

Three-Dimensional and Multidimensional Microscopy: Image Acquisition and Processing XXIII

**Thomas G. Brown
Carol J. Cogswell
Tony Wilson**
Editors

**15–17 February 2016
San Francisco, California, United States**

Sponsored and Published by
SPIE

Volume 9713

Proceedings of SPIE, 1605-7422, V. 9713

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

Three-Dimensional and Multidimensional Microscopy: Image Acquisition and Processing XXIII,
edited by Thomas G. Brown, Carol J. Cogswell, Tony Wilson, Proc. of SPIE Vol. 9713, 971301
© 2016 SPIE · CCC code: 1605-7422/16/\$18 · doi: 10.1117/12.2239756

The papers 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. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIDigitalLibrary.org.

The papers 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 these proceedings:

Author(s), "Title of Paper," in *Three-Dimensional and Multidimensional Microscopy: Image Acquisition and Processing XXIII*, edited by Thomas G. Brown, Carol J. Cogswell, Tony Wilson, Proceedings of SPIE Vol. 9713 (SPIE, Bellingham, WA, 2016) Six-digit Article CID Number.

ISSN: 1605-7422

ISSN: 2410-9045 (electronic)

ISBN: 9781628419474

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 © 2016, 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. 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 1605-7422/16/\$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

Paper Numbering: *Proceedings of SPIE* follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a six-digit CID article numbering system structured as follows:

- 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.

Contents

vii	<i>Authors</i>
ix	<i>Conference Committee</i>

SESSION 1 IMAGING AND RECONSTRUCTION BEYOND THE DIFFRACTION LIMIT

- 9713 02 **Microscopy using source and detector arrays (Invited Paper)** [9713-1]
- 9713 03 **Novel contrast mechanism for label free super-resolution imaging** [9713-2]
- 9713 04 **Point spread function engineering with multiphoton SPIFI** [9713-3]
- 9713 05 **Investigating the performance of reconstruction methods used in structured illumination microscopy as a function of the illumination pattern's modulation frequency** [9713-4]
- 9713 06 **Sectioning and super-resolution using unknown random patterns** [9713-5]

SESSION 2 INSTRUMENTAL METHODS I

- 9713 09 **Acoustic effects analysis utilizing speckle pattern with fixed-particle Monte Carlo** [9713-8]
- 9713 0A **Fluorescence microscopy with isotropic resolution using three objectives** [9713-9]

SESSION 3 HOLOGRAPHIC MICROSCOPY I

- 9713 0B **Digital aberration correction of fluorescent images with coherent holographic image reconstruction by phase transfer (CHIRPT)** [9713-10]
- 9713 0D **New approaches for the analysis of confluent cell layers with quantitative phase digital holographic microscopy** [9713-12]
- 9713 0F **Dual-detection confocal microscopy: high-speed surface profiling without depth scanning** [9713-14]

SESSION 4 INSTRUMENTAL METHODS II

- 9713 0H **Confocal fluorometer for diffusion tracking in 3D engineered tissue constructs** [9713-17]
- 9713 0J **The impact of absorption coefficient on polarimetric determination of Berry phase based depth resolved characterization of biomedical scattering samples: a polarized Monte Carlo investigation** [9713-19]

POSTER SESSION

- 9713 0M **Application of linear-scale differential analysis in phase correlation method of image stitching** [9713-57]
- 9713 0N **Improving lateral resolution of optical coherence tomography for imaging of skins** [9713-58]
- 9713 0O **Three-dimensional measurement of cAMP gradients using hyperspectral confocal microscopy** [9713-59]
- 9713 0Q **3D imaging of the cleared intact murine colon with light sheet microscopy** [9713-61]
- 9713 0R **Hologram encoding strategies for non-Bayesian noise suppression in digital holography reconstructions and optical display** [9713-62]

SESSION 5 INNOVATIONS IN OPTICAL MODES

- 9713 0U **Super-resolution optical microscopy by using dielectric microwires** [9713-21]
- 9713 0W **Lensfree on-chip high-resolution imaging using two-way lighting, and its limitations** [9713-23]

SESSION 6 IMAGE RECONSTRUCTION AND ANALYSIS I

- 9713 0Y **Three-dimensional imaging using phase retrieval with two focus planes** [9713-25]
- 9713 0Z **Compressive sensing in reflectance confocal microscopy of skin images: a preliminary comparative study** [9713-26]
- 9713 11 **Fabrication of two-color annular hybrid wave plate for three-dimensional super-resolution microscopy** [9713-28]

SESSION 7 INSTRUMENTAL METHODS III

- 9713 12 **Development of a temporal multiplexed 3D beam-scanning Lissajous trajectory microscope for rapid multimodal volumetric imaging** [9713-29]
- 9713 13 **Deformable mirror based remote focusing for fast three-dimensional microscopy** [9713-30]
- 9713 14 **Design of adaptive objective lens for ultrabroad near infrared imaging** [9713-31]
- 9713 15 **Optical transfer function characterization using a weak diffuser** [9713-32]
- 9713 16 **Confocal imaging with orthogonally polarized illumination beams** [9713-33]
- 9713 17 **A linear algorithm for quantitative measure of corneal collagen fiber orientation using second harmonic generation microscopy** [9713-66]

SESSION 8 LIGHT SHEET AND EXTENDED DEPTH OF FOCUS MICROSCOPY

9713 1C **Volumetric retinal fluorescence microscopic imaging with extended depth of field**
[9713-63]

SESSION 9 HOLOGRAPHIC MICROSCOPY II

9713 1G **Dynamic photothermal interferometric phase microscopy** [9713-41]

SESSION 10 QUANTITATIVE PHASE IMAGING

9713 1I **Dual function microscope for quantitative DIC and birefringence imaging** [9713-43]

9713 1K **A novel phase shifting structured illumination microscopy** [9713-45]

SESSION 11 INNOVATIVE METHODS IN MICROSCOPY

9713 1M **Investigating the usage of point spread functions in point source and microsphere localization** [9713-47]

9713 1N **STED-like resolution enhancement with focus extension** [9713-48]

SESSION 12 IMAGE RECONSTRUCTION AND ANALYSIS II

9713 1R **Modified K-factor image decomposition for three-dimensional super resolution microscopy**
[9713-52]

9713 1T **A computational hyperspectral imaging technique** [9713-54]

Authors

Numbers in the index correspond to the last two digits of the six-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first four digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Abolbashari, Mehrdad, 1T
Adachi, Yasuhiko, 0W
Ahmad, Azeem, 1K
Alexandrov, Sergey A., 03
Allende-Motz, Alyssa M., 04
Amiel, Aliza, 1R
Annamdevula, Naga, 0O
Antipa, Nick, 15
Arias, Fernando X., 0Z
Arranz, A., 0Q
Arzuaga, Emmanuel, 0Z
Azari, Mohammad, 1T
Baba, J. S., 0J
Bartels, Randy A., 04, 0B
Belashenkov, Nikolai R., 0M
Bezzubik, Vitalii V., 0M
Bianco, V., 0R
Blum, Omry, 1G
Bocancea, D. I., 0Q
Boccafoschi, Francesca, 03
Bokor, Nador, 11
Booth, Martin, 13
Boruah, Bosanta R., 16
Britain, Andrea L., 0O
Buttenschoen, K., 0H
Castello, Marco, 02
Chao, Jerry, 1M
Chikkanna, B., 0H
Chu, Shi-Wei, 1N
Daly, D., 0H
Darafsheh, Arash, 0U
DeLuca, Jennifer G., 04
DeLuca, Keith F., 04
Desco, M., 0Q
Diaspro, Alberto, 02
DiMarzio, Charles A., 06, 09, 17
Dinh, Janny, 12
Domingue, Scott R., 04
Dubey, Vishesh, 1K
Duocastella, Martí, 02
Ebeling, Carl G., 1R
Farahi, Faramarz, 1T
Favreau, Peter F., 0O
Ferraro, P., 0R
Field, Jeffrey J., 04, 0B
Finizio, A., 0R
Finlay, Jarod C., 0U
Fischer, Andrew, 1C
Frade, Maria, 13
Fresno, M., 0Q
Giannini, Cinzia, 03
Gómez-Gaviro, M. V., 0Q
Goycoolea, F., 0D
Gunjala, Gautam, 15
Gweon, Dae-Gab, 0F
Habibi, Nasim, 1T
Hoffman, Zachary R., 06
Hollmann, Joseph A., 09
Holt, R. Glynn, 09
Hsu, Kuo-Jen, 1N
Huelsnitz, Thomas, 0A
Hughes, C., 0H
Iketaki, Yoshinori, 11
Ilovitsh, Asaf, 0Y
Ilovitsh, Tali, 0Y, 1R
Jaedicke, Volker, 15
Jahn, Kornel, 11
John, D., 0J
Kaiser, M., 0D
Kalita, Ranjan, 16
Kato, Yoshihisa, 0W
Katz, Hila, 1R
Kemper, Björn, 0D
Ketelhut, S., 0D
Kner, Peter, 0A
Koju, V., 0J
Kumagai, Hiroshi, 11
Lan, Gongpu, 14
Leahy, Martin, 03
Leavesley, Silas J., 0O
Lee, Dong-Ryoung, 0F
Levi, Dean H., 04
Li, Chengshuai, 11
Li, Guoqiang, 14, 1C
Li, Wei, 1C
Li, Zengzhuo, 1C
Lin, Wei-Kuan, 1N
Lin, Yen-Yin, 1N
Losev, Sergei V., 0M
Lu, Hui, 0N
Mannasse-Green, Batya, 1R
Marsden, B., 0H
Mayes, Samuel, 0O
McGrath, James, 03
McLean, James, 17
Mehta, D. S., 1K
Meir, Rinat, 0Y
Meiri, Amihai, 1R

Memmo, P., 0R
Motomura, Hideto, 0W
Newman, Justin A., 12
Ober, Raimund J., 1M
Paturzo, M., 0R
Pereira, S., 0D
Pohl, L., 0D
Preza, C., 05
Rajadhyaksha, Milind, 0Z
Ram, Sripad, 1M
Reynolds, J., 0H
Rich, Thomas C., 0O
Ripoll, J., 0Q
Sánchez-Ortiga, E., 05
Sarkar, Sreya, 12
Shabani, H., 05
Shaked, Natan T., 1G
Shanker, Aamod, 15
Shen, Kai, 0N
Sheppard, Colin J. R., 02
Sierra, Heidy, 0Z
Simpson, Garth J., 12
Singh, Gyanendra, 1K
Singh, Veena, 1K
Squier, Jeff A., 04
Subhash, Hrebesh, 03
Sullivan, Shane Z., 12
Tamaki, Tokuhiko, 0W
Tan, N., 0H
Turko, Nir A., 1G
Vakili, Ali, 09
Vaquero, J. J., 0Q
Vicidomini, Giuseppe, 02
Waller, Laura, 15
Wang, Michael R., 0N
Ward, E. Sally, 1M
Weiss, Aryeh, 0Y, 1R
Wernsing, Keith A., 04
Wu, Gaoxiang, 0U
Yang, Kai-Ping, 1N
Yang, Shu, 0U
Yoo, Hongki, 0F
Young, Michael D., 04
Zalevsky, Zeev, 0Y, 1R
Zhu, Yizheng, 1I
Zilioli, A., 0H
Zufiria, B., 0Q
Zurauskas, Mantas, 13

Conference Committee

Symposium Chairs

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

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

Program Track Chairs

Ammasi Periasamy, University of Virginia (United States)

Daniel L. Farkas, University of Southern California (United States) and
Spectral Molecular Imaging, Inc. (United States)

Conference Chairs

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

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

Tony Wilson, University of Oxford (United Kingdom)

Conference Program Committee

Martin J. Booth, University of Oxford (United Kingdom)

Charles A. DiMarzio, Northeastern University (United States)

Raimund J. Ober, Texas A&M University (United States)

Chrysanthe Preza, University of Memphis (United States)

Monika Ritsch-Marte, Medizinische Universität Innsbruck (Austria)

Laura Waller, University of California, Berkeley (United States)

Session Chairs

- 1 Imaging and Reconstruction Beyond the Diffraction Limit

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

- 2 Instrumental Methods I

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

- 3 Holographic Microscopy I

Monika Ritsch-Marte, Medizinische Universität Innsbruck (Austria)

- 4 Instrumental Methods II

Charles A. DiMarzio, Northeastern University (United States)

- 5 Innovations in Optical Modes
Thomas G. Brown, University of Rochester (United States)
- 6 Image Reconstruction and Analysis I
Laura Waller, University of California, Berkeley (United States)
- 7 Instrumental Methods III
Tony Wilson, University of Oxford (United Kingdom)
- 8 Light Sheet and Extended Depth of Focus Microscopy
Chrysanthe Preza, University of Memphis (United States)
- 9 Holographic Microscopy II
Martin J. Booth, University of Oxford (United Kingdom)
- 10 Quantitative Phase Imaging
Raimund J. Ober, Texas A&M University (United States)
- 11 Innovative Methods in Microscopy
Carol J. Cogswell, University of Colorado Boulder (United States)
- 12 Image Reconstruction and Analysis II
Thomas G. Brown, University of Rochester (United States)