-9]

17:50: **Model-based confocal fluorescence microscopy measurements of  
submerged micro geometries**, Merlin Mikulewitsch, Axel von Freyberg, Univ.  
Bremen (Germany); Dirk Stöbener, Universität Bremen (Germany) and MAPEX  
Centre for Materials and Processes, Univ. Bremen (Germany); Andreas Fischer,  
Universität Bremen (Germany) and MAPEX Centre for Materials and Processes  
(Germany) .....[11057-10]

#### WORLD OF PHOTONICS CONGRESS: NOBEL PLENARY SESSION

LOCATION: ICM, SAAL 1 ..... MON 18:00 TO 19:00

#### Passion for Extreme Light

**Gerard Mourou**, École Polytechnique (France)

2018 Physics Nobel Prize Laureate

For details, please see page 6.

TUESDAY 25 JUNE

SESSION 3

LOCATION: ICM, 12B ..... TUE 8:30 TO 10:00

3D and Shape Metrology

Session Chair: **Bryan M. Barnes**, National Institute of Standards and Technology (USA)

8:30: **Model based laser focus scanning: the path towards improved lateral resolution** (*Invited Paper*), Jörg Bischoff, Rostyslaw Mastylo, Technische Univ. Ilmenau (Germany); Gerard Granet, Université Clermont Auvergne, CNRS, SIGMA Clermont, Institut Pascal (France); Eberhard Manske, Technische Univ. Ilmenau (Germany) ..... [11057-11]

9:00: **Characterization of the topography fidelity of 3D optical microscopy**, Sai Gao, Physikalisch-Technische Bundesanstalt (Germany) ..... [11057-12]

9:20: **Simulation of 3D laser scanning with phase-based EDM for the prediction of systematic deviations**, Sukant Chaudhry, David Salido-Monzú, Andreas Wieser, ETH Zurich (Switzerland) ..... [11057-13]

9:40: **Design of a null-screen for a compact corneal topographer**, Manuel Campos-García, Daniel Aguirre-Aguirre, José Antonio Lechuga-Núñez, Andrés Peña-Conzuelo, Univ. Nacional Autónoma de México (Mexico) ..... [11057-14]

Coffee Break ..... Tue 10:00 to 10:30

SESSION 4

LOCATION: ICM, 12B ..... TUE 10:30 TO 12:30

Scatterometry

Session Chair: **Jörg Bischoff**, Osires Optical Engineering (Germany)

10:30: **Efficient global sensitivity analysis for silicon line gratings using polynomial chaos** (*Invited Paper*), Nando Farchmin, Sebastian Heidenreich, Markus Bär, Physikalisch-Technische Bundesanstalt (Germany); Martin Hammerschmidt, Philipp-Immanuel Schneider, JCMwave GmbH (Germany) and Zuse Institute Berlin (Germany) ..... [11057-15]

11:00: **Supplementing rigorous electromagnetic modeling with atomic simulations for optics-based metrology** (*Invited Paper*), Bryan M. Barnes, Hui Zhou, Richard M. Silver, Mark-Alexander Henn, National Institute of Standards and Technology (USA) ..... [11057-16]

11:30: **Benchmarking global optimization and machine learning methods for parameter reconstruction**, Philipp-Immanuel Schneider, Martin Hammerschmidt, Lin Zschiedrich, Sven Burger, JCMwave GmbH (Germany) ..... [11057-17]

11:50: **Reference-free GIXRF of nanostructures for element sensitive profile reconstruction**, Anna Andrie, Victor Soltwisch, Philipp Hönicke, Yves Kayser, Burkhard Beckhoff, Physikalisch-Technische Bundesanstalt (Germany); Philipp-Immanuel Schneider, Martin Hammerschmidt, JCMwave GmbH (Germany); Sven Burger, Konrad-Zuse-Zentrum für Informationstechnik Berlin (Germany) and JCMwave GmbH (Germany); Frank Scholze, Physikalisch-Technische Bundesanstalt (Germany) ..... [11057-18]

12:10: **Accurate and robust characterization of volume scattering materials using the intensity-based inverse adding-doubling method**, António Correia, Peter Hanselaer, Youri Meuret, KU Leuven (Belgium) ..... [11057-19]

Lunch Break ..... Tue 12:30 to 13:30

SESSION 5

LOCATION: ICM, 12B ..... TUE 13:30 TO 15:40

Mueller Matrix, Ellipsometry and Polarimetry

Session Chair: **Alois Herkommer**, Institut für Technische Optik (Germany)

13:30: **Tomographic Mueller-matrix scatterometry for nanostructure metrology: principle and opportunities** (*Invited Paper*), Xiuguo Chen, Shiyuan Liu, Huazhong Univ. of Science and Technology (China) ..... [11057-20]

14:00: **Polarization metrology for high numerical aperture DUV objectives**, Robert D. Grejda, Paul F. Michaloski, Duncan C. Spaulding, Stephen K. Mack, Robert L. Michaels, Paul G. Dewa, David L. Aronstein, Corning Tropol Corp. (USA) ..... [11057-21]

14:20: **Vectorial modeling for the image formation of a high-numerical-aperture Mueller-matrix ellipsometer**, Cai Wang, Chao Chen, Xiuguo Chen, Shiyuan Liu, Huazhong Univ. of Science and Technology (China) ..... [11057-22]

14:40: **Mueller matrix ellipsometry for enhanced optical form metrology of sub-lambda structures**, Tim Käseberg, Johannes Dickmann, Physikalisch-Technische Bundesanstalt (Germany); Thomas Siefke, Friedrich-Schiller-Univ. Jena (Germany) and Physikalisch-Technische Bundesanstalt (Germany); Stefanie Kroker, Technische Univ. Braunschweig (Germany) and Physikalisch-Technische Bundesanstalt (Germany); Bernd Bodermann, Physikalisch-Technische Bundesanstalt (Germany) ..... [11057-23]

15:00: **An improved method to derive best-fit parameters and their uncertainties from depolarizing Mueller-matrices**, Tobias Grunewald, Physikalisch-Technische Bundesanstalt (Germany); Matthias Wurm, Sven Teichert, Bernd Bodermann, Physikalisch-Technische Bundesanstalt (Germany); Johanna Reck, Uwe Richter, SENTECH Instruments GmbH (Germany) ..... [11057-24]

15:20: **Fast compressed channeled spectropolarimeter for full Stokes vector measurement**, Guodong Zhou, Yanqiu Li, Jianhui Li, Jiazhi Wang, Beijing Institute of Technology (China) ..... [11057-25]

Coffee Break ..... Tue 15:40 to 16:10

SESSION 6

LOCATION: ICM, 12B ..... TUE 16:10 TO 17:30

Interferometry II

Session Chair: **Giancarlo Pedrini**, Institut für Technische Optik (Germany)

16:10: **An improved control structure for the tracking of sine command in a motion simulator**, Bernard Vau, iXBlue SAS (France); Damien Ponceau, iXBlue Motion Systems (France); Mehdi Bussutil, iXBlue SAS (France) ..... [11057-26]

16:30: **Physical optics modeling of interferometer-based metrology systems**, Site Zhang, LightTrans International UG (Germany); Huiying Zhong, Rui Shi, Friedrich-Schiller-Univ. Jena (Germany); Christian Hellmann, Wyrowski Photonics UG (Germany); Frank Wyrowski, Friedrich-Schiller-Univ. Jena (Germany) ..... [11057-27]

16:50: **Extending wavefront sensing range of phase diversity**, Zhao-jun Yan, Shanghai Astronomical Observatory (China); Pengqian Yang, Shanghai Institute of Optics and Fine Mechanics (China) ..... [11057-29]

17:10: **Faster region-based convolutional neural network method for estimating parameters from Newton's rings**, Chenchen Ji, Mingfeng Lu, Jinmin Wu, Zhen Guo, Feng Zhang, Ran Tao, Beijing Institute of Technology (China) ..... [11057-30]

WEDNESDAY 26 JUNE

**SPIE OPTICAL METROLOGY PLENARY SESSION**

**LOCATION: ICM, SAAL 1 ..... WED 10:30 TO 11:25**

**Towards a complete framework for calibration of optical surface and coordinate measuring instruments**

**Richard Leach, Univ. of Nottingham (United Kingdom)**

*For details, please see page 7.*

**POSTERS-WEDNESDAY**

**LOCATION: ICM, HALL BO ..... WED 11:30 TO 12:30**

Conference attendees are invited to attend the Optical Metrology Poster Session 2 on Wednesday. Come view the posters and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Posters will be available for viewing starting at 11:30 through 12:30 hrs on Wednesday. Poster authors, view poster presentation guidelines and set-up instructions on page 6, and at <http://spie.org/x6513.xml>. (Follow the Special Events link)

**Determination of the reference length to increase the accuracy of measuring the optical thickness of the layers during the production of interference coatings**, Thai Phi Ngo, Lyudmila Aleksandrovna Gubanova, Pham Van Hoa, ITMO Univ. (Russian Federation) ..... [11057-42]

**Development of a measuring system based on the principles of stereo vision**, Kseniia Ezhova, Duy Hung Nguyen, ITMO Univ. (Russian Federation) ..... [11057-43]

**Modelling of direct laser writing in multilayer absorbing medium**, Anton V. Saetchnikov, Ruhr-Univ. Bochum (Germany); Elina Tcherniavskaja, Vladimir Saetchnikov, Belarusian State Univ. (Belarus); Andreas Ostendorf, Ruhr-Univ. Bochum (Germany) ..... [11057-44]

**Phase dispersion measurement on laser mirrors using fringe-free spectral interferometry**, Katalin Csonti, ELI-HU Nonprofit Kft. (Hungary); Attila Pál Kovács, ELI-HU Nonprofit Kft. (Hungary) and Univ. of Szeged (Hungary); Gergő Mészáros, ELI-HU Nonprofit Kft. (Hungary) ..... [11057-45]

**Enhancing detail of 3D terrain models using GAN**, Vladimir S. Gorbatshevich, Mikhail Melnechenko, Oleg Vygodov, GosNIIAS (Russian Federation) [11057-46]

**Modeling of spectroradiometric error due to unoptimized choice of array photodetector for integrated photosynthetically active radiation spectroradiometer**, Sergei S. Baev, Valery V. Korotaev, ITMO Univ. (Russian Federation); Vladimir N. Kuzmin, TKA Scientific Instruments (Russian Federation); Ivan S. Nekrylov, ITMO Univ. (Russian Federation); Joel Jose Puca Coelho Rodrigues, National Institute of Telecommunications (Inatel) (Brazil); Konstantin A. Tomskiy, TKA Scientific Instruments (Russian Federation) ..... [11057-47]

**Optical attachment for spatial conversion shape and divergence of UV laser output beam**, Aleksandr S. Grishkanich, Aleksandr Zhevlakov, ITMO Univ. (Russian Federation) ..... [11057-48]

**High-order transmissive diffraction grating for high-resolution spectral systems**, Vasily I. Kazakov, Oleg D. Moskaletz, Mikhail A. Vaganov, Saint-Petersburg State Univ. of Aerospace Instrumentation (Russian Federation) ..... [11057-49]

**Analysis of LAD on eXTP for space optical environment**, Tao Luo, Yupeng Xu, Wei Li, Institute of High Energy Physics (China) ..... [11057-50]

**Comparison of SCC and OCV-based maximum power point tracking algorithms with hybrid method that uses a light and temperature sensors in the real shading conditions**, Mariusz Ostrowski, Wroclaw Univ. of Science and Technology (Poland) ..... [11057-51]

**Error estimation due to approximations in Shack-Hartmann sensor based measurement of high slope freeform wavefront**, Ashish Dwivedi, Kamal K. Pant, Dali R. Burada, Gufran S. Khan, Anurag Sharma, Indian Institute of Technology Delhi (India) ..... [11057-52]

**Development of the device for positioning control mirrors**, Igor V. Lapkaev, Anastasiya D. Kozhina, Vasilisa V. Ezhova, Zlobin A. Dmitriy, Dmitriy D. Zharov, ITMO Univ. (Russian Federation) ..... [11057-53]

**Calculation of intensity distribution from a wavefront using ray-counting method**, Manuel Campos-García, Univ. Nacional Autónoma de México (Mexico); Ángel Eugenio Martínez-Rodríguez, Fermín Salomon Granados-Agustín, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico) ..... [11057-54]

**A method for improving the accuracy of an extinction coefficient measurement of weakly absorbing interference layers**, Van Ba Nguyen, Lyudmila Aleksandrovna Gubanova, ITMO Univ. (Russian Federation); Dinh Bao D. B. Bui, Le Quy Don Technical Univ. (Viet Nam) ..... [11057-55]

**Evaluation of the aberrations of a PDMS lens**, Manuel Campos-García, Univ. Nacional Autónoma de México (Mexico); Ángel Eugenio Martínez-Rodríguez, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico); Oliver Huerta-Carranza, Celestino Vargas-Alfredo, Univ. Nacional Autónoma de México (Mexico); Agustín Santiago-Alvarado, Univ. Tecnológica de la Mixteca (Mexico); Victor Iván Moreno-Oliva, Univ. del Istmo (Mexico) ..... [11057-56]

**Modelling and tolerance analysis of volume-phase gratings in complex dispersive units**, Andrey Melnikov, OJSC "Scientific and Production Association State Institute of Applied Optics" (Russian Federation); Maxim Bakshaev, Kazan National Research Technical Univ. A.N. Tupoleva - KAI (Russian Federation); Eduard R. Muslimov, Lab. d'Astrophysique de Marseille (France) and Kazan National Research Technical Univ. A.N. Tupolev - KAI (Russian Federation); Ilya Guskov, Kazan National Research Technical Univ. A.N. Tupoleva - KAI (Russian Federation) ..... [11057-57]

**A fully coupled diffusional-mechanical formulation for growth kinetics of precipitates in laser powder bed fusion process using a phase field approach**, Fikret K. Mirzade, Institute of Laser and Information Technologies of the RAS (Russian Federation) ..... [11057-58]

**On modeling of heat transfer and molten pool behavior in multilayer and multitrack laser additive manufacturing process**, Alexander V. Dubrov, Fikret K. Mirzade, Institute of Laser and Information Technologies of the RAS (Russian Federation); Vladimir D. Dubrov, Institute on Laser and Information Technologies of the RAS (Russian Federation) ..... [11057-59]

**A flexible and simplified calibration procedure for fringe projection profilometry**, Raúl Vargas, Andrés Marrugo, Jesus Pineda, Lenny Romero, Univ. Tecnológica de Bolívar (Colombia) ..... [11057-60]

**Measurement of errors by axial misalignment and tilt of the null screen used in experimental arrangements by deflectometry**, Diana Nallely Castán-Ricaño, Fermín S. Granados-Agustín, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico); Andrea F. Muñoz-Potosi, Gabriel Valdivieso-González, Univ. de Investigación y Desarrollo (Colombia); María Elizabeth Percino-Zacarias, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico); Maximino Avedaño-Alejo, Univ. Nacional Autónoma de México (Mexico); Alejandro Cornejo-Rodríguez, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico) ..... [11057-61]

**Design of a two-mirror telescope using a freeform surface for the primary mirror**, Jorge de Jesús Alvarado-Martínez, F. Granados Agustín, Sergio Vázquez y Montiel, María Elizabeth Percino-Zacarias, Alejandro Cornejo-Rodríguez, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico) ..... [11057-62]

Lunch Break ..... Wed 12:30 to 13:40

**SESSION 7**

**LOCATION: ICM, 12A ..... WED 13:40 TO 15:30**

**Photometry and Radiometry**

Session Chair: **Wolfgang Osten, Univ. Stuttgart (Germany)**

**Please note the room change**

13:40: **Hyperspectral imager calibration using ceramic color tiles** (*Invited Paper*), Matti A. Eskelinen, Univ. of Jyväskylä (Finland); Clarence J. Zarobila, David W. Allen, National Institute of Standards and Technology (USA) ..... [11057-31]

14:10: **Performance enhancement of a BRDF test bench using an algorithm feed with laser-tracker measurements**, Lionel Clermont, Céline Michel, Emmanuel Mazy, Ctr. Spatial de Liège (Belgium) ..... [11057-32]

14:30: **Simulation of computational ghost imaging: application for 3D measurement**, Christoph Freitag, Peter Kühmstedt, Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany); Gunther Notni, Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany) and Ilmenau University of Technology (Germany); Herbert Gross, Institute of Applied Physics, Abbe Center of Photonics, Friedrich Schiller University Jena (Germany) ..... [11057-33]

14:50: **Anomaly detection method of satellites working status based on photometric data**, Can Xu, Peng Li, Xia Wang, Space Engineering Univ. (China) ..... [11057-34]

15:10: **Wavefront and focal spot control of the SG II petawatt laser facility**, Pengqian Yang, Shanghai Institute of Optics and Fine Mechanics (China); Zhaojun Yan, Shanghai Astronomical Observatory (China); Yong Cui, Quantang Fan, Zhuocai Jiang, Liangjun Zhang, Guang Xu, Jian Zhu, Jianqiang Zhu, Shanghai Institute of Optics and Fine Mechanics (China) ..... [11057-35]

Coffee Break ..... Wed 15:30 to 16:00



SESSION 8

LOCATION: ICM, 12A ..... WED 16:00 TO 18:00

**Optical Systems**

Session Chair: **Karsten Frenner**, Institut für Technische Optik  
(Germany)

**Please note the room change**

16:00: **Modelling of coherence scanning interferometry for complex surfaces based on a boundary element method**, Matthew Thomas, Rong Su, The Univ. of Nottingham (United Kingdom); Nikolay Nikolaev, Jeremy M. Coupland, Loughborough Univ. (United Kingdom); Richard Leach, The Univ. of Nottingham (United Kingdom). . . . . [11057-36]

16:20: **Optical time domain reflectometer for precision measurement of signal delay in optical fiber**, Sergey S. Donchenko, Oleg Kolmogorov, Dmitrie Prokhorov, Ekaterina Chemesova, VNIIFTRI (Russian Federation). . . [11057-37]

16:40: **ELT-HIRES the high-resolution spectrograph for the ELT: simulation results of polarimetric aberrations for the polarimetric module**, Igor Di Varano, Manfred Woche, Michael Weber, Klaus G. Strassmeier, Leibniz-Institut für Astrophysik Potsdam (Germany); Shu Yuan, Yunnan Astronomical Observatories (China) . . . . . [11057-38]

17:00: **Estimation of reflectance factors and their uncertainties from multiple measurements**, Matti A. Eskelinen, Univ. of Jyväskylä (Finland); John Lu, National Institute of Standards and Technology (USA). . . . . [11057-39]

17:20: **Superaccurate camera calibration via inverse rendering**, Morten Hannemose, Technical Univ. of Denmark (Denmark); Jakob Wilm, University of Southern Denmark (Denmark) and University of Southern Denmark (Denmark); Jeppe Revall Frisvad, Technical Univ. of Denmark (Denmark) . . . . . [11057-40]

17:40 **Transmission telescope optical metrology**, Viviana Vladutescu, New York City College of Technology (USA); Aaron J. Swank, Dzu K. Le, Calvin R. Robinson, Félix A. Miranda, NASA Glenn Research Ctr. (USA); Victor Pena, Baruch College (USA); Katherine Chun, Univ. of Washington (USA) . [11057-63]

LOCATION: ICM, 12A ..... 18:00 TO 18:10

**Closing Remarks**

# CONFERENCE 11058

LOCATION: ICM, 12A

Monday–Wednesday 24–26 June 2019 • Proceedings of SPIE Vol. 11058

## Optics for Arts, Architecture, and Archaeology VII

Conference Chairs: **Haida Liang**, Nottingham Trent Univ. (United Kingdom); **Roger Groves**, Technische Univ. Delft (Netherlands)

Conference Co-Chair: **Piotr Targowski**, Nicolaus Copernicus Univ. (Poland)

Programme Committee: Dario Ambrosini, Univ. degli Studi dell'Aquila (Italy); Marta Castillejo, Consejo Superior de Investigaciones Científicas (Spain); Daniela Comelli, Politecnico di Milano (Italy); Claudia Daffara, Univ. degli Studi di Verona (Italy); Vincent Detalle, Centre de Recherche et de Restauration des Musées de France (C2RMF) (France); John K. Delaney, National Gallery of Art (USA); Martin C. Fischer, Duke Univ. (USA); Raffaella E. M. Fontana, Istituto Nazionale di Ottica (Italy); Igor P. Gurov, ITMO Univ. (Russian Federation); Alexander J. Kossolapov, State Hermitage Museum (Russian Federation); Gaël Latour, Univ. Paris-Sud (France); Nicola Masini, Consiglio Nazionale delle Ricerche (Italy); Luca Pezzati, Istituto Nazionale di Ottica-CNR (Italy); David R. Saunders, International Institute for Conservation (United Kingdom); Robert Sitnik, Warsaw Univ. of Technology (Poland); Vivi Tornari, Foundation for Research and Technology-Hellas (Greece)

### MONDAY 24 JUNE

#### SESSION 1

LOCATION: ICM, 12A ..... MON 8:30 TO 10:00

#### 3D Tomography: Applications

Session Chair: **Luca Pezzati**, Istituto Nazionale di Ottica-CNR (Italy)

8:30: **Nondestructive observation of multilayered modern paintings by electromagnetic waves** (*Invited Paper*), Kaori Fukunaga, National Institute of Information and Communications Technology (Japan); Yoshimi Ueno, CRS Corp. (Japan); Yasunobu Ito, Ikea Museum of 20th Century Art (Japan) .....[11058-1]

9:00: **A noninvasive investigation of Limoges enamels using both optical coherence tomography (OCT) and spectral imaging**, Margaret Read, Nottingham Trent Univ. (United Kingdom) and The British Museum (United Kingdom); Chi Shing Cheung, Haida Liang, Nottingham Trent Univ. (United Kingdom); Denise Ling, Capucine Korenberg, The British Museum (United Kingdom) .....[11058-2]

9:20: **Nd:YAG vs Er:YAG : a comparative study of laser varnish removal on easel paintings**, Maxime Lopez, Ctr. de Recherche et de Restauration des Musées de France (France); Xueshi Bai, Ctr. de Recherche et de Restauration des Musées de France (France) and Ctr. de Recherche sur la Conservation des Musées de France (France); Corinna Koch-Dandolo, Ctr. de Recherche et de Restauration des Musées de France (France) and Fondation des Sciences du Patrimoine (France); Stéphane Serfaty, Nicolas Wilkie-Chancellor, Univ. de Cergy-Pontoise (France); Vincent Detalle, Ctr. de Recherche et de Restauration des Musées de France (France) .....[11058-3]

9:40: **An exploratory study for the noninvasive detection of metal soaps in paintings through optical coherence tomography**, Alessandra Vichi, Chi Shing Cheung, Haida Liang, Nottingham Trent Univ. (United Kingdom); Daniela Comelli, Alessia Artesani, Gianluca Valentini, Politecnico di Milano (Italy); Austin Nevin, CNR-Istituto di Fotonica e Nanotecnologie (Italy); Anna Piccirillo, Fondazione Centro Conservazione e Restauro dei Beni Culturali La Venaria Reale (Italy); Tommaso Poli, Univ. degli Studi di Torino (Italy); Paola Croveri, Univ. degli Studi di Torino (Italy) and Fondazione Centro Conservazione e Restauro dei Beni Culturali La Venaria Reale (Italy) .....[11058-4]

#### WORLD OF PHOTONICS CONGRESS-WIDE PLENARY SESSION

LOCATION: 11CM, SAAL 1 ..... MON 10:00 TO 11:00

#### Listening to the universe with gravitational waves

**Karsten Danzmann**, Max Planck Institute for Gravitational Physics and Leibnitz Univ. Hannover (Germany)

See details page 6.

Coffee Break ..... Mon 11:00 to 11:15

#### SESSION 2

LOCATION: ICM, 12A ..... MON 11:20 TO 13:10

#### Light-Matter Interaction and Nonlinear Optics

Session Chair: **John K. Delaney**, National Gallery of Art (USA)

11:20: **The study of the degradation of cadmium yellow paints through their photoluminescence emission from trap states** (*Invited Paper*), Daniela Comelli, Marta Ghirardello, Gianluca Valentini, Politecnico di Milano (Italy); Austin Nevin, CNR-Istituto di Fotonica e Nanotecnologie (Italy); Douglas MacLennan, Alan Phenix, Catherine Schmidt Patterson, Herant Khanjian, Karen Trentelman, The Getty Conservation Institute (USA); Lucia Toniolo, Politecnico di Milano (Italy); Aviva Burnstock, Courtauld Institute of Art (United Kingdom); Markus Gross, Fondation Beyeler (Switzerland) .....[11058-5]

11:50: **Visualization of vermilion degradation using pump-probe microscopy**, Martin C. Fischer, Jin Yu, Warren S. Warren, Duke Univ. (USA) .....[11058-6]

12:10: **Determination of thresholds for safe analyses of acrylic paintings by nonlinear optical microscopy**, Mikel Sanz, Mohamed Oujja, Consejo Superior de Investigaciones Científicas (Spain); Raffaella E. M. Fontana, Riccardo Cicchi, Alice Dal Fovo, Sara Mattana, Consiglio Nazionale delle Ricerche, Istituto Nazionale di Ottica (Italy); Marco Marchetti, LENS - Lab. Europeo di Spettroscopia Non-Lineari (Italy); Marta Castillejo, Consejo Superior de Investigaciones Científicas (Spain) .....[11058-7]

12:30: **The potential of nonlinear optical microscopy to noninvasively quantify the degradation state of historical parchments**, Margaux Schmelz, Lab. d'Optique et Biosciences (France); Laurianne Robinet, Ctr. de Recherche sur la Conservation (France) and Muséum national d'Histoire naturelle, Ctr. de Recherche sur la Conservation (France); Sylvie Thao, Ctr. de Recherche sur la Conservation (France); Claire Teulon, Guillaume Ducourthial, Marie-Claire Schanne-Klein, Lab. d'Optique et Biosciences (France); Gaël Latour, Imagerie et Modélisation en Neurobiologie et Cancérologie (France) and Univ. Paris-Sud (France) and Univ. Paris-Saclay (France) .....[11058-8]

12:50: **A study on the coloring mechanism of famous ancient Chinese ceramics**, Weidong Li, Shanghai Institute of Ceramics (China) .....[11058-9]

Lunch Break ..... Mon 13:10 to 14:10

#### SESSION 3

LOCATION: ICM, 12A ..... MON 14:10 TO 15:50

#### Imaging and Spectroscopy for Material Analysis

Session Chair: **Martin C. Fischer**, Duke Univ. (USA)

14:10: **A hyperspectral camera for conservation science, based on a birefringent ultrastable common path interferometer**, Cristian Manzoni, CNR-IFN Padova (Italy) and Politecnico di Milano (Italy); Antonio Perri, Politecnico di Milano (Italy); Bárbara E. Nogueira de Faria, Danielle C. Teles Ferreira, Univ. Federal de Minas Gerais (Brazil); Dario Polli, Daniela Comelli, Gianluca Valentini, Giulio N. Cerullo, Politecnico di Milano (Italy) .....[11058-10]

14:30: **Maximizing the microscope: instrument design and data processing strategies for hyperspectral imaging of cross-sectional cultural heritage samples**, Lindsay Oakley, Marc S. Walton, Northwestern Univ. (USA)[11058-11]

TUESDAY 25 JUNE

## SESSION 5

LOCATION: ICM, 12A ..... TUE 8:10 TO 10:00

### Optical Coherence Tomography: Instruments and Methods

Session Chair: **Gaël Latour**, Univ. Paris-Sud (France)

8:10: **Multiscale optical coherence tomography imaging of "The girl with a pearl earring"** (*Invited Paper*), Jeroen Kalkman, Joris Dik, Tom Callewaert, Technische Univ. Delft (Netherlands) ..... [11058-20]

8:40: **High-penetration high-resolution time domain optical coherence tomography for cultural heritage applications**, Bingjie Xu, Kuan He, Pengxiao Hao, Jian Gao, Florian Willomitzer, Aggelos K. Katsaggelos, John E. Tumblyn, Oliver Cossairt, Marc S. Walton, Northwestern Univ. (USA) [11058-21]

9:00: **Multimodal mid-infrared optical coherence tomography for art diagnosis**, Ivan Zorin, RECENDT (Austria) ..... [11058-22]

9:20: **Simultaneous measurement of refractive index and dispersion using optical coherence tomography for the conservation of plastic sculptures**, Mixon Faluweki, Haida Liang, Chi Shing Cheung, Nottingham Trent Univ. (United Kingdom) ..... [11058-23]

9:40: **Noninvasive depth-resolved material characterisation using OCT and spectral imaging**, Patrick S. Atkinson, Chi Shing Cheung, Haida Liang, Nottingham Trent Univ. (United Kingdom); Catherine Higgitt, Marika Spring, The National Gallery (United Kingdom) ..... [11058-24]

Coffee Break ..... Tue 10:00 to 10:30

## SESSION 6

LOCATION: ICM, 12A ..... TUE 10:30 TO 11:30

### Advanced Image Processing

Session Chair: **Marta Castillejo**, Consejo Superior de Investigaciones Científicas (Spain)

10:30: **A novel methodology for the automatic analysis of large collections of paintings**, Sotiria Kogou, Nottingham Trent Univ. (United Kingdom); Lynn Lee, The Getty Conservation Institute (USA); Golnaz Shahtahmassebi, Haida Liang, Nottingham Trent Univ. (United Kingdom) ..... [11058-25]

10:50: **MID-FTIR macro mapping and clustering-based automatic brushing: an advanced diagnostic tool for in situ investigations of artworks**, Emilio Catelli, Giorgia Scitutto, Silvia Prati, Univ. degli Studi di Bologna (Italy); Paolo Oliveri, Univ. degli Studi di Genova (Italy); Stijn Legrand, Koen Janssens, Univ. Antwerpen (Belgium); Rocco Mazzeo, Univ. degli Studi di Bologna (Italy) ..... [11058-26]

11:10: **Unbending light: new computational methods for the correction of 3D effects in scanning XRF**, Monica Gano, The Getty Conservation Institute (USA); Stephen Parsons, Seth Parker, Univ. of Kentucky (USA); Marie Svoboda, J. Paul Getty Museum (USA); Brent Seales, Univ. of Kentucky (USA); Catherine Schmidt Patterson, The Getty Conservation Institute (USA) ..... [11058-27]

## SESSION 7

LOCATION: ICM, 12A ..... TUE 11:30 TO 12:30

### Poster Pitch Presentations

Session Chair: **Vivi Tornari**, Foundation for Research and Technology-Hellas (Greece)

Three-minute oral presentations (poster pitch presentations) will take place in the conference room. Each brief poster overview will consist of three-minute talk including no more than three slides (powerpoint presentation) as part of this presentation. Poster Pitch Session will be followed by the official conference Poster Session 12.30 to 13.10 hrs in the designated area in Hall B1 with all posters on display and authors present at their posters.

**The metallography and corrosion of an ancient Chinese bimetallic bronze sword** ..... [11058-45]

**Analytical characterization of gold leaves of forth (innermost) shrine of the King Tut Ankh Amun** ..... [11058-46]

**Fluorescence lifetime imaging a good approach to revealed gilded and polychromed surface under black encrustation of marble object**[11058-47]

**Colour and spectral characterisation of the particulate matter deposited on the mosaic at the House of Hippolytus in Complutum (Spain)**[11058-48]

**Follow up of restoration of works of art of the patrimony by infrared thermography** ..... [11058-49]

14:50: **Methodological considerations regarding the problem of apparent versus intrinsic fluorescence properties of historical paint layers**, Fabien Pottier, Anne Michelin, Christine Andraud, Ctr. de recherche sur la conservation des collections, Muséum national d'Histoire naturelle (France); Fabrice Goubard, Univ. de Cergy-Pontoise (France); Bertrand Lavédrine, Ctr. de recherche sur la conservation des collections, Muséum national d'Histoire naturelle (France) ..... [11058-12]

15:10: **Investigation of reflectance-based pigment classification in layered media**, Lionel Fiske, Oliver Cossairt, Aggelos K. Katsaggelos, Marc S. Walton, Northwestern Univ. (USA) ..... [11058-13]

15:30: **Development of a hyperspectral imaging setup for the noninvasive identification and mapping of unstable corrosion products in ancient bronze**, Alessandra Vichi, Alex Hogg, Nottingham Trent Univ. (United Kingdom); Wei Liu, National Museum of China (China); Sotiria Kogou, Haida Liang, Nottingham Trent Univ. (United Kingdom) ..... [11058-58]

Coffee Break ..... Mon 15:50 to 16:15

## SESSION 4

LOCATION: ICM, 12A ..... MON 16:15 TO 17:55

### Structural Analysis

Session Chair: **Robert Sitnik**, Warsaw Univ. of Technology (Poland)

16:15: **Deformation measurement of large buildings by holographical point replication**, Flavio S. Guerra, Simon Hartlieb, Tobias Haist, Alexander Warsawa, Wolfgang Osten, Oliver Sawodny, Univ. Stuttgart (Germany) ..... [11058-15]

16:35: **Combined hardware and software approaches for infrared thermographic analysis of wall paintings**, Kamel Mouhoubi, Jean Luc Bodnar, Univ. de Reims Champagne-Ardenne (France); Vincent Detalle, Ctr. de Recherche et de Restauration des Musées de France (France); Jean-Marc Vallet, Ctr. Interrégional de Conservation et Restauration du Patrimoine (France) ..... [11058-16]

16:55: **Comparison of induced thermal change to climate chamber simulated environmental change in mosaic model by digital holographic speckle pattern interferometry (DHSPi)**, Antonina Chaban, Univ. degli Studi di Padova (Italy); Vivi Tornari, Institute of Electronic Structure and Laser, Foundation for Research and Technology-Hellas (Greece); Michalis Andrianakis, Foundation for Research and Technology-Hellas (Greece); Rita Deiana, Univ. degli Studi di Padova (Italy) ..... [11058-17]

17:15: **X-ray tomography and aggregated analysis for Bavay treasure bronze statuettes analysis**, Clotilde Boust, Elsa Lambert, Charlotte Hochart, Benoît Mille, Ctr. de Recherche et de Restauration des Musées de France (France) ..... [11058-18]

17:35: **Use of 3D laser scanning for documentation, digital reconstruction and physical replication of sculptural monuments**, Vadim Parfenov, Saint Petersburg Electrotechnical Univ. "LETI" (Russian Federation) ..... [11058-19]

### WORLD OF PHOTONICS CONGRESS: NOBEL PLENARY SESSION

LOCATION: ICM, SAAL 1 ..... MON 18:00 TO 19:00

### Passion for Extreme Light

**Gerard Mourou**, École Polytechnique (France)

2018 Physics Nobel Prize Laureate

For details, please see page 6.

# CONFERENCE 11058

**High-resolution visible and infrared imaging for large paintings: a case study of Israel in Egypt by Poynter** ..... [11058-50]

**Tattoo Wall@: study of the stability of an innovative decorative technique through hyperspectral imaging and possible application in the mural painting's restoration** ..... [11058-51]

**In-situ nondestructive detection and analysis of the structure of clay statue cultural heritage** ..... [11058-52]

**Early detection of biofilm development on stone monuments thanks to pulsed IRT and SVD** ..... [11058-53]

**Evaluation methods of effect of cleaning techniques on library collagen materials** ..... [11058-54]

**Method for the analysis of spectral Imaging data from Tang Tomb murals** ..... [11058-55]

**Smartphone diagnostics for cultural heritage** ..... [11058-56]

**Scanning the Celts: evaluation of 2D and 3D techniques in protohistoric archaeology** ..... [11058-57]

**Machine learning analysis of illuminated Southeast Asian manuscripts using complementary noninvasive imaging techniques** ..... [11058-59]

**Comprehensive study of the fresco of Raphael's workshop "Venus tying a sandal" from the State Hermitage Museum's collection** ..... [11058-60]

**Non-artistic materials in artistic works by David Lynch: multidisciplinary approach** ..... [11058-61]

**Incrustation of ancient Saka scabbard: material studies by Raman and FTIR spectroscopy** ..... [11058-62]

**Development of a drone-based spectral imaging system for archaeological applications** ..... [11058-63]

## POSTERS TUESDAY

**LOCATION: ICM, HALL B0 ..... TUE 12:30 TO 13:10**

Conference attendees are invited to attend the Digital Optical Technologies Poster Session 1 on Tuesday. Come view the posters and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Posters will be available for viewing starting at 12:30 through 13:10 hrs on Tuesday. Poster authors, view poster presentation guidelines and set-up instructions on page 6, and at <http://spie.org/x6513.xml> . (Follow the Special Events link)

**The metallography and corrosion of an ancient Chinese bimetallic bronze sword**, Wei Huang, China Numismatic Museum (China) ..... [11058-45]

**Analytical characterization of gold leaves of forth (innermost) shrine of the King Tut Ankh Amun**, Mohamed Abdel Aziz, The Grand Egyptian Museum (Egypt) ..... [11058-46]

**Fluorescence lifetime imaging a good approach to revealed gilded and polychromed surface under black encrustation of marble object**, Eman Taha, The Grand Egyptian Museum (Egypt) ..... [11058-47]

**Colour and spectral characterisation of the particulate matter deposited on the mosaic at the House of Hippolytus in Complutum (Spain)**, Cristina Cabello-Briones, Univ. Autónoma de Madrid (Spain); Santiago Mayorga-Pinilla, Daniel Vázquez-Moliní, Univ. Complutense de Madrid (Spain); Joaquín Barrio-Martín, Univ. Autónoma de Madrid (Spain) ..... [11058-48]

**Follow up of restoration of works of art of the patrimony by infrared thermography**, Kamel Mouhoubi, Jean Luc Bodnar, Univ. de Reims Champagne-Ardenne (France); Vincent Detalle, Ctr. de Recherche et de Restauration des Musées de France (France); Jean-Marc Vallet, Ctr. Interrégional de Conservation et Restauration du Patrimoine (France) [11058-49]

**High-resolution visible and infrared imaging for large paintings: a case study of Israel in Egypt by Poynter**, Charles Willard, Adam P. Gibson, Univ. College London (United Kingdom); Nancy Wade, Guildhall Art Gallery (United Kingdom) ..... [11058-50]

**Tattoo Wall@: study of the stability of an innovative decorative technique through hyperspectral imaging and possible application in the mural painting's restoration**, Giorgia Agresti, Univ. degli Studi della Toscana (Italy); Giuseppe Bonifazi, Giuseppe Capobianco, Sapienza Univ. di Roma (Italy); Claudia Pelosi, Univ. degli Studi della Toscana (Italy); Silvia Serranti, Sapienza Univ. di Roma (Italy); Antonella Veneri, Univ. degli Studi della Toscana (Italy) ..... [11058-51]

**In-situ nondestructive detection and analysis of the structure of clay statue cultural heritage**, Ke Bai, Shaanxi Institute for the Preservation of Cultural (China) ..... [11058-52]

**Stimulated IRT for detection of bacterial biofilm on building limestones**, Stéphanie Eyssautier, Kamel Mouhoubi, Fany Reffluveille, Jean Luc Bodnar, Univ. de Reims Champagne-Ardenne (France) ..... [11058-53]

**Evaluation methods of effect of cleaning techniques on library collagen materials**, Magda Součková, Jitka Neoralová, Petra Vávrová, The National Library of the Czech Republic (Czech Republic); Ludmila Mašková, Jiří Smolík, Institute of Chemical Process Fundamentals of the CAS, v.v.i. (Czech Republic) ..... [11058-54]

**Method for the analysis of spectral Imaging data from Tang Tomb murals**, Qunxi Zhang, Shaanxi History Museum (China); Jun Wang, Zhenrong Sun, Yongqin Zhang, Jinye Peng, Northwest Univ. (China); Haida Liang, Nottingham Trent Univ. (United Kingdom) ..... [11058-55]

**Smartphone diagnostics for cultural heritage**, Claudia Daffara, Univ. degli Studi di Verona (Italy) and Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello", Consiglio Nazionale delle Ricerche (Italy); Giacomo Marchioro, Univ. degli Studi di Verona (Italy); Dario Ambrosini, Univ. degli Studi dell'Aquila (Italy) and Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello", Consiglio Nazionale delle Ricerche (Italy) ... [11058-56]

**Scanning the Celts: evaluation of 2D and 3D techniques in protohistoric archaeology**, Charlotte Hochart, Elsa Lambert, Ctr. de Recherche et de Restauration des Musées de France (France) ..... [11058-57]

**Machine learning analysis of illuminated Southeast Asian manuscripts using complementary noninvasive imaging techniques**, Luke Butler, Sotiria Kogou, Yu Li, Chi Shing Cheung, Haida Liang, Nottingham Trent Univ. (United Kingdom); Annabel T. Gallop, Paul Garside, Christina Duffy, The British Library (United Kingdom) ..... [11058-59]

**Comprehensive study of the fresco of Raphael's workshop "Venus tying a sandal" from the State Hermitage Museum's collection**, Irina A. Grigorieva, Ksenia Chugunova, Sergey Khavrin, Polina Kondrakhina, Ludmila Gavrilenko, Inga Budnichenko, The State Hermitage Museum (Russian Federation); Anastasia Povolotckaia, Dmitrii V. Pankin, Saint Petersburg State Univ. (Russian Federation) ..... [11058-60]

**Non-artistic materials in artistic works by David Lynch: multidisciplinary approach**, Mirosław Wachowiak, Grazyna Szczepańska, Klaudia Gontowska, Nicolaus Copernicus Univ. (Poland) ..... [11058-61]

**Incrustation of ancient Saka scabbard: material studies by Raman and FTIR spectroscopy**, Zainolla Samashev, Institute of Archeology (Kazakhstan); Nikolai S. Kurganov, Saint Petersburg State Univ. (Russian Federation) and Institute for the History of Material Culture (Russian Federation); Dmitrii V. Pankin, Anastasia Povolotskaya, Alexey Kurochkin, Saint Petersburg State Univ. (Russian Federation) ..... [11058-62]

**Development of a drone-based spectral imaging system for archaeological applications**, Florence Liggins, Chi Shing Cheung, Sotiria Kogou, Haida Liang, Nottingham Trent Univ. (United Kingdom) ..... [11058-63]

Lunch Break ..... Tue 13:10 to 14:20

## SESSION 8

**LOCATION: ICM, 12A ..... TUE 14:20 TO 15:30**

### Remote Imaging and Spectroscopy

Session Chair: **Vincent Detalle**, Centre de Recherche et de Restauration des Musées de France (C2RMF) (France)

14:20: **Standoff mid-infrared emissive imaging spectroscopy to identify and map materials in paintings** (*Invited Paper*), John K. Delaney, Francesca Gabrieli, Kathryn A. Dooley, National Gallery of Art (USA); Jason G. Zeibel, U.S. Army Night Vision & Electronic Sensors Directorate (USA) ..... [11058-28]

14:50: **Long-range remote spectroscopy for wall paintings and architectural interiors**, Yu Li, Chi Shing Cheung, Sotiria Kogou, Alex Hogg, Florence Liggins, Luke Butler, Haida Liang, Nottingham Trent Univ. (United Kingdom) ..... [11058-29]

15:10: **Palm-sized and tough two-dimensional spectroscopic imager: the so-called hyperspectral camera for visible and mid-infrared light**, Ichiro Ishimaru, Hanyue Kang, Natsumi Kawashima, Tomoya Kitazaki, Jyunya Iwaki, Satoru Adachi, Sora Mizutani, Kotone Yokoyama, Kagawa Univ. (Japan) ..... [11058-30]

Coffee Break ..... Tue 15:30 to 16:00



SESSION 9

LOCATION: ICM, 12A ..... TUE 16:00 TO 17:50

Applications to Cultural Heritage

Session Chair: Daniela Comelli, Politecnico di Milano (Italy)

16:00: **Optical coherence tomography of 19th century glass: facts and phantoms** (*Invited Paper*), Lynn Brostoff, Carol Lynn Ward Bamford, Library of Congress (USA); Tara Diba, Murray H. Loew, Jason M. Zara, The George Washington Univ. (USA) ..... [11058-31]

16:30: **Novel imaging spectroscopy applications for the study of ancient and Byzantine Cypriot monumental paintings**, Roxanne Radpour, Univ. of California, Los Angeles (USA); John K. Delaney, National Gallery of Art (USA); Ioanna Kakoulli, Univ. of California, Los Angeles (USA) ..... [11058-32]

16:50: **Analysis of the physical characteristics and chemical composition of gold leaf in works of art by scanning macro X-ray fluorescence (MA-XRF) spectroscopy**, Douglas MacLennan, The Getty Conservation Institute (USA); Arlen Heginbotham, J. Paul Getty Museum (USA); Monica Ganio, The Getty Conservation Institute (USA); John K. Delaney, National Gallery of Art (USA); Lynn Lee, The Getty Conservation Institute (USA); Laura Llewellyn, J. Paul Getty Museum (USA); Karen Trentelman, The Getty Conservation Institute (USA) ..... [11058-33]

17:10: **Physicochemical monitoring of conservation state of the 19th century glass beads**, Dmitrii V. Pankin, Saint Petersburg State Univ. (Russian Federation); Irina F. Kadikova, GosNIIR (Russian Federation); Ekaterina A. Morozova, GosNIIR (Russian Federation) and Kurnakov Institute of General and Inorganic Chemistry of the RAS (Russian Federation); Tatyana V. Yuryeva, GosNIIR (Russian Federation); Irina A. Grigorieva, The State Hermitage Museum (Russian Federation); Ilya B. Afanasyev, The Russian Federal Ctr. of Forensic Science of the Ministry of Justice (Russian Federation); Maria V. Lukashova, TESCAN Ltd. (CIS) (Russian Federation); Anastasia Povolotckaia, Saint Petersburg State Univ. (Russian Federation); Vladimir A. Yuryev, A.M. Prokhorov General Physics Institute of the RAS (Russian Federation) [11058-34]

17:30: **Multianalytical investigation of the ancient nomads polychromic belt buckles**, Nikolai S. Kurganov, Saint Petersburg State Univ. (Russian Federation) and Institute for the History of Material Culture (Russian Federation); Sergey Khavrin, The State Hermitage Museum (Russian Federation); Dmitrii V. Pankin, Saint Petersburg State Univ. (Russian Federation); Irina A. Grigorieva, Ksenia Chugunova, The State Hermitage Museum (Russian Federation); Marina Kilunovskaya, Institute for the History of Material Culture (Russian Federation); Anastasia Povolotckaia, Alexey Kurochkin, Saint Petersburg State Univ. (Russian Federation) ..... [11058-35]

WEDNESDAY 26 JUNE

SESSION 10

LOCATION: ICM, 12A ..... WED 8:20 TO 10:00

3D Surface Analysis

Session Chair: Roger Groves, Technische Univ. Delft (Netherlands)

8:20: **A new method to improve reconstruction and rendering of RTI images**, Yuly Castro, Univ. de Bourgogne (France); Gilles Pitard, Saphir (France); Gaetan Le Goic, Vincent Brost, Alamin Mansouri, Univ. de Bourgogne (France); Anthony Pamart, Ctr. National de la Recherche Scientifique (France); Jean-Marc Vallet, Ctr. Interdisciplinaire de Conservation et Restauration du Patrimoine (France); Livio De Luca, Ctr. National de la Recherche Scientifique (France) ..... [11058-38]

8:40: **Monitoring surface degradation process by 3D structured light scanning**, Robert Sitnik, Krzysztof Lech, Warsaw Univ. of Technology (Poland); Eryk Bunsch, Wilanow Palace Museum (Poland) ..... [11058-36]

9:00: **Monitoring microclimate-induced deformations on hygroscopic materials using conoscopic holography sensors**, Giacomo Marchioro, Luca Perlini, Claudia Daffara, Univ. degli Studi di Verona (Italy) ..... [11058-37]

9:20: **Lights on the Dark Ages: multiscale 2D and 3D imagery for the study of medieval graffiti at the Chateau de Selles Cambrai, France**, Nicolas Melard, Ctr. de Recherche et de Restauration des Musées de France (France) ..... [11058-39]

9:40: **FringeMatchNet: effective stereo matching onboard of mobile structured light 3D scanner**, Vladimir V. Kniaz, GosNIIAS (Russian Federation) ..... [11058-40]

Coffee Break ..... Wed 10:00 to 10:30

SPIE OPTICAL METROLOGY PLENARY SESSION

LOCATION: ICM, SAAL 1 ..... WED 10:30 TO 11:25

Towards a complete framework for calibration of optical surface and coordinate measuring instruments

Richard Leach, Univ. of Nottingham (United Kingdom)

For details, please see page 7.

SESSION 11

LOCATION: ICM, 12A ..... WED 11:30 TO 12:50

Multimodal Imaging and Spectroscopy

Session Chair: Haida Liang, Nottingham Trent Univ. (United Kingdom)

11:30: **Merging of imaging techniques based on reflectance hyperspectral and neutron tomography for characterization of a modern replica of a 13th century knife from Croatia**, Costanza Cucci, Andrea Casini, Lorenzo Stefani, Marcello Picollo, Consiglio Nazionale delle Ricerche, Istituto di Fisica Applicata "Nello Carrara" (Italy); Nikolay Kardjilov, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany); Adam Thiele, Budapest Univ. of Technology and Economics (Hungary); Jiri Hosek, Archeologický ústav AV ČR, Praha, v.v.i. (Czech Republic); Francesco Grazzi, Consiglio Nazionale delle Ricerche, Istituto di Fisica Applicata "Nello Carrara" (Italy) ..... [11058-41]

11:50: **Terahertz time domain imaging and optical coherence tomography for the subsurface noninvasive inspection of a 21st Dynasty Egyptian coffin**, Corinna Ludovica Koch Dandolo, Ctr. de Recherche et de Restauration des Musées de France (France); Lucile Brunel-Duverger, Ctr. de Recherche et de Restauration des Musées de France (France) and Univ. de Cergy-Pontoise (France); David Giovannacci, Lab. de Recherche des Monuments Historiques (France); Ruven Pillay, Ctr. de Recherche et de Restauration des Musées de France (France); Maxime Lopez, Ctr. de Recherche et de Restauration des Musées de France (France); Xueshi Bai, Ctr. de Recherche et de Restauration des Musées de France (France) and Muséum national d'Histoire naturelle, Ctr. de Recherche sur la Conservation (France); Sandrine Pagès-Camagna, Ctr. de Recherche et de Restauration des Musées de France (France); Nancy Brodie-Linder, Univ. de Cergy-Pontoise (France) and Lab. Léon Brillouin (France); Michel Menu, Vincent Detalle, Ctr. de Recherche et de Restauration des Musées de France (France) ..... [11058-42]

12:10: **Integrating LIBS LIF Raman into one multispectroscopic mobile device for in situ cultural heritage analysis**, Xueshi Bai, Ctr. de Recherche et de Restauration des Musées de France (France) and Ctr. de Recherche sur la Conservation (France); Mohamed Oujja, Mikel Sanz, Consejo Superior de Investigaciones Científicas (Spain); Maxime Lopez, Corinna Ludovica Koch Dandolo, Ctr. de Recherche et de Restauration des Musées de France (France) and Fondation des Sciences du Patrimoine (France); Marta Castillejo, Consejo Superior de Investigaciones Científicas (Spain); Vincent Detalle, Ctr. de Recherche et de Restauration des Musées de France (France) ..... [11058-43]

12:30: **Micro-Raman spectroscopy and THz time domain spectroscopic imaging of 'Pietra Dura' marble inlay work resembling Taj Mahal architectural motifs**, Amartya Sengupta, Indian Institute of Technology Delhi (India); Aparajita Bandyopadhyay, Joint Advanced Technology Ctr., Indian Institute of Technology Delhi (India); Diksha Garg, Indian Institute of Technology Delhi (India) ..... [11058-44]

# CONFERENCE 11059

LOCATION: ICM, 12B

Wednesday–Thursday 26–27 June 2019 • Proceedings of SPIE Vol. 11059

## Multimodal Sensing and Artificial Intelligence: Technologies and Applications

Conference Chair: **Ettore Stella**, CNR (Italy)

Conference Co-Chairs: **Shahriar Negahdaripour**, Univ. of Miami (USA); **Dariusz Ceglarek**, The Univ. of Warwick (United Kingdom); **Christian Möller**, Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung (Germany)

Programme Committee: Andrei G. Anisimov, Technische Univ. Delft (Netherlands); Salah Bourennane, Institut Fresnel (France); Cosimo Distanti, Univ. del Salento (Italy); Pietro Ferraro, Istituto di Scienze Applicate e Sistemi Intelligenti “Eduardo Caianiello” (Italy); Marc P. Georges, Liège Univ. (Belgium); Antonio Lanzotti, Univ. degli Studi di Napoli Federico II (Italy); Luiz Marcos Garcia Gonçalves, UFRN (Brazil); Michele Meo, Univ. of Bath (United Kingdom); Thomas B. Moeslund, Aalborg Univ. (Denmark); Nicola Mosca, CNR (Italy); Vito Pagliarulo, Istituto di Scienze Applicate e Sistemi Intelligenti “Eduardo Caianiello” (Italy); Clive Roberts, The Univ. of Birmingham (United Kingdom); Pierre R. Slangen, Mines Alès (France); Rocco Zito, Flinders Univ. (Australia)

### WEDNESDAY 26 JUNE

#### SESSION 1

LOCATION: ICM, 12B ..... WED 8:10 TO 10:00

#### Multimodal Sensing for Surveillance

Session Chairs: **Francesco Soldovieri**, Istituto per il Rilevamento Elettromagnetico dell’Ambiente (Italy); **Massimiliano Nolich**, Univ. degli Studi di Trieste (Italy)

8:10: **Multimodal surveillance systems for the continuous monitoring of heterogeneous environments and danger prevention**, Massimiliano Nolich, Univ. degli Studi di Trieste (Italy); Francesco Soldovieri, Istituto per il Rilevamento Elettromagnetico dell’Ambiente (Italy); Massimiliano Nitti, Antonio Petitti, Vito Renò, Istituto di Sistemi e Tecnologie Industriali Intelligenti per il Manifatturiero Avanzato (Italy); Ilaria Catapano, Gianluca Gennarelli, Istituto per il Rilevamento Elettromagnetico dell’Ambiente (Italy); Raol Buqi, Univ. degli Studi di Trieste (Italy) ..... [11059-1]

8:30: **Radar for indoor surveillance: state of art and perspectives** (*Invited Paper*), Francesco Soldovieri, Istituto per il Rilevamento Elettromagnetico dell’Ambiente (Italy); Moeness Amin, Villanova Univ. (USA) ..... [11059-2]

9:00: **Microwave imaging through an unknown wall by a MIMO configuration and SVD approach**, Raffaele Solimene, Tushar Rajvanshi, Giovanni Buonanno, Angela dell’Aversano, Univ. degli Studi della Campania Luigi Vanvitelli (Italy) ..... [11059-3]

9:20: **Radiometer effectiveness in real cases for disclosing stealth**, Hao Liu, Harbin Institute of Technology (China); Chao Wu, Harbin Institute of Technology (China); Dajing Wang, Hongmei Li, Jinghui Qiu, Alexander G. Denisov, Harbin Institute of Technology (China) ..... [11059-4]

9:40: **Passive radar for measuring passive sensors: direct signal interference suppression on FPGA using orthogonal matching pursuit and stochastic gradient descent**, Jean-Michel Friedt, Institut Franche-Comte Electronique Mecanique Thermique et Optique (France); WeiKe Feng, Tohoku Univ. (Japan); Stephane Chretien, National Physical Lab. (United Kingdom); Gwenhael Goavec, Institut Franche-Comte Electronique Mecanique Thermique et Optique (France); Motoyuki Sato, Tohoku Univ. (Japan) ..... [11059-5]

Coffee Break ..... Wed 10:00 to 10:30

#### SPIE OPTICAL METROLOGY PLENARY SESSION

LOCATION: ICM, SAAL 1 ..... 10:30 TO 11:25

#### Towards a complete framework for calibration of optical surface and coordinate measuring instruments

**Richard Leach**, Univ. of Nottingham (United Kingdom)

*For details, please see page 7.*

### POSTERS-WEDNESDAY

LOCATION: ICM, HALL B0 ..... WED 11:30 TO 12:30

Conference attendees are invited to attend the Optical Metrology Poster Session 2 on Wednesday. Come view the posters and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Posters will be available for viewing starting at 11:30 through 12:30 hrs on Wednesday. Poster authors, view poster presentation guidelines and set-up instructions on page 6, and at <http://spie.org/x6513.xml>. (Follow the Special Events link)

**Multibiometric systems in hospitality: methodologies and use cases in hotel scenarios**, Massimiliano Nolich, Sara Carciotti, Raol Buqi, Walter Ukovich, Univ. degli Studi di Trieste (Italy); Francesco Soldovieri, Istituto per il Rilevamento Elettromagnetico dell’Ambiente (Italy) ..... [11059-36]

**Study of the 360° light field display**, Chong Zeng, Zhihong Zeng, Hualong Guo, Longyan Univ. (China) ..... [11059-37]

**A full Stokes imaging polarimeter based on a consumer CMOS camera**, Sara Peña-Gutiérrez, María Ballesta, Santiago Royo, Univ. Politècnica de Catalunya (Spain) ..... [11059-38]

**Power law scaling of test error versus number of training images for deep convolutional neural networks**, Vittorio Sala, IMAGE S S.p.A. (Italy) [11059-39]

**Robot welding seam tracking system research based on image identification**, Hongwei Sun, Peng Xu, Yu Han, Chao Liu, Jiangsu Automation Research Institute (China) ..... [11059-40]

**Research of spatial alignment techniques for multimodal image fusion**, Artyom Akhmerov, Alexandr S. Vasilev, Anna V Vasileva, ITMO Univ. (Russian Federation) ..... [11059-41]

**Predictive models for abundance estimation and distribution maps of the striped dolphin *Stenella coeruleoalba* and the bottlenose dolphin *Tursiops truncatus* in the Northern Ionian Sea (North-eastern Central Mediterranean)**, Vito Renò, Consiglio Nazionale delle Ricerche (Italy); Carmelo Fanizza, Jonian Dolphin Conservation (Italy); Giovanni Dimauro, Univ. degli Studi di Bari Aldo Moro (Italy); Vito Telesca, Univ. degli Studi della Basilicata (Italy); Pierluigi Dibari, Gennaro Gala, Univ. degli Studi di Bari Aldo Moro (Italy); Nicola Mosca, Consiglio Nazionale delle Ricerche (Italy); Giulia Cipriano, Roberto Carlucci, Univ. degli Studi di Bari Aldo Moro (Italy); Rosalia Maglietta, Consiglio Nazionale delle Ricerche (Italy) ..... [11059-42]

**An electro-optical system for transverse displacement measurement with rotation parameters estimation of the measurement unit**, Anh Phuong Hoang, Alexey Gorbachev, ITMO Univ. (Russian Federation) ..... [11059-43]

**A rapid nanotexturing of microneedle patch procedure for multimodal sensing and fabricating polymeric 3D arrays with biomaterials using hydrophobic elastomeric molds**, Sungwon Hwang, Sangmyung Univ. (Korea, Republic of) ..... [11059-44]

**Floor integrated optical fall detector for frail people**, Ronny Maschke, Westsächsische Hochschule Zwickau (Germany); Christopher Taudt, Westsächsische Hochschule Zwickau (Germany) and Fraunhofer Institut für Werkstoff- und Strahltechnik IWS, Anwendungszentrum für Optische Messtechnik (Germany) and Fakultät Elektrotechnik und Informationstechnik, Technische Universität Dresden (Germany); Florian Rudek, Peter Hartmann, Westsächsische Hochschule Zwickau (Germany) and Fraunhofer Institut für Werkstoff- und Strahltechnik IWS, Anwendungszentrum für Optische Messtechnik (Germany) ..... [11059-45]

Lunch Break ..... Wed 12:30 to 13:40

## JOINT SESSION

LOCATIONS: HALL A1,  
ROOM GUSTAV HERTZ ..... WED 13:40 TO 15:25

### Holography Technology

Session Chairs: **Pietro Ferraro**, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy); **Pierre R. Slangen**, Mines Alès (France)

**Joint Session between SPIE Optical Metrology Conferences  
11059 and 11060.**

**Please note the room change.**

13:40: **Time resolved digital holography applied to droplets fragmentation by shockwave** (*Invited Paper*), Zacaria Essaidi, Pierre Lauret, Pierre R. Slangen, Mines Alès (France) ..... [11059-6]

14:10: **Automated cell identification with 3D optical imaging** (*Keynote Presentation*), Bahram Javidi, Univ. of Connecticut (USA); Arun Anand, The Maharaja Sayajirao Univ. of Baroda (India); Timothy O'Connor, Univ. of Connecticut (USA); Inkyu Moon, Daegu Gyeongbuk Institute of Science & Technology (Korea, Republic of); Adam S. Markman, Univ. of Connecticut (USA) ..... [11060-38]

14:45: **Holographic imaging of erythrocytes in acoustofluidic platforms**, Teresa Cacace, Pasquale Memmolo, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy); Massimiliano M. Villone, Univ. degli Studi di Napoli Federico II (Italy); Marco De Corato, Imperial College London (United Kingdom); Melania Paturzo, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy); Pier Luca Maffettone, Univ. degli Studi di Napoli Federico II (Italy); Pietro Ferraro, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy) ..... [11060-43]

15:05: **How holographic imaging can improve machine learning**, Pasquale Memmolo, Vittorio Bianco, Pierluigi Carcagni, Francesco Merola, Melania Paturzo, Cosimo Distante, Pietro Ferraro, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy) ..... [11059-7]

Coffee Break ..... Wed 15:25 to 16:00

## SESSION 2

LOCATION: ICM, 12B ..... WED 16:00 TO 18:10

### Multiwave Light Technology

Session Chairs: **Pasquale Franciosa**, The Univ. of Warwick (United Kingdom); **Darek J. Ceglarek**, The Univ. of Warwick (United Kingdom)

16:00: **Automated visual inspection of friction stir welds: a deep learning approach**, Roman Hartl, Institut für Werkzeugmaschinen und Betriebswissenschaften, Technische Univ. München (Germany); Johannes Landgraf, Julian Spahl, Andreas Bachmann, Michael F. Zaeh, Institute for Machine Tools and Industrial Management, Technical University of Munich (Germany) ..... [11059-8]

16:20: **Multi-wave light technology enabling closed-loop in-process quality control for automotive battery assembly with remote laser welding** (*Invited Paper*), Pasquale Franciosa, The Univ. of Warwick (United Kingdom); Tianzhu Sun, The University of Warwick (United Kingdom); Darek Ceglarek, The Univ. of Warwick (United Kingdom); Salvatore Gerbino, Univ. degli Studi della Campania Luigi Vanvitelli (Italy); Antonio Lanzotti, Univ. degli Studi di Napoli Federico II (Italy) ..... [11059-9]

16:50: **3D convolutional neural networks to estimate assembly process parameters using 3D point-clouds**, Sumit Sinha, Emile Glorieux, Pasquale Franciosa, Dariusz Ceglarek, The Univ. of Warwick (United Kingdom) [11059-10]

17:10: **Model-based interfacing of large scale metrology instruments**, Benjamin Montavon, Martin Peterek, Robert H. Schmitt, RWTH Aachen Univ. (Germany) ..... [11059-11]

17:30: **Concept, functionality and controller integration of a combined geometry-temperature sensor unit for the improvement of open die forging processes**, Steffen Ihlenfeldt, TU Dresden (Germany) ..... [11059-12]

17:50: **Robust principal component analysis of ultrasonic sectorial scans for defect detection in weld inspection**, Bryan Cassels, Lik-Kwan Shark, Stephen Mein, Univ. of Central Lancashire (United Kingdom); Andrew Nixon, Thomas Barber, Ray Turner, BAE Systems (United Kingdom) ..... [11059-13]

## THURSDAY 27 JUNE

### SESSION 3

LOCATION: ICM, 12B ..... THU 8:10 TO 10:00

### Multimodal Sensing for Infrastructure Monitoring

Session Chairs: **Ilaria Catapano**, Istituto per il Rilevamento Elettromagnetico dell'Ambiente (Italy); **Shahriar Negahdaripour**, Univ. of Miami (USA)

8:10: **UAV radar imaging for target detection** (*Invited Paper*), Ilaria Catapano, Istituto per il Rilevamento Elettromagnetico dell'Ambiente (Italy); Giancarmine Fasano, Alfredo Renga, Univ. degli Studi di Napoli Federico II (Italy); Giovanni Ludeno, Istituto per il Rilevamento Elettromagnetico dell'Ambiente (Italy) ..... [11059-14]

8:40: **Imaging capabilities of an airborne X-band SAR based on the FMCW technology**, Antonio Natale, Carmen Esposito, Paolo Berardino, Istituto per il Rilevamento Elettromagnetico dell'Ambiente (Italy); Gianfranco Palmese, Elettra Microwave S.r.l. (Italy); Riccardo Lanari, Istituto per il Rilevamento Elettromagnetico dell'Ambiente (Italy); Stefano Perna, Univ. degli Studi di Napoli Parthenope (Italy) ..... [11059-15]

9:00: **Study of complementary multisensor data influence on infrared thermography measurements for in situ long-term monitoring**, Thibaud Toullier, Institut National de Recherche en Informatique et en Automatique (France) and Institut Français des Sciences et Technologies des Transports de l'aménagement et des Réseaux (France); Jean Dumoulin, Institut Français des Sciences et Technologies des Transports de l'aménagement et des Réseaux (France) and Institut National de Recherche en Informatique et en Automatique (France); Laurent Mevel, Institut de Recherche en Informatique et Systèmes Aléatoires (France) and Institut Français des Sciences et Technologies des Transports de l'aménagement et des Réseaux (France) ..... [11059-16]

9:20: **Automatic network level bridge monitoring by integration of InSAR and GIS catalogues**, Luca Bianchini Ciampoli, Valerio Gagliardi, Alessandro Calvi, Fabrizio D'Amico, Univ. degli Studi di Roma Tre (Italy); Fabio Tosti, Univ. of West London (United Kingdom) ..... [11059-17]

9:40: **Methodology for utilization of a generalised antenna in gprMax simulator**, Sumona Chatterjee, Amitabha Bhattacharya, Indian Institute of Technology Kharagpur (India); Swati Duggal, Space Applications Ctr. (India) ..... [11059-18]

Coffee Break ..... Thu 10:00 to 10:30

### SESSION 4

LOCATION: ICM, 12B ..... THU 10:30 TO 12:10

### Hyperspectral Imaging Applications

Session Chairs: **Salah Bourennane**, Ecole Centrale de Marseille (France); **Nicola Mosca**, Consiglio Nazionale delle Ricerche (Italy)

10:30: **Palm-sized and tough two-dimensional spectroscopic imager: the so-called hyperspectral camera for visible and mid-infrared light. Proposal of plant-species identification regardless of zenith and azimuth angles based on only two types of basic spectroscopic data (near-surface and internal reflectance)**, Hanyue Kang, Natsumi Kawashima, Sora Mizutani, Tomoya Kitazaki, Satoru Adachi, Jyunya Iwaki, Kotone Yokoyama, Ichiro Ishimaru, Kagawa Univ. (Japan) ..... [11059-31]

10:50: **Unsupervised feature extraction based on improved Wasserstein generative adversarial network for hyperspectral classification**, Qiaoqiao Sun, Salah Bourennane, Ecole Centrale de Marseille (France) ..... [11059-32]

11:10: **Target detection based on classification in shadow region of hyperspectral image**, Xuefeng Liu, Congcong Wang, Qingdao Univ. of Science and Technology (China); Min Fu, Ocean Univ. of China (China); Salah Bourennane, Institut Fresnel (France) and Ecole Centrale de Marseille (France) ..... [11059-33]

11:30: **Overview of tensor-based processing methods to improve classification and detection results in hyperspectral images, including the case of signal dependant noise and small targets**, Caroline Fossati, Salah Bourennane, Institut Fresnel (France) ..... [11059-34]

11:50: **Hybrid spectroscopic microscopy for the characterization of dried DNA samples**, Vassilis M. Papadakis, George Kenanakis, Foundation for Research and Technology-Hellas (Greece) ..... [11059-35]

Lunch Break ..... Thu 12:10 to 13:20

# CONFERENCE 11059

## SESSION 5

LOCATION: ICM, 12B ..... THU 13:20 TO 15:30

### Machine Learning Applications

Session Chairs: **Cosimo Distante**, Univ. del Salento (Italy); **Luiz Marcos Garcia Goncalves**, UFRN (Brazil)

13:20: **Multimodal data fusion for object recognition**, Vladimir A. Knyaz, GosNIIAS (Russian Federation) ..... [11059-19]

13:40: **Deep learning approaches to EEG feature extraction** (*Invited Paper*), Francesco Carlo Morabito, Univ. Mediterranea di Reggio Calabria (Italy) ..... [11059-20]

14:10: **Challenges of hand recognition and interpretation for a manual assembly assistance system**, Martin Root, Christian Jauch, Fraunhofer-Institut für Produktionstechnik und Automatisierung (Germany) ... [11059-21]

14:30: **Convolutional neural networks for recognition and segmentation of aluminum profiles**, Pier Luigi Mazzeo, Arturo Argentieri, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy); Federico De Luca, Univ. del Salento (Italy); Paolo Spagnolo, Cosimo Distante, Marco Leo, Pierluigi Carcagni, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy) ..... [11059-22]

14:50: **Scene disparity estimation with convolutional neural networks**, Essa Anas, Li Guo, Ahmed Onsy, Bogdan Matuszewski, Univ. of Central Lancashire (United Kingdom). ..... [11059-23]

15:10: **Image quality evaluation and CNN segmentation of thermal cutting edges using a mobile device**, Omar De Mitri, Univ. del Salento (Italy); Janek Stahl, Christian Jauch, Fraunhofer-Institut für Produktionstechnik und Automatisierung (Germany); Cosimo Distante, Univ. del Salento (Italy) ..... [11059-24]

Coffee Break ..... Thu 15:30 to 16:00

## SESSION 6

LOCATION: ICM, 12B ..... THU 16:00 TO 18:10

### Multimodal Sensing Applications

Session Chairs: **Andrei G. Anisimov**, Technische Univ. Delft (Netherlands); **Michele Meo**, Univ. of Bath (United Kingdom)

16:00: **Hyperspectral image segmentation based on the estimation of the multiway signal subspace dimension**, Pierre Delmas, Caroline Fossati, Salah Bourennane, Ecole Centrale de Marseille (France) ..... [11059-25]

16:20: **Multimodal nondestructive inspection of impact damages in composite laminates: a case study to assess the damage volume** (*Invited Paper*), Andrei G. Anisimov, Technische Univ. Delft (Netherlands); Mariya G. Serikova, NIPK Electron, Ltd. (Russian Federation); Nan Tao, Chirag Anand, Fardin Esrail, Christos Kassapoglou, Roger M. Groves, Technische Univ. Delft (Netherlands) ..... [11059-26]

16:50: **Multimodal calibration of laser optics for sensor guided remote cutting**, Daniel Valencia, Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung (Germany); Benjamin Schulze, Fraunhofer-Institut für Fertigungstechnik Materialforschung (Germany); Christian Möller, Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung (Germany); Jörg Wollnack, Technische Univ. Hamburg-Harburg (Germany) and Fraunhofer-Institut für Fertigungstechnik Materialforschung (Germany) ..... [11059-27]

17:10: **An effective approach for 3D point cloud registration in railway contexts**, Cosimo Patrino, Roberto Colella, Massimiliano Nitti, Ettore Stella, Consiglio Nazionale delle Ricerche (Italy) ..... [11059-28]

17:30: **Multiple honey bees tracking and trajectory modeling**, Baptiste Magnier, Behrang Moradi, Pierre R. Slangen, Faysal Bougamale, Eliyahou Gabbay, François Pfister, Mines Alès (France) ..... [11059-29]

17:50: **New applications of electronic speckle pattern interferometry in novel materials and structures**, Vito Pagliarulo, Pietro Ferraro, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy). [11059-30]



# CONFERENCE 11060

LOCATION: HALL A1, ROOM GUSTAV HERTZ

Monday–Wednesday 24–26 June 2019 • Proceedings of SPIE Vol. 11060

## Optical Methods for Inspection, Characterization, and Imaging of Biomaterials IV

**Conference Chairs:** **Pietro Ferraro**, Institute of Applied Sciences and Intelligent Systems (ISASI-CNR) (Italy); **Simonetta Grilli**, Institute of Applied Sciences and Intelligent Systems (ISASI-CNR) (Italy); **Monika Ritsch-Marte**, Medizinische Univ. Innsbruck (Austria); **Christoph K. Hitzinger**, Medizinische Univ. Wien (Austria)

**Programme Committee:** Luigi Ambrosio, CNR (Italy); Giuseppe Chirico, Univ. degli Studi di Milano-Bicocca (Italy); Jonathan M. Cooper, Univ. of Glasgow (United Kingdom); Diego di Bernardo, Telethon Institute of Genetics and Medicine (Italy); Alberto Diaspro, Istituto Italiano di Tecnologia (Italy); Frank Dubois, Univ. Libre de Bruxelles (Belgium); Wolfgang A. Ertmer, Leibniz Univ. Hannover (Germany); Roger Groves, Technische Univ. Delft (Netherlands); Jochen R. Guck, Technische Univ. Dresden (Germany); Theo Lasser, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Pasquale Memmolo, Istituto di Scienze Applicate e Sistemi Intelligenti (ISASI-CNR) (Italy); Fernando Mendoza Santoyo, Ctr. de Investigaciones en Óptica, A.C. (Mexico); Lisa Miccio, Institute of Applied Sciences and Intelligent Systems (ISASI-CNR) (Italy); Serge Monneret, Institut Fresnel (France); Paolo A. Netti, Univ. degli Studi di Napoli Federico II (Italy); Fiorenzo Gabriele Omenetto, Tufts Univ. (USA); Pablo D. Ruiz, Loughborough Univ. (United Kingdom); David D. Sampson, The Univ. of Western Australia (Australia); Natan Tzvi Shaked, Tel Aviv Univ. (Israel); Claudia Tortiglione, Institute of Applied Sciences and Intelligent Systems (ISASI-CNR) (Italy); Ruikang K. Wang, Univ. of Washington (USA); Zeev Zalevsky, Bar-Ilan Univ. (Israel)

### MONDAY 24 JUNE

#### SESSION 1

LOCATION: HALL A1,  
ROOM GUSTAV HERTZ ..... MON 8:30 TO 10:00

#### Advanced Microscopy Modalities

Session Chair: **Lisa Miccio**, Istituto di Scienze Applicate e Sistemi Intelligenti “Eduardo Caianiello” (Italy)

8:30: **Fluorescence and scattering, a tug of war towards multimessenger optical microscopy** (*Keynote Presentation*), Alberto Diaspro, Istituto Italiano di Tecnologia (Italy) and Univ. degli Studi di Genova (Italy) ..... [11060-1]

9:00: **Design and implementation of a compact high-throughput echelle spectrometer using off-the-shelf off-axis parabolic mirrors for analysis of biological samples by LIBS**, Hamed Abbasi, Georg Rauter, Raphael Guzman, Philippe C. Cattin, Azhar Zam, Univ. Basel (Switzerland) ..... [11060-2]

9:20: **Video rate scanning endomicroscopy through a coherent fiber bundle using a galvo scanner**, Elias Scharf, Robert Kuschmierz, Jürgen W. Czarske, TU Dresden (Germany) ..... [11060-3]

9:40: **Microsphere-aided imaging of subdiffraction-limited translucent features**, Stéphane Perrin, Paul C. Montgomery, Sylvain Lecler, Lab. des sciences de l'Ingénieur, de l'Informatique et de l'Imagerie (France) . . [11060-4]

#### WORLD OF PHOTONICS CONGRESS-WIDE PLENARY SESSION

LOCATION: 11CM, SAAL 1 ..... MON 10:00 TO 11:00

#### Listening to the universe with gravitational waves

**Karsten Danzmann**, Max Planck Institute for Gravitational  
Physics and Leibniz Univ. Hannover (Germany)

See details page 6.

Coffee Break ..... Mon 11:00 to 11:15

#### SESSION 2

LOCATION: HALL A1,  
ROOM GUSTAV HERTZ ..... MON 11:20 TO 12:50

#### Advanced Diagnostics by Speckle Techniques

Session Chair: **Aydogan Ozcan**, Univ. of California, Los Angeles (USA)

11:20: **Secondary speckle-based tomography and tissue probing** (*Keynote Presentation*), Ariel Schwarz, Nisan Ozana, Ran Califa, Amir Shemer, Hadar Genish, Zeev Zalevsky, Bar-Ilan Univ. (Israel) ..... [11060-5]

11:50: **Detection of self-propelling bacteria by speckle correlation assessment and applications to food industry**, Vittorio Bianco, Biagio Mandracchia, Istituto di Scienze Applicate e Sistemi Intelligenti “Eduardo Caianiello” (Italy); Filomena Nazzaro, Istituto di Scienze dell’Alimentazione (Italy); Romina Rega, Pietro Ferraro, Simonetta Grilli, Istituto di Scienze Applicate e Sistemi Intelligenti “Eduardo Caianiello” (Italy) ..... [11060-6]

12:10: **In-plane deformation gradient measurement using common-path spatial phase shift shearography**, Heliya Hooshmand-Ziafi, Shahid Beheshti Univ. (Iran, Islamic Republic of); Khosrow Hassani, Univ. of Tehran (Iran, Islamic Republic of); Masoomeh Dashtdar, Shahid Beheshti Univ. (Iran, Islamic Republic of) ..... [11060-7]

12:30: **A pyroelectric-based system for sensing low abundant lactose molecules**, Romina Rega, Istituto di Scienze Applicate e Sistemi Intelligenti “Eduardo Caianiello” (Italy); Juan Francisco Muñoz Martínez, Universidad Politécnica de Madrid (Spain); Martina Mugnano, E. Oleandro, Istituto di Scienze Applicate e Sistemi Intelligenti “Eduardo Caianiello” (Italy); Oriella Gennari, Istituto Nazionale di Ottica (Italy); P. Orlando, Istituto di Scienze Applicate e Sistemi Intelligenti “Eduardo Caianiello” (Italy); G. Cabassi, V Pelizzola, CRA-FLC (Italy); Pietro Ferraro, Simonetta Grilli, Istituto di Scienze Applicate e Sistemi Intelligenti “Eduardo Caianiello” (Italy) ..... [11060-8]

Lunch Break ..... Mon 12:50 to 13:50

#### SESSION 3

LOCATION: HALL A1,  
ROOM GUSTAV HERTZ ..... MON 13:50 TO 15:55

#### Digital Holography

Session Chair: **Pierre P. Marquet M.D.**, Ctr. de Recherche de l’Univ. Laval Robert-Giffard (Canada)

13:50: **Digital holography in optogenetics: a new window to the brain** (*Invited Paper*), Jürgen W. Czarske, TU Dresden (Germany) ..... [11060-9]

14:20: **A review on optical methods to assess dental behavior under stress** (*Invited Paper*), Pascal Picart, Lab. d’Acoustique de l’Univ. du Mans (France); Michel Fages, Univ. Montpellier (France); Pierre R. Slangen, Mines Alès (France); Haiting Xia, Kunming Univ. of Science and Technology (China); Silvio Montrésor, Lab. d’Acoustique de l’Univ. du Maine (France); Rongxin Guo, Junchang Li, Kunming Univ. of Science and Technology (China); Osama Y. Soliman, Univ. Montpellier (France); Jean-Cédric Durand, Univ. de Montpellier (France) ..... [11060-10]

# CONFERENCE 11060

14:50: **Morphology and spatial refractive index distribution of the retina accessed by hyperspectral quantitative phase microscopy**, Álvaro Barroso Peña, Steffi Ketelhut, Peter Heiduschka, Gerburg Nettels-Hackert, Jürgen Schnekenburger, Björn Kemper, Westfälische Wilhelms-Universität Münster (Germany) ..... [11060-11]

15:10: **Matched filter applied to discriminate particles with different sizes in biological flows**, Marina Gómez Climente, Julia Lobera Salazar, Virginia Palero-Díaz, M. Pilar Arroyo de Grandes, Univ. de Zaragoza (Spain) ..... [11060-12]

15:30: **Imaging the competition between growth and production of self-assembled lipid droplets at the single-cell level** (*Invited Paper*), Andreas E. Vasdekis, Hamdah Alanazi, Univ. of Idaho (USA); Andrew M. Silverman, Massachusetts Institute of Technology (USA); Amrah J. Canul, Univ. of Idaho (USA); Alice C. Dohnalkova, John B. Cliff, Pacific Northwest National Lab. (USA); Gregory Stephanopoulos, Massachusetts Institute of Technology (USA) ..... [11060-39]

Coffee Break ..... Mon 15:55 to 16:15

## SESSION 4

**LOCATION: HALL A1,  
ROOM GUSTAV HERTZ ..... MON 16:15 TO 17:35**

### Learning Approaches in Microscopy I

Session Chair: **Jürgen W. Czarske**, TU Dresden (Germany)

16:15: **Toward a thinking microscope: deep learning-enabled computational microscopy and sensing** (*Keynote Presentation*), Aydogan Ozcan, Univ. of California, Los Angeles (USA) ..... [11060-14]

16:45: **Applications of deep learning in computational imaging** (*Invited Paper*), Guohai Situ, Hao Wang, Fei Wang, Shanghai Institute of Optics and Fine Mechanics (China) ..... [11060-15]

17:15: **Identification and classification of biological micro-organisms by holographic learning**, Pasquale Memmolo, Vittorio Bianco, Pierluigi Carcagni, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy); Andouglas Goncalves da Silva Junior, Luiz Marcos Garcia Goncalves, Univ. Federal do Rio Grande do Norte (Brazil); Francesco Merola, Melania Paturzo, Cosimo Distante, Pietro Ferraro, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy) ..... [11060-16]

### WORLD OF PHOTONICS CONGRESS: NOBEL PLENARY SESSION

**LOCATION: ICM, SAAL 1 ..... MON 18:00 TO 19:00**

### Passion for Extreme Light

**Gerard Mourou**, École Polytechnique (France)

2018 Physics Nobel Prize Laureate

For details, please see page 6.

## TUESDAY 25 JUNE

### SESSION 5

**LOCATION: HALL A1,  
ROOM GUSTAV HERTZ ..... TUE 8:20 TO 10:00**

### Understanding Biomechanics by Optical Methods I

Session Chair: **Kirill V. Larin**, Univ. of Houston (USA)

8:20: **Substrate developments for exploring living cells in culture with quantitative phase imaging: towards label-free high-content screening** (*Invited Paper*), Pierre P. Marquet M.D., Ctr. de Recherche de l'Univ. Laval Robert-Giffard (Canada); Erik Bélanger, Ctr. de Recherche Cervo de l'Univ. Laval (Canada); Bertrand de-Dorlodot, Émile Rioux-Pélerin, Sébastien Lévesque, CERVO Brain Research Ctr. (Canada) ..... [11060-17]

8:50: **Engineering light-responsive substrates for the dynamic display of patterns of adhesive signals to control cell functions in vitro** (*Invited Paper*), Paolo A. Nettì, Univ. degli Studi di Napoli Federico II (Italy) ..... [11060-18]

9:20: **The evolution of the mechanical properties of orthodontic arches by stimulated infrared thermography**, Nafez Chahine, Kamel Mouhoubi, Jean-Luc Bodnar, yessine toumi, Pierre Millet, abdulillah benmarouwan, Univ. de Reims Champagne-Ardenne (France); Steeve Harakeh, King Fahd Medical Research Ctr. (Saudi Arabia) ..... [11060-19]

9:40: **Design of an optofluidic device for the measurement of the elastic modulus of deformable particles**, Massimiliano M. Villone, Univ. degli Studi di Napoli Federico II (Italy); Janine K. Nunes, Yankai Li, Howard A. Stone, Princeton Univ. (USA); Pier Luca Maffettone, Univ. degli Studi di Napoli Federico II (Italy) ..... [11060-20]

Coffee Break ..... Tue 10:00 to 10:30

## SESSION 6

**LOCATION: HALL A1,  
ROOM GUSTAV HERTZ ..... TUE 10:30 TO 12:00**

### Understanding Biomechanics by Optical Methods II

Session Chair: **Christoph K. Hitzengerger**, Medizinische Univ. Wien (Austria)

10:30: **Dynamic optical coherence elastography for noninvasive quantification of tissue mechanical properties** (*Invited Paper*), Kirill V. Larin, Univ. of Houston (USA) ..... [11060-21]

11:00: **Boosting accessibility of diagnostics tools for 3D printing, consumer electronics, digital imaging and open source software conversion** (*Invited Paper*), Stefano Selleri, Univ. degli Studi di Parma (Italy); Alessandro Tonelli, DNAPhone (Italy); Francesco Pasquali, University of Modena and Reggio Emilia (Italy); Alessandro Candiani, DNAPhone (Italy); Annamaria Cucinotta, Francesco Biasion, Matteo Barozzi, Univ. degli Studi di Parma (Italy) ..... [11060-22]

11:30: **Analysis of retinal and choroidal images measured by laser Doppler holography** (*Invited Paper*), Leo Puyo, Institut Langevin Ondes et Images (France); Michel Pâques, Ctr. Hospitalier National d'Ophthalmologie des Quinze-Vingts (France); Mathias Fink, Institut Langevin Ondes et Images (France); José-Alain Sahel, Ctr. Hospitalier National d'Ophthalmologie des Quinze-Vingts (France); Michael Atlan, Institut Langevin Ondes et Images (France) ..... [11060-23]

## POSTERS-TUESDAY

**LOCATION: ICM, HALL BO ..... TUE 12:05 TO 12:40**

Conference attendees are invited to attend the Optical Metrology Poster Session 1 on Tuesday. Come view the posters and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Posters will be available for viewing starting at 12:05 through 12:40 hrs on Tuesday. Poster authors, view poster presentation guidelines and set-up instructions on page 6, and at <http://spie.org/x6513.xml>. (Follow the Special Events link)

**The effect of particle aspect ratio on spatially and angularly resolved vis-NIR spectroscopy of suspensions**, Daria Stoliarskaia, Kelly Thomson, Leo Lue, Yi-Chieh Chen, Univ. of Strathclyde (United Kingdom) ..... [11060-45]

**3D manipulation of micro-objects based on optical tweezers using acousto-optic deflector and varifocal system**, Yulia Pichugina, Scientific and Technological Ctr. for Unique Instrumentation (Russian Federation); Pavel A. Nosov, Vladislav I. Batshev, Bauman Moscow State Technical Univ. (Russian Federation); Alexander S. Machikhin, Alexey Kozlov, Scientific and Technological Ctr. for Unique Instrumentation (Russian Federation); George Krasin, Bauman Moscow State Technical Univ. (Russian Federation) [11060-46]

**Effect of nanoparticle polyethylene glycol surface density for biomaterials: toward redesigning the PEG surface of nanocarriers**, Sungwon Hwang, Sangmyung Univ. (Korea, Republic of) ..... [11060-47]

**Optical design of infrared endoscope systems for laparoscopic surgery**, Alisa S. Ekimenkova, Alexandra Bobe, Anna O. Voznesenskaya, Alexey Bakholdin, ITMO Univ. (Russian Federation) ..... [11060-48]

**Metamaterial structure for potential image processing**, Hongwei Sun, Jiangsu Automation Research Institute (China) ..... [11060-49]

**Characterization of microplastics by holographic features for automatic detection in heterogeneous samples**, Vittorio Bianco, Pasquale Memmolo, Francesco Merola, Pierluigi Carcagni, Melania Paturzo, Cosimo Distante, Pietro Ferraro, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy) ..... [11060-50]

**In vivo skin surface study by scattered ellipsometry method**, Anastasiia B. Bulykina, Victoria A. Ryzhova, Valery V. Korotaev, ITMO Univ. (Russian Federation) ..... [11060-51]

**A method for reconstruction of terahertz dielectric response of thin liquid samples**, Arseniy A. Gavdush, A.M. Prokhorov General Physics Institute of the RAS (Russian Federation) and Bauman Moscow State Technical Univ. (Russian Federation); Vladislav Ulitko, Bauman Moscow State Technical Univ. (Russian Federation); Guzel R Musina, Bauman Moscow State Technical Univ. (Russian Federation) and A.M. Prokhorov General Physics Institute of the RAS (Russian Federation); Irina N Dolganova, Bauman Moscow State Technical Univ. (Russian Federation) and Institute of Solid State Physics of the Russian Academy of Sciences (Russian Federation) and Sechenov First Moscow State Medical University (Russian Federation); Nikita V. Chernomyrdin, A.M. Prokhorov General Physics Institute of the RAS (Russian Federation) and Bauman Moscow State Technical Univ. (Russian Federation); Vladimir N Kurlov, Institute of Solid State Physics of the Russian Academy of Sciences (Russian Federation); Gennady A. Komandin, A.M. Prokhorov General Physics Institute of the RAS (Russian Federation); Valery V Tuchin, Saratov State University (Russian Federation) and ITMO University (Russian Federation) and Institute of Precision Mechanics and Control of the Russian Academy of Sciences (Russian Federation); Kirill I. Zaytsev, A.M. Prokhorov General Physics Institute of the RAS (Russian Federation) and Bauman Moscow State Technical Univ. (Russian Federation) ..... [11060-52]

**Intensity favored switching of nonlinear optical absorption mechanism in silver nanoparticles under nanosecond pulsed laser excitation**, Sharafudeen Kaniyarakkal Naduvil Valappil, Kuwait College of Science and Technology (Kuwait); Siji Narendran N. K., T. K. Madhava Memorial College (India); Shiju E., Department of Physics, National Institute of Technology Calicut (India); Vijayakumar S, Department of Physics, NSS College Pandalam (India); Chandrasekharan Keloth, National Institute of Technology, Calicut (India) ..... [11060-53]

**Local orthostatic maneuver in the optical diagnosis of peripheral blood oxygenation**, Sylwester Nowocien, Wroclaw Univ. of Science and Technology (Poland) ..... [11060-54]

Lunch Break ..... Tue 12:40 to 14:00

## SESSION 7

**LOCATION: HALL A1,  
ROOM GUSTAV HERTZ ..... TUE 14:00 TO 15:30**

### Phase Contrast and 3D Imaging

Session Chair: **Demetri Psaltis**, Ecole Polytechnique Fédérale de Lausanne (Switzerland)

14:00: **Quantifying myelination at the individual axon scale using color spatial light interference microscopy (cSLIM)** (*Keynote Presentation*), Gabriel Popescu, Univ. of Illinois (USA) ..... [11060-24]

14:30: **Phenotypical analysis of hematological disorders for advanced label-free detection and classification by holographic microscopy**, Dominik Heim, Stefan Röhl, Christian Klenk, Klaus Diepold, Katharina Götze, Oliver Hayden, Matthias Ugele, Technische Univ. München (Germany) ... [11060-25]

14:50: **Phase imaging of free-standing thin films for biomaterials engineering**, Vincenzo Ferraro, Univ. degli Studi di Napoli Federico II (Italy); Zhe Wang, Beijing Univ. of Technology (China); Biagio Mandracchia, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy); Ernesto Di Maio, Pier Luca Maffettone, Univ. degli Studi di Napoli Federico II (Italy) ..... [11060-26]

15:10: **Automatic calibration of the spatial position and orientation for the tomographic digital holographic microscopy**, Li-Chien Lin, Feng Chia Univ. (Taiwan); Chau-Jern Cheng, National Taiwan Normal Univ. (Taiwan); Yu-Chun Hu, Feng Chia Univ. (Taiwan) ..... [11060-27]

Coffee Break ..... Tue 15:30 to 16:00

## SESSION 8

**LOCATION: HALL A1,  
ROOM GUSTAV HERTZ ..... TUE 16:00 TO 17:30**

### Learning Approaches in Microscopy II

Session Chair: **Pietro Ferraro**, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy)

16:00: **Optical imaging using learning techniques** (*Keynote Presentation*), Demetri Psaltis, Ecole Polytechnique Fédérale de Lausanne (Switzerland) ..... [11060-28]

16:30: **Deep learning for analysis and synthesis of dense and multicolor localization microscopy** (*Invited Paper*), Elias Nehme, Eran Hershko, Lucien E. Weiss, Tomer Michaeli, Yoav Shechtman, Technion-Israel Institute of Technology (Israel) ..... [11060-29]

17:00: **Label-free biomarker information by high-throughput holographic microscopy to support detection of cancer and neglected tropical diseases** (*Invited Paper*), Matthias Ugele, Christian Klenk, Dominik Heim, Stefan Röhl, Technische Univ. München (Germany); Frea Mehta, Ludwig-Maximilians-Univ. München (Germany); Nermina Vejzagic, Technische Univ. München (Germany); Katja Peschke, Klinikum rechts der Isar der Technischen Univ. München (Germany); Klaus Diepold, Clarissa Prazeres da Costa, Technische Univ. München (Germany); Maximilian Reichert, Klinikum rechts der Isar der Technischen Univ. München (Germany); Markus Meissner, Ludwig-Maximilians-Univ. München (Germany); Katharina Götze, Klinikum rechts der Isar der Technischen Univ. München (Germany); Oliver Hayden, Technische Univ. München (Germany) ..... [11060-30]

## WEDNESDAY 26 JUNE

## SESSION 9

**LOCATION: HALL A1,  
ROOM GUSTAV HERTZ ..... WED 8:30 TO 10:00**

### Advanced Biosensors

Session Chair: **Andreas E. Vasdekis**, Pacific Northwest National Lab. (USA)

8:30: **Ultralarge scale single-cell image-based biophysical phenotyping: opportunities and challenges** (*Keynote Presentation*), Kevin K. Tsia, The Univ. of Hong Kong (Hong Kong, China) ..... [11060-31]

9:00: **Advanced label-free cellular identification in flow by collaborative coherent imaging techniques**, David Dannhauser, Domenico Rossi, Istituto Italiano di Tecnologia (Italy); Maria Isabella Maremonti, Univ. degli Studi di Napoli Federico II (Italy); Pasquale Memmolo, Pietro Ferraro, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy); Paolo Antonio Netti, Filippo Causa, Univ. degli Studi di Napoli Federico II (Italy) ..... [11060-32]

9:20: **Nano-biosensors based on dynamic light scattering**, Alexander Levin, The All-Russian Research Institute for Optical and Physical Measurements (Russian Federation); Maxim Nikitin, Moscow Institute of Physics and Technology (Russian Federation); Mikhail Alenichev, Ekaterina Drozhzhennikova, The All-Russian Research Institute for Optical and Physical Measurements (Russian Federation); Vitaly Grigorenko, Lomonosov Moscow State University Chemical Department (Russian Federation); Alina Ringaci, Moscow Institute of Physics and Technology (Russian Federation); Irina Andreeva, Lomonosov Moscow State University Chemical Department (Russian Federation) ..... [11060-33]

9:40: **Wound healing assay of two competing cell types with dry mass measurement**, Shir Cohen Maslaton, Natan T. Shaked, Tel Aviv Univ. (Israel) ..... [11060-55]

Coffee Break ..... Wed 10:00 to 10:30

### SPIE OPTICAL METROLOGY PLENARY SESSION

**LOCATION: ICM, SAAL 1 ..... WED 10:30 TO 11:25**

### Towards a complete framework for calibration of optical surface and coordinate measuring instruments

**Richard Leach**, Univ. of Nottingham (United Kingdom)

*For details, please see page 7.*

# CONFERENCE 11060

## SESSION 10

LOCATION: HALL A1,  
ROOM GUSTAV HERTZ ..... WED 11:30 TO 12:40

### Thermal Imaging for Medicine and Biotechnology

Session Chair: **Giuseppe Chirico**, Univ. degli Studi di Milano-Bicocca (Italy)

11:30: **Photo-activated thermal imaging at subdiffraction resolution** (*Invited Paper*), Margaux Bouzin, Mario Marini, Amirbahador Zeynali, Univ. degli Studi di Milano Bicocca (Italy); Laura Sironi, Laura D'Alfonso, Francesca Mingozzi, Francesca Granucci, Giuseppe Chirico, Maddalena Collini, Univ. degli Studi di Milano-Bicocca (Italy) ..... [11060-35]

12:00: **Sources of uncertainty in the evaluation of thermal images in medicine**, Kurt Ammer M.D., European Association of Thermology (Austria) ..... [11060-36]

12:20: **Toward single cell thermal biology**, Guillaume Baffou, Institut Fresnel (France) ..... [11060-37]

Lunch Break ..... Wed 12:40 to 13:40

## JOINT SESSION

LOCATION: HALL A1,  
ROOM GUSTAV HERTZ ..... 13:40 TO 15:25

### Holography Technology

Session Chairs: **Pietro Ferraro**, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy); **Pierre R. Slangen**, Mines Alès (France)

**Joint Session between SPIE Optical Metrology Conferences 11059 and 11060.**

**Please note room change.**

13:40: **Time resolved digital holography applied to droplets fragmentation by shockwave** (*Invited Paper*), Zacaria Essaidi, Pierre Lauret, Pierre R. Slangen, Mines Alès (France) ..... [11059-6]

14:10: **Automated cell identification with 3D optical imaging** (*Keynote Presentation*), Bahram Javidi, Univ. of Connecticut (USA); Arun Anand, The Maharaja Sayajirao Univ. of Baroda (India); Timothy O'Connor, Univ. of Connecticut (USA); Inkyu Moon, Daegu Gyeongbuk Institute of Science & Technology (Korea, Republic of); Adam S. Markman, Univ. of Connecticut (USA) ..... [11060-38]

14:45: **Holographic imaging of erythrocytes in acoustofluidic platforms**, Teresa Cacace, Pasquale Memmolo, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy); Massimiliano M. Villone, Univ. degli Studi di Napoli Federico II (Italy); Marco De Corato, Imperial College London (United Kingdom); Melania Paturzo, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy); Pier Luca Maffettone, Univ. degli Studi di Napoli Federico II (Italy); Pietro Ferraro, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy) ..... [11060-43]

15:05: **How holographic imaging can improve machine learning**, Pasquale Memmolo, Vittorio Bianco, Pierluigi Carcagni, Francesco Merola, Melania Paturzo, Cosimo Distante, Pietro Ferraro, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy) ..... [11059-7]

Coffee Break ..... Wed 15:25 to 16:00

## SESSION 11

LOCATION: HALL A1,  
ROOM GUSTAV HERTZ ..... WED 16:00 TO 17:40

### Phase Contrast Tomography: New Trends

Session Chair: **Christoph K. Hitzengerger**, Medizinische Univ. Wien (Austria)

16:00: **Quantitative phase imaging and artificial intelligence** (*Keynote Presentation*), Geon Kim, KAIST (Korea, Republic of); Hyungjoo Cho, Tomocube, Inc. (Korea, Republic of); Donghun Ryu, KAIST (Korea, Republic of); Hyeonseok Min, Tomocube, Inc. (Korea, Republic of); YongKeun Park, KAIST (Korea, Republic of) ..... [11060-40]

16:30: **Fast label-free optical diffraction tomography compatible with conventional wide-field microscopes** (*Invited Paper*), José A. Rodrigo, Juan M. Soto, Tatiana Alieva, Univ. Complutense de Madrid (Spain) ..... [11060-41]

17:00: **Holographic processing pipeline for tomographic flow cytometry**, Pietro Ferraro, Francesco Merola, Lisa Miccio, Pasquale Memmolo, Martina Mugnano, Istituto di Scienze Applicate e Sistemi Intelligenti "Eduardo Caianiello" (Italy) ..... [11060-42]

17:20: **BM3D filtration in holographic tomography reconstruction**, Piotr Stepien, Michal Ziemczonok, Arkadiusz T. Kuś, Malgorzata Kujawińska, Warsaw Univ. of Technology (Poland) ..... [11060-44]



# CONFERENCE 11061

LOCATION: ICM, 12A

Thursday 27 June 2019 • Proceedings of SPIE Vol. 11061

# Automated Visual Inspection and Machine Vision III

*Conference Chairs:* **Jürgen Beyerer**, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung IOSB (Germany), Karlsruhe Institut für Technologie (Germany); **Fernando Puente León**, Karlsruhe Institut für Technologie (Germany)

*Programme Committee:* Christian Frese, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany); Andreas Heinrich, Hochschule Aalen (Germany); Michael Heizmann, Karlsruher Institut für Technologie (Germany); Bernd Jähne, Ruprecht-Karls-Univ. Heidelberg (Germany); Thomas Längle, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany); Markus Maurer, VITRONIC Dr.-Ing. Stein Bildverarbeitungssysteme GmbH (Germany); Wolfgang Osten, Univ. Stuttgart (Germany); Felix Salazar, Univ. Politécnica de Madrid (Spain); Robert Schmitt, Fraunhofer-Institut für Produktionstechnologie (Germany); Hugo Thienpont, Vrije Univ. Brussel (Belgium); Stefan Werling, Duale Hochschule Baden-Württemberg (Germany); Ernst Wiedenmann, Serious Enterprises (Germany); Volker Willert, Technische Univ. Darmstadt (Germany)

## THURSDAY 27 JUNE

### SESSION 1

LOCATION: ICM, 12A ..... THU 10:30 TO 11:30

### Image Acquisition

Session Chair: **Jürgen Beyerer**, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany)

10:30: **A simulation framework for the design and evaluation of computational cameras**, Thomas Nürnberg, Maximilian Schambach, David Uhlig, Michael Heizmann, Fernando Puente León, Karlsruhe Institut für Technologie (Germany) ..... [11061-1]

10:50: **Robust phase unwrapping based on non-coprime fringe pattern periods for deflectometry measurements**, Stephan Allgeier, Ulrich Gengenbach, Bernd Köhler, Klaus-Martin Reichert, Veit Hagenmeyer, Karlsruhe Institut für Technologie (Germany) ..... [11061-2]

11:10: **Coded aperture imaging of high-energy radiation: modeling and primary experimental research**, Anna V. Vasileva, Aleksandr S. Vasilev, Victoria A. Ryzhova, ITMO Univ. (Russian Federation) ..... [11061-3]

### POSTERS-THURSDAY

LOCATION: ICM, HALL B0 ..... THU 11:30 TO 12:30

Conference attendees are invited to attend the Optical Metrology Poster Session 3 on Thursday. Come view the posters and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Posters will be available for viewing starting at 11:40 through 12:40 hrs on Thursday. Poster authors, view poster presentation guidelines and set-up instructions on page 6, and at <http://spie.org/x6513.xml>. (Follow the Special Events link)

**Region of interest detection based on visual saliency analysis and iteratively clustering for remote sensing images**, Yang Sun, Shuang Wang, Libao Zhang, Beijing Normal Univ. (China) ..... [11061-8]

**Region proposal-based semantic matcher**, Anastasiia Moiseenko, Vladimir S. Gorbatshevich, Yuri Vizilter, Boris V. Vishnyakov, Vygodov Oleg, GosNIIAS (Russian Federation) ..... [11061-9]

**Image filtering using morphological thickness map**, Stanislav Brianskiy, Moscow Aviation Institute (Russian Federation); Boris V. Vishnyakov, Vladimir S. Gorbatshevich, Yuri Vizilter, GosNIIAS (Russian Federation) ..... [11061-10]

**Applying computer simulation using optical design software to multi-spectral geometrical calibration of stereoscopic measurement systems**, Demid Khokhlov, Alexey Gorevoy, Alexander S. Machikhin, Scientific and Technological Ctr. for Unique Instrumentation (Russian Federation) ..... [11061-11]

**Medical image segmentation based on the modified model of active contour in a quaternion framework**, Viacheslav V. Voronin, Oxana Balabaeva, Evgeny A. Semenishchev, Don State Technical Univ. (Russian Federation) ..... [11061-12]

**Automated visual inspection algorithm for the reflection detection in image sequences**, Viacheslav V. Voronin, Evgeny A. Semenishchev, Don State Technical Univ. (Russian Federation) ..... [11061-13]

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## Digital Optical Technologies II

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Programme Committee: Tibor Balogh, Holografika Kft. (Hungary); Partha P. Banerjee, Univ. of Dayton (USA); Christian Bosshard, Ctr. Suisse d'Electronique et de Microtechnique SA (Switzerland); Arie den Boef, ASML Netherlands B.V. (Netherlands); Federico Capasso, Harvard School of Engineering and Applied Sciences (USA); Oliver Cossairt, Northwestern Univ. (USA); Andreas Hermerschmidt, HOLOEYE Photonics AG (Germany); Yoshio Hayasaki, Utsunomiya Univ. (Japan); Hans Peter Herzog, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Hong Hua, College of Optical Sciences, The Univ. of Arizona (USA); Fu-Chung Huang, nVIDIA Corp. (USA); Bahram Javidi, Univ. of Connecticut (USA); Sabina Jeschke, RWTH Aachen Univ. (Germany); Norbert Kerwien, Carl Zeiss AG (Germany); Joel S. Kollin, Microsoft Corp. (USA); Byoung-Ho Lee, Seoul National Univ. (Korea, Republic of); Scott McEldowney, Facebook/Oculus VR, LLC (USA); Juan C. Minano, Limbak 4PI S.L. (Spain); Ilmars Osmanis, Lightspace Technologies, SIA (Latvia); Silvana F. Pereira, Technische Univ. Delft (Netherlands); Christophe Peroz, Magic Leap, Inc. (USA); Pascal Picart, Univ. du Maine (France); Ting-Chung Poon, Virginia Polytechnic Institute and State Univ. (USA); Demetri Psaltis, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Monika Ritsch-Marte, Medizinische Univ. Innsbruck (Austria); Robert E. Stevens, Adlens Ltd. (United Kingdom); Hagen Stolle, SeeReal Technologies GmbH (Germany); Adrian Travis, Microsoft Research (France); Reinhard Voelkel, SUSS MicroOptics SA (Switzerland); Angus Wu, Huawei Technologies Co., Ltd. (USA); Frank Wyrowski, LightTrans International UG (Germany)

### MONDAY 24 JUNE

#### WORLD OF PHOTONICS CONGRESS-WIDE PLENARY SESSION

LOCATION: 11CM, SAAL 1 ..... MON 10:00 TO 11:00

#### Listening to the universe with gravitational waves

**Karsten Danzmann**, Max Planck Institute for Gravitational  
Physics and Leibnitz Univ. Hannover (Germany)

See details page 6.

Coffee Break ..... Mon 11:00 to 11:15

Lunch Break ..... Mon 11:15 to 13:00

#### SPIE DIGITAL OPTICAL TECHNOLOGIES PLENARY SESSION

LOCATION: HALL A1,  
ROOM ARTHUR SCHAWLOW ..... MON 13:00 TO 14:00

13:00 to 13:15: **Welcome and Introduction**

**Bernard C. Kress**, Microsoft Corp. (USA);  
**Peter Schelkens**, Vrije Univ. Brussel (Belgium)

13:15 to 14:00: **Light field image processing:  
overview and research problems**

**Christine Guillemot**, INRIA, France

#### SESSION 1

LOCATION: HALL A1,  
ROOM ARTHUR SCHAWLOW ..... MON 14:00 TO 15:40

#### 3D Display Techniques and Technologies

Session Chair: **Bernard C. Kress**, Microsoft Corp. (USA)

14:00: **Design and fabrication of flexible naked-eye 3D display thin film  
device based on micro nanostructure**, Axiu Cao, Institute of Optics and  
Electronics (China); Lifang Shi, Hui Pang, Qiling Deng, Song Hu, Institute of  
Optics and Electronics (China) .....[11062-1]

14:20: **Large-scale full-color computer-generated display holograms  
created by stacking transferred volume holograms**, Orié Kunieda, Kyoji  
Matsushima, Kansai Univ. (Japan) .....[11062-2]

14:40: **Exact mask-based occlusion processing in large-scale computer  
holography for 3D display**, Kenta Nakamoto, Kyoji Matsushima, Kansai Univ.  
(Japan) .....[11062-3]

15:00: **Epipolar-like image analysis for projection-based light field displays**,  
Oleksii Doronin, Attila Barsi, Holografika Kft. (Hungary) .....[11062-4]

15:20: **Design of free-form surface backlight unit for displays**, Nikolai I.  
Petrov, Scientific and Technological Ctr. for Unique Instrumentation (Russian  
Federation) .....[11062-5]

Coffee Break ..... Mon 15:40 to 16:10

#### SESSION 2

LOCATION: ARTHUR SCHAWLOW,  
HALL A1 ..... MON 16:10 TO 17:50

#### Switchable, Tunable and Reconfigurable Optics

Session Chair: **Svetlana Samoilova**, NewSight Reality (USA)

16:10: **Tunable filter using birefringent plasmonic structures and liquid  
crystals**, Benjamin Gallinet, Ctr. Suisse d'Electronique et de Microtechnique  
SA (Switzerland); Dimitrios Kazazis, Yasin Ekinci, Paul Scherrer Institut  
(Switzerland); François Federspiel, Richard Frantz, Rolic Technologies Ltd.  
(Switzerland); Rolando Ferrini, Luc Driencourt, Ctr. Suisse d'Electronique et de  
Microtechnique SA (Switzerland) .....[11062-6]

16:30: **Optically computational 3D structural measuring approaches and  
integration architecture with digitally reconfigurable digital optics array  
platform**, Cheng-Feng Yue, Jasper Display Corp. (Taiwan) .....[11062-7]

16:50: **Broadband visible reflective metasurfaces for the visualisation of 3D  
effects**, Diane J. Roth, Alexander E. Minovich, King's College London (United  
Kingdom); Guixin Li, Southern Univ. of Science and Technology of China  
(China); Anatoly V. Zayats, King's College London (United Kingdom) .....[11062-8]

17:10: **1x4 VLC wavelength demultiplexer based on multislot waveguide  
structures**, Moriel Gindi II, Amit Melamed D.D.S., Dror Malka, Holon Institute of  
Technology (Israel) .....[11062-9]

17:30: **Design of a tunable automotive light system with high collimated  
light engine for adaptive headlight system application**, Luan-Ying Chen,  
Industrial Technology Research Institute (Taiwan); Jui-Wen Pan, National Chiao  
Tung Univ. (Taiwan); Kao-Der Chang, National Central Univ. (Taiwan)[11062-10]

#### WORLD OF PHOTONICS CONGRESS: NOBEL PLENARY SESSION

LOCATION: ICM, SAAL 1 ..... MON 18:00 TO 19:00

#### Passion for Extreme Light

**Gerard Mourou**, École Polytechnique (France)

2018 Physics Nobel Prize Laureate

For details, please see page 6.

# CONFERENCE 11062

TUESDAY 25 JUNE

## SESSION 3

LOCATION: HALL A1,  
ROOM ARTHUR SCHAWLOW ..... TUE 8:00 TO 10:00

### Novel Optics for Augmented, Mixed and Virtual Reality Systems (AR, MR, VR)

Session Chair: **Christian Hellmann**, Wyrowski Photonics UG (Germany)

8:00: **Crystal: an optical train for upscale VR** (*Invited Paper*), Pablo Benitez, Dejan Grabovičič, Marina Buljan, Milena I. Nikolić, Julio Cesar Pinto Chaves, Juan C. Miñano, Pablo Zamora, Rubén Mohedano, Limbak 4PI S.L. (Spain) ..... [11062-71]

8:30: **NewSight Reality Inc. (NSR) novel transparent optical module for augmented reality glasses** (*Invited Paper*), Svetlana Samoilova, NewSight Reality (USA); Amitava Gupta, Foresightvision Inc. (USA); Roland Blum, NewSight Reality (USA); Igor Landau, OpticsWorks Inc. (USA) . . . . [11062-11]

9:00: **A novel approach to freeform optimization: designing an eye-tracking augmented reality system using grid-based sag optimization**, Zachary Derocher, Shawn Gay, Ken Moore, Zemax, LLC (USA) ..... [11062-12]

9:20: **A compact red-green-blue superluminescent diode module: A novel light source for AR microdisplays**, Nikolay Primerov, Jean Dahdah, Stefan Gloor, Tim von Niederhäusern, Nicolai Matuschek, Antonino Castiglia, Marco Malinverni, Christian Mounir, Marco Rossetti, Marcus Duell, Christian Vélez, EXALOS AG (Switzerland) . . . . . [11062-13]

9:40: **Innovative systematic design approach for lightguide devices for XR applications**, Christian Hellmann, Wyrowski Photonics UG (Germany); Stefan Steiner, Roberto Knoth, Site Zhang, LightTrans International UG (Germany); Frank Wyrowski, Friedrich-Schiller-Univ. Jena (Germany) . . . . . [11062-14]

Coffee Break ..... Tue 10:00 to 10:35

## SESSION 4

LOCATION: HALL A1,  
ROOM ARTHUR SCHAWLOW ..... TUE 10:35 TO 12:50

### Waveguide Optics for AR/MR Systems

Session Chair: **Sébastien de Cunsel**, WaveOptics Ltd. (United Kingdom)

10:35: **Optical design of a thin curved lightguide and manufacturing using ophthalmic approaches** (*Invited Paper*), Ozan Cakmakci, Oscar Martinez, Jerry Carollo, Google (USA) ..... [11062-15]

11:00: **Physical-optics analysis of lightguides for augmented and mixed reality glasses**, Christian Hellmann, Wyrowski Photonics UG (Germany); Stefan Steiner, Roberto Knoth, Site Zhang, LightTrans International UG (Germany); Frank Wyrowski, Friedrich-Schiller-Univ. Jena (Germany) . . . . . [11062-16]

11:20: **Features and limitations of waveguide combiner architectures for augmented reality headsets**, Bernard C. Kress, Microsoft Corp. (USA) . . . . . [11062-17]

11:40: **Physical-optical analysis of lightguide coupling setup and systematic design strategy**, Roberto Knoth, Stefan Steiner, Site Zhang, LightTrans International UG (Germany); Christian Hellmann, Wyrowski Photonics UG (Germany); Frank Wyrowski, Friedrich-Schiller-Univ. Jena (Germany) . . . . . [11062-18]

12:00: **Waveguide grating combiner for small form factor smart glasses** (*Invited Paper*), Antti Sunnari, Dispelix Oy (Finland) ..... [11062-19]

12:30: **Waveguide optics enabled consumer HUD's, revolutionizing AR transportation applications**, Jonathan D. Waldern, Alastair J. Grant, DigiLens Inc. (USA); Milan M. Popovich, DigiLens, Inc. (United Kingdom) . . . [11062-72]

Lunch Break ..... Tue 12:50 to 13:50

## SESSION 5

LOCATION: HALL A1,  
ROOM ARTHUR SCHAWLOW ..... TUE 13:50 TO 15:30

### Digital Optics for Image Formation

Session Chair: **Aleksandra Pedraszewska**, VividQ Ltd., (United Kingdom)

13:50: **3D imaging systems based on projectors and mobile phones**, Nikolai I. Petrov, Maxim N. Khromov, Vladislav G. Nikitin, Scientific and Technological Ctr. for Unique Instrumentation (Russian Federation); Yuri M. Sokolov, RUDN Univ. (Russian Federation). . . . . [11062-20]

14:10: **PixMap: automatic license plate recognition with convolutional neural network based on saliency maps**, Assan Sanogo, Arcadi Llanza, Nadiya Shvai, Abul Hasnat, Marouan Khata, Yassine El Khattabi, Antoine Meicler, Alice Hemery, cyclope.ai (France); Amir Nakib, Univ. Paris-Est Créteil (France) . . . . . [11062-21]

14:30: **Holistic optimization of optical systems**, Kumar Rishav, Carsten Reichert, Alois Herkommer, Institut für Technische Optik (Germany). [11062-22]

14:50: **Research on influences of atmospheric turbulence on long-distance Fourier pthchographic imaging**, Mingyang Yang, Xi'an Institute of Optics and Precision Mechanics (China) and Univ. of Chinese Academy of Sciences (China); Xuewu Fan, Hui Zhao, Chuang Li, Xi'an Institute of Optics and Precision Mechanics (China); Meng Xiang, Xi'an Institute of Optics and Precision Mechanics (China) and Univ. of Chinese Academy of Sciences (China) . . . . . [11062-23]

15:10: **Investigation the effect of shapes, size and orientation of dielectric rods on the photonic band gap for various lattices in 2D anisotropic photonic crystals**, Mahsa Hadadi Moghadam, Behrooz Rezaei, Ali Soltani Vala, Manoochehr Kalafi, Univ. of Tabriz (Iran, Islamic Republic of) . [11062-25]

Coffee Break ..... Tue 15:30 to 16:00

## SESSION 6

LOCATION: HALL A1,  
ROOM ARTHUR SCHAWLOW ..... TUE 16:00 TO 17:45

### Increasing Visual Comfort in 3D Displays

Session Chair: **Kriss Osmanis**, Lightspace Technologies, SIA (Latvia)

16:00: **Accommodation cue vs. compute: context dependent dynamic layer allocation in holographic display**, Omer Tastemur, Tom Durrant, Andrzej Kaczorowski, Darran Milne, VividQ Ltd. (United Kingdom) . . . . . [11062-73]

16:20: **Accommodation corrected 3D displays using spatial volume demultiplexer chip**, Kriss Osmanis, Roberts Zabels, Lightspace Technologies, SIA (Latvia); Ainars Ozols, EuroLCDs (Latvia); Martinš Narels, Lightspace Technologies, SIA (Latvia); Ugis Gertners, Hansamatrix Innovation (Latvia); Karlis Rutenbergs, Hansamatrix Ventspils (Latvia); Ilmars Osmanis, Lightspace Technologies, SIA (Latvia) . . . . . [11062-27]

16:40: **Advanced screen-space ambient occlusion on HoloVizio 3D display**, Oleksii Doronin, Attila Barsi, Holografika Kft. (Hungary) . . . . . [11062-28]

17:00: **Evaluation of AR displays performances based on human visual perception**, Sébastien de Cunsel, WaveOptics Ltd. (United Kingdom) . . . . . [11062-29]

17:25: **Analysis of the visual perception conflicts in the mixed reality systems with the real-world illumination parameters restoration**, Andrey Zhdanov, Dmitry Zhdanov, Igor S. Potemin, Nikolay Bogdanov, ITMO Univ. (Russian Federation) . . . . . [11062-30]

## WEDNESDAY 26 JUNE

### SESSION 7

**LOCATION: HALL A1,  
ROOM ARTHUR SCHAWLOW . . . . . WED 8:20 TO 10:00**

### Digital Optics for Display and Sensing

Session Chair: **Thomas Milde**, Carl Zeiss AG (Germany)

8:20: **High refractive index glass wafers for AR waveguide technology**, Berthold Lange, SCHOTT AG (Germany) . . . . . [11062-74]

8:40: **Enhanced field-of-view structured illumination projector using stacked microlens arrays**, Rohan Kundu, Friedrich-Schiller-Univ. Jena (Germany); Peter Schreiber, Peter Dannberg, Stephanie Fischer, Chen Li, Uwe D. Zeitner, Andreas Tünnermann, Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany) . . . . . [11062-31]

9:00: **Inspection of surface imperfections via height contrast imaging based on angle selective illumination**, Thomas Milde, Carl Zeiss AG (Germany); Christina Knechtel, Carl Zeiss SMT GmbH (Germany) . . . [11062-32]

9:20: **Ultraprecision angle measurement sensors with optimized size, weight and power**, Edward R. Dowski Jr., Ascentia Imaging, Inc. (USA); Greg Johnson, nelson claytor, Ascentia Imaging (USA) . . . . . [11062-33]

9:40: **Dot pattern generation using thick sinusoidal phase grating under Gaussian beam illumination**, Maryam Yousefi, Toralf Scharf, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Markus Rossi, ams AG (Switzerland) . . . . . [11062-34]

Coffee Break . . . . . Wed 10:00 to 10:30

### SESSION 8

**LOCATION: HALL A1,  
ROOM ARTHUR SCHAWLOW . . . . . WED 10:30 TO 11:50**

### Computation Display and Imaging I

Session Chair: **Peter Schelkens**, Vrije Univ. Brussel (Belgium)

10:30: **Single exposure lensless subpixel phase imaging**, Péter Kocsis, Igor Shevkunov, Vladimir Katkovnik, Karen Egiazarian, Tampere Univ. (Finland) . . . . . [11062-35]

10:50: **Increasing the accessible resolution range for computational ghost imaging based on Hadamard matrices**, Robert Aare, Andreas Valdmann, Univ. of Tartu (Estonia) . . . . . [11062-36]

11:10: **Optical quality metrics for image restoration**, Patrick Müller, Matthias Lehmann, Alexander Braun, Hochschule Düsseldorf (Germany) . . . [11062-37]

11:30: **Computational imaging technology based on birefringent materials**, Lifang Shi, Axiu Cao, Institute of Optics and Electronics (China); Hui Pang, Institute of Optics and Electronics (China); Qiling Deng, Institute of Optics and Electronics (China) . . . . . [11062-38]

Lunch Break . . . . . Wed 11:50 to 12:50

### POSTERS-WEDNESDAY

**LOCATION: ICM, HALL B0 . . . . . WED 12:50 TO 13:50**

Conference attendees are invited to attend the Digital Optical Technologies Poster Session on Wednesday. Come view the posters and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Posters will be available for viewing starting at 12:50 through 13:50 hrs on Wednesday. Poster authors, view poster presentation guidelines and set-up instructions on page 6, and at <http://spie.org/x6513.xml>. (Follow the Special Events link)

**Design and research of lenses with a remote pupil and a telecentric beam path**, Vasilisa Ezhova, Alexey Ikonnikov, Galina E. Romanova, Lev Andreev, ITMO Univ. (Russian Federation) . . . . . [11062-49]

**Determination of sample surface microrelief by optical vortices superposition**, Bogdan V. Sokolenko, Dmitrii Poletaev, Nataliya Shostka, V.I. Vernadsky Crimean Federal Univ. (Ukraine) . . . . . [11062-50]

**Arbitrary power splitting ratio on logic operation of NL-MMI**, Mehdi Tajaldini, Graduate Univ. of Advanced Technology (Iran, Islamic Republic of); Mohamad Zubir Mat Jafri, Univ. Sains Malaysia (Malaysia) . . . . . [11062-51]

**Automatised fine-focusing in digital microscopy**, Petr Pokorný, Filip Šmejkal, Pavel Novák, Jirí Novák, Antonín Mikš, Czech Technical Univ. in Prague (Czech Republic) . . . . . [11062-52]

**A method of increasing the depth-of-field of images of flat discrete transparencies, reconstructed using synthesized holograms**, Marina Frolova, ITMO Univ. (Russian Federation) . . . . . [11062-53]

**Computational ghost imaging using the native aspect ratio of a digital light projector**, Joonas Ariva, Andreas Valdmann, Jan Bogdanov, Univ. of Tartu (Estonia) . . . . . [11062-54]

**Design of real-time compression and storage system for CoaXPress high-speed camera based on MPSoc FPGA**, Qingkai Hou, Qiong Yao, Fuyin Wang, Hu Chen, Shuidong Xiong, Chunyan Cao, Weihua Zhang, Changxiang Linghu, National Univ. of Defense Technology (China) . . . . . [11062-55]

**Formation and identification of atmospheric structure data by digital holography methods**, Ekaterina Seledkina, Anton Ekimenko, ITMO Univ. (Russian Federation) . . . . . [11062-56]

**Segmentation of illuminated areas of light using fully-convolutional neural networks and computer vision algorithms for augmented reality systems**, Maxim Sorokin, Andrey Zhdanov, Dmitry Zhdanov, Igor S. Potemin, Nikolay Bogdanov, ITMO Univ. (Russian Federation) . . . . . [11062-57]

**Digital methods of impact on the image**, Kseniia Ezhova, Anton Chukhramov, ITMO Univ. (Russian Federation) . . . . . [11062-58]

**Simultaneous quantification of biomarkers using wax-patterned paper-polymer centrifugal optics**, Sejin Kim, Dami Kim, Sanghyo Kim, Gachon Univ. (Korea, Republic of) . . . . . [11062-59]

**Colorimetric detection of acetylcholinesterase using paper hybrid centrifugal fluidic on disc platform**, Dami Kim, Sejin Kim, Sanghyo Kim, Gachon Univ. (Korea, Republic of) . . . . . [11062-60]

**Graphene nonlinear optic all-optical switch based on multimode interference coupler**, Mohamad Zubir Mat Jafri, Muhd. Adnin Abd. Hassim, Univ. Sains Malaysia (Malaysia) . . . . . [11062-61]

**Modeling and design of Vanguard high-NA projection lens with central obscuration**, Aleksandr S. Grishkanich, Aleksandr Zhevlakov, ITMO Univ. (Russian Federation) . . . . . [11062-62]

**Increase of the magnetic information sensing performance of magneto-optical plasmonic structures**, Stepan Baryshev, Alexey Kuznetsov, Sergey Odinkov, Bauman Moscow State Technical Univ. (Russian Federation) . . . . . [11062-63]

**Review and analysis of optics for road lighting**, Xuanlin Qiao, Galina E. Romanova, ITMO Univ. (Russian Federation) . . . . . [11062-64]

**Design and aberration analysis of several AR optical architectures working with different sources of image**, Tatiana A. Koneva, Galina E. Romanova, ITMO Univ. (Russian Federation) . . . . . [11062-65]

**Experiments of DOEs for augmented reality indicator**, Artem B. Solomashenko, Yanina Grad, Sergey Odinkov, Vladimir Nikolaev, Dmitriy Lushnikov, Vladimir Markin, Bauman Moscow State Technical Univ. (Russian Federation) . . . . . [11062-66]

**Achromatic image rotator**, Nikolai I. Petrov, Scientific and Technological Ctr. for Unique Instrumentation (Russian Federation) . . . . . [11062-67]

**The efficient method of mixed reality light restoration using HDR image of 3D scene**, Nikolay Bogdanov, Igor S. Potemin, Dmitry Zhdanov, Andrey Zhdanov, ITMO Univ. (Russian Federation) . . . . . [11062-68]

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**Modified algorithm of 3D motion capture camera for martial power estimation**, Nur Zaidi Azraai, Ahmad Afiq Sabqi M. Awang Soh, Mohamad Zubir Mat Jafri, Univ. Sains Malaysia (Malaysia) . . . . . [11062-69]

**An extrapolation-based method for improving the accuracy of phase retrieval with the transport of intensity equation**, Zixin Zhao, Chen Fan, Xi'an Jiaotong Univ. (China); Jinlei Zhao, No.203 Research Institute of China Ordnance Industries (China); Yiyang Zhuang, Hangying Zhang, Hong Zhao, Xi'an Jiaotong Univ. (China) . . . . . [11062-70]

## SESSION 9

**LOCATION: HALL A1,  
ROOM ARTHUR SCHAWLOW . . . . . WED 13:50 TO 15:30**

### Computation Display and Imaging II

Session Chair: **Tatiana A. Koneva**, ITMO Univ., (Russian Federation)

13:50: **Adaptation of tone mapping algorithms for light field displays**, Oleksii Doronin, Attila Barsi, Holografika Kft. (Hungary) . . . . . [11062-40]

14:10: **A plug-n-play framework and acquisition methodology for remote exploration systems with single pixel cameras**, Protim Bhattacharjee, Anko Börner, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany). [11062-41]

14:30: **Design of a spectral zoom imaging system**, Xiaohu Guo, Chenxiao Zhao, Ping Zhou, Jingjing Zhu, Weiwei Zhu, Zuming Kang, China North Vehicle Research Institute (China) . . . . . [11062-42]

14:50: **Study of peak to background-noise ratio for digital optical phase conjugator**, Yeh-Wei Yu, Ching-Cherng Sun, National Central Univ. (Taiwan) . . . . . [11062-43]

15:10: **Automated, AI-driven reconfigurable phase contrast microscope for the diagnostic of fibers in air samples**, David A. Mendels, xRapid-Group (France) . . . . . [11062-44]

Coffee Break . . . . . Wed 15:30 to 16:00

## SESSION 10

**LOCATION: HALL A1,  
ROOM ARTHUR SCHAWLOW . . . . . WED 16:00 TO 17:20**

### Computation Display and Imaging III

Session Chair: **Bernard C. Kress**, Microsoft Corp. (USA)

16:00: **Improved vector extrapolation based Richardson-Lucy algorithm used for wavefront coded imaging and experimental demonstration**, Hui Zhao, Jingjing Xia, Ling Zhang, Congcong Yu, Xuewu Fan, Xi'an Institute of Optics and Precision Mechanics (China) . . . . . [11062-45]

16:20: **Visibility enhancement for haze removal based on adaptive double opponency**, Ruxi Xiang, Changzhou Institute of Technology (China) [11062-46]

16:40: **Spatially-varying blur kernel measurement based on discrete cosine transform single-pixel imaging**, Hongzhi Jiang, Yu Wang, Huijie Zhao, Xudong Li, Yang Xu, Yuxi Li, Yunfan Wang, Beihang Univ. (China) . [11062-47]

17:00: **Refractive telescope design with digital correction of residual chromatic aberrations**, Jingang Zhang, Univ. of Chinese Academy of Sciences (China) and Chinese Academy of Sciences (China); Yunfeng Nie, Vrije Univ. Brussel (Belgium); Qiang Fu, King Abdullah Univ. of Science and Technology (Saudi Arabia); Yifan Peng, The Univ. of British Columbia (Canada); Shuzhen Wang, Xidian Univ. (China) . . . . . [11062-48]

# Digital Optical Technologies

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## International Day of Light

16 May

The International Day of Light is a global initiative highlighting to the citizens of the world the importance of light and light-based technologies in their lives, for their futures, and for the development of Society.

**SPIE supports the International Day of Light and its annual celebration on 16 May.**



### SPIE IDL GRANTS

SPIE will provide seed funding up to US\$3,000 to organizations creating Day of Light activities.



### IDL RESOURCES

SPIE encourages communities to plan their own annual celebration on 16 May and provides various resources to help create an event.



### SPIE PHOTO CONTEST

Amateur and professional photographers alike should submit photos demonstrating the vital role that light plays in our lives for a chance to win US\$2,500.



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Learn more: [spie.org/idl](http://spie.org/idl)

# Digital Optical Technologies

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## Registration

### Onsite Registration and Badge Pick-up Hours

ICM Foyer West

Sunday 23 June · 7:30 to 17:30 hrs.

Monday 24 June · 7:30 to 17:00 hrs.

Tuesday 25 June · 8:00 to 17:00 hrs.

Wednesday 26 June · 8:30 to 17:00 hrs.

Thursday 27 June · 8:30 to 16:00 hrs.

### Conference Registration

Includes admission to all conference sessions, plenaries, panels, and poster sessions, admission to the AR/VR headset demonstrations, admission to the Laser World of Photonics Exhibition, Welcome Reception, coffee breaks, and a choice of online proceedings.

### SPIE Member, SPIE Student Member, and Student Pricing

- SPIE Members receive conference registration discounts. Discounts are applied at the time of registration.
- Student registration rates are available only to undergraduate and graduate students who are enrolled full time and have not yet received their Ph.D. Post-docs may not register as students. A student ID number or proof of student status is required with your registration.

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ICM Foyer West

Open during registration hours

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Preregistered attendees who did not receive a receipt or attendees who need a Certificate of Attendance may obtain those from the SPIE Cashier.

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Badge corrections can be made by the SPIE Cashier. Please have your badge removed from the badge holder and marked with your changes before approaching the counter.

### Refund Information

There is a €40 service charge for processing refunds. Requests for refunds must be received by 13 June 2019; all registration fees will be forfeited after this date. Membership dues, SPIE Digital Library subscriptions, or Special Events purchased are not refundable.

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1. The onsite AV management is handled by Neumann & Müller, the local AV agency tasked by Messe München GmbH. Speakers have been contacted by this agency and are asked to follow the guidelines received by Neumann & Müller.

2. Preview your presentation onsite

All presenters are strongly encouraged to visit Speaker Check-In at least 2 hours prior to their presentation to preview their files through the SPIE presentation system, or the day before if presenting in first morning session).

# GENERAL INFORMATION

## Author / Presenter Information

### Speaker Check-In and Preview Station

ICM, First Floor Foyer, and Hall A1

Monday through Thursday · Open during registration hours

All conference rooms have a computer workstation, projector, screen, lapel microphone, and laser pointer. All presenters are requested to come to Speaker Check-In (their conference room during the breaks) with their memory devices or laptops to confirm their presentation display settings. The local AV supplier M-Events will assist you. As stated in the author submission guidelines, please note that SPIE will be recording audio and slide content.

### SPIE Optical Metrology and SPIE Digital Optical Technologies Joint Poster Sessions

Tuesday - Thursday 25 - 27 June 2019 · 12:00 - 12:40

Location: ICM, Hall BO

All symposium attendees are invited to attend Digital Optical Technologies and Optical Metrology Joint Poster Sessions provided as an opportunity to enjoy networking while reviewing poster papers.

Please note that the Digital Optical Technologies Conference Poster Session (Conf. 10335) has been scheduled as part of the Wednesday Poster Session 2, and will run from 12:50 to 13:50 hrs.

**TUESDAY POSTER SESSION 1:** Conf. 11056, 11058, 11060 (Optical Metrology)

**WEDNESDAY POSTER SESSION 2:** Conf. 11057, 11059 (Optical Metrology), 11062 (Digital Optical Technologies)

**THURSDAY POSTER SESSION 3:** Conf. 11061 (Optical Metrology)

Attendees are encouraged to review the high-quality papers and interact with the poster authors. Poster authors must be present at their posters at the Poster Session times designated for their conference to answer questions and interact with the poster session audience. Attendees are requested to wear their conference registration badges to the poster sessions.

**Please see below for specific conference poster session timing.**

#### Tuesday 25 June · Poster Session 1

**Optical Metrology, Conf. 11056** (Opt. Measurement Systems-Industrial Inspection): 13:00 to 14:20

**Optical Metrology, Conf. 11058** (Optics for Arts, Architecture, and Archaeology): 12:30 to 13:10

**Optical Metrology, Conf. 11060** (Opt. Methods for Inspection, Characterization, and Imaging of Biomaterials): 12:10 to 12:40

#### Wednesday 26 June · Poster Session 2

**Digital Optical Technologies, Conf. 11062:** 12:50 to 13:50

**Optical Metrology, Conf. 11057** (Modeling Aspects in OM): 11:30 to 12:40

**Optical Metrology, Conf. 11059** (Multimodal Sensing and Artificial Intelligence: Technologies and Applications): 11:30 to 12:40

#### Thursday 27 June · Poster Session 3

**Optical Metrology, Conf. 11061** (Automated Visual Inspection and Machine Vision): 11:30 to 12:30

### Set up and removal times for each of the Poster Session days.

Your poster may be displayed any time after setup time and must be removed by the break-down time noted below.

**Tuesday 27 June** - Conf. 11056, 11058, 11060

Setup—Monday, 13:00 hrs; Break-down—Tuesday, 17:00 hrs

**Wednesday 28 June** - Conf. 11057, 11059, 11062

Setup—Wednesday, 10:00 hrs; Break-down—Wednesday, 17:00 hrs

**Thursday 29 June** - Conf. 10334

Setup—Thursday, 9:30 hrs; Break-down—Thursday, 16:30 hrs

Poster presenters may post their poster papers starting at the announced times for each conference, and present them during their respective conference Poster Session. Any papers left on the boards following the poster removal time will be considered unwanted and will be discarded. SPIE assumes no responsibility for posters left up after the end of the Poster Session. Poster authors should be at their papers during their assigned times to answer questions from attendees.

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## Food and Beverage Services

### Coffee Breaks

#### ICM Foyers, and Hall A1

Complimentary coffee will be served twice daily at the times indicated in the programme. Check individual conference listings for exact times and locations.

### Food and Refreshments for Purchase

The ICM has three permanent food-service operations in the foyer area – the ICM Bistro, ICM Bar, and ICM Café where guests can purchase food. There is also the “Am See” Restaurant located on the 1st floor above the registration in Entrance West. In good weather, a beer garden is operated in the courtyard between Halls A and C. There are also a number of bars and restaurants located in the surrounding hotels as well as the “Riem Arkaden” shopping centre on the other side of the underground station “Messestadt West”.

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3. This special offer is available for rentals from June 15- July 7, 2019.

## Digital Optical Technologies

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INCLUSION**

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DL 11057	<b>Modeling Aspects in Optical Metrology VII</b> <i>Bernd Bodermann, Karsten Frenner, Richard M. Silver</i>
DL 11058	<b>Optics for Arts, Architecture, and Archaeology VII</b> <i>Roger Groves, Haida Liang</i>
DL 11059	<b>Multimodal Sensing: Technologies and Applications</b> <i>Ettore Stella</i>
DL 11060	<b>Optical Methods for Inspection, Characterization, and Imaging of Biomaterials IV</b> <i>Pietro Ferraro, Monika Ritsch-Marte, Simonetta Grilli, Christoph K. Hitztenberger</i>
DL 11061	<b>Automated Visual Inspection and Machine Vision III</b> <i>Jürgen Beyerer, Fernando Puente León</i>

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SPIE does not tolerate harassment of event participants, attendees, exhibitors, speakers, volunteers, contractors, service providers, venue staff, or SPIE staff. This Code of Conduct applies to all SPIE meeting-related events, including those sponsored by other organizations but held in conjunction with SPIE events, in public or private facilities.

The SPIE Anti-Harassment Policy may be found at <http://spie.org/policy> (PDF)

The SPIE Code of Conduct may be found at <http://spie.org/conduct> (PDF)

In addition, SPIE Members and authors of SPIE publications must adhere to the SPIE Code of Ethics, found at <http://spie.org/ethics> (PDF)

### Reporting of Unethical or Inappropriate Behavior

Onsite at an SPIE meeting, contact any SPIE Staff with concerns or questions for thorough follow-up. If you feel in immediate danger, please dial the local emergency number for police intervention.

SPIE has established a confidential reporting system for staff and all meetings participants to raise concerns about possible unethical or inappropriate behavior within our community. Complaints may be filed by phoning toll-free to +1-888-818-6898 from within the United States and Canada, or online at [www.SPIE.ethicspoint.com](http://www.SPIE.ethicspoint.com) and may be made anonymously.

### Identification Requirement Policy

To verify registered participants and provide a measure of security, SPIE will ask attendees to present a government-issued photo identification at registration to collect registration materials.

Individuals are not allowed to pick up badges for other attendees. Further, attendees may not have some other person participate in their place at any conference-related activity. Such other individuals will be required to register on their own behalf to participate.

### Access to Conference Events / Access for Children Younger than 18

All conference technical and networking events require a badge for admission. Registered attendees may bring children with them as long as they have been issued a badge. Registration badges for children under 18 are free and available at the SPIE registration desk onsite. Children under 14 years of age must be accompanied by an adult at all times, and guardians are asked to help maintain a professional, disturbance-free conference environment.

### Exhibition Hall Access / Access for Children Younger than 18

Everyone who attends the exhibition must be registered and have a badge. Badges for children are free and available onsite at the registration desk. Children under 14 years of age must be accompanied by an adult at all times. Guardians are asked to help maintain a professional, disturbance-free exhibition environment. Children under 18 are not allowed in the exhibition area during exhibition move-in and move-out.

### Unauthorized Solicitation Policy

Unauthorized solicitation in the Exhibition Hall is prohibited. Any nonexhibiting manufacturer or supplier observed to be distributing information or soliciting business in the aisles, or in another company's booth, will be asked to leave immediately.

### Recording Policy

Conferences, courses, and poster sessions: For copyright reasons, recordings of any kind are prohibited without prior written consent of the presenter or instructor. Attendees may not capture or use materials presented in any meeting/course room or in course notes on display without written permission. Consent forms are available at Speaker Check-In or SPIE Registration. Individuals not complying with this policy will be asked to leave a given session and/or asked to surrender their recording media. Refusal to comply with such requests is grounds for expulsion from the event.

Exhibition Hall: Recordings of any kind are prohibited without explicit permission from on-site company representatives. Individuals not complying with this policy will be asked to surrender their recording media and to leave the exhibition hall. Refusal to comply with such requests is grounds for expulsion from the event.

## Capture and Use of a Person's Image

By registering for an SPIE event, you grant full permission to SPIE to capture, store, use, and/or reproduce your image or likeness by any audio and/or visual recording technique and create derivative works of these images and recordings in any SPIE media now known or later developed, for any legitimate SPIE marketing or promotional purpose.

By registering for an SPIE event, you waive any right to inspect or approve the use of the images or recordings or of any written copy. You also waive any right to royalties or other compensation arising from or related to the use of the images, recordings, or materials. By registering, you release, defend, indemnify and hold harmless SPIE from and against any claims, damages or liability arising from or related to the use of the images, recordings or materials, including but not limited to claims of defamation, invasion of privacy, or rights of publicity or copyright infringement, or any misuse, distortion, blurring, alteration, optical illusion or use in composite form that may occur or be produced in taking, processing, reduction or production of the finished product, its publication or distribution.

## Laser Pointer Safety Information/Policy

SPIE supplies tested and safety-approved laser pointers for all conference meeting rooms. For safety reasons, SPIE requests that presenters use provided laser pointers.

Use of a personal laser pointer represents the user's acceptance of liability for use of a non-SPIE-supplied laser pointer. If you choose to use your own laser pointer, it must be tested to ensure <5 mW power output. Laser pointers in Class II and IIIa (<5 mW) are eye safe if power output is correct, but output must be verified because manufacturer labeling may not match actual output. You are required to sign a waiver releasing SPIE of any liability for use of potentially non-safe, personal laser pointers. Waivers are available at Speaker Check-In.

## Unsecured Items Policy

Personal belongings should not be left unattended in meeting rooms or public areas. Unattended items are subject to removal by security. SPIE is not responsible for items left unattended.

## Wireless Internet Service Policy

At most events, SPIE provides wireless access for attendees. Properly secure your computer before accessing the public wireless network. SPIE is not responsible for computer viruses or other computer damage.

## No-Smoking Policy

Smoking, including e-cigarettes, is not permitted at any SPIE event.

## Agreement to Hold Harmless

Attendee agrees to release and hold harmless SPIE from any and all claims, demands, and causes of action arising out of or relating to your participation in the event you are registering to participate in and use of any associated facilities or hotels.

## Event Cancellation Policy

If for some unforeseen reason SPIE should have to cancel an event, processed registration fees will be refunded to registrants. Registrants will be responsible for cancellation of travel arrangements or housing reservations and the applicable fees.

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## SPIE International Headquarters

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