

PROGRESS IN BIOMEDICAL OPTICS AND IMAGING

Vol. 12, No. 22

# ***Three-Dimensional and Multidimensional Microscopy: Image Acquisition and Processing XVIII***

**Jose-Angel Conchello**  
**Carol J. Cogswell**  
**Tony Wilson**  
**Thomas G. Brown**  
*Editors*

**24–27 January 2011**  
**San Francisco, California, United States**

*Sponsored and Published by*  
SPIE

**Volume 7904**

Proceedings of SPIE, 1605-7422, v. 7904

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

The papers included in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. The papers published in these proceedings reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *Three-Dimensional and Multidimensional Microscopy: Image Acquisition and Processing XVIII*, edited by Jose-Angel Conchello, Carol J. Cogswell, Tony Wilson, Thomas G. Brown, Proceedings of SPIE Vol. 7904 (SPIE, Bellingham, WA, 2011) Article CID Number.

ISSN 1605-7422

ISBN 9780819484413

Published by

**SPIE**

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445

SPIE.org

Copyright © 2011, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at [copyright.com](http://copyright.com). Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 1605-7422/11/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

**SPIE**   
Digital Library

[SPIDigitalLibrary.org](http://SPIDigitalLibrary.org)

---

**Paper Numbering:** Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc.

The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

# Contents

ix *Conference Committee*

---

## SESSION 1 NEW DEVELOPMENTS IN HOLOGRAPHIC MICROSCOPY I

---

- 7904 02 **Lens-less holographic microscope with high resolving power and no-distortion** [7904-01]  
K. Sato, O. Murata, Univ. of Hyogo (Japan)
- 7904 03 **In-line digital holographic microscopy based on intensity measurements at two planes**  
[7904-02]  
B. Das, C. S. Yelleswarapu, D. V. G. L. N. Rao, Univ. of Massachusetts Boston (United States)
- 7904 04 **Simplified setup for imaging with digital holographic microscopy and enhanced  
quantitative phase contrast by osmotic stimulation of living cells** [7904-03]  
B. Kemper, S. Przibilla, C. E. Rommel, A. Vollmer, S. Ketelhut, J. Schnekenburger, G. von Bally,  
Univ. Muenster (Germany)
- 7904 05 **Whole cell imaging based on wide-field interferometric phase microscopy and its  
application to cardiomyocytes** [7904-04]  
N. T. Shaked, L. L. Satterwhite, N. Bursac, A. Wax, Duke Univ. (United States)

---

## SESSION 2 NEW DEVELOPMENTS IN HOLOGRAPHIC MICROSCOPY II

---

- 7904 08 **Spatial-spectral 3D imaging system using broadband sources** [7904-07]  
J. M. Castro, The Univ. of Arizona (United States); J. K. Barton, College of Optical Sciences,  
The Univ. of Arizona (United States) and The Univ. of Arizona (United States); E. E. de Leon,  
J. Brownlee, College of Optical Sciences, The Univ. of Arizona (United States); R. K. Kostuk,  
The Univ. of Arizona (United States) and College of Optical Sciences, The Univ. of Arizona  
(United States)
- 7904 09 **Development of a digital holographic microscopy system integrated with atomic force  
microscope** [7904-08]  
N. Cardenas, N. Ingle, The Univ. of Texas at Arlington (United States); L. Yu, Nanoscope  
Technologies LLC (United States); S. Mohanty, The Univ. of Texas at Arlington (United States)
- 7904 0A **3D optical trapping calibration and optical micromanipulation using 808-nm diode-laser  
bar** [7904-09]  
M. Potcoava, Colorado School of Mines (United States) and JILA, Univ. of Colorado and  
National Institute of Standards and Technology (United States); L. Krzewina, Univ. of South  
Florida (United States); E. Hoover, Colorado School of Mines (United States); M. K. Kim, Univ.  
of South Florida (United States); J. Squier, D. W. M. Marr, Colorado School of Mines (United  
States); R. Jimenez, JILA, Univ. of Colorado and National Institute of Standards and  
Technology (United States)

---

**SESSION 3 ILLUMINATION METHODS FOR BETTER RESOLUTION**

---

- 7904 0B **Heart synchronization for SPIM microscopy of living zebra fish** [7904-10]  
J. M. Taylor, C. D. Saunter, Durham Univ. (United Kingdom); B. Chaudhry, D. J. Henderson, Newcastle Univ. (United Kingdom); G. D. Love, J. M. Girkin, Durham Univ. (United Kingdom)
- 7904 0C **High-speed focal modulation microscopy using acousto-optical modulators for visualization of thick biological specimens** [7904-11]  
S. P. Chong, G. Gao, C. J. R. Sheppard, N. Chen, National Univ. of Singapore (Singapore)
- 7904 0D **Simulating structured-illumination microscopy in the presence of spherical aberrations** [7904-12]  
C. Preza, The Univ. of Memphis (United States)
- 7904 0E **Spatial frequency modulation imaging of absorption and fluorescent objects using a single element detector** [7904-13]  
G. L. Fufia, P. Schlup, D. G. Winters, R. A. Bartels, Colorado State Univ. (United States)

---

**SESSION 4 TOMOGRAPHIC MICROSCOPY**

---

- 7904 0G **Positioning systems for high-resolution tissue imaging** [7904-15]  
T. M. Haylock, A. T. Cenko, L. M. Chifman, P. B. Christensen, F. Kazemzadeh, Univ. of Waterloo (Canada); A. R. Hajian, Univ. of Waterloo (Canada) and Tornado Medical Systems (Canada); J. Hendrikse, Tornado Medical Systems (Canada); J. T. Meade, Univ. of Waterloo (Canada)
- 7904 0H **Computational model of optical scattering by elastin in lung** [7904-16]  
T. B. Swedish, J. P. Robinson, M. R. Silva, A. Gouldstone, D. Kaeli, C. A. DiMarzio, Northeastern Univ. (United States)
- 7904 0J **Real-time dual-mode standard/complex Fourier-domain OCT system using graphics processing unit accelerated 4D signal processing and visualization** [7904-18]  
K. Zhang, J. U. Kang, The Johns Hopkins Univ. (United States)
- 7904 0L **High resolution optical projection tomographic microscopy for 3D tissue imaging** [7904-20]  
Q. Miao, Univ. of Washington (United States); J. Hayenga, M. G. Meyer, T. Neumann, F. Patten, A. C. Nelson, VisionGate, Inc. (United States); E. J. Seibel, Univ. of Washington (United States)
- 7904 0M **3D fluorescence microscopy imaging accounting for depth-varying point-spread functions predicted by a strata interpolation method and a principal component analysis method** [7904-94]  
S. Yuan, C. Preza, The Univ. of Memphis (United States)

---

**SESSION 5 A CLEAR VIEW AT TRANSPARENT SPECIMENS**

---

- 7904 0O **Dynamic phase imaging utilizing a 4-dimensional microscope system** [7904-22]  
K. Creath, 4D Technology Corp. (United States) and Optineering (United States) and College of Optical Sciences, The Univ. of Arizona (United States)

7904 0P **Quadriwave lateral shearing interferometry for quantitative phase microscopy: coupling phase imaging and fluorescence imaging** [7904-23]  
P. Bon, Institut Fresnel, CNRS, Aix-Marseille Univ. (France) and PHASICS S.A. (France); J. Savatier, Institut Fresnel, CNRS, Aix-Marseille Univ. (France); B. Wattellier, PHASICS S.A. (France); D. Marguet, Ctr. Immunologique de Marseille Luminy, CNRS, Univ. de Provence (France); S. Monneret, Institut Fresnel, CNRS Aix-Marseille Univ. (France)

7904 0R **Refractive index reconstruction of biological samples from multimodal phase microscopy** [7904-25]  
H. Sierra, Rutgers Univ. (United States); C. A. DiMarzio, D. H. Brooks, Northeastern Univ. (United States)

---

#### SESSION 6 VIEWING TRANSPARENT SPECIMENS AND NEW VISUALIZATION METHODS

---

7904 0S **Beyond the lateral resolution limit by phase imaging** [7904-26]  
Y. Cotte, M. F. Toy, C. Depeursinge, Ecole Polytechnique Fédérale de Lausanne (Switzerland)

7904 0T **Wide-field reflection phase microscope** [7904-27]  
Z. Yaqoob, Massachusetts Institute of Technology (United States); T. Yamauchi, Hamamatsu Photonics K.K. (Japan); D. Fu, Massachusetts Institute of Technology (United States); W. Choi, Korea Univ. (Korea, Republic of); R. R. Dasari, M. S. Feld, Massachusetts Institute of Technology (United States)

7904 0W **Autostereoscopic visualization of 3D time-varying complex objects in volumetric image sequences** [7904-30]  
A. Benassarou, G. Valette, CReSTIC-SIC, Univ. de Reims (France); D. Debons, 3DTV Solutions (France); Y. Remion, L. Lucas, CReSTIC-SIC, Univ. de Reims (France) and 3DTV Solutions (France)

---

#### SESSION 7 EXCITING DEVELOPMENTS IN FLUORESCENCE MICROSCOPY

---

7904 0X **Optically sectioned imaging by oblique plane microscopy** [7904-31]  
S. Kumar, Z. Lin, A. R. Lyon, K. T. MacLeod, C. Dunsby, Imperial College London (United Kingdom)

---

#### SESSION 8 SHAPING WAVES FOR BETTER IMAGING

---

7904 12 **Myopic deconvolution of adaptive optics retina images** [7904-36]  
L. Blanco, ONERA (France) and Observatoire de Paris à Meudon (France); L. M. Mugnier, ONERA (France); M. Glanc, Observatoire de Paris à Meudon (France)

7904 13 **Three-dimensional data acquisition with aberrations correction for video-rate microscopy** [7904-37]  
M. Samim, R. Cisek, D. Sandkuijl, I. Tretyakov, S. Siu, S. Musikhin, V. Barzda, Univ. of Toronto (Canada)

7904 14 **Adaptive optics for wide-field microscopy** [7904-38]  
C. Bourgenot, C. D. Saunter, J. M. Girkin, G. D. Love, Durham Univ. (United Kingdom)

- 7904 15 **Comparative assessment of three algorithms to control a deformable mirror for an adaptive optics system with no wavefront sensor** [7904-39]  
M. R. Nasiri-Avanaki, Univ. of Kent (United Kingdom); H. Sarmadi, Univ. of Tehran (Iran, Islamic Republic of); A. Meadway, A. G. Podoleanu, S. A. Hojjatoleslami, Univ. of Kent (United Kingdom)
- 7904 16 **Pupil engineering for a confocal reflectance line-scanning microscope** [7904-40]  
Y. G. Patel, Northeastern Univ. (United States); M. Rajadhyaksha, Memorial Sloan-Kettering Cancer Ctr. (United States); C. A. DiMarzio, Northeastern Univ. (United States)
- 7904 17 **Sagnac-interferometry-based digital optical phase conjugation (DOPC) system for turbidity suppression** [7904-41]  
T. R. Hillman, Massachusetts Institute of Technology (United States); Y. Park, Massachusetts Institute of Technology (United States) and KAIST (Korea, Republic of); Z. Yaqoob, Massachusetts Institute of Technology (United States); W. Choi, Massachusetts Institute of Technology (United States) and Korea Univ. (Korea, Republic of); D. Fu, Massachusetts Institute of Technology (United States); T. Yamauchi, Massachusetts Institute of Technology (United States) and Hamamatsu Photonics K. K. (Japan); R. R. Dasari, M. S. Feld, Massachusetts Institute of Technology (United States)

---

**SESSION 9 COMPUTATIONAL MICROSCOPY**

---

- 7904 19 **Fourier analysis of mitochondrial distribution in oocytes** [7904-43]  
J. L. Hollmann, D. H. Brooks, Northeastern Univ. (United States); J. A. Newmark, Northeastern Univ. (United States) and CompuCyte (United States); C. M. Warner, C. A. DiMarzio, Northeastern Univ. (United States)
- 7904 1A **Semi-automated algorithm for localization of dermal/epidermal junction in reflectance confocal microscopy images of human skin** [7904-44]  
S. Kurugol, J. G. Dy, Northeastern Univ. (United States); M. Rajadhyaksha, Memorial Sloan-Kettering Cancer Ctr. (United States); K. W. Gossage, J. Weissmann, Unilever HPC (United States); D. H. Brooks, Northeastern Univ. (United States)
- 7904 1C **Sparse OCT: optimizing compressed sensing in spectral domain optical coherence tomography** [7904-46]  
X. Liu, J. U. Kang, The Johns Hopkins Univ. (United States)
- 7904 1D **Effect of double-helix point-spread functions on 3D imaging in the presence of spherical aberrations** [7904-47]  
S. Ghosh, The Univ. of Memphis (United States); G. Grover, R. Piestun, Univ. of Colorado at Boulder (United States); C. Preza, The Univ. of Memphis (United States)
- 7904 1E **Reducing noise in extended depth of field microscope images by optical manipulation of the point spread function** [7904-48]  
R. N. Zahreddine, R. H. Cormack, C. J. Cogswell, Univ. of Colorado at Boulder (United States)

---

**SESSION 10    CONFOCAL AND NONLINEAR MICROSCOPY**

---

- 7904 1F    **Time-resolved confocal microscopy of cryogenic processes in biological tissues** [7904-49]  
M. Schellenberg, Fachhochschule Oldenburg/Ostfriesland/Wilhelmshaven (Germany);  
T. Bergmann, Fachhochschule Giessen-Friedberg (Germany); E. Peev, M. Kloster, J. Napier,  
W. Neu, Fachhochschule Oldenburg/Ostfriesland/Wilhelmshaven (Germany)
- 7904 1G    **In-vivo third-harmonic generation microscopy at 1550nm three-dimensional long-term  
time-lapse studies in living *C. elegans* embryos** [7904-50]  
R. Aviles-Espinosa, S. I. C. O. Santos, ICFO-Instituto de Ciencias Fotónicas (Spain);  
A. Brodschelm, W. G. Kaenders, TOPTICA Photonics AG (Germany); C. Alonso-Ortega,  
ICFO-Instituto de Ciencias Fotónicas (Spain); D. Artigas, ICFO-Instituto de Ciencias Fotónicas  
(Spain) and Univ. Politècnica de Catalunya (Spain); P. Loza-Alvarez, ICFO-Instituto de  
Ciencias Fotónicas (Spain)

---

**POSTER SESSION**

---

- 7904 1L    **Design and analysis of confocal-spectral microscopy using wavelength scanning scheme**  
[7904-55]  
D. Do, W. Chun, H. Jeong, D.-G. Gweon, KAIST (Korea, Republic of)
- 7904 1M    **Correction of defocused images in full-field optical coherence tomography using digital  
holography** [7904-56]  
G. Min, J. W. Kim, W. J. Choi, B. H. Lee, Gwangju Institute of Science and Technology (Korea,  
Republic of)
- 7904 1N    **Two dimensional scanning probe using off-axis magnetic force of single solenoid for 3D OCT  
imaging** [7904-57]  
E. J. Min, J. G. Shin, Y. Kim, B. H. Lee, Gwangju Institute of Science and Technology (Korea,  
Republic of)
- 7904 1O    **Comparison of resolution in tomographic diffractive microscopy using combinations of  
sample rotation and illumination rotation** [7904-58]  
S. Vertu, Physikalisch-Technische Bundesanstalt (Germany); E. Maeda, The Univ. of Tokyo  
(Japan); J. Flügge, Physikalisch-Technische Bundesanstalt (Germany); J.-J. Delaunay, The  
Univ. of Tokyo (Japan); O. Haeberlé, Univ. of Haute Alsace (France)
- 7904 1Q    **An automated wide-field, time-gated, optically sectioning, and fluorescence lifetime  
imaging multiwell plate reader for high-content analysis of protein-protein interactions**  
[7904-61]  
D. Alibhai, S. Kumar, D. Kelly, S. Warren, Y. Alexandrov, I. Munro, J. McGinty, C. Talbot,  
Imperial College London (United Kingdom); E. J. Murray, F. Stuhmeier, Pfizer Group Ltd.  
(United Kingdom); M. A. A. Neil, C. Dunsby, P. M. W. French, Imperial College London (United  
Kingdom)
- 7904 1R    **Spectral characterization of a volume holographic imaging system** [7904-62]  
E. E. de Leon, J. Brownlee, College of Optical Sciences, The Univ. of Arizona (United States);  
J. M. Castro, The Univ. of Arizona (United States); R. K. Kostuk, College of Optical Sciences,  
The Univ. of Arizona (United States) and The Univ. of Arizona (United States)

*Author Index*



# Conference Committee

## *Symposium Chairs*

**James G. Fujimoto**, Massachusetts Institute of Technology (United States)

**R. Rox Anderson**, Wellman Center for Photomedicine, Massachusetts General Hospital, Harvard School of Medicine (United States)

## *Program Track Chairs*

**Ammasi Periasamy**, University of Virginia (United States)

**Daniel L. Farkas**, Cedars-Sinai Medical Center (United States)

## *Conference Chairs*

**Jose-Angel Conchello**, Harvard University (United States)

**Carol J. Cogswell**, University of Colorado at Boulder (United States)

**Tony Wilson**, University of Oxford (United Kingdom)

**Thomas G. Brown**, University of Rochester Medical Center (United States)

## *Program Committee*

**G. J. Brakenhoff**, Universiteit van Amsterdam (Netherlands)

**Charles A. DiMarzio**, Northeastern University (United States)

**Mats G. L. Gustafsson**, Howard Hughes Medical Institute (United States)

**Raimund J. Ober**, The University of Texas at Dallas (United States)

**Chrysanthe Preza**, The University of Memphis (United States)

## *Session Chairs*

1 New Developments in Holographic Microscopy I  
**Carol J. Cogswell**, University of Colorado at Boulder (United States)

2 New Developments in Holographic Microscopy II  
**Carol J. Cogswell**, University of Colorado at Boulder (United States)

3 Illumination Methods for Better Resolution  
**Carol J. Cogswell**, University of Colorado at Boulder (United States)

4 Tomographic Microscopy  
**Thomas G. Brown**, University of Rochester Medical Center (United States)

- 5 A Clear View at Transparent Specimens  
**Charles A. DiMarzio**, Northeastern University (United States)
- 6 Viewing Transparent Specimens and New Visualization Methods  
**Charles A. DiMarzio**, Northeastern University (United States)
- 7 Exciting Developments in Fluorescence Microscopy  
**Thomas G. Brown**, University of Rochester Medical Center (United States)
- 8 Shaping Waves for Better Imaging  
**Chrysanthe Preza**, The University of Memphis (United States)
- 9 Computational Microscopy  
**Thomas G. Brown**, University of Rochester Medical Ctr. (United States)
- 10 Confocal and Nonlinear Microscopy  
**Chrysanthe Preza**, The University of Memphis (United States)