OSA Digital Holography & 3-D Imaging

19—23 May 2019

Institut d'Optique Graduate School

Bordeaux, France

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General Information

Registration

Big Hall

Please note: Registration desk will be closed during lunch breaks.

Sunday, 19 May	**14:30—17:00**
Monday, 20 May	**07:00—18:00**
Tuesday, 21 May	**07:00—18:00**
Wednesday, 22 May	**07:00 –18:00**
Thursday, 23 May	**07:00—16:00**

Coffee Breaks

Rooms A3 and A5

Monday, 20 May	**10:00– 10:30** **16:00—16:30**
Tuesday, 21 May	**10:00—10:30**
Wednesday, 22 May	**10:00 —10:30** **16:00—16:30**
Thursday, 23 May	**10:00—10:30** **16:00—16:30**

Poster Presentation Setup

Rooms A1, A2, A3, and A5

All poster presenters will be supplied with a bulletin board that is 100 cm high x 70 cm wide and pins. Set-up for posters will begin at 07:30 on the morning of your poster presentation (either Wednesday or Thursday) and must be completely set up by 13:30. Poster sessions will be begin at 14:00. All posters must be removed immediately following your presentation (by 16:30). Authors must remain in the vicinity of the bulletin board for the duration of the session to answer questions. Poster presenters are not supplied with any audiovisual equipment.

Oral Presentation Setup

Technical Session Rooms Amphitheater and E300

For oral presenters, you presentation can be loaded directly onto the computers located within each session room. Please load your presentation in advance of your session start time. PowerPoints and PDF presentations are accepted. Presentations are not able to be removed except by OSA staff for security purposes, but presentations will be removed at the end of each day. PowerPoint dimensions should be set to 16:9. Presentations within the room will have Windows OS 10.

Transportation

There are several options to get to the Institut d'optique.

Tram from Bordeaux Saint-Jean Station

Take Tram C, Direction "Gare de Blanquefort" or "Bordeaux-Parc des expositions", leave at "Quinconces", Change for Tram B, Direction "Pessac Centre" or "France Alouette", leave at "Arts & Métiers"

Cost of ticket: 1.70€
Cost of 10 ticket: 13.20€
Cost of one-day ticket: 4.70€
Duration: 30 minutes from the main railway station then walk about 150 meters to get to the main entrance of IOGS.

All conference participants will receive a free tram/bus ticket valid for the entire conference duration to assist in transportation. A tram map may be downloaded at : https://www.infotbm.com/sites/default/files/medias/fichiers/2019-02/SCHEMA_JOUR_HIVER_2018_WEB.pdf.

Taxi

Below is a list of local taxi phone numbers for your reference:

Aero Taxi Concorde: 0033.5.56.97.11.27
Aero Taxi: 0033.5.56.40.17.53
Alliance Taxi Bordeaux: 0033.5.56.77.24.24
Allo Bordeaux Taxis: 0033.5.56.31.61.07
Aquitaine Taxis Radio: 0033.5.56.86.80.30
Taxis Girondins: 0033.5.56.80.70.37
Taxi: 0033.5.56.29.10.25
Taxis Tele: 0033.5.56.96.00.34
Taxis 33: 0033.5.56.74.95.06

Access to the Wireless Internet

There is free wifi in within the Institut d'Optique. Connection information will be provided at the registration table when you pick up your badge and registration materials. A EDUROAM connection is also available within the building.

Program Updates

Should updates to the program occur, they will be announced via a program update sheet and posted near the registration desk. Please check frequently to see if any changes to programming has occurred.

General Information

Online Access to Technical Digest

Full Technical Attendees have both EARLY and FREE continuous online access to the DH Meeting Technical Digest and Postdeadline papers through OSA Publishing's Digital Library. The presented papers can be downloaded individually or by downloading .zip files (.zip files are available for 60 days).

1. Visit the conference website at www.osa.org/DH
2. Select the "Access digest papers" link on the right hand navigation.
3. Log in using your email address and password used for registration. You will be directed to the conference page where you will see the .zip file link at the top of this page. [**Note**: if you are logged in successfully, you will see your name in the upper right-hand corner.]

Access is limited to Full Technical Attendees only. If you need assistance with your login information, please use the "forgot password" utility or "Contact Help" link.

About OSA Publishing's Digital Library

Registrants and current subscribers can access all of the meeting papers, posters and postdeadline papers on OSA Publishing's Digital Library. The OSA Publishing's Digital Library is a cutting-edge repository that contains OSA Publishing's content, including 16 flagship, partnered and co-published peer reviewed journals and 1 magazine. With more than 304,000 articles including papers from over 640 conferences, OSA Publishing's Digital Library is the largest peer-reviewed collection of optics and photonics.

Anti-harassment Policy and Code of Conduct

All OSA guests, attendees, and exhibitors are subject to the Code of Conduct policy, the full text of which is available at osa.org/codeofconduct. Conference management reserves the right to take any and all appropriate actions to enforce the Code of Conduct, up to and including ejecting from the conference individuals who fail to comply with the policy.

If you wish to report bullying, discrimination, or harassment you have witnessed or experienced, you may do so through the following methods:

- use the online portal osa.org/IncidentReport (or email CodeOfConduct@OSA.org)
- contact any OSA staff member (if onsite at an event or meeting)

Special Events

Bordeaux Cultural Experience Welcome Reception

Monday, 20 May, 18:30—23:-00
Chateau Luchey-Halde
Shuttle buses will be provided at 18:00.

Join us for networking and wine tour of beautiful Chateau Luchey-Halde to kick off the 2019 Digital Holography and 3-D Imaging meeting! Tickets for the reception must be purchased for $45 USD and may be purchased through OSA's registration page at www.osa.org or at the OSA registration desk. Shuttle buses will take participants from the conference venue to the reception site and will leave at 18:00. The visit starts with a view on the vineyards where you will learn about the work carried out there and the Pessac-Leognan appellation. The next stop is the winery where we will explain the wine-making process from the harvest to the bottling. The best part of the visit is left for the end: a tasting of two wines, one red and the other white. For more information about the reception venue, visit http://luchey-halde.com/en/home-luchey-halde.

Keynote Sessions

Monday, 20 May, 08:30—09:15 (Opening remarks at 08:15) and Tuesday, 21 May, 08:00—08:45
Amphitheater

This year's DH meeting will feature two Keynote speakers. Wolfgang Osten will present a talk entitled "True Holography or Simply Beguiling the Eye: Where the Journey May Go?" during the Conference opening Remarks and Keynote Session I at 08:30 on Monday, 20 May. Daniel Smalley will discuss Improving Photophoretic Trap Volumetric Displays on Tuesday, 21 May at 08:00 on Tuesday, 21 May. For more information on the plenary presentations, see the Plenary descriptions on page 7 of this program.

Free Afternoon to Explore

Tuesday, 21 May, 14:00—19:00
On Your Own

Technical sessions will end by 14:00 on Tuesday, 21 May so that attendees can enjoy all that Bordeaux has to offer. For more information about the location visit https://www.bordeaux-tourisme.com/ or https://www.bordeaux-tourism.co.uk for tourism information.

Bordeaux River Cruise Conference Banquet

Tuesday, 21 May, 18:30—21:-00
Boat Boarding located at 157 Quai des Chartrons, 33000 Bordeaux, France
Although transportation from the venue will not be provided, the banquet boat can easily be reached by Tram B (CAPC Musée d'Art Contemporain station) or Tram C (Paul doumer Station) from the conference venue and from most of the hotels. Each conference participant will receive a tram/bus ticket valid for all the conference duration.

Join your fellow attendees for a festive evening and another opportunity to network with your colleagues. Ideally located in the heart of Bordeaux , Bordeaux River Cruise invites you aboard its new restaurant-boat, the SICAMBRE, to discover Bordeaux in a whole new light, along the city's "Port de la Lune" and its UNESCO World Heritage facades, during a unique 2-hour cruise. Our friendly on-board catering staff offers you top-quality cuisine inspired by the Gironde Estuary. Our talented chef invites you to try his "finger foods" menu: a convivial meal of refined dishes, in perfect harmony with the region's wines and sure to delight you. For more information on the cruise visit https://bordeaux-river-cruise.com.

Poster Sessions

Wednesday, 22 May, 14:00—16:00
Thursday, 23 May, 14:00—16:00
Rooms A1, A2, A3 and A5

Poster presentations offer an effective way to communicate new research findings and provide a venue for lively and detailed discussion between presenters and interested viewers. Don't miss this opportunity to discuss current research one-on-one with the presenters. Each author is provided with a board to display the summary and results of his or her paper. All posters must be set by the start of the poster session. The presenter must remain in the vicinity of their poster for the duration of the session. All presenters must remove their posters at the conclusion of the session. Management will remove and discard any remaining posters after the time listed below.

A Revolution in Display Holography: CHIMERA™, the Third Generation of Holoprinter

Wednesday, 22 May, 18:15—19:15
Amphitheater

Join author Yves Gentet, *Ultimate-Holography.com* for a public conference on a revolution in display holography: CHIMERA™, the third generation of Holoprinter. This event is open to the public.

Keynote Speakers

Wolfgang Osten

Institute for Applied Optics, University Stuttgart, Germany

True Holography or Simply Beguiling the Eye: Where the Journey May Go?

Monday, 20 May, 08:30—09:15

Amphitheater

Biography: Wolfgang Osten received the MSc/Diploma in Physics from the Friedrich-Schiller-University Jena in 1979. From 1979 to 1984 he was a member of the Institute of Mechanics in Berlin working in the field of experimental stress analysis and optical metrology. In 1983 he received the PhD degree from the Martin-Luther-University Halle-Wittenberg for his thesis in the field of holographic interferometry. From 1984 to 1991 he was employed at the Central Institute of Cybernetics and Information Processes ZKI in Berlin making investigations in digital image processing and machine vision. Between 1988 and 1991 he was heading the Institute for Digital Image Processing at the ZKI. In 1991 he joined the Bremen Institute of Applied Beam Technology (BIAS) to establish and to direct the Department Optical 3D-Metrology till 2002. From September 2002 till October 2018 he has been a full professor at the University of Stuttgart and director of the Institute for Applied Optics. From 2006 till 2010 he was the vice rector for research and technology transfer of the Stuttgart University. His research work is focused on new concepts for industrial inspection and metrology by combining modern principles of optical metrology, sensor technology and digital image processing. Special attention is directed to the development of resolution enhanced technologies for the investigation of micro and nano structures. Wolfgang Osten is fellow of OSA, SPIE, EOS, SEM, and senior member of IEEE. He is a Honorary Professor of the Shenzhen University, China, a Honorary Doctor of the University of Technology of Ilmenau, Germany, the 2011 recipient of the Dennis Gabor Award of the The International Society for Optics and Photonics SPIE, the 2018 recipient of the Rudolf Kingslake Medal of the SPIE, the 2019 recipient of the Chandra Vikram Award of the SPIE, and the 2019 recipient of the Emmett N. Leith medal of the OSA.

Daniel Smalley

Brigham Young University, USA

Improving Photophoretic Trap Volumetric Displays

Tuesday, 21 May, 08:00—08:45

Amphitheater

Biography: Late on a stormy night (Friday the 13th it was!) a shrill cry pierced the darkness and Daniel Smalley was born. Young Daniel was a farmhand by day and an intrepid experimenter by night. He once used an old metal bucket, some sand and a computer fan to construct an aluminum furnace for melting pop-cans and old screen doors into machine tool parts. He also built a number of circuits, a methane digester, a wind-powered electrolysis machine, a laser and a number of fine origami creations of various shapes and sizes. He experimented a great deal with holography, and for this reason was led to attend MIT where he earned a B.S., M.Eng, M.S., and Ph.D. degrees while working to create the world's first low-cost holographic video monitor. Now as a newly minted BYU professor, he is continuing his work in electroholography by fabricating new waveguide-based modulators. Professor Smalley aspires to create large, high resolution, interactive holographic and volumetric displays. He is also part of collaborations pursuing novel brain probes and tractor beam technologies.

Tutorial Speakers

Tomasz Kozacki
Watsaw University of Technology

Reconstruction Algorithms, Capture Systems and Applications of Holographic Tomography
Tuesday, 21 May, 08:45—09:30
Amphitheater

Biography: Tomasz Kozacki received the Ph.D. (2005) and DHs (2013) in photonics from the Warsaw University of Technology, Poland. Since 2003 he has been with the department of Mechatronics, Photonics Engineering Division, where he is now a professor. His scientific research is related to digital holography, holographic displays, holographic microscopy, computational diffraction, and holographic tomography. Leader or co-leader of national or international projects. He has authored and co-authored more than 50 scientific journal publications, and more than 90 papers in conference proceedings.

Guohai Situ
Shanghai Inst. Opt. Fine Mechanics

Reconstruction Algorithms, Capture Systems and Applications of Holographic Tomography
Monday, 20 May, 09:15—10:00
Amphitheater

Biography: Guohai Situ is a professor with the Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences. His research interests span a wide field of computational optical imaging, ranging from developing novel techniques and algorithms including deep learning for optical imaging, to actively engineering the wavefront for optical signal processing. Dr. Situ has published 50+ papers in leading journals, and served in the editorial board of Applied Optics, Applied Physics B, China Laser, and Scientific Reports. He is currently a member of the OSA Robert E. Hopkins Leadership Award Committee.

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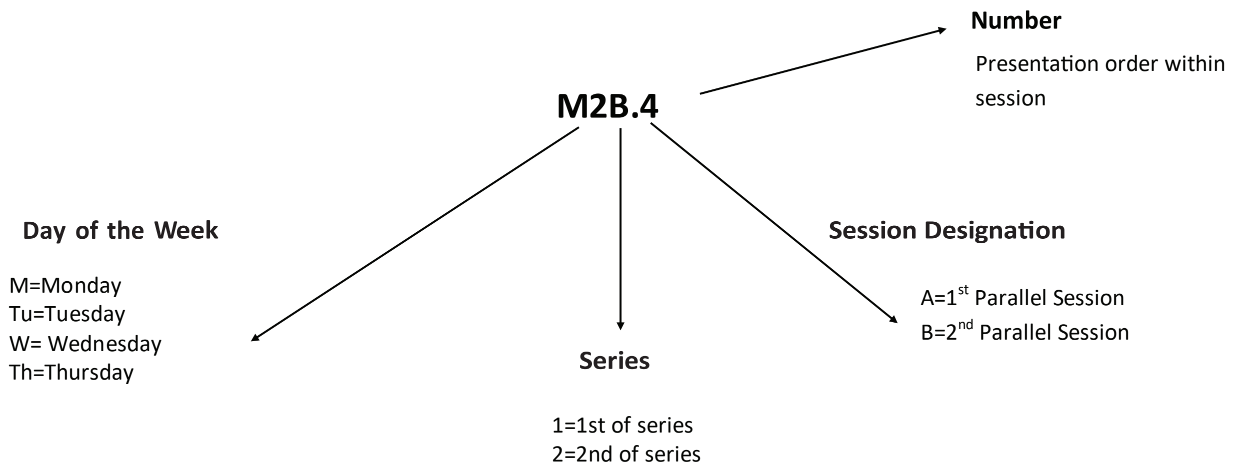
LP2N
Laboratoire Photonique
Numérique & Nanosciences

Explanation of Session Codes



The first letter of the code designates the meeting. The second element denotes the day of the week . The third element indicates the session series in that day (for instance, 1 would denote the first sessions in that day). Each day begins with the letter A in the fourth element and continues alphabetically through the parallel session. The lettering then restarts with each new series. The number on the end of the code (separated from the session code with a period) signals the position of the talk within the session (first, second, third, etc.). For example, a presentation coded M2B.4 indicates that this paper is being presented on Monday (M) in the second series of sessions (2), and is the second parallel session (B) in that series and the fourth paper (4) presented in that session.

Online Access to Technical Digest

Full Technical Attendees have both EARLY and FREE perpetual access to the digest papers through

OSA Publishing's Digital Library.

To access the papers go to

www.osa.org/DH and select the "Access Digest Papers"

As access is limited to Full Technical Conference Attendees only, you will be asked to validate your credentials by entering the same login email address and password provided during the Conference registration process.
If you need assistance with your login information, please use the "forgot password" utility or "Contact Help" link.

Agenda of Sessions

Sunday, 19 May	
14:30—17:00	**Registration**, *Big Hall*

Monday, 20 May		
07:00—18:00	**Registration**, *Big Hall*	
08:15—09:15	**M1A • Opening Remarks and Keynote Session I**, *Amphitheater*	
09:15—10:00	**M2A • Tutorial Session I,** *Amphitheater*	
10:00—10:30	**Coffee Break and Exhibition**, *A3 and A5*	
10:30—12:30	**M3A • 3D Imaging and Display Systems I**, *Amphitheater*	**M3B • Imaging I**, *E300*
12:30—14:00	**Lunch Provided,** *Big Hall*	
14:00—16:00	**M4A • 3D Imaging and Display Systems II,** *Amphitheater*	**M4B • Metrology and Profilometry I**, *E300*
16:00—16:30	**Coffee Break and Exhibition**, *A3 and A5*	
16:30—18:30	**M5A • Emerging and Advanced Techniques I,** *Amphitheater*	**M5B • Imaging II**, *E300*
18:30—23:00	**Bordeaux Cultural Experience Conference Reception,** *Chateau Luchey-Halde (buses will be provided)*	

Agenda of Sessions

Tuesday, 21 May		
07:00—18:00	**Registration**, *Big Hall*	
08:00—08:45	**Tu1A • Keynote Session II**, *Amphitheater*	
08:45—09:30	**Tu2A • Tutorial Session II**, *Amphitheater*	
09:30—10:30	**Tu3A • Metasurface Holograms and Metalenses for AR/VR**, *Amphitheater*	
10:00—10:30	**Coffee Break and Exhibition**, *A3 and A5*	
10:30—12:30	**Tu4A • Computer Generated Holography**, *Amphitheater*	**Tu4B • Metrology and Profilometry II,** *E300*
12:30—14:00	**Lunch Provided,** *Big Hall*	
14:00—19:00	**Free Afternoon** *(On Your Own)*	
18:30—21:00	**Conference Banquet**, *Bordeaux River Cruise (Banquet Boarding at 157 Quai des Chartrons, 33000 Bordeaux, France)*	

Wednesday, 22 May		
07:00—18:00	**Registration**, *Big Hall*	
08:00—10:00	**W1A • Emerging and Advanced Techniques II**, *Amphitheater*	**W1B • Imaging III,** *E300*
10:00—10:30	**Coffee Break and Exhibition,** *, A3 and A5*	
10:30—12:30	**W2A • 3D Imaging and Display Systems III**, *Amphitheater*	**W2B • Digital Holographic Microscopy,** *E300*
12:30—14:00	**Lunch Provided,** *Big Hall*	
14:00—16:00	**W3A • Poster Session I**, *A1, A2, A3, and A5*	
16:00—16:30	**Coffee Break and Exhibition,** *A3 and A5*	
16:30—18:00	**W4A • 3D Imaging and Display Systems IV,** *Amphitheater*	**W4B • Tomography I,** *E300*
18:15—19:15	**A Revolution in Display Holography: CHIMERA™, the Third Generation of Holoprinter**, *Amphitheater*	

Agenda of Sessions

Thursday, 23 May		
07:00—16:00	**Registration**, *Big Hall*	
08:00—10:00	**Th1A • Bio and Medical Applications I,** *Amphitheater*	**Th1B • Emerging and Advanced Techniques III,** *E300*
10:00—10:30	**Coffee Break and Exhibition,** *A3 and A5*	
10:30—12:30	**Th2A • Particles Imaging,** *Amphitheater*	**Th2B • Tomography II,** *E300*
12:30—14:00	**Lunch Provided**, *Big Hall*	
14:00—16:00	**Th3A • Poster Session II**, *A1, A2, A3, and A5*	
16:00—16:30	**Coffee Break and Exhibition,** *A3 and A5*	
16:00—17:00	**Th4A • Bio and Medical Applications II,** *Amphitheater*	**Th4B • Emerging and Advanced Techniques (Gated and THz) IV,** *E300*

Amphitheater

08:15 -- 09:15
M1A • Opening Remarks and Keynote Session I

Presider: Pascal Picart; LAUM CNRS Le Mans Université, France

Opening Remarks will be presented by the Conference Chairs from 08:15—08:30.

M1A.1 • 08:30 Keynote

True Holography or Simply Beguiling the Eye: Where the Journey May Go?, Wolfgang Osten[1]; [1]*Universität Stuttgart, Germany.* The continuing hype of virtual (VR), augmented (AR) and mixed (MR) reality contributes to the fact that one meets the term "holography" now at almost every opportunity where principles of stereoscopic or quasi 3d-imaging are applied. May be it is a commercial trick as in case of the Microsoft HoloLens, or the advertisement for some clever methods to display quasi-spatial image data, that give the observer the illusion it is a holographic technique where spatial image information is presented in perfect manner. However, in all that cases real holography is not involved. The reason for this conceptual confusion is justified probably by the Greek term holos. The term was chosen by Dennis Gabor, the inventor of holography, to point out that only holography can store and reconstruct the complete information that is contained in a light field to represent the complete diversity of a natural scene: amplitude, phase, and frequency. But for the perception of any 3d image information this challenge seems to be not so dramatic, because the spatial illusion can be represented almost perfectly even with conventional techniques. We can explore this with stereoscopic techniques. So what is special or the added value of holography and what practical application potential does it open up? So it's well worth a look behind the scenes of holographic imaging. In the talk an attempt is made to differentiate the holographic method from stereoscopic and multi-stereoscopic imaging. The resulting physical-technical challenges to a practical implementation are discussed and an overview is given that summarizes the meanwhile very diverse application scenarios, which result from the holographic principle of wave field recording and reconstruction. It should not be concealed, which practical hurdles accompany the implementation of the

09:15 -- 10:00
M2A • Tutorial Session I

Presider: Pascal Picart; LAUM CNRS Le Mans Université, France

M2A.1 • 09:15 Tutorial

Deep Learning for Computational Imaging, Fei Wang[1], Hao Wang[1], Guohai Situ[1]; [1]*Shanghai Inst. Opt. Fine Mech., China.* In this tutorial, we will introduce the basic concept of deep learning and its use for computational imaging. In particular use cases discussed here are digital holography, ghost imaging, and imaging through scattering.

10:00—10:30 • Coffee Break and Exhibition, *Rooms A3 and A5*

Amphitheater	Room E300

Monday, 20 May

10:30 -- 12:30
M3A • 3D Imaging and Display Systems I
Presider: Liangcai Cao; Tsinghua Univ., China

M3A.1 • 10:30 Invited

Holographic See-Through Displays, Pierre-Alexandre Blanche[1], Colton Bigler[1], Craig T. Draper[1], Micah S. Mann[1]; [1]*Univ. of Arizona, USA.* Waveguide combiner are used in see-through display to recirculate the light several times while it propagates inside the material. Edge lit Holograms are used to inject, redirect, and extract the image inside the waveguide.

M3A.2 • 11:00

Projection of aerial volumetric graphics formed by femtosecond laser excitation, Kota Kumagai[1], Shun Miura[1], Yoshio Hayasaki[1]; [1]*Utsunomiya Univ., Japan.* An aerial volumetric display using femtosecond laser-induced plasma was proposed. The aerial voxels were projected by two parabolic mirrors with a changeable color filter. The volumetric graphics can achieve the full-color and touchable graphics.

M3A.3 • 11:15

Withdrawn.

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10:30 -- 12:30
M3B • Imaging I
Presider: Jae-Hyeung Park, Inha Univ., South Korea

M3B.1 • 10:30

Fresnel Zone Aperture Imaging Using Compressive Sensing, Jiachen Wu[1], Hua Zhang[1], Wenhui Zhang[1], Guofan Jin[1], Liangcai Cao[1]; [1]*Tsinghua Univ., China.* A imaging method using single Fresnel zone aperture for coding the incoherent rays as wavefront is proposed. Digital holography and compressive sensing techniques are utilized to reconstruct image with an improved signal to noise ratio.

M3B.2 • 10:45

Deep Learning for Single View Focal Plane Reconstruction in Integral Imaging, Yongri Piao[1], Zhengkun Rong[1], Miao Zhang[1], Yukun Zhang[1], Xinxin Ji[1]; [1]*Dalian Univ. of Technology, China.* In this work, we present a single view focal plane reconstruction by using deep learning in integral imaging. To synthesize multi-views from single view, a learning-based method is used to generate depth and render a Lambertian approximation. The experimental results show that the significant superiority of the proposed method.

M3B.3 • 11:00

Deep Learning for Compressive Spectral Imaging, Xin Miao[2], Xin Yuan[1], Paul Wilford[1]; [1]*Bell Labs, USA;* [2]*Computer Science and Engineering, Univ. of Texas at Arlington, USA.* We develop a deep learning network to recover hyperspectral images (\eg, with 24 spectral channels) from a single shot measurement. A dual-stage generative model is devised, which can finish the reconstruction task within sub-seconds instead of hours taken by the most recently proposed DeSCI algorithm with a higher quality.

M3B.4 • 11:15

Compressive Sensing for Photon Counting Integral Imaging, Yongri Piao[1], Wanhua Yang[1], Miao Zhang[1], Yu Zhang[1], Jie Liu[1]; [1]*Dalian Univ. of Technology, China.* In this paper, we present a photon counting integral imaging based on compressive sensing to improve the reconstructed 3D images. The proposed method recovers elemental images have higher SNR than the conventional imaging under ultra-low light conditions. To show the feasibility of the proposed method, the preliminary experiments are presented.

Amphitheater	Room E300

M3A • 3D Imaging and Display Systems I—Continued

M3A.4 • 11:30
Autostereoscopic transparent display using a wedge light guide and a holographic optical element, Thomas Crespel[2,3], Patrick Reuter[4,1], Xavier Granier[3,5], Adrian Travis[6]; *[1]Inria Bordeaux-Ouest, France; [2]Inria Bordeaux Sud-Ouest, France; [3]LP2N / Institut d'Optique d'Aquitaine, France; [4]LaBRI, France; [5]Archéovision, France; [6]Travoptics, France.* We present a novel transparent autostereoscopic display consisting of laser picoprojectors, a wedge light guide and a holographic optical element. Such a display can superimpose 3D data on the real world without any wearables.

M3A.5 • 11:45
Development of High-Performance 35" Tabletop Display using Projection-based Light Field Technology, Wongun Jang[1], Hamong Shim[1], Dongkil Lee[1], Jongbok Park[1], Seon Kyu Yoon[1], Hoemin Kim[1], Sungkuk Chun[1], Kwanghoon Lee[1]; *[1]Korea Photonics Technology Inst., Korea.* We completed the integration of 72 micro-projectors for 35", wide viewing-angle tiled tabletop display system. Sophisticated image generation by author tooling and pixel-realignment algorithm enabled us to play entire and complete 3-dimensional images

M3A.6 • 12:00
Apodized Volume Bragg Gratings in Photo-Thermo-Refractive Glass, Sergiy Mokhov[1]; *[1]Univ. of Central Florida, CREOL, USA.* Uniform refractive index modulation causes sidelobes in diffraction spectra of volume Bragg gratings (VBGs). Sequential recording two slightly different interference patterns and cutting specimen at zeros of moire envelope produces apodized VBGs with suppressed sidelobes.

M3A.7 • 12:15
A Zerotrope™ with an ultra-realistic full-color digital hologram, Philippe Gentet[1], Jinbeom Joung[1], Yves Gentet[2], Seung-Hyun Lee[1]; *[1]Kwangwoon Univ., Korea; [2]Ultimate holography, France.* This paper presents an upgrade of the first Zerotrope™, a dynamic holographic display made by the authors in 2018, with a Chimera™ the last generation of full-color digital hologram instead of Denisyuk analog hologram.

M2B • 3D Imaging and Display Systems I—Continued

M3B.5 • 11:30
Variational approach in time-averaged interference microscopy for full-field vibration profilometry, Maria Cywinska[1], Maciej Trusiak[1], Adam Styk[1], Krzysztof Patorski[1]; *[1]Warsaw Univ. of Technology, Poland.* We propose a new algorithmic solution for time averaged interference microscopy called Variational Hilbert Amplitude Imaging. In a robust, automatic and single-frame manner it calculates full-field vibration amplitude map from recorded interference pattern.

M3B.6 • 11:45
Evaluation of the spatial resolution alteration of speckle de-noising algorithms, Silvio Montresor[1], Pascal Picart[1]; *[1]LAUM CNRS Le Mans Université, France.* This paper discusses on the influence of de-noising algorithms from the point of view of the spatial frequency contents of the restored image. Amplitude images from simulated holograms of the siemens target are used as images including large spatial frequency diversity.

M3B.7 • 12:00
Restoration of phase data with high noise and dislocations by combining filtering, masking, unwrapping and inpainting, Hai-Ting Xia[3,1], Silvio Montresor[1], Rongxin Guo[3], Junchang Li[3], Pascal Picart[1,2]; *[1]CNRS UMR 6613, LAUM, Le Mans Université, France; [2]École Nationale Supérieure d'Ingénieurs du Mans, France; [3]Kunming Univ. of Science and Technology, China.* A robust approach to restore phase data with high noise and dislocations is proposed based on combining filtering, masking, unwrapping and inpainting. Simulations and experimental results demonstrate the proposed approach is robust and fast.

M3B.8 • 12:15
EPI Restoration in Synthetic Aperture Integral Imaging, Miao Zhang[1], Jie Liu[1], Yongri Piao[1], Yu Zhang[1], Xinxin Ji[1], Yukun Zhang[1]; *[1]Dalian Univ. of Technology, China.* The resolution of reconstructed 3D images can be seriously degraded by undesired occlusions in synthetic aperture integral imaging. To solve the problem of occlusions, we present an occlusion removal based on epipolar plane images restoration in SAII. The preliminary experiments are presented to verify the feasibility of the proposed system.

12:30—14:00 • Lunch Provided, *Big Hall*

Amphitheater	Room E300

14:00 -- 16:00
M4A • 3D Imaging and Display Systems II

Presider: Naveen Nishchal; Indian Inst. of Technology Patna, India

M4A.1 • 14:00 Invited

HolographicTrue 3D Virtual Reality based on Big Data, Hongyue Gao[1]; *[1]Shanghai Univ., China.* We studied holographic true 3D virtual reality based on 4K spatial light modulators for its potential near-eye head-mounted display applications, and in real-time holographic materials for its potential naked-eye large size display applications.

M4A.2 • 14:30

Towards 1.5 micrometer pixel pitch holographic display using $Ge_2Sb_2Te_5$ phase change material , Yong-Hae Kim[1], Chi Young Hwang[1], Gi Heon Kim[1], Seong M. Cho[1], Kyunghee Choi[1], Sanghoon Cheon[1], Chi-Sun Hwang[1]; *[1]Electronics and Telecom Research Inst, Korea.* We fabricated 1.5 um pixel pitch holographic display using $Ge_2Sb_2Te_5$ (GST) phase change material. We developed a new structure for GST device and was successful to control the GST phase of every pixel so that a reconstructed image from GST device array was same to the original image.

M4A.3 • 14:45

Binocular full-color optical scanning holography camera, Eung Joon Lee[1], Seung Ram Lim[1], Kyung Beom Kim[1], Taegeun Kim[1]; *[1]Sejong Univ., Korea.* We propose binocular full-color complex holograms with lines of sight matching for a binocular display. In which, we record the holograms for binocular display and match the lines of sight using feature matching.

M4A.4 • 15:00

Object Non-monotonic Motion in Auto-stereoscopic Vision, Marie Dejean[1,2], V. Nourrit[1], J-L De Bougrenet De La Tocnaye[1]; *[1]IMT Atlantique - optique, France; [2]Oberthur Fiduciaire, France.* We established a way of coding object non-monotonic motion-in-depth, with a multi-view auto-stereoscopic system and a set of still images. The principal interest is the creation of impressive motion effects, whatever the observer's parallax motion.

14:00 -- 16:00
M4B • Metrology and Profilometry I

Presider: Mikael Sjodhal, Lulea Tekniska Universitet, Sweden

M4B.1 • 14:00

Full field holographic vibrometry at ultimate measurement limits, Laure Lagny[1], Silvio Montresor[1], François Gautier[1], Charles Pezerat[1], Pascal Picart[1]; *[1]LAUM CNRS Le Mans Université, France.* This paper proposes a processing method for full-field vibrometry based on digital on-line holography at 100kHz. We demonstrate that 20nm vibrations at 17kHz can be measured over large field of view (~500cm^2).

M4B.2 • 14:15

Noise and bias in off-axis digital holography for applicability to thermoacoustic experiments, Lijia Gong[1], Guillaume Penelet[1], Pascal Picart[1]; *[1]LAUM CNRS Le Mans Université, France.* This article presents an analysis of noise and bias in off -axis holographic interferometry applied to the study of thermo-acoustic resonators.

M4B.3 • 14:30

Withdrawn.

M4B.4 • 14:45

Tip crack detection using a single off-axis hologram along with transport of intensity, Wenjing Zhou[1], Dengke He[1], Xiaofei Guan[1], Yingjie Yu[1], Ting-Chung Poon[2]; *[1]Shanghai Univ., China; [2]Virginia Polytechnic Inst. and State Univ., USA.* Our experiments indicate that digital holography along with the transport of intensity algorithm could not only recover the phase without unwrapping, but also eliminate the spherical phase error introduced by the micro-objective during holographic recording.

M4B.5 • 15:00

Quantitative phase imaging for in-situ monitoring of adaptive lenses, Nektarios Koukourakis[1], Wenjie Wang[1], Katrin Philipp[1], Jürgen Czarske[1]; *[1]TU Dresden, Germany.* We use quantitative phase imaging based on partitioned-aperture wavefront sensing to monitor and control the behavior of novel adaptive lenses that enable simultaneous axial scanning and aberration control.

Amphitheater	Room E300

M4A • 3D Imaging and Display Systems II —Continued

M4A.5 • 15:15
Color reconstructions of real objects in DMD holographic display with LED illumination, Maksymilian Chlipala[1], Tomasz Kozacki[1]; [1]*Warsaw Univ. of Technology, Poland.* In this work we present DMD holographic display with LED illumination, which is capable of RGB color reconstructions of large, real 3D objects with their original dimensions. Obtained optical reconstructions illustrate high quality images at large object depth.

M4A.6 • 15:30
Holographic dual system for display and infrared imaging, Zhenlv Lv[1], Juan Liu[1], Jiasheng Xiao[1], Ying Kuang[1]; [1]*Beijing Inst. of Technology, China.* An novel integrated holographic waveguide display system with common optical path for visible and infrared light is proposed for system miniaturization. This is a feasible method to achieve light and thin eye tracking near-eye display.

M4A.7 • 15:45
An analysis of color separation and ghost images in waveguide-type optical-see-through near-to-eye displays using full color holographic optical elements, Myeong-Ho Choi[1], Jae-Hyeung Park[1]; [1]*Dept. of Information and communication Engineering, Inha Univ., Korea.* Holographic optical elements are important components which serve as compact optical combiner and input/output couplers for waveguide-type near-to-eye displays. In this paper, we describe the causes of unwanted color separation and ghost images of the full-color holographic optical elements.

M4B • Metrology and Profilometry I —Continued

M4B.6 • 15:15
Measurement of Temperature Profile around Textile Conductive Yarn using Digital Holography, Pramod Sankara Pillai[1], Shilpi Agarwal[1], Bipin Kumar[1], R. Alagirusamy[1], Apurba Das[1], Chandra Shakher[1]; [1]*Indian Inst. of Technology, Delhi, India.* In this paper, the application of digital holographic interferometry (DHI) to measure temperature and temperature profile of copper conductive yarn is investigated. The study may find application to design and develop heating compression bandages.

M4B.7 • 15:30
Phase-resolved Semiconductor Overlay Metrology with a Dark Field Holographic Microscope, Vasco T. Tenner[1,2], Christos Messinis[1,2], Arie J. den Boef[1,3]; [1]*Vrije Universiteit , Netherlands;* [2]*Advanced Research Center for Nanolithography (ARCNL), Netherlands;* [3]*ASML Netherlands B.V., Netherlands.* Current optical sensors used for overlay metrology during semiconductor manufacturing are limited on the available stack-thickness wavelength combinations. We present a dark field holographic sensor concept that lifts this limitation and show an experimental demonstration.

M4B.8 • 15:45
Quadriwave Lateral Shearing Interferometry applied to Multiwell Plates Imaging with dedicated Acquisition and Treatment Processing , Sherazade Aknoun[1], Anaïs Saintoyant[1], Fabrice Valentino[1], Antoine Federici[1], Benoit Wattellier[1]; [1]*Phasics S.A., France.* We present a quadriwave lateral shearing interferometry system and special post-processing algorithms solving issues related to scanning, defocusing and management of multiwell plates imaging over a long period of time. Large amount of cell populations information.is then extracted and analyzed.

16:00—16:30 • Coffee Break and Exhibition, *Rooms A3 and A5*

Amphitheater	Room E300

16:30 -- 18:30
M5A • Emerging and Advanced Techniques I
Presider: Nikolai Petrov; ITMO Univ., Russian Federation

M5A.1 • 16:30
Super-Resolved Interferometric Imaging with a Self-Cohering Si-Photonic Beam-Steering LIDAR Array, Kelvin H. Wagner[1], Daniel Feldkhun[1], Bohan Zhang[2], Nathan Dostart[1,2], Michael Brand[1], Milos Popovic[2]; *[1]Univ. of Colorado at Boulder, USA; [2]Photonics Center, Boston Univ., USA.* We present a SCALABLE (Self-Calibrated Adaptive Lidar Aperture Beamsteering Light Engine) serpentine-grating Silicon-photonic emitting aperture for rapid 2-D beamsteering and show how to perform computational interferometric image synthesis within each beam.

M5A.2 • 16:45
Tabletop Radar Range Using Interferometric Time-of-Flight, Pierre-Alexandre Blanche[1], Mark Neifeld[1], Nasser Peyghambarian[1]; *[1]Univ. of Arizona, USA.* We are presenting a tabletop radar range with a scale factor of 100,000. This scale reduction allows to use near IR wavelength instead of radio frequency to determine the radar cross section of complex objects.

M5A.3 • 17:00
3D Heterodyne Sensing using Photon-Counting Arrays, Maureen Crotty[1], Edward Watson[2], David J. Rabb[1]; *[1]US Air Force Research Laboratory, USA; [2]Univ. of Dayton Research Inst., USA.* Simulated photon-counting arrays are used to estimate object spatial frequency content through spatial heterodyne measurements. We extend spatial sampling to three dimensions using extremely low photo-count rates enabled by Geiger-mode avalanche photodiode arrays.

M5A.4 • 17:15
Portable size incoherent digital holographic video camera using geometric phase, KiHong Choi[1], Sungwon Choi[1], Sung-Wook Min[1]; *[1]Kyung Hee Univ., Korea.* The common-path in-line incoherent holographic video recording system is presented. The system simply consists of the input lens, linear polarizer, band-pass filter geometric phase lens, and the polarized image sensor.

M5A.5 • 17:30
Simultaneous interferometric measurement of independent wave fronts using multiple signal classification, Claas Falldorf[1], André Müller[1], Mostafa Agour[1], Ralf B. Bergmann[1]; *[1]BIAS, Germany.* We show shear interferometry in combination with multiple signal classification (MUSIC) to determine several independent wave fronts at the same time. We demonstrate the method by simultaneously measuring front and reverse side reflections of a lens.

16:30 -- 18:30
M5B • Imaging II
Presider: Juan Liu; Beijing Inst. of Technology, China

M5B.1 • 16:30 Invited
Phase Retrieval for Digital Holography, Tatiana Latychevskaia[1,2]; *[1]Physics Inst., Univ. of Zurich, Switzerland; [2]Paul Scherrer Institut, Switzerland.* Iterative phase retrieval methods and practical issues related to their application to experimental holograms and diffraction patterns will be discussed. Resolution enhancement obtained through the extrapolation of holograms and diffraction patterns will be demonstrated.

M5B.2 • 17:00
Noninvasive imaging through a thin scattering layer using coded phase masks, Saswata Mukherjee[1], Vijayakumar Anand[1], Joseph Rosen[1]; *[1]Ben-Gurion Univ. of the Negev, Israel.* A noninvasive imaging technique to see through scattering layers using spatial light modulator (SLM) has been demonstrated. A phase retrieval algorithm is used to process the object information from the recorded intensity patterns.

M5B.3 • 17:15
Wavefront Sensing with a Thin Diffuser: Application to Super-localization, Tengfei Wu[1,2], Marc Guillon[1], Hervé Rigneault[4], Gilles Tessier[1,2], Pierre Bon[3], Pascal Berto[1,2]; *[1]Univ. of Paris Descartes, France; [2]Univ. of Sorbonne, France; [3]Univ. of Bordeaux, France; [4]Univ. of Aix-Marseille, France.* Using the “memory effect”, we propose and implement a broadband, compact, and cost-effective Wavefront Sensing scheme with a simple thin diffuser. We experimentally demonstrate its capability to provide quantitative phase imaging and nanoparticle super-localization.

M5B.4 • 17:30
Phase imaging based on transport of intensity equation using liquid crystal variable waveplate, Alok Kumar Gupta[1], Areeba Fatima[1], Naveen K. Nishchal[1]; *[1]Indian Inst. of Technology Patna, India.* A non-interferometric phase imaging using liquid crystal variable waveplate is demonstrated that uses the concept of modified transport of intensity equation. Refractive index is modulated through the variable waveplate.

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Amphitheater	Room E300

M5A • Emerging and Advanced Techniques I—Continued

M5A.6 • 17:45
Single-shot Fresnel incoherent digital holography based on geometric phase lens, Jun Liu[1]; *[1]Shanghai Inst of Optics and Fine Mech, China.* A simple and compact Fresnel incoherent digital holographic system with the capabilities of single-shot and three-dimensional imaging based on GP lens and polarization imaging camera is proposed and confirmed by imaging two standard test charts.

M5A.7 • 18:00
Scheme of lensless optical encryption with spatially incoherent illumination, Vitaly V. Krasnov[1], Ilya Ryabcev[1], Anna Shifrina[1]; *[1]NRNU MEPhI, Russian Federation.* Lensless encryption scheme with spatially incoherent illumination is presented. Encoding diffraction optical element was designed to form desired light distribution in photosensor plane under spherically diverging illumination. Validity is supported by results of optical experiments.

M5A.8 • 18:15
Lattice Light-Sheet and Self-Interference Incoherent Digital Holography, Mariana Potcoava[1], Shelagh Rodriguez[1], Simon Alford[1]; *[1]Univ. of Illinois at Chicago, USA.* We demonstrate lattice light-sheet microscopy combined with Fresnel incoherent correlation holography (FINCH) in the detection path. We present the imaging performance of the microscope with an example of post-data-acquisition image reconstruction.

M5B • Imaging II—Continued

M5B.5 • 17:45
Single-shot fluorescence quantitative phase microscopy using Transport of Intensity Equation, Praveen Kumar[1], Vimal Prabhu Pandiyan[1], Subha Narayan Rath[1], Renu John[1]; *[1]Dept. of Biomedical Engineering, Indian Inst. of Technology Hyderabad, India.* In this work, we report retrieval of 3-D phase of homogenously fluorescent objects with a constant absorption coefficient that is homogenous. TIE equations can be used to retrieve the 3-D phase.

M5B.6 • 18:00
Phase correlation microscopy employing single-shot quantitative phase imaging, Ying Li[2], Wanqing Wu[1], Jianglei Di[2], Peng Shang[1,3], Jianlin Zhao[2]; *[1]Key Laboratory for Space Bioscience and Biotechnology, Inst. of Special Environmental Biophysics, School of Life Sciences, Northwestern Polytechnical Univ., China; [2]MOE Key Laboratory of Material Physics and Chemistry under Extraordinary Conditions, and Shaanxi Key Laboratory of Optical Information Technology, School of Science, Northwestern Polytechnical Univ., China; [3]Research & Development Inst. in Shenzhen, Northwestern Polytechnical Univ., Fictitious College Garden, Gaoxin Fourth South Road 19, Shenzhen, China.* In this paper, we present phase correlation microscopy (PCM) based on time-lapse quantitative phase stacks to study the dynamic properties of living cells, which allows us to distinguish different cell types with a label-free approach.

M5B.7 • 18:15
Single-shot transport of intensity equation based phase imaging using refractive index variation, Alok Kumar Gupta[1], Naveen K. Nishchal[1]; *[1]Indian Inst. of Technology Patna, India.* We present a single-shot transport of intensity equation based phase imaging technique which utilizes refractive index variation property of liquid crystal spatial light modulator. It eliminates the need of linear phase calibration.

18:30—23:00 • Bordeaux Cultural Experience Conference Reception, *Chateau Luchey-Halde (buses will be provided)*

Tuesday, 21 May

Amphitheater

08:00 -- 08:45
Tu1A • Keynote Session II
Presider: Marc Georges; Liege Universite, Belgium

Tu1A.1 • 08:00 Keynote

Improving Photophoretic Trap Volumetric Displays, Daniel Smalley[1]; [1]*Brigham Young Univ., USA.* Photophoretic trap volumetric displays or have been reported as a solution for creating small, full-color, high-definition, freespace, volumetric images. However, to be useful as a display, more broadly, photophoretic trap displays must be made safe, robust and scalable. In this work, the author describes possible roadmaps for reducing danger, increasing image size, and improving image reliability. The author also describes future applications and synergies with other 3D technologies.

08:45 -- 09:30
Tu2A • Tutorial Session II
Presider: Marc Georges; Liege Universite, Belgium

Tu2A.1 • 08:45 Tutorial

Reconstruction Algorithms, Capture Systems and Applications of Holographic Tomography, Tomasz Kozacki[1], Julianna Winnik[1]; [1]*Warsaw Univ. of Technology, Poland.* Holographic tomography (HT) is a noninvasive, quantitative imaging technique, which enables reconstruction of three-dimensional distribution of refractive index. In this paper we describe the basic concept of HT as well as discuss various methods of its realization. The emphasis is put on the tomographic reconstruction algorithms, practical implementation and applications of tomographic systems.

09:30 -- 10:00
Tu3A • Metasurface Holograms and Metalenses for AR/VR
Presider: Marc Georges; Liege Universite, Belgium

Tu3A.1 • 09:30 Invited

Metasurface Holograms and Metalenses for AR/VR, Byoungho Lee[1], Jangwoon Sung[1], Gun-Yeal Lee[1]; [1]*Seoul National Univ., Korea.* We present recent advances on metasurface-originated applications. Two metasurfaces for full complex-amplitude hologram and full-space phase control and in particular, metalens for augmented reality with wide viewing angle are discussed.

10:00—10:30 • Coffee Break and Exhibition, *Rooms A3 and A5*

Amphitheater	Room E300

10:30 -- 12:30
Tu4A • Computer Generated Holography
Presider: Yoshio Hayasaki; Utsunomiya Univ., Japan

Tu4A.1 • 10:30
Design and Experiments with Static Computer-generated Fourier Holograms of Colored 3D objects, Michael A. Golub[1]; [1]*Tel-Aviv Univ., Israel.* Design of Fourier holograms of 3D objects with analytical equations on general polygonal mesh enabled to consider shading effects. Optical experiments proved feasibility for 3D aerial reconstruction from computer-generated Fourier holograms in RGB colors.

Tu4A.2 • 10:45
Exact Compensation of Rotational Motion for Holographic Video Compression, Raees Kizhakkumkara Muhamad[1,2], Athanasia Symeonidou[1,2], David Blinder[1,2], Tobias Birnbaum[1,2], Colas Schretter[1,2], Peter Schelkens[1,2]; [1]*Dept. of Electronics and Informatics (ETRO), Vrije Universiteit Brussel, Belgium;* [2]*imec, Belgium.* Holographic video imposes impractical bitrates for storage and communication without compression. We introduce exact motion compensation in a codec using rotational transformation of angular spectrum and obtain SNR improvements of 20 dB over HEVC.

Tu4A.3 • 11:00
Stratified Multiplexing Computer-Generated Holograms, Haiyan Wang[1], Rafael Piestun[1]; [1]*Electrical, Computer, and Energy Engineering, Univ. of Colorado Boulder, USA.* We design stratified computer-generated holograms to achieve multiplexing, a technique that enables recording of multiple output signals that are switched upon change of light input parameters. The concept and design are demonstrated experimentally.

Tu4A.4 • 11:15
Computer-generated holograms of a life-size human captured from multi-viewpoint cameras, Shunsuke Igarashi[1], Kentaro Kakinuma[1], Tomoya Nakamura[1,2], Kensuke Ikeya[3], Jun Arai[3], Tomoyuki Mishina[3], Kyoji Matsushima[4], Masahiro Yamaguchi[1]; [1]*Tokyo Inst. of Technology, Japan;* [2]*PRESTO, Japan Science and Technology Agency, Japan;* [3]*NHK Science and Technology Research Laboratories, Japan;* [4]*Faculty of Engineering Science, Kansai Univ., Japan.* We propose a method to overcome difficulty of calculating holograms that reconstruct a life-size human using ray-wavefront conversion and multi-viewpoint cameras. Reconstruction of 3D images was verified through a hologram of 128K x 256K.

10:30 -- 12:30
Tu4B • Metrology and Profilometry II
Presider: Maria Pilar Arroyo; Universidad de Zaragoza, Spain

Tu4B.1 • 10:30 Invited
Industrial Applications of Digital Holography, Markus Fratz[1], Tobias Beckmann[1], Joachim Anders[1], Alexander Bertz[1], Markus Bayer[2], Thomas Gießler[2], Daniel Carl[1]; [1]*Fraunhofer Inst. for Physical Measurement Techniques IPM, Germany;* [2]*Werner Gießler GmbH, Germany.* We present inline integration of a digital holographic sensor in a precision turning plant and results of one-year long-term height-measurements of a turning part produced once per second to verify suitability for industrial use.

Tu4B.2 • 11:00
Decorrelation-induced speckle phase noise in two-wavelength digital holographic profilometry, Matthieu Piniard[1], Pascal Picart[2,4], Béatrice Sorrente[1], Gilles Hug[3]; [1]*ONERA, France;* [2]*LAUM CNRS Le Mans Université, France;* [3]*ONERA - Laboratoire d'Etude des Microstructures, France;* [4]*École Nationale Supérieure d'Ingénieurs du Mans, France.* This paper proposes a realistic wavelength decorrelation induced speckle noise simulator considering the surface shape and the surface roughness. The investigation of the dependence of the coherence factor versus the surface roughness and the wavelength change is carried out.

Tu4B.3 • 11:15
***Multiwavelength Holography: Height Measurements Despite Axial Motion of Several Wavelengths During Exposure*,** Annelie F. Schiller[1], Tobias Beckmann[1], Markus Fratz[1], Alexander Bertz[1], Daniel Carl[1], Karsten Buse[1,2]; [1]*Fraunhofer Inst. for Physical Measurement Techniques, Germany;* [2]*Dept. of Microsystems Engineering, Univ. of Freiburg, Germany.* In a typical interferometer, axial motion of half a wavelength reduces the contrast to zero. Our setup compensates this component of motion utilizing a piezoelectric actuator, demonstrating height measurements despite axial motion of 14 wavelengths.

Amphitheater	Room E300

Tuesday, 21 May

Tu4A • Computer Generated Holography—Continued

Tu4A.5 • 11:30
An optimization approach of computer generated hologram (CGH) for divergent light shaping, Qiang Song[1]; [1]*OPT Dept., IMT atlantique, France.* An optimization method of pure phase CGH for beam shaping with divergent incoherent light is proposed. The sample experiment fabricated with our home built photo-plotter shows a good agreement with the numerical simulation results.

Tu4A.6 • 11:45
Pre-compensation for Holographic Image Blur Caused by Light Source of Extended Spatial Area and Spectral Linewidth, Askari Mehdi[1], Jae-Hyeung Park[1]; [1]*Inha Univ., Korea.* We propose a method to deal with the 2-D image blur problem in holographic displays caused by using light source which has extended spatial area and spectral linewidth. Our method is based on pre-compensating the source image based on the simultaneous algebraic reconstruction technique (SART) when generating the corresponding hologram.

Tu4A.7 • 12:00
Calculating Real-time Computer-Generated Holograms for Holographic 3D Displays through Deep Learning, Sheng-Chi Liu[1], JIn Li[1], Daping Chu[1]; [1]*Univ. of Cambridge, UK.* A deep learning method is proposed to calculate holograms in real-time. After training, it can generate holograms for all R/G/B channels within 10 msec. Simulation results confirm successfully reconstruct the target training and testing images.

Tu4A.8 • 12:15
A Rapid Optimization Algorithm Applied to Diffractive Optical Elements with Millions of Pixels, Wei-Feng Hsu[1], Shyh-Tsong Lin[1], Jeng-Feng Lin[2]; [1]*National Taipei Univ. of Technology, Taiwan;* [2]*Southern Taiwan Univ. of Science and Technology, Taiwan.* We present an optimization algorithm to calculate diffractive optical elements (DOEs) comprising millions of pixels in reasonable time which have been applied for advanced applications of spatial light modulator requiring diffractive images of high quality.

Tu4B • Metrology and Profilometry II—Continued

Tu4B.4 • 11:30
Use of Wollaston prism for dual-reference digital holographic interferometry, Jean-Michel Desse[1], François Olchewsky[1]; [1]*Office Natl d'Etudes Rech Aerospatiales, France.* A Wollaston prism is used in digital holographic interferometer developed for analyzing high density gradients encountered in transonic and supersonic flows. Inserted in the reference arm of the interferometer, the Wollaston prism allows generating two orthogonally crossed waves and analyzing shocks waves whatever their orientation.

Tu4B.5 • 11:45
Multiwavelength digital holography in the presence of vibrations: laterally resolved multi-step phase-shift extraction, Tobias B. Seyler[1], Lasse Bienkowski[1], Tobias Beckmann[1], Markus Fratz[1], Alexander Bertz[1], Daniel Carl[1]; [1]*Fraunhofer IPM, Germany.* In rough environments such as machine tools, we cannot rely on the complete absence of vibrations. The evaluation of temporal phase-shifting in sections allows to determine and take into account random sub-wavelength tilt of the sensor with respect to a work piece. In this regard, measurements inside a machine tool are evaluated and discussed.

Tu4B.6 • 12:00
Interferometric Measurement of Shape with Spatially Incoherent Light, Mikael Sjodahl[1], Kerstin Ramser[1]; [1]*Lulea Tekniska Universitet, Sweden.* The purpose of this presentation is to discuss the possibility of using high- power, monochromatic spatially quasi-coherent light sources for interferometric detection of shape in a single-shot.

Tu4B.7 • 12:15
High-Resolution Single-Shot Surface Shape and in-situ Measurements using Quadriwave Lateral Shearing Interferometry, Sherazade Aknoun[1], Antoine Federici[1], Anaïs Saintoyant[1], William Boucher[1], Benoit Wattellier[1]; [1]*Phasics S.A., France.* We present a high-sensitive single-arm interferometry technology, called quadriwave lateral shearing interferometry, applied to surface shape and *in-situ* refractive index variation measurements. This full-field artefact-free technology enables single-shot measurement over a large field of view along with an OPD resolution of 0.5nm.

12:30—14:00 • Lunch Provided, *Big Hall*

14:00—19:00 • Free Afternoon (On your own)

18:30—21:00 • Conference Banquet, *Bordeaux River Cruise Banquet Boarding at 157 Quai des Chartrons, 33000 Bordeaux, France) - accessible via Tram B (CAPC Musée d'Art Contemporain station) or Tram C (Paul doumer Station)*

Amphitheater	Room E300

08:00 -- 10:00
W1A • Emerging and Advanced Techniques II
Presider: Hui Cao; Yale Univ., USA

W1A.1 • 08:00
Creating and Controlling Complex Light, Nicholas Bender[1], Hasan Yilmaz[1], Yaron Bromberg[2], Hui Cao[1]; *[1]Yale Univ., USA; [2]The Racah Inst. of Physics, The Hebrew Univ. of Jerusalem, Israel.* In this work, we develop a general method for customizing speckle intensity statistics. Using a phase-only spatial light modulator we can experimentally generate speckle patterns with customized intensity probability-distributions or tailored spatial intensity-correlations.

W1A.2 • 08:15
Geometrical transform of hologram for the tilted SLM plane, Hyon-Gon Choo[1], Tomasz Kozacki[2], Jinwoong Kim[1]; *[1]Electronics & Telecomm Res. Inst, Korea; [2]Warsaw Univ. of Technology, Poland.* In this paper, we introduce a geometrical transformation of hologram for tilted image plane. The procedure for transform is consisted of propagation to the tilted and focus plane. Numerical simulation results are provided using CGH and HD.

W1A.3 • 08:30
Phase Distortion Corrections of Phase-Only LCoS Devices for Digital Holographic Applications, Yuan Tong[1], Mike Pivnenko[1], Daping Chu[1]; *[1]Univ. of Cambridge, UK.* Significant phase distortion corrections of nearly perfect phase linearity and minimum phase flicker with doubled meaningful phase levels was achieved by optimising the digital driving patterns of phase-only LCoS devices for digital holographic applications.

W1A.4 • 08:45
2D resolution enhancement from 1D scanning Space-Time Digital Holography (STDH), Zhe Wang[1,2], Vittorio Bianco[1], Yutong Cui[2], Melania Paturzo[1], Zhuqing Jiang[2], Pietro Ferraro[1]; *[1]ISASI-CNR, Italy; [2]College of Applied Sciences, Beijing Univ. of Technology, China.* We introduce a new STDH modality to record and process hybrid space-time representations. This allows improving resolution with one single object scan. Onion epidermal cells has been used as samples to verify this approach.

08:00 -- 10:00
W1B • Imaging III
Presider: Wolfgang Osten; Universität Stuttgart, Germany

W1B.1 • 08:00 Invited
Analysis of Phasing, Registration, and 3D Reconstruction Performance for Digital Holography, Nicholas Miller[1], Thomas Welsh[1], Jason Stafford[1], Maureen Crotty[1], David J. Rabb[1]; *[1]US Air Force Research Laboratory, USA.* Here multiple coherent imaging methods are discussed and analyzed, which can be used for aperture phasing in the presence of noise.

W1B.2 • 08:30
Hyperspectral phase imaging with denoising in SVD image subspace, Vladimir Katkovnik[1], Igor A. Shevkunov[1], Daniel Claus[3], Giancarlo Pedrini[2], Karen Egiazarian[1]; *[1]Faculty of Information Technology and Communication Sciences, Tampere Univ., Finland; [2]Inst. of Applied Optics, Univ. of Stuttgart, Germany; [3]Inst. for Laser Technology in Medicine and Measurement Technique, Germany.* We propose a modified denoising algorithm for hyperspectral data. The algorithm is based on a complex domain block-matching 3D filter, on estimation of the noise correlation matrix and on dimension reduction of the Singular Value Decomposition (SVD) eigenspace

W1B.3 • 08:45
Highly robust digital holographic polarization imaging, Daesuk Kim[1], Inho Choi[1], Vamara Dembele[1]; *[1]Chonbuk National Univ., Korea.* We describe a new concept on compact and highly robust polarization imaging method with a numerical focusing capability. It is based on a specially designed interferometric polarization-modulation module. We can reconstruct a spatially resolved polarimetric phase image for an anisotropic object in real time speed.

Amphitheater	Room E300

Wednesday, 22 May

W1A • Emerging and Advanced Techniques II—Continued

W1A.5 • 09:00
Annular pupil in optical scanning holography, Yaping Zhang[1], Rende Wang[1], Lin Wang[2], Peter Tsang[3], Ting-Chung Poon[4]; [1]*Kunming Univ. of Science and Technology, China;* [2]*School of Electronic and Optical Engineering, Nanjing Univ. of Science and Technology, China;* [3]*Dept. of Electronic Engineering, City Univ. of Hong Kong, China;* [4]*Bradley Dept. of Electrical and Computer Engineering, Virginia Tech, USA.* Optical scanning holography (OSH) is a variant of two-pupil heterodyning image processing. We investigate the use of one pupil as a delta function and the other being an annulus as an extended application of OSH.

W1A.6 • 09:15
Stepwise Approach to Numerical Simulation of Broadband Femtosecond Pulses Propagation through Amplitude and Phase Objects, Andrei V. Belashov[1,2], Andrei Gorodetsky[1,3], Maksim S. Kulya[1], Nikolay V. Petrov[1]; [1]*Univ. ITMO, Russian Federation;* [2]*Ioffe Inst., Russian Federation;* [3]*Dept. of Chemistry, Imperial College London, UK.* In this paper, basic principles of broadband femtosecond pulse propagation through an amplitude and phase object are presented. A novel approach of stepwise progressive propagation through the object is introduced and discussed. A comparative analysis of "progressively" and "simultaneously" propagated femtosecond pulses is presented.

W1A.7 • 09:30
Local Optical Nonlinear Responses in Time-Resolved Inline Digital Holographic Measurements, Nikolai V. Petrov[1], Andrei V. Belashov[1], Sergei S. Nalegaev[1], Igor A. Shevkunov[1], Sergei E. Putilin[1], Yu-Chih Lin[2], Chau-Jern Cheng[2]; [1]*Digital and Display Holography Laboratory, ITMO Univ., Russian Federation;* [2]*Information Optics & Photonics Laboratory, Inst. of Electro-Optical Science and Technology, National Taiwan Normal Univ., Taiwan.* We investigate the possibilities of the time-resolved inline digital holography to study local optical nonlinear properties. Proposed approach includes the registration, processing and simulation of the diffraction patterns and enables to distinguish local nonlinear responses

W1A.8 • 09:45
Optimization of diffractive waveplate optics for visual perception, David E. Roberts[1], Sarik Nersisyan[1], Nelson V. Tabiryan[1]; [1]*BEAM Engineering for Adv. Measurements, USA.* Improvements are possible in the tradeoff between bandwidth, diffraction efficiency, and manufacturability in diffractive waveplate optics. We report recent progress in development and fabrication of diffractive waveplate optics using multilayer designs, with weighting of the optimization matching to the spectral response of the human eye.

W1B • Imaging III—Continued

W1B.4 • 09:00
3D thin liquid films full-field measurement, Vincenzo Ferraro[1], Zhe Wang[2], Biagio Mandracchia[2], Ernesto Di Maio[1], Pier Luca Maffettone[1], Pietro Ferraro[2]; [1]*Università Federico II - DICMaPI, Italy;* [2]*Inst. of Applied Sciences and Intelligent Systems 'E. Caianiello', National Research Council of Italy, Italy.* The dynamics of thin films and bubbles are of great interest in life sciences. Here we show an innovative holographic technique to evaluate the 3D topography and its temporal evolution in these systems.

W1B.5 • 09:15
Common-path two-shot binary checker grating based interference microscope for quantitative bio-phase imaging, Piotr Zdankowski[1], Maria Cywinska[1], Krzysztof Patorski[1], Maciej Trusiak[1]; [1]*Politechnika Warszawska, Poland.* A simple binary-checker-grating is used to realize proof-of-concept low-cost common-path interference microscope for quantitative phase imaging of *Navicula elliptica*. Phase demodulation quality is improved combining two π-phase-shifted grating-interferograms and filtering second harmonic-peak in the Fourier domain.

W1B.6 • 09:30
Novel highly stable wavelength independent quantitative phase microscope, Azeem Ahmad[1], Vishesh Dubey[2], Ankit Butola[2], Dalip Singh Mehta[2], Balpreet Singh Ahluwalia[1]; [1]*UiT The Arctic Univ. of Norway, Norway;* [2]*Physics, Indian Inst. of Technology Delhi, India.* A single element highly stable quantitative phase microscope is developed to measure membrane fluctuation of the biological specimens. With the proposed system, single-shot multispectral study is possible without any optical realignment.

W1B.7 • 09:45
Calibration for Spatial Light Interference Microscopy, Zhengyuan Tang[1], Bryan Hennelly[1]; [1]*Maynooth Univ., Ireland.* The Spatial Light Interference Microscopy technique uses four annular phase patterns sequentially displayed on a spatial light modulator. The steps involved in accurately determining the optimal values of these four phase patterns are discussed.

10:00—10:30 • Coffee Break and Exhibition, *A3 and A5*

Amphitheater	Room E300

10:30 -- 12:30
W2A • 3D Imaging and Display Systems III
Presider: Bertrand Simon; Institut d'Otpique Graduate School, France

W2A.1 • 10:30
Phase-coded computational imaging for depth of field extension, Erdem Sahin[1], Ugur Akpinar[1], Atanas Gotchev[1]; [1]*Faculty of Information Technology and Communication Sciences, Tampere Univ., Finland.* We present a computational imaging approach, combining a phase-coded computational camera with a corresponding CNN-based deblurring network that enables extended depth of field images. The simulations demonstrate promising results achieving significant extensions in the depth of field.

W2A.2 • 10:45
An autostereoscopic display with time-multiplexed directional backlight using a decentered lens array, Garimagai Borjigin[1], Hideki Kakeya[1]; [1]*Univ. of Tsukuba, Japan.* We propose an autostereoscopic display with time division multiplexing directional backlight using a decentered lens array. By using this method we can suppress stray light to reduce the crosstalk level.

W2A.3 • 11:00
Design and fabrication of extended eye-box holographic lens using holographic printer, Jinsoo Jeong[1], Jaebum Cho[1], Changwon Jang[1], Chanhyung Yoo[1], Byoungho Lee[1]; [1]*Seoul National Univ., Korea.* We propose a method to design and manufacture a holographic lens that can extend the eye-box in a near eye display. The designed holographic lens is printed by a holographic wave printer. The experimental result to verify the feasibility is presented.

W2A.4 • 11:15
Light field compression with holography, Ni Chen[1], Jinsoo Jeong[1], Byoungho Lee[1]; [1]*Seoul National Univ., Korea.* We propose a holographic light field encoding and decoding technique, which can greatly reduce the light field data size. This technique has many potential applications, such as fast light field data transfer, holographic display for light field data and light field display for holographic data.

10:30 -- 12:30
W2B • Digital Holographic Microscopy
Presider: Björn Kemper; Univ. of Muenster, Germany

W2B.1 • 10:30 Invited
Numerical Reconstruction of Holograms Using Inverse Problems Approaches, Corinne Fournier[1]; [1]*Univ. of Lyon, France, France.* New reconstruction approaches of digital holograms based on inverse problems (also called compressive sensing, Bayesian approaches, model fitting) have been proposed recently. We demonstrate that such approaches can accurately reconstruct holograms acquired in various configurations with several types of objects.

W2B.2 • 11:00
Reconstruction of in-line holograms combining model fitting and image-based regularized inversion, Anthony Berdeu[1], Corinne Fournier[1], Olivier Flasseur[1], Loïc Méès[2], Loïc Denis[1], Fabien Momey[1], Thomas Olivier[1], Nathalie Grosjean[2]; [1]*Université de Saint-Étienne, France;* [2]*Laboratoire de Mécanique des Fluidezs et d'Acoustiques, Ecole Centrale de Lyon, France.* We propose to reconstruct in-line holograms using a joint forward model on samples composed of a simple subpart estimated by model fitting and a complex shape subpart reconstructed using numerical (pixel-based) regularized inversion.

W2B.3 • 11:15
Digital Holography Microscopes (DHM) applications, Yves Emery[1], Jérôme Parent[1], benjamin rappaz[1], Shenqi Xie[1], Etienne Cuche[1]; [1]*Lyncee Tec SA, Switzerland.* DHM are now mature systems commercialized for more than 15 years. Innovation lies nowadays in applications. A few will be presented: vacuum tribometry, signature scanner for forensic recognition, MEMS vibration analysis, and living cell investigations.

Amphitheater	Room E300

Wednesday, 22 May

W2A • 3D Imaging and Display Systems III —Continued

W2A.5 • 11:30

Viewing angle enlarged in-line holographic 3D display system using multi-sideband filtering method, ShuFeng Lin[1], Qiong-Hua Wang[1], Eunsoo Kim[2]; *[1]Beihang Univ., China; [2]Kwangwoon Univ., Korea.* We propose an omnidirectional viewing zone based in-line holographic 3D display system using center-symmetric multi-sideband filtering method for viewing angle enlargement. Optical analysis and experiments are executed to confirm the feasibility of the proposed system.

W2A.6 • 11:45

Position Prediction for Eye-tracking based 3D Display, Seok Lee[1], Byongmin Kang[1], Dongkyung Nam[1]; *[1]Samsung, Korea.* The accurate eye position prediction method is presented for eye-tracking based glasses free 3D display to reduced system latency effect on the 3D image quality. Proposed method is experimentally validated using 3D display prototype.

W2A.7 • 12:00

Realization of liquid crystal privacy display using a face tracking ray control system, HyeonTaek Lee[1], Minyoung Park[1], Hee-Jin Choi[1]; *[1]Dept. Physics and Astronomy, Sejong Univ., Korea.* In this paper, we propose a liquid crystal privacy display using a face tracking ray control system. The proposed system can prevent a visual hacking by providing the displayed information to a registered user only.

W2A.8 • 12:15

Holographic display system to suppress speckle noise based on two spatial light modulators, Di Wang[1], Nan-Nan Li[1], Chao Liu[1], Qiong-Hua Wang[1]; *[1]Beihang Univ., China.* A holographic display system to suppress speckle noise is proposed. By loading the holograms on two spatial light modulators respectively and using spatiotemporal multiplexing method, the reconstructed image can be displayed with lower speckle noise.

W2B • Digital Holographic Microscopy —Continued

W2B.4 • 11:30

Microscopic 3D imaging through scattering media based on in-line phase-shift digital holography, Shutaro Kodama[1], Kanami Ikeda[2], Yoko Miyamoto[1], Wolfgang Osten[3], Mitsuo Takeda[4], Eriko Watanabe[1]; *[1]The Univ. of Electro-Communications, Japan; [2]Osaka Prefecture Univ., Japan; [3]Institut für Technische Optik ITO and Stuttgart Research Center of Photonic Engineering (SCoPE), Univ. of Stuttgart, Germany; [4]Center for Optical Research and Education (CORE), Utsunomiya Univ., Japan.* We demonstrate microscopic three-dimensional imaging of an object hidden behind a diffuser by using in-line phase-shift digital holography. A spatial resolution of 2.9 µm was achieved, and highly accurate quantitative phase imaging and three-dimensional imaging were realized.

W2B.5 • 11:45

High space-bandwidth product with high spatial phase sensitivity in single-shot digital holographic microscopy, Azeem Ahmad[1], Nikhil Jayakumar[1], Vishesh Dubey[2], Ankit Butola[2], Dalip Singh Mehta[2], Balpreet Singh Ahluwalia[1]; *[1]UiT The Arctic Univ. of Norway, Norway; [2]Physics, Indian Inst. of Technology Delhi, India.* The high space-bandwidth product with high spatial phase sensitivity is achieved by utilizing low spatial and high temporal coherence properties of pseudo-thermal light source in digital holographic microscopy system without sacrificing temporal resolution.

W2B.6 • 12:00

A multiwavelength, common-mode architecture for a digital holographic microscope, J. Kent Wallace[1], Eugene Serabyn[1], Christian Lindensmith[1], Stephanie Rider[3], Jay Nadeau[2]; *[1]Jet Propulsion Laboratory, USA; [2]Portland State Univ., USA; [3]California Inst. of Technology, USA.* Here we describe a multiwavelength DHM which simultaneously records wavelength multiplexed holograms of a microscopic sample. This coarse spectral encoding is akin to RGB values, thereby producing colorized images of the species.

W2B.7 • 12:15

Assessing the Focal Length and Wavefront Error of Liquid Crystal Micro Lens Arrays, Ping-Yen Chou[2], Daniel Prigge[4], Han-Ping Shieh[2], Ralf B. Bergmann[3,4], Claas Falldorf[1]; *[1]BIAS, Germany; [2]Dept. of Photonics & Inst. of Electro-Optical Engineering, National Chiao Tung Univ., Taiwan; [3]Bremer Institut füs angewandte Strahltechnik GmbH, Germany; [4]Faculty of Physics and Electrical Engineering, Univ. of Bremen, Germany.* We present a quantitative method to measure focal length and imaging performance of liquid crystal micro lens arrays, which is based on wave front analysis using computational shear interferometry.

12:30—14:00 • Lunch Provided, *Big Hall*

Poster Room
14:00 -- 16:00
W3A • Poster Session I

W3A.1

Speckle Denoising of Computer-Generated Macroscopic Holograms, Tobias Birnbaum[1], Ayyoub Ahar[1], Silvio Montresor[2], Colas Schretter[1], Pascal Picart[2,3], Peter Schelkens[1]; *[1]Virje Universiteit Brussels - ETRO-IMEC, Belgium; [2]LAUM, CNRS UMR 6613, Le Mans Université, France; [3]-, École Nationale Supérieure d'Ingénieurs du Mans, France.* An investigation of subjective quality of 16 numerical speckle denoising filter techniques for computer-generated holograms of macroscopic objects with diffuse surfaces is undertaken. Promising candidates with respect to computational complexity and quality are emphasized.

W3A.2

Effect of Demagnification on 3D Object Localisation in Digital Holography, Matthew L. Hall[1], Catherine E. Towers[1], Philip McCall[2], David P. Towers[1]; *[1]Optical Engineering Group, Univ. of Warwick, UK; [2]Vector Biology Dept., Liverpool School of Tropical Medicine, UK.* The ability to localise the 3D position of small objects is examined as the recorded volume is increased in size. The object field is reconstructed for different demagnifications and a best-focus plane is determined.

W3A.3

Parallax based Motion Estimation in Integral Imaging, Miao Zhang[1], Jie Liu[1], Yongri Piao[1], Yu Zhang[1], Xinxin Ji[1], Yukun Zhang[1]; *[1]Dalian Univ. of Technology, China.* In this paper, we present a parallax based motion estimation in integral imaging. Motion detection is achieved by calculation the PSFs of the parallax information. The experimental results show that the proposed method can improve the quality of the reconstructed 3D images.

W3A.4

Depth From Efficient Combination of Local Cues for Flexible-Sensing Autostereoscopic Display, Jian Wei[1], Shigang Wang[1], Yan Zhao[1], Meilan Piao[1]; *[1]Communication Engineering, Jilin Univ., China.* A method estimating depth from a video with arbitrary camera trajectory is proposed for flexible-sensing autostereoscopic display. To solve occlusions and weak textures, we use the inner-boundaries of homogeneous areas and combine the surface smoothness and density. With the gotten geometry, images with recognizable perspectives are well presented.

W3A.5

Simultaneous imaging of dual-focal planes for microscopy using geometric phase hologram lens, Chanhyung Yoo[1], Byounghyo Lee[1], Youngmo Jeong[1], Byoungho Lee[1]; *[1]Seoul National Univ., Korea.* We propose a method to acquire two depth images for microscopy. Without mechanical movement, the focal shift of the object plane can be realized by inserting a geometric phase hologram lens in the additional 4-*f* system.

W3A.6

Highly Sensitive THz-Imaging with CW Sources and Heterodyne Detection, Dai Aoki[1], Yoshiaki Sasaki[2], Tetsuya Yuasa[1], Chiko Otani[2]; *[1]Yamagata Univ., Japan; [2]Riken, Japan.* We proposed a highly sensitive transillumination imaging method with THz CW sources based on the heterodyne detection. The method was applied to tomosynthesis imaging of a 5-mm-thick wooden board to reproduce the depth information.

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W3A.7

Autostereoscopic Full-Screen Resolution Imaging Based on Amplitude-Polarization Imager with Front Dynamic Complex Parallax Barrier, Vasily A. Ezhov[1]; *[1]GPI RAS, Russian Federation.* Known full-screen resolution autostereoscopic layouts use static phase-polarization or dynamic amplitude parallax barriers or their various combinations with locations in different planes of the layout. The novel layout uses single dynamic parallax barrier with complex (amplitude-polarization) transmittance

W3A.8

Scattering of arbitrary wave from 3D dielectric surfaces by Born series expansion, Tomasz Kozacki[1]; *[1]Warsaw Univ. of Technology, Poland.* We propose a method that allows for computation of wave field propagation through 3D micro-objects. Method has high efficiency for scattering cases of arbitrary distribution of incidence wave. Numerical simulation results are provided.

W3A.9

3D spectral imaging of fluorescent micro beads using multispectral incoherent holography, Yuya Nagata[1,] Masaki Obara[1], Masahiro Ihara[1],Kyu Yoshimori[2]; *[1]Technology Research Laboratory, Shiamdzu Corporation, Japan; Dept. of System Innovation Engineering, Iwate Univ., Japan.* We propose a new method of multispectral incoherent holography by combining Fourier transform spectroscopy and incoherent digital holography. A microscopic system was constructed to demonstrate multispectral imaging.

W3A.10

Optical Scanning Fourier Ptychographic Microscopy, Lin Wang[1,3], Qihao Song[3], Honbo Zhang[2], Yu Xin[1], Ting-Chung Poon[3]; *[1]School of Electronic and Optical Engineering, Nanjing Univ. of Science and Technology, China; [2]Virginia Military Instuitue, USA; [3]Bradley Dept. of Electrical and Computer Engineering, Virginia Tech, USA.* We propose optical scanning Fourier ptychographic microscopy (OSFPM). The proposed system can more precisely control the overlap of the incident light illumination as compared to conventional FPM systems.

Poster Room
14:00 -- 16:00
W3A • Poster Session I

W3A.11
Multicolor lensless three-dimensional imaging with full space-bandwidth product and no mechanical scanning by wavelength-selective phase-shifting digital holography, Yutaka Endo[3], Tatsuki Tahara[1,2], Yasuhiro Takaki[4]; [1]*National Inst. of Informatics, Japan;* [2]*PRESTO, Japan Science and Technology Agency, Japan;* [3]*Inst. of Science and Engineering, Kanazawa Univ., Japan;* [4]*Inst. of Engineering, Tokyo Univ. of Agriculture and Technology, Japan.* We propose a multicolor lensless three-dimensional image-sensing technique with a full space-bandwidth product of an image sensor, seven wavelength-multiplexed holograms, a single reference arm, and no mechanical movements. Its effectiveness is experimentally demonstrated.

W3A.12
Evaluation of Non-Approximated Numerical Calculation of the Diffraction Integral, Carlos A. Buitrago[1], Jorge Garcia-Sucerquia[1]; [1]*School of Physics, Universidad Nacional de Colombia - Sede Medellin, Colombia.* Rayleigh-Sommerfeld diffraction (RSD) is revisited as an accurate full-range alternative for numerical scalar diffraction calculations. Range and fidelity in phase retrieval of Angular Spectrum and Fresnel transform are contrasted to a GPU implementation of RSD.

W3A.13
Biomedical image enhancement using liquid crystal cells , Ping-Yen Chou[1], Amir Hassanfiroozi[1], Yi-Pai Huang[1], Han-Ping D. Shieh[1]; [1]*Photonics, national chiao tung Univ., Taiwan.* In this paper, liquid crystal lens array is utilized in 3D bio-medical applications including 3D endoscope and light field microscope. Comparing with conventional lens array, proposed method has enhanced the focus ability and resolution.

W3A.14
Effects of membrane and nucleus on spatial light scattering study for label free cells in human peripheral blood, Jing Li[1], Lu Zhang[3], Yingze Tu[3], Li Yuan[2], Ning Lv[3,2], Lili Jiang[3], Shuang Chen[3]; [1]*Sports Center, Xi'an Jiaotong Univ., China;* [2]*Dept. of Laboratory Medicine, the First Affiliated Hospital, China;* [3]*State Key Laboratory for Manufacturing System Engineering, School of Mechanical Engineering, Xi'an Jiaotong Univ., China.* The effects of label free cell's membrane and nucleus on spatial light scattering are studied which may provide a non-destructive and non-toxic single cell detection method for recognizing malignant cells in human peripheral blood in early stage.

W3A.15
A novel microfluidic chip design with integrated micro-optical system for label free cells'scattering detection, Lu Zhang[2], Lili Jiang[2], Ning Lv[2], Li Yuan[1], Jing Li[3]; [1]*Xianning East Road No.28, Dept. of Laboratory Medicine, the First Affiliated Hospital, Xi'an Jiaotong Univ., Xi'an Jiaotong Univ., China;* [2]*State Key Laboratory for Manufacturing System Engineering, School of Mechanical Engineering, Xi'an Jiaotong Univ., China;* [3]*Sports Center, Xi'an Jiaotong Univ., China.* A novel design for microfluidic chips is put forward to solve the problems in label free cells' scattering study that forward scattering light has low signal-to-noise ratio due to incident light divergence in traditional design.

W3A.16
Detection of biomolecular interaction based on digital holographic surface plasma resonance imaging, Shiping Li[1], Zibang Zhang[1], Ying Li[2], Pan Qi[3], Yuhuan Shuai[4], Jingang Zhong[1]; [1]*Dept. of Optoelectronic Engineering, JinanUniv., China;* [2]*Pre-Univ., Jinan Univ., China;* [3]*Dept. of Electronics Engineering, Guangdong Communication Polytechnic, China;* [4]*Dept. of Physics, Jinan Univ., China.* A biomolecular interaction analysis by use of surface plasma resonance imaging based on digital holography is proposed. The proposed technique is validated by detect the interaction between acidic fibroblast growth factor protein and its antibody.

W3A.17
Whole-Cell Biophysical Parameters Measured With Quantitative-Phase Digital Holographic Microscopy, Erik Bélanger[1], Émile Rioux-Pellerin[1], Pauline Lavergne[1], Philippe Bilodeau[1], Bertrand De Dorlodot[1], Sebastien levesque[1], Pierre M. Marquet[1]; [1]*CERVO Brain Research Centre, Canada.* We demonstrate the measurement of whole-cell biophysical parameters with quantitative-phase digital holographic microscopy. For different cell types, whole-cell mechanical properties and refractive index, mean cell thickness and absolute cell volume were obtained.

W3A.18
Linear System of Single-pixel Digital Holography with Coded Reference Beam, Yutaka Endo[1]; [1]*Kanazawa Univ., Japan.* We formulate the measurement of single-pixel digital holography with coded reference beam as a linear system. This formulation reveals the number of measurements required to solve the system accurately.

W3A.19
Compressive Optical Encryption of Three-dimensional Image, Zhang Cheng[1], Xu Haitao[1], Wang Meiqin[1], Chen Qianwen[1]; [1]*Anhui Univ., China.* A new compressive optical encryption of three-dimensional image method is presented. The 3D object can be encrypted into a hologram and recovered via phase-shifting first and compressive Fresnel holography. The feasibility and superiority are verified.

Poster Room
14:00 -- 16:00
W3A • Poster Session I

W3A.20

Testing compressive holography in deformation measurements of optically rough surfaces, Pablo Etchepareborda[1,2], Arturo A. Bianchetti[1,2], Alejandro Federico[1]; [1]*Instituto Nacional de Tecnologia Industrial, Argentina;* [2]*Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina.* Phase shifting holography based benchmarking test of compressive holography in recovering optical phase changes produced by deformations in optically rough surfaces. A convenient variable splitting functional model requiring one image per deformation state is evaluated.

W3A.21

3D image encryption based on computer-generated hologram, Mei-Lan Piao[1], Hui-Ying Wu[2], Nam Kim[2]; [1]*Jilin Univ., China;* [2]*Chungbuk National Univ., Korea.* We propose a robust 3D image encryption scheme based on computer-generated hologram with pixel superimposed method. The cryptosystem is asymmetric and high resistance against to the chosen-plaintext attack.

W3A.22

Depth scanning using binary digital micro-mirror devices, Mostafa Agour[1], Claas Falldorf[1], Ralf B. Bergmann[1]; [1]*BIAS, Germany.* We present an experimental configuration for phase retrieval utilizing fast object's depth scanning. The configuration is composesed of a digital micro-mirror device enabling fast manipulation of light-fields with binarized holograms of the transfer-function of propagation.

W3A.23

Analytical laser beam shaping in fractional Fourier optics, Alberto Patiño-Vanegas[1]; [1]*Universidad Tecnologica de Bolivar, Colombia.* We propose an analytical calculation of the phase function of diffractive components for laser beam shaping in fractional Fourier optics. The results for super-Gaussian beams, on both spherical and toric emitters, are shown.

W3A.24

Interferometric Correction of Point Spread Function Spot in Projection Based on a Collective Matrix of Spatial Light Modulators, Adam Kowalczyk[1], Michal Makowski[1], Izabela Ducin[1], Maciej Sypek[1], Andrzej Kolodziejczyk[1]; [1]*Warsaw Univ. of Technology, Poland.* Identical phase-only SLMs assembled side-by-side create a synthetic-aperture SLM. It allows scalable increase of image resolution for the price of strong side-lobes in the PSF spots. In this paper we present method of interferometric correction of the PSF spot.

W3A.25

Image quality evaluation of partially bleached hologram, Hiroshi Yoshikawa[1]; [1]*Nihon Univ., Japan.* Partially bleached holograms are evaluated on diffraction efficiency and structural similarity index. Numerical experiments show the bleach factor of 0.9 gives bright and quality image. Results are useful for optically recorded hologram.

W3A.26

A Method of Color Holographic Display with Reduced Ringing Artifacts, Dan Xiao[1], Chun Chen[1,2], Ling Xin[1,2], Di Wang[1], Qiong-Hua Wang[1,2]; [1]*Beihang Univ., China;* [2]*Sichuan Univ., China.* A method of color holographic display with reduced ringing-artifacts is proposed. By reducing the distance between hologram and scene plane according to random phase-free theory, the color high-quality display can be achieved by space multiplexing.

W3A.27

Increasing reconstructed image quality using a random-repeated and displaced phase in time-average computer-generated holograms., Maria L. Cruz[1], Nancy L. Domínguez-Hernández[2]; [1]*Facultad de Ingeniería, Universidad Panamericana., Mexico;* [2]*Universidad Veracruzana, Mexico.* We use a random-repeated and displaced phase in time-average holograms to reduce the speckle noise in the reconstructed image and keep the object information dispersion in the hologram. We found that for less of 20 holograms the new phase has better performance than the random phase.

W3A.28

Adaptive Randomization of Pixel Pattern for Suppressing Higher Orders of Diffraction, Joanna Starobrat[1], Jan Bolek[1], Michal Makowski[1]; [1]*Politechnika Warszawska, Poland.* Randomization of pixel positions in the computer-generated hologram is proved to suppress the higher diffraction orders in the image reconstruction. In order to prevent the possible resultant decrease of the SNR and improve the diffraction efficiency of the phase pattern displayed on the SLM, correction algorithms are proposed.

W3A.29

Partially Overlapping Printing to Improve Image Quality of Volume Hologram Printer - Numerical Simulation, Hangbo Hua[1], Takeshi Yamaguchi[1], Hiroshi Yoshikawa[1]; [1]*Nihon Univ., Japan.* Different partially overlapped holograms are reconstructed with digital spatial filter. Compare with the non-overlapped holograms, the overlapped ones show weaker gaps and black lines.The result contributes to improve image quality.

W3A.30

Full-Color Holographic System Featuring Non-uniform Sampled 2D Images for Representation of Real 3D objects, Yu Zhao[1], Munkh-Uchral Erdenebat[1], Ki-Chul Kwon[1], Seok-Hee Jeon[2], Nam Kim[1]; [1]*Chungbuk National Univ., Korea;* [2]*Incheon National Univ., Korea.* Multi cameras are used to acquire depth and color information from real scenes, and then virtually reconstruct point cloud by using non-uniform sampled method.MR-PCG method is proposed to accelerate the calculation speed of the CGH.

Poster Room
14:00 -- 16:00
W3A • Poster Session I

W3A.31
Phase-only Fresnel Hologram Generation From Halftone Images, Fabriciu A. Benini[1], Ben-Hur V. Borges[1], Luiz G. Neto[1]; [1]*Univ. of Sao Paulo, Brazil.* We suggest the use of halftone images for the generation of phase-only Fresnel holograms. The hologram is calculated by spatial filtering. No iterative method is used in the calculation.

W3A.32
Autofocusing of fluorescent microscopic images through deep learning convolutional neural networks, Thanh Nguyen[1], Anh Thai[1], Pasham Adwani[1], George Nehmetallah[1]; [1]*Catholic Univ. of America, USA.* We present convolutional neural network models that can predict focused fluorescent microscopic images (modified UNET with cGAN) as well as the focal length (using the VGG model) from blurred images captured at overfocused or underfocused planes.

W3A.33
Generation of high-resolution and speckle reduced light field data from hologram using deep learning, Dae-Youl Park[1], Jae-Hyeung Park[1]; [1]*Inha Univ., Korea.* We proposed a method to create light field data of three-dimensional scene from its hologram. To overcome low resolution and speckle noise of the light field data, we applied deep learning technique.

W3A.34
Experimental Gabor hologram rendering by a convolutional neural network trained with synthetic holograms, Julie Rivet[1], Clement Fang[1], Leo Puyo[1], Jean-Pierre Huignard[1], Michael Atlan[1]; [1]*CNRS, France. We demonstrate digital hologram rendering by a convolutional neural network, trained with image pairs generated by wave propagation from random data. Experimental Gabor magnitude holograms are reconstructed by a U-Net trained with 50,000 image pairs*.

W3A.35
Holographic Data Compression with JPEG Standard and Deep Learning, Yang Gao[1], Shuming Jiao[1], Zhi Jin[1]; [1]*Shenzhen Univ., China.* We propose a phase-only hologram compression scheme based on "JPEG standard + deep learning". Our scheme is compatible with universal JPEG standard and the compression artifacts are effectively restored by a deep convolutional network.

16:00—16:30 • Coffee Break and Exhibition, *Rooms A3 and A5*

Amphitheater	Room E300

Wednesday, 22 May

16:30 -- 18:00
W4A • 3D Imaging and Display Systems IV
Presider: Chau-Jern Cheng; National Taiwan Normal Univ., Taiwan

W4A.1 • 16:30 Invited

Parabolic-mirror-reflection Holographic 3D Display for Super Wide Viewing Zone and its Fast Calculation Algorithm, Yusuke Sando[1], Daisuke Barada[2,3], Toyohiko Yatagai[2]; [1]*Osaka Res. Inst. of Ind. Sci. and Tech., Japan;* [2]*Center for Optical Research & Education,, Utsunomiya Univ., Japan;* [3]*Graduate School of Engineering, Utsunomiya Univ., Japan.* Radial reflection of wavefronts by a convex parabolic mirror can drastically enlarge the viewing zone in holographic 3D displays. Optical demonstration of super wide viewing zone and its fast calculation algorithm are presented.

W4A.2 • 17:00

Continuous Recording of Holographic Stereograms, Pierre-Alexandre Blanche[1]; [1]*Univ. of Arizona, USA.* We achieve the continuous recording and refreshing of holographic stereograms by replacing the translation stage scanning the holographic screen with a belt system holding flexible holographic lenses. This system is removing one of the roadblocks standing in the pathway of 3D videorate holographic display.

W4A.3 • 17:15

Proposal of holographic display using MEMS-SLM and pulse modulated laser, Yoshitaka Takekawa[1], Yuki Nagahama[1], Yuzuru Takashima[2], Yasuhiro Takaki[1]; [1]*Tokyo Univ. of Agriculture and Technology, Japan;* [2]*Univ. of Arizona, USA.* The MEMS-SLM which displays hologram patterns is illuminated by a short-pulse laser during the rotation of the MEMS mirrors. The pulse generation timing is controlled for scanning the modulated light to enlarge the viewing zone.

16:30 -- 18:00
W4B • Tomography I
Presider: Victor Dyomin; Tomsk State Univ., Russian Federation

W4B.1 • 16:30

Methods for holographic 3D tracking and rotating angle recovery in tomographic flow cytometry, Pasquale Memmolo[1], Massimiliano M. Villone[2], Francesco Merola[1], Martina Mugnano[1], Lisa Miccio[1], Pier Luca Maffettone[2], Pietro Ferraro[1]; [1]*National Research Council of Italy, Inst. of Applied Sciences and Intelligent Systems "E. Caianiello", Italy;* [2]*Dipartimento di Ingegneria Chimica, dei Materiali e della Produzione Industriale, Univ. of Naples "Federico II", Italy.* Tomographic flow cytometry allows to reconstruct the 3D refractive index distribution of rotating cells in microfluidic flow. Here we compare different methods to track the 3D position and the 3D orientation of flowing cells.

W4B.2 • 16:45

Effect of Hologram Size on 3D Reconstruction using Multi-wavelength Digital Holography, Haowen Zhou[1], Runzi Hou[1], Behzad Bordbar[1], Partha P. Banerjee[1]; [1]*Electro-Optics and Photonics, Univ. of Dayton, USA.* Hologram size reduction affects its reconstruction. The effect of hologram size on transverse and longitudinal resolution is investigated in multi-wavelength digital holography, for potential applications in 3D imaging and implementation of deep learning.

W4B.3 • 17:00

Snapshot Optical Coherence Tomography, Mu Qiao[2], Yangyang Sun[3], Xuan Liu[2], Xin Yuan[1], Paul Wilford[1]; [1]*Bell Labs, USA;* [2]*ECE, New Jersey Inst. of Technology, USA;* [3]*College of Optics and Photonics (CREOL), Univ. of Central Florida, USA.* An ultrafast snapshot compressive spectral optical coherence tomography system is demonstrated, which can acquire 3D data at 20 gigavoxels per second.

W4B.4 • 17:15

XUV coherence tomography with nanoscale resolution using one-dimensional phase retrieval, Silvio Fuchs[1,2], Martin Wünsche[1,2], Jan Nathanael[1,2], Johann Jakob Abel[1], Julius Reinhard[1], Felix Wiesner[1,2], Slawomir Skruszewicz[1], Christian Rödel[1,2], Gerhard G. Paulus[1,2]; [1]*Univ. of Jena, Germany;* [2]*Helmholtz Inst. Jena, Germany.* We present XUV Coherence Tomography (XCT) driven by a high-harmonic generation (HHG) light source. Using a novel one-dimensional phase retrieval algorithm, XCT enables non-destructive, artifact-free, nanoscale, cross-sectional imaging, of, e.g., semiconductor devices.

Amphitheater	Room E300

Wednesday, 22 May

W4A • 3D Imaging and Display Systems IV—Continued

W4A.4 • 17:30
21-inch color 3D dynamic holographic display, Pan He[1], Juan Liu[1], Tao Zhao[1], Yu Han[1], Yongtian Wang[1]; *[1]Beijing Inst. of Technology, China.* A compact display system is proposed for color dynamic holographic display with a 21-inch liquid crystal display (LCD) panel. An independent block holographic algorithm is developed to record accurate depth information.

W4A.5 • 17:45
3D head-mounted projection display using retro-reflective screen, Pal Koppa[1]; *[1]Budapesti Muszaki es Gaz. Egyetem, Hungary.* We propose a compact 3D display using two head-mounted picoprojectors projecting images on a retro-reflective screen that reflects left and right images to the appropriate eye. Key system properties – brightness and cross-talk – are investigated.

W4B • Tomography I—Continued

W4B.5 • 17:30
Label-free quantitative material sensitive tomography with extreme ultraviolet light, Felix Wiesner[1,2], Silvio Fuchs[1,2], Martin Wünsche[1,2], Jan Nathanael[1,2], Johann Jakob Abel[1], Julius Reinhard[1,2], Slawomir Skruszewicz[1], Christian Rödel[2,1], Annett Gawlik[3], Gabriele Schmidl[3], Uwe Hübner[3], Jonathan Plentz[3], Gerhard G. Paulus[1,2]; *[1]Friedrich-Schiller-Univ., Germany; [2]Helmholtz Inst., Germany; [3]Leibniz Inst. of Photonic Technology (IPHT), Germany.* We report on quantitative material-sensitive cross-sectional imaging with nanoscale axial resolution. First experimental results show that in addition to the structural information element-specific identification of buried layers is possible.

W4B.6 • 17:45
Tomographic particle holography: light scattering model and preliminary experimental verification, Yingchun Wu[1], Xiaodan Lin[1], Longchao Yao[1], Xuecheng Wu[1], Qiang Wang[2], Kefa Cen[1]; *[1]Zhejiang Univ., China; [2]China Aerodynamic Research and Development Center, China.* The model of the formation in tomographic particle holography reveals that the hologram contains a DIH, off-axis DIH and self-reference holography, verified by reconstructed droplet images in droplet impact on surface experiment.

18:15—19:15 • A Revolution in Display Holography: CHIMERA™, the Third Generation of Holoprinter, *Amphitheater*

Amphitheater	Room E300

08:00 -- 10:00
Th1A • Bio and Medical Applications I
Presider: Elena Stoykova; Bulgarian Academy of Sciences, Bulgaria

Th1A.1 • 08:00 Invited
Measuring the phase and intensity of the light in microscopy for biological sample characterization at the nanoscale, Pierre Bon[1]; *[1]LP2N, CNRS / Institut optique Gradutate School / Univ. Bordeaux, France.* Quantitative intensity and phase imaging in microscopy has many applications in biology, especially at the ultimate resolution. It can be applied both for label-free sample characterization and molecular imaging in 3D using fluorescent dyes.

Th1A.2 • 08:30
Ultrafast digital holography for in vivo retinal blood flow imaging and assessment of flow resistance, Léo Puyo[1], Michel Paques[2,3], Mathias fink[1], Jose Sahel[2,3], Michael Atlan[1]; *[1]Institut Langevin, France; [2]Institut de la Vision, France; [3]Centre d'Investigation Clinique des Quinze-Vingts, France.* Digital holography allows for quantitative blood flow imaging in the human eye with a yet unrivaled temporal resolution that allows for the study of local waveforms and vessel type identification.

Th1A.3 • 08:45
Exploring living neuronal network dynamics and homeostasis with multimodal digital holographic microscopy: towards identifying early biomarkers for neurodevelopmental disorders, Pierre M. Marquet[1], Erik belanger[1], Sebastien levesque[1], pascal jourdain[2], Pierre magistretti[2]; *[1]Universite Laval, Canada; [2]Univ. of Lausanne, Joint International Research Unit, Switzerland.* Quantitative phase digital holography microscopy has recently emerged as a powerful label-free technique in the field of cell imaging. In this talk, it will explain how QP-DHM can assess living neuronal network maturation and homeostasis .

Th1A.4 • 09:00
Quantitative Phase Imaging with Digital Holographic Microscopy Applied for Label-free Analysis of Confluent Cell Layers, Björn Kemper[1], Luisa Pohl[1], Mathias Kaiser[2], Jürgen Schnekenburger[1], Steffi Ketelhut[1]; *[1]Univ. of Muenster, Germany; [2]Max Delbrück Center for Molecular Medicine, Germany.* We explored strategies to analyze confluent cell layers utilizing digital holographic microscopy (DHM). Our results show that histogram-based evaluation of quantitative DHM phase images enables a highly reliable quantitative observation of global morphology changes.

08:00 -- 10:00
Th1B • Emerging and Advanced Techniques III
Presider: Claas Falldorf; BIAS, Germany

Th1B.1 • 08:00 Invited
Speckle-Based Spectrometers, Hui Cao[1]; *[1]Yale Univ., USA.* The speckle pattern, produced by a random scattering medium or a multimode fiber/waveguide, is sensitive to wavelength and used as a fingerprint to recover the spectrum. We achieve high spectral resolution with small footprint.

Th1B.2 • 08:30
Fourier Holography in Wavefront Sensing: Pro et Contra, Vladimir Y. Venediktov[1]; *[1]Saint-Petersburg Electrotechnical Univ, Russian Federation.* We consider and compare various possible schemes of the holographic wavefront sensors, based upon the use of Fourier holograms, including straightforward record, computer synthesized and Fourier holograms, recorded with the use of diffuse scattered radiation.

Th1B.3 • 08:45
Bio-Lithography by RBC-lenses: DH Wavefront evaluation of imprinted structures in Lithium Niobate, Lisa Miccio[1], Jaromir Behal[2,1], Pasquale Memmolo[1], Martina Mugnano[1], Francesco Merola[1], Biagio Mandracchia[1], Simonetta Grilli[1], Pietro Ferraro[1]; *[1]CNR-ISASI, Italy; [2]Dept. of Optics, Palacký Univ., Czechia.* Unique feature of DH for implementing numerical scanning of the reconstruction distance is used to characterize near-field propagation properties of phase structures imprinted into photorefractive Lithium Niobate crystals by biolenses as Red Blood Cells

Th1B.4 • 09:00
Characterization of Monolayer Graphene by Combining Surface Plasmon Resonance with Digital Holographic Microscopy, Siqing Dai[1], Jianglei Di[1], Hua Lu[1], Jianlin Zhao[1]; *[1]Northwestern Polytechnical Univ., China.* The reflection phase shift difference in the five-layer SPR configuration is experimentally measured to characterize the complex refractive index of monolayer graphene by combing surface plasmon resonance with the digital holographic microscopy.

Amphitheater	Room E300

Thursday, 23 May

Th1A • Bio and Medical Applications I—Continued

Th1A.5 • 09:15
Aggregation of Human Blood Platelets in Chronic Obstructive Pulmonary Disease vs. Healthy Case: a Comparative Study Using Color Digital Holographic Microscopy, Jerome Dohet-Eraly[1,2], Daniel Ribeiro de Sousa[2], Catherine Yourassowsky[1], Alexandre Rousseau[2], Alain Van Meerhaeghe[2], Karim Zouaoui Boudjeltia[2], Frank Dubois[1]; *[1]Universite libre de Bruxelles, Belgium; [2]CHU de Charleroi, Belgium.* Digital holographic microscopy is used for studying the aggregation of thrombocytes. Healthy people and patients suffering from chronic obstructive pulmonary disease are compared. Phase analysis is provided to investigate the associated biological mechanisms.

Th1A.6 • 09:30
Local particle concentration measurement with two holographic approaches, Marina Gómez Climente[1], Eva M. Roche Seruendo[1], Julia Lobera Salazar[1], Virginia Palero[1], Maria Pilar Arroyo[1]; *[1]I3A, Universidad de Zaragoza, Spain.* Local concentration of magnetic particles inside a capillary model under the effect of an external magnetic field is measured. Particle concentration shows a gradient in the flow cross-section, which agrees with theoretical models.

Th1A.7 • 09:45
Observation of Plant Cell by Holographic 3D Illumination and Imaging Functional Optical Microscopy, Manoj Kumar[1], Xiangyu Quan[1], Yasuhiro Awatsuji[2], Yosuke Tamada[3], Osamu Matoba[1]; *[1]Kobe Univ., Japan; [2]Kyoto Inst. of Technology, Japan; [3]National Inst. for Basic Biology, Japan.* We demonstrate a common-path off-axis incoherent digital holographic and active multi-beam illumination microscopic system for 3D fluorescence imaging. The proposed system is employed for the 3D imaging of the fluorescent beads and plant Physcomitrella patens .

Th1B • Emerging and Advanced Techniques III—Continued

Th1B.5 • 09:15
Optical variable device based on plasmonic structures produced by image matrix method, Maria V. Shishova[1], Sergey B. Odinokov[1], Catherine A. Drozdova[1], Alexander Y. Zherdev[1], Andrey Smirnov[2], Boris V. Akimov[2]; *[1]Bauman Moscow State Technical Univ., Russian Federation; [2]JSC «RPC «Krypten», Russian Federation.* We demonstrate transparent optical security element based on silver plasmonic structures that provides zero order filtering with non-spectral color. It is distinguished with image-matrix mastering and large area design with specific angular selectivity.

Th1B.6 • 09:30
Non-diffractive Optical Scanning Holography for Hologram Acquisition, Peter Tsang[1], Ting-Chung Poon[2]; *[1]City Univ. of Hong Kong, Hong Kong; [2]Virginia Tech., USA.* We propose and demonstrate a new Non-diffractive Optical Scanning Holography (ND-OSH) method, that is lower in complexity and more compact than existing Optical Scanning Holography (OSH) framework, for capturing in-line holograms of physical objects.

Th1B.7 • 09:45
Contribution of Debye Series to Particle Characterization with Holography and the Photonic Jet Method, Fabrice Onofri[1], Fabrice Lamadie[2], Matthias Sentis[1]; *[1]IUSTI-DME, CNRS/Aix-Marseille Univ., France; [2]DEN, DTEC, SGCS, CEA, France.* Physical insights are provided on the relative contributions of the scattering processes (pure diffraction, specular reflection, tunneling and grazing waves, single refraction…) in the reconstruction of the photonic jet of spherical particles with Digital-in-Line Holography .

10:00—10:30 • Coffee Break and Exhibition, *Rooms A3 and A5*

Amphitheater	Room E300

10:30 -- 12:30
Th2A • Particles Imaging
Presider: Yoshio Hayasaki; Utsunomiya Univ., USA

Th2A.1 • 10:30 Invited
Holography of Particles for Diagnostic Tasks, Victor V. Dyomin[1]; [1]*Tomsk State Univ., Russian Federation.* The opportunities and special features of using a multi-purpose digital holographic camera adapted for particle research for various diagnostic tasks, like plankton investigation in its habitat, optical glass diagnostics, and study of defects in single crystals, are investigated.

Th2A.2 • 11:00
Probing micro-plastic items with coherent light enables their identification through digital holography, Vittorio Bianco[1], Pasquale Memmolo[1], Pierluigi Carcagnì[1], Francesco Merola[1], Melania Paturzo[1], Cosimo Distante[1], Pietro Ferraro[1]; [1]*Consiglio Nazionale delle Ricerche-ISASI, Italy.* We probe micro-plastics with coherent light and image them by digital holography microscopy. Thus, we access the phase-contrast map of the object. This can be used as a distinctive fingerprint to identify microplastics in water .

Th2A.3 • 11:15
Accurate Detection of Samll Particles in Digital Holography using Fully Convolutional Networks**,** Xinwen Li[1], Yingchun Wu[1], Longchao Yao[1], Xiaodan Lin[1], Xuecheng Wu[1], Kefa Cen[1]; [1]*State Key Lab. of Clean Energ. Utiliz., China.* A modified fully convolutional networks is proposed to detect small solid fuel particles in reconstructed holographic images. Results show a higher recognition accuracy compared with the traditional threshold-based methods.

10:30 -- 12:30
Th2B • Tomography II
Presider: Tomasz Kozacki; Warsaw Univ. of Technology, Poland

Th2B.1 • 10:30
Withdrawn.

Th2B.2 • 10:45
Metrological studies of limited angle holographic tomography systems based on a phase phantom mimicking biological cell , Malgorzata Kujawinska[1], Michal Ziemczonok[1], Arkadiusz Kus[1], Wojciech Krauze[1]; [1]*Inst. of Micromechanics and Photonics, Warsaw Univ. of Technology, Poland.* The method for determination of metrological parameters of limited angle holographic tomography systems (LAHT) is presented. The applicability of designated phase phantom which mimics biological cell is shown in comparative investigations of commercial and research LAHTs.

Th2B.3 • 11:00
Vertical digital holographic bench for underexpanded jet gas density reconstruction, François Olchewsky[1], Jean-Michel Desse[1], David Donjat[1], Frédéric Champagnat[1]; [1]*Office Natl d'Etudes Rech Aerospatiales, France.* The built of a multi-viewpoint digital holographic bench permits to study snapshots of a three-dimensional underexpanded jet. The coincidence in time between the measurements allows to study unsteadiness of the jet and explain Fluid Dynamics phenomenon.

Th2B.4 • 11:15
Wavefront manipulation and processing for digital holographic tomography, Vinoth Balasubramani[1], Chau-Jern Cheng[1]; [1]*National Taiwan Normal Univ., Taiwan.* Novel wavefront manipulation techniques are proposed for holographic optical tweezer to manipulate the trapping beam combined with digital holographic tomography, and also demonstrated the adaptive wavefront correction technique to enhance the spatial resolution in three-dimensions

Amphitheater	Room E300

Thursday, 23 May

Th2A • Particles Imaging —Continued

Th2A.4 • 11:30
Influence of flame on 3D location of particles in digital in-line holography, Longchao Yao[1], Xiaodan Lin[1], Yingchun Wu[1], Xuecheng Wu[1], Kefa Cen[1]; [1]*State Key Lab. of Clean Energ. Utiliz., China.* Influences of flame on particle measurement with digital in-line holography is investigated experimentally and numerically. Results of a jet flame show an overall shift of z positions, and the RMS also increases significantly.

Th2A.5 • 11:45
Polarization Resolved Dual-View Holographic System for Investigation of Microparticles, Johan M. Ohman[1], Per Gren[1], Mikael Sjodahl[1]; [1]*Lulea Univ. of Technology, Sweden.* A dual-view polarization resolved digital-holographic system is presented. The necessary calibration for both polarization and spatial coordinates are outlined. As an example the system is is used to track spherical microparticles in a cuvette.

Th2A.6 • 12:00
Holography-based tracking spectroscopy to study galvanic exchange on single silver nanoparticles, Minh-Chau Nguyen[1,2], Pascal Berto[2,3], Fabrice Valentino[3], Jean-Francois Lemineur[1], Jean-Marc Noel[1], Catherine Combellas[1], Frédéric Kanoufi[1], Gilles Tessier[2,3]; [1]*Université Paris Diderot, France;* [2]*Institut de la Vision, France;* [3]*Université Paris Descartes, France.* 3D particle tracking by Digital Holographic Microscopy is used to drive a real-time adaptive spectroscopy system. Moving plasmonic nanoparticles are characterized individually during their chemical transformation in solution.

Th2A.7 • 12:15
Single Shot Quantitative Phase Imaging and Complex Spectroscopy of Trapped Atoms, Jian Zhao[1], Liyang Qiu[1], Yuzhuo Wang[1], Saijun Wu[1]; [1]*Fudan Univ., China.* We report quantitative phase imaging of micron-sized trapped atomic samples using inline holography. Absorption and phase images near fundamental limits are retrieved from single-shots holograms. We demonstrate complex spectroscopy and quasi-3D imaging of atomic samples.

Th2B • Tomography II—Continued

Th2B.5 • 11:30
Coherent x-ray imaging at the nanoscale: propagating from cells to tissues, Chris J. Jacobsen[2,1], Ming Du[3], Sajid S. Ali[4], Saugat Kandel[4]; [1]*Dept. of Physics & Astronomy, Northwestern Univ., USA;* [2]*Advanced Photon Source, Argonne National Laboratory, USA;* [3]*Dept. of Materials Science and Engineering, Northwestern Univ., USA;* [4]*Applied Physics Program, Northwestern Univ., USA.* Coherent x-ray imaging techniques are delivering sub-20 nanometer resolution images of cells and manufactured materials. We discuss advances towards 3D imaging of tissues and thicker materials using numerical optimization to account for beam propagation effects.

Th2B.6 • 11:45
Simplified Reconstruction For Mirror-Assited Tomographic Diffractive Microscopy, Ludovic Foucault[1], Nicolas Verrier[1], Matthieu Debailleul[1], Bertrand SIMON[2], Olivier Haeberlé[1]; [1]*EA7499 IRIMAS, France;* [2]*Institut Optique, France.* We propose a novel technique for spatial demodulation of mirror-assisted tomographic diffractive microscopy images. Demodulation takes into account symmetry introduced by this mirror-effect, to properly reassign information in Fourier space.

Th2B.7 • 12:00
Compressive sensing holographic microscopy for imaging of sparse moving objects in 3D, Michel Gross[1], Nitin Rawat[1], Dario Donnarumma[1], Danial Alexandre[1], Nicolas Cubedo[2]; [1]*Laboratoire Charles Coulomb UMR5221 CNRS UM, Universite de Montpellier II, France;* [2]*Mécanismes Moléculaires dans les Démences Neurodégénératives (MMDN),U1198: INSERM UM, Université Montmellier, France.* Compressive sensing combined with digital holographic microscopy is used to image in 3D and in time, red blood cells (RBCs) circulating in the vascular system of a zebrafish larva (Danio rerio).

Th2B.8 • 12:15
Effect of Hologram Windowing on Correlation of 3D Objects, Haowen Zhou[1], Runzi Hou[1], Behzad Bordbar[1], Partha P. Banerjee[1]; [1]*Electro-Optics and Photonics, Univ. of Dayton, USA.* Holograms are recorded, windowed, cropped and correlated. Correlation peak values are extracted as a metric to evaluate correlation of 3D surface features. The effect of hologram windowing on correlation of 3D real objects are investigated.

12:30—14:00 • Lunch Provided, *Big Hall*

Poster Room
14:00 -- 16:00
Th3A • Poster Session II

Th3A.1

Digital hologram reconstruction segmentation using a convolutional neural network, Tomi Pitkäaho[1], Aki Manninen[2], Thomas J. Naughton[1]; *[1]Maynooth Univ., Ireland; [2]Univ. of Oulu, Finland.* Digital holographic microscopy allows capture of the full wavefront from microscopic objects without marking and scanning. Multi-label segmentation of digital holograms of three-dimensional Madin-Darby canine kidney cell clusters is realized using a fully convolutional neural network.

Th3A.2

Automated alignment for Fluorescence Holographic Microscope, Zbynek Dostal[1], Pavel Kolman[1], Radim Chmelík[1]; *[1]CEITEC Brno Univ. of Technology, Czechia.* Fluorescence Holographic Microscope extends the capabilities of DHM in the study of living cells. However, the use of low coherence emitted light for holography is accompanied by increased sensitivity of the system to correct alignment. Therefore, the introduction of an automatic self-correcting system is inevitable.

Th3A.3

Detection of an object in the field of view of a digital hologram with an heuristic algorithm parameterized using a convolutional neural network, Tomi Pitkäaho[1], Aki Manninen[2], Thomas J. Naughton[1]; *[1]Maynooth Univ., Ireland; [2]Univ. of Oulu, Finland.* Detecting the presence of an object in a digital hologram reconstruction is an important consideration in many applications. We use the analysis of a convolutional neural network to parameterize and improve the performance of an heuristic algorithm.

Th3A.4

Digital holographic microscopy and machine learning approach for the classification of inflammation in macrophages, Vishesh Kumar Dubey[1,3], Azeem Ahmad[1,3], Rajwinder Singh[2,3], Dalip Singh Mehta[1], Balpreet Singh Ahluwalia[3]; *[1]Indian Inst. of Technology, Delhi, India; [2]European Molecular Biology Laboratory, Germany; [3]UiT The Arctic Univ. of Norway, Norway.* Digital holographic microscopy system is developed for the quantitative phase imaging of the macrophages. The results are utilized as input of the support vector machine based classifier for the detection of inflammation in macrophages.

Th3A.5

Digital Lensless Holographic Microscopy with Engineered Optical Fiber Point Source, Brayan Patiño[1], Juan F. Botero-Cadavid[1], Jorge Garcia-Sucerquia[1]; *[1]Universidad Nacional de Colombia, Colombia.* An alternative point source for digital lensless holographic microscopy is engineered from a step-index optical fiber. Numerical aperture of 0.88 is achieved with a mechanically solid set-up utilized to image bio samples.

Th3A.6

SNR enhancement in in-line particle holography using off-axis illumination, Shengfu Li[1]; *[1]CAEP, IFP, China.* Combining several holograms captured under on- and off-axis illuminations can mitigate the noise from out-of-focus particles, and thus can improve the performance in terms of SNR and false-detection-ratio.

Th3A.7

Digital Holographic Microscopy for 200 € Using Open-Source Hard- and Software, Tobias Beckmann[1], Markus Fratz[1], Annelie F. Schiller[1], Alexander Bertz[1], Daniel Carl[1]; *[1]Fraunhofer Inst. for Physical Measurement Techniques, Germany.* 3D-printed mounts and off-the-shelf components result in a digital holographic microscope for 200 € – including camera and computer. Short source code and a simple design put noninvasive quantitative bio-imaging within reach of secondary schools.

Th3A.8

Compressive depth-resolved holographic microscope, Wenhui Zhang[1,2], Hua Zhang[1,2], David Brady[2], Guofan Jin[1], Liangcai Cao[1]; *[1]Tsinghua Univ., China; [2]Duke Univ., USA.* Holographic imaging suffers from twin images and cross-talks between different layers of three-dimensional objects even at millimeter scale. Compressive sensing associated with holographic microscope achieves micron level depth-resolved imaging free from the mentioned noises above.

Th3A.9

Morphological Transformations in Hela Living Cells at Early Apoptosis Stages Observed by Off-axis Digital Holographic Microscopy, Andrei V. Belashov[2,1], Anna A. Zhikhoreva[2], Tatyana N. Belyaeva[3], Elena S. Kornilova[3], Anna V. Salova[3], Irina V. Semenova[2], Oleg S. Vasyutinskii[2]; *[1]Univ. ITMO, Russian Federation; [2]Ioffe Inst., Russian Federation; [3]Inst. of Cytology of RAS, Russian Federation.* In this paper we present an holographic analysis of HeLa cells in normal state and early apoptosis. The obtained data demonstrate statistically significant difference between optical parameters in populations of normal and apoptotic cells.

Poster Room
14:00 -- 16:00
Th3A • Poster Session II

Th3A.10

Performance evaluation of digital holographic microscopy for rapid inspection, Vira Besaga[1], Anton V. Saetchnikov[2], Nils C. Gerhardt[1], Andreas Ostendorf[2], Martin Hofmann[1]; *[1]Chair for Photonics and Terahertz Technology, Ruhr Univ. Bochum, Germany; [2]Chair of Applied Laser Technologies, Ruhr Univ. Bochum, Germany.* In this paper we discuss capabilities of the digital holography for rapid inspection. We consider the case of a transmission mode off-axis configuration and compare its performance with a reference non-optical metrological method.

Th3A.11

Label-free analysis of Oral Cytology Specimens through Digital Holographic Microscopy and Deep-Neural Networks, Prashanth Panta[2,1], Hanu Ram[2], Ashwini Galande[2], Vikas Thapa[2], Renu John[2]; *[1]MNR Dental College and Hospital, India; [2]Indian Inst. of Technology Hyderabad, India.* 'Oral cytology' is a potential strategy for early detection of oral cancers. The present work utilizes Deep Convolutional Neural Network (D-CNN) based classification model to detect normal and malignant cytological changes in Digital Holographic Microscopy (DHM) images of oral specimens

Th3A.12

Observation of Daphnia using Phase Retrieval Holography with Two High-Speed Cameras, Yohsuke Tanaka[1], Hiroki Matsushi[1], Shigeru Murata[1]; *[1]Kyoto Inst. of Technology, Japan.* We apply the proposed phase retrieval holography with two high-speed cameras to an observation of daphnia as plankton in order to suppress the twin-image problem.

Th3A.13

Noise reduction of Digital Holography by using two different wavelengths, Wanhee Han[1], No-cheol Park[1], Jinsang Lim[1]; *[1]Yonsei Univ., Korea.* By using LED dual-wavelength, we propose the quality-enhanced low-coherence digital holography. With decreased the number of phase unwrapping process, the system can be less sensitive to any kind of noises.

Th3A.14

Phase-shifting algorithm based on PCA method in Digital Holographic Microscopy under Structured Illumination, Da Yin[1], Jun Ma[2], Qingyu Ma[1], Caojin Yuan[1]; *[1]Nanjing Normal Univ., China; [2]Nanjing Univ. of Science and Technology, China.* We present a phase shift extraction algorithm in digital holographic microscopy under structured illumination based on principal component analysis (PCA) method. The experinments is obtained satisfactory results by this method and shows 78% resolution improvement.

Th3A.15

Denoising Phase Maps of Digital Holographic Microscopy by Complex Tuning, Carlos A. Buitrago[1], Raul Castañeda[1,2], Jorge Garcia-Sucerquia[1]; *[1]School of Physics, Universidad Nacional de Colombia - Sede Medellin, Colombia; [2]Metropolitan Technological Institution (ITM), Colombia.* Noisy phase maps are numerically compensated by their understanding as a complex vector superposition of the object and the noise. Denoising by estimating the noise vector achieves PSNR increase from 2 dB to 22 dB.

Th3A.16

A Quantitative Research on Human Mesenchymal Stem Cell Morphological Changes by Trypsin-EDTA via Digital Holographic Microscopy, Litong Chen[1], Feng Pan[1], Leiping Che[1], Runyu Cao[1], Xiaosu Yi[1], Qiang Zeng[2], Zhihui Tang[2], Wen Xiao[1]; *[1]Beihang Univ., China; [2]Peking Univ. School and Hospital of Stomatology, China.* Morphological changes of a single human mesenchymal stem cell by Trypsin-EDTA were measured via digital holographic microscopy. Cell contact area decreased, the maximum height increased and volume fluctuated as cell changed from flat to stereoscopic.

Th3A.17

Full-parallax holographic stereogram printer for computer-generated volume hologram, Anar Khuderchuluun[1], Erkhembaatar Dashdavaa[1], Young-Tae Lim[1], Jong-Rae Jeong[2], Nam Kim[1]; *[1]Chungbuk National Univ., Korea; [2]Suwon Science College, Korea.* An implementation of full-parallax holographic stereogram printer is presented. The sequence of the two-dimensional perspectives of the three-dimensional object is formed hogel images and produced the entire stereogram. Numerical simulation and optical reconstructions are implemented.

Th3A.18

Optical encryption of images in spatially incoherent light using DMD modulator, Dmitriy Y. Molodtsov[1], Pavel A. Cheremkhin[1], Vitaly V. Krasnov[1], Vladislav G. Rodin[1]; *[1]MEPhI, Russian Federation.* Scheme of real time optical encryption using DMD modulator is described. Experimental results of optical encryption of images in spatially incoherent light are demonstrated.

Th3A.19

Security analysis of the first phase mask in double random phase encryption, Lingfei Zhang[1], Thomas J. Naughton[1]; *[1]Maynooth Univ., Ireland.* We study the security of double random phase encoding when partial knowledge of the first mask is available. We propose a greedy algorithm that can be parallelized efficiently and converges with low errors.

Th3A.20

Introducing the counter mode of operation into optical image encryption, Lingfei Zhang[1], Thomas J. Naughton[1]; [1]*Maynooth Univ., Ireland.* The conventional counter mode of operation has been redesigned for the optical encryption domain. It shows distinct advantages over the modes previously introduced into double random phase encoding.

Th3A.21

300-GHz holography with heterodyne detection, Hui Yuan[2], Min Wan[1], Alvydas Lisauskas[3], John Sheridan[1], Hartmut Roskos[2]; [1]*Univ. College Dublin, Ireland;* [2]*Johann Wolfgang Goethe-Universität, Germany;* [3]*Vilnius Univ., Lithuania.* A novel continuous-wave terahertz holography imaging system based on heterodyne detection is presented. It employs a field-effect transistor as a fast coherent detector for digital data recording.

Th3A.22

Binarization of digital holograms by thresholding and error diffusion techniques, Pavel A. Cheremkhin[1], Ekaterina A. Kurbatova[1]; [1]*MEPhI, Russian Federation.* Binarization of holograms is used for the tasks of data compression, digital micromirror device (DMD) application, and etc. 50 non-iterative local, global thresholding and error diffusion binarization methods were analyzed and applied to optically recorded holograms.

Th3A.23

Digital Holographic Tomography for 3D imaging of Ferroelectric Single-Crystal Domain Walls, Marek Mach[2,1], Frantisek Kavan[1], Pavel Psota[1], Pavel Mokrý[2], Vít Lédl[1]; [1]*Toptec, Czechia;* [2]*Technical Univ. of Liberec, Czechia.* This paper presents digital holographic method for vizualization of 3D refractive index distribution within ferroelectric crystal. The metod is based on digital holographic microscopy with tomographic approach where the sample – Lithium Niobate – is placed on rotary stage.

Th3A.24

Holographic Angular Amplification for LIDAR Scanner, Pierre-Alexandre Blanche[1], Colton Bigler[1], Joshua P. McDonald[1], Zachary Rovig[1]; [1]*Univ. of Arizona, USA.* Holographic multiplexing in thick media offers the possibility to amplify the angular scanning of non-mechanical MEMS LIDAR to cover up to 4pi steradian.

Th3A.25

Asymmetric Multiple-image Encryption using Multistage Gyrator Transform, Jiabin Dong[1], Aimin Yan[1], Zhijuan Hu[1]; [1]*Shanghai Normal Univ., China.* We propose a novel asymmetric multiple-image encryption method using multi-stage gyrator transform (GT). Numerical simulation results demonstrate the validity of the proposed method. Private keys greatly increase the security of encryption system.

Th3A.26

Robust Method for Quantitative Phase Image Synthesis out of Coherence-gated Multiply Scattered Light, Miroslav Duris[1], Radim Chmelik[1,2]; [1]*Central European Inst. of Technology, Czechia;* [2]*Inst. of Physical Engineering, Faculty of Mechanical Engineering, Brno Univ. of Technology, Czechia.* This work deals with the robustness improvement of quantitative phase image synthesis procedures for imaging through strongly scattering layers. Phase distortion compensation and weighing algorithms are developed and tested on simulated and experimental data.

Th3A.27

A technique of asymmetrical profiles in surface-relief holograms recording, Alexander Smyk[1], Alexander Shurygin[1], Sergey B. Odinokov[2], Maria V. Shishova[2]; [1]*James River Branch llc., Russian Federation;* [2]*BMSTU, Russian Federation.* Surface-relief holograms with asymmetrical profile are considered and proper devices described. Asymmetry leads to the brightness increase and higher security. Photos of the results are presented.

Th3A.28

Magnification distortion in Self-Interference Digital Holography (SIDH), PhilJun Jeon[1], Hee Jung Lee[1], JongWu Kim[1], Dugyoung Kim[1]; [1]*Physics, Yonsei Univ., Korea.* Self-interference holography is the general method to acquire incoherent holography, such as Fresnel Incoherent Correlation Holography (FINCH) and Self-Interference Digital Holography (SIDH). In this paper, we confirm the magnification distortion, which is reported in FINCH, in SIDH.

Th3A.29
Digital hyperspectral holography and Denisyuk holograms. Principles and analogy., Sergey G. Kalenkov[2], Georgy S. Kalenkov[1], Alexander E. Shtanko[3]; [1]*IDG RAS, Russian Federation;* [2]*Moscow Polytechnic Univ., Russian Federation;* [3]*Moscow State Univ. of Technology "Stankin", Russian Federation.* We show that an interferogram registered at the output of the interferometer as the function of the mirror displacement has the same mathematical form as a darkening function of photographic emulsions in analog Denisyuk holograms (holograms in colliding beams).

Th3A.30
Digital holographic subaperture stitching interferometry based on machine learning, Bin Dong[1], Wen Xiao[1], Feng Pan[1], Xiaosu Yi[1]; [1]*Beihang Univ., China.* A novel method of spherical subaperture stitching based on digital holography and machine learning is proposed. The parameters of training model are discussed and experiments are carried out to verify the validity of the method.

Th3A.31
Fourier Spectral Analysis to Reduce the Gamma Effect in Fringe Projection Profilometry, Andrés L. González[1]; [1]*Universidad Industrial de Santander, Colombia.* In this work is proposed find a strategy based in the Fourier spectral analysis to reduce the ripples due to gamma effect, which generate errors in the three-dimensional reconstruction when FPP is used.

Th3A.32
Special structuring of diffraction gratings for optical position encoder, Alexander Y. Zherdev[1], Mikhail S. Kovalev[1], Maria V. Shishova[1], Sergey B. Odinokov[1], Dmitrii S. Lushnikov[1], Vladimir V. Markin[1]; [1]*Bauman Moscow State Technical Univ., Russian Federation.* An optical position encoder uses two diffraction gratings in a measurement scale and a measuring head for generating cosine measurement signals. This report is about special subperiod structuring of these gratings for generating of two signals with quadrature phase shift for better resolution of an optical position encoder.

Th3A.33
Transmission of Structured Light Through a Multimode Fiber Using Digital Optical Phase Conjugation, Lars Buettner[1], Martin Thümmler[1], Nektarios Koukourakis[1], Jürgen Czarske[1]; [1]*Technische Universität Dresden, Germany.* The generation of a localized fringe system through a multimode fiber at a certain distance to the distal fiber end without additional relay optics is reported. Perspectives for application in measurement are given.

Th3A.34
Frequency Sweeping Digital Holography in Fourier Arrangement for Topography Measurement of Complex Surfaces, Frantisek Kavan[2,1], Pavel Psota[1]; [1]*TOPTEC, IPP, ASCR, Czechia;* [2]*Faculty of Mechatronics Informatics and Interdisciplinary Studies, Technical Univ. of Liberec, Czechia.* This paper introduces Frequency Sweeping Fourier Digital Holography for absolute measurement of complex surfaces topography. Optical fiber components in combination with Fourier lensless arrangement allow to avoid dispersion and make the arrangement compact.

Th3A.35
Dual wavelength digital holographic interferometry based on VCSEL laser sources , Igor Alexeenko[1,2], Daniel Claus[1], Martin Grabherr[3], Raimund Hibst[1]; [1]*Institut für Lasertechnologien in der Medizin und Meßtechnik, Germany;* [2]*Immanuel Kant Baltic Federal Univ., Russian Federation;* [3]*Priolas GmbH, Germany.* In the presented paper we propose the dual wavelength digital holographic interefrometry method based on compact VCSEL laser diode. The advantage of VCSEL is the possibility to adjust the output wavelength in the range of 2 nm by changing current or temperature. This property allows to realize the dual wavelength method for shape measurement.

Th3A.36
Geometric-Phase Microscopy for Quantitative Phase Imaging of Plasmonic Metasurfaces, Petr Bouchal[1,4], Petr Dvorak[1,4], Jiri Babocky[1,4], Zdenek Bouchal[2], Filip Ligmajer[1,4], Martin Hrton[1,4], Vlastimil Krapek[1,4], Alexander Faßbender[3], Stefan Linden[3], Radim Chmelik[1,4], Tomas Sikola[1,4]; [1]*Central European Inst. of Technology, Brno Univ. of Technology, Czechia;* [2]*Dept. of Optics, Palacky Univ., Czechia;* [3]*Physikalisches Institut, Universität Bonn, Germany;* [4]*Inst. of Physical Engineering, Brno Univ. of Technology, Faculty of Mechanical Engineering, Czechia.* We demonstrate a new tool for quantification of phase of plasmonic metasurfaces. The measurement is based on incoherent holography enhanced by the geometric-phase control of light and provides instantaneous operation in a stable common-path setup.

Th3A.37
Numerical evaluation of transport-of-intensity phase imaging with oblique illumination for refractive index tomography, Koshi Komuro[1], Yusuke Saita[2], Yosuke Tamada[3], Takanori Nomura[2]; [1]*Graduate School of Systems Engineering, Wakayama Univ., Japan;* [2]*Faculty of Systems Engineering, Wakayama Univ., Japan;* [3]*Division of Evolutionary Biology, National Inst. for Basic Biology, Japan.* A scanless phase retrieval method based on the transport of intensity equation is proposed for refractive index tomography. A phase distribution is measured from defocused intensity distributions obtained with oblique illumination of different tilt angles.

Th3A.38
Digital Filtering Approaches for Noise Reduction in Quantitative Digital Holographic Phase Contrast Imaging of Living Cells, Lena Tacke[2], Klaus Brinker[2], Björn Kemper[1]; [1]*Univ. of Muenster, Germany;* [2]*Hamm-Lippstadt Univ. of Applied Sciences, Germany.* We explored digital filtering strategies for noise reduction in quantitative phase imaging of living cells with digital holographic microscopy and demonstrate that non-local means denoising represents a promising approach for reduction of coherence induced image disturbances.

Th3A.39
Classification of Cells in Time-Lapse Quantitative Phase Image by Supervised Machine Learning, Lenka Strbkova[1], Pavel Vesely[1], Radim Chmelik[2]; [1]*Central European Inst. of Technology, Czechia;* [2]*Inst. of Physical Engineering, Brno Univ. of Technology, Czechia.* This work focuses on the classification of cells in time-lapse quantitative phase images by supervised machine learning. We compare the performance with the classification based on single-time-point quantitative phase images.

Th3A.40
Terahertz Spectrum Detection Based on Interferometry, Min Wan[1], Hui Yuan[2], Dovile Cibiraite[2], John Healy[1], Hartmut Roskos[2], John Sheridan[1]; [1]*Univ. College Dublin, Ireland;* [2]*Johann Wolfgang Goethe-Universität, Germany.* A high-resolution, high-precision interferometer system for measuring terahertz spectrum is proposed and experimentally demonstrated using a 300 GHz source and an array THz camera.

Th3A.41
Probe position correction for continuous-wave terahertz ptychography, Chao Tang[1], Lu Rong[1], Dayong Wang[1], Yunxin Wang[1], Xiaoyu Shi[1]; [1]*Beijing Univ. of Technology, China.* We propose a probe position correction method based on cross-correlation for continuous-wave terahertz ptychography, by which the scanning position errors could be minimized in the order of 0.01 pixels.

16:00—16:30 • Coffee Break and Exhibition, *Rooms A3 and A5*

Amphitheater	Room E300

Thursday, 23 May

16:30 -- 18:00
Th4A • Bio and Medical Applications II
Presider: Pascal Picart; LAUM CNRS Le Mans Université, France

Th4A.1 • 16:30
Digital holographic, dual beam frequency comb FTIR nanoscopy for label free pathogen identification, Walter R. Buchwald[1], Jon Mooney[2]; *[1]Univ. of Massachusetts Boston, USA; [2]Solid State Scientific Corporation, USA.* A 2-D digital holographic system with field of view spectral content obtained via a dual-beam, IR frequency comb is presented. Deep learning algorithms interpret the spatial/spectral data for the rapid, label free, un-assisted identification of pathogens.

Th4A.2 • 16:45
Machine learning and phase signatures in cell line classification , Van Lam[1], Thanh Nguyen[1], Thuc Phan[1], Byung-Min Chung[1], George Nehmetallah[1], Christopher Raub[1]; *[1]Catholic Univ. of America, USA.* Optical phase signatures obtained from a telecentric DHM system input to machine learning algorithms classify cell lines of mesenchymal and epithelial morphologies with high accuracy, leading to sensitive and reproducible phenotypic profiling of cell lines.

Th4A.3 • 17:00
Classification of human spermatozoa using quantitative phase imaging and machine learning, Ankit Butola[1,2], Daria Popova[2], Azeem Ahmad[2], Vishesh Dubey[1], Ganesh Acharya[3], Purusotam Basnet[4], P Senthilkumaran[1], Balpreet Singh Ahluwalia[2], Dalip Singh Mehta[1]; *[1]IIT Delhi, India; [2]Physics and Technology, UiT, Norway; [3]Karolinska Univ. Hospital, Sweden; [4]Dept. of Clinical Medicine, UiT, Norway.* Quantitative phase microscopy is used to determine phase map of human sperm cells and found that the maximum phase value decreases under oxidative stressed conditions. Machine learning is used to classify various parameters.

Th4A.4 • 17:15
Using Digital Holography to Characterize Thin Layers and Harmful Algal Blooms in Aquatic Environments , Aditya R. Nayak[1], Malcolm N. McFarland[1], Michael S. Twardowski[1], James M. Sullivan[1], Timothy S. Moore[2], Fraser R. Dalgleish[1]; *[1]Florida Atlantic Univ., USA; [2]Univ. of New Hampshire, USA.* Digital holography was used to characterize particle/plankton distributions, biophysical interactions and ‘patchiness’ phenomena including ‘thin layers’ and harmful algal blooms in diverse aquatic environments. An autonomous underwater holographic system with long-term deployment capabilities was developed.

16:30 -- 18:00
Th4B • Emerging and Advanced Techniques (Gated and THz) IV
Presider: Juan Liu; Beijing Inst. of Technology, China

Th4B.1 • 16:30
Femtosecond multiframe digital holography with parallel coherence shutters, Guanghua Chen[1], Jianfeng Li[1], Jun Li[1]; *[1]Inst. of Fluid Physics, CAEP, China.* Ultrafast multiframe digital holography with frame rate of 8 trillion frames per second, exposure time of about 40 fs and total frames of 8 has been developed by means of parallel coherence shutters (PCS). Ultrafast physical process experiments have been conducted to show the ability of the system.

Th4B.2 • 16:45
Coherent Terahertz Imaging of a Textile and a Hidden Object, Lorenzo Valzania[1], Peter Zolliker[1], Erwin Hack[1]; *[1]Empa, Switzerland.* We present a technique reconstructing the transmission function of a textile and a hidden object. It is demonstrated at terahertz wavelengths, and achieves a lateral resolution of the reconstructed hidden object of about 1.5λ.

Th4B.3 • 17:00
Imaging Quality and Resolution Enhancement by Iterative Phase Retrieval in THz Off-axis Digital Holography, Yuchen ZHAO[1], Jean-François Vandenrijt[1], Murielle Kirkove[1], Marc P. Georges[1]; *[1]Centre Spatial de Liège, Université de Liège, Belgium.* In 2.52 THz off-axis digital holography, reference wavefront suffers excessive diffraction or obstruction with a large off-axis angle. We propose a phase-retrieval-assisted solution to correct errors caused by reference wave to improve imaging quality.

Th4B.4 • 17:15
Hyperspectral terahertz pulse time-domain holography: noise filtering, Maksim S. Kulya[1,2], Nikolay V. Petrov[1], Karen Egiazarian[2], Vladimir Katkovnik[2]; *[1]ITMO Univ., Russian Federation; [2]Signal processing, Tampere Univ., Finland.* Using the block-matching denoising algorithms adapted to spatio-temporal and spatio-spectral volumetric data, we optimized the parameters to improve the phase/amplitude image reconstruction in hyperspectral terahertz pulse time-domain holography. Experimental data demonstrates essential improvement in the quality of the resulting phase imaging.

Amphitheater	Room E300

Th4A • Bio and Medical Applications II—Continued

Th4A.5 • 17:30

Polarized Digital Holography as Valuable Analytical Tool in Biological and Medical Research, Giuseppe Coppola[1], Anna Chiara De Luca[2], Gianluigi Zito[2], Maria Antonietta Ferrara[1]; *[1]Inst. for Microelectronic and Microsystems, National Research Council, Italy; [2]Inst. of Protein Biochemistry, National Research Council, Italy.* We propose a new, simple digital holography-based polarization microscope for birefringence imaging of biological cells. Although further experimentation is required, the proposed approach could represent a potential label-free diagnostic tool for use in biological and medical research and diagnosis.

Th4A.6 • 17:45

High-Definition Quantitative Phase Imaging System applied to live cell samples, Anaïs Saintoyant[1], Sherazade Aknoun[1], Antoine Federici[1], Benoit Wattellier[1]; *[1]Phasics S.A., France.* We present a new process overcoming the definition limitation of conventional QuadriWave Lateral Shearing Interferometry (QWLSI) systems by combining a set of interferograms. 5.5MPixels quantitative phase images with a 6.5µm-pixel resolution and a phase sensitivity of 0.5nm will be shown.

Th4B • Emerging and Advanced Techniques (Gated and THz) IV—Continued

Th4B.5 • 17:30

Continuous-wave Terahertz Computed Tomography for Analysing Biological Bone, Bin Li[1], Dayong Wang[1], Lu Rong[1], Jie Zhao[1], Yunxin Wang[1], Xiaoyu Shi[1]; *[1]Beijing Univ. of Technology, China.* We reported an application of terahertz computed tomography for bone density analysis. Two-dimensional cross-sectional images of the chicken ulna were obtained through the continuous-wave terahertz imaging system.

Th4B.6 • 17:45

The terahertz pulse time-domain holography method for phase imaging of breast tissue sample, Olga A. Smolyanskaya[1], Nikolay Balbekin[1], Quentin Cassar[2], Gaetan MacGrogan[3], Jean-Paul Guillet[2], Patrick Mounaix[2], Olga Kravtsenyuk[1], Maksim S. Kulya[1], Nikolay V. Petrov[1]; *[1]ITMO Univ., Russian Federation; [2]Bordeaux Univ., France; [3]Bergonie Inst., France.* Using the THz-PTDH method we have created the theoretical model and experimental set up for phase imaging of breast tissue sample and designed the image reconstruction

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Digital Holography and 3-D Imaging 2019 Feature Issue

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