Multiphoton Microscopy in the Biomedical Sciences XVI

Ammasi Periasamy
Peter T. C. So
Karsten König
Editors

14–16 February 2016
San Francisco, California, United States

Sponsored by
SPIE

Cosponsored by
Becker & Hickl GmbH (Germany)
Carl Zeiss (United States)
Chroma Technology Corp. (United States)
Coherent Inc. (United States)
Semrock Inc. (United States)
ISS, Inc. (United States)
JenLab GmbH (Germany)
Leica Microsystems (United States)
Spectra-Physics®, a Newport Company (United States)

Published by
SPIE

Volume 9712

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

JENLAB YOUNG INVESTIGATOR AWARD PAPERS PRESENTATION

9712 02 Four-wave mixing based light sources for real-world biomedical applications of coherent Raman microscopy (JenLab Young Investigator Award) [9712-61]

9712 03 In vivo imaging flow cytometry based on laser scanning two-photon microscopy at kHz cross-sectional frame rate [9712-59]

KEYNOTE SESSION

9712 04 Correlated FLIM and PLIM for cell metabolism (Keynote Paper) [9712-1]

BIOMEDICAL APPLICATIONS OF COHERENT RAMAN II

9712 0G Hyperspectral stimulated Raman scattering and multiphoton imaging for digital pathology of colonic disease [9712-13]

COHERENT RAMAN TECHNICAL DEVELOPMENT

9712 0M M-CARS and EfishG study of the influence of a static electric field on a non-polar molecule [9712-19]

9712 0N Synchronized and timing-stabilized pulse generation from a gain-switched laser diode for stimulated Raman scattering microscopy [9712-20]

FLIM/FRET/FCS I

9712 0P Binding of the immunomodulatory drug Bz-423 to mitochondrial F0F1-ATP synthase in living cells by FRET acceptor photobleaching (Invited Paper) [9712-22]
Investigation of prostate cancer cells using NADH and Tryptophan as biomarker: multiphoton FLIM-FRET microscopy [9712-23]

Temporal and spatial binning of TCSPC data to improve signal-to-noise ratio and imaging speed (Invited Paper) [9712-24]

Tunable PIE and synchronized gating detections by FastFLIM for quantitative microscopy measurements of fast dynamics of single molecules (Invited Paper) [9712-25]

ns-time resolution for multispecies STED-FLIM and artifact free STED-FCS (Invited Paper) [9712-26]

Metabolic microscopy of head and neck cancer organoids [9712-29]

A phasor approach analysis of multiphoton FLIM measurements of three-dimensional cell culture models [9712-31]

Using multiphoton fluorescence lifetime imaging to characterize liver damage and fluorescein disposition in liver in vivo [9712-86]

Recent developments in widely tunable and high peak power ultrafast laser sources and their adoption in biological imaging [9712-34]

Characterization of human arterial tissue affected by atherosclerosis using multimodal nonlinear optical microscopy [9712-39]

Forward versus backward polarization-resolved SHG imaging of collagen structure in tissues [9712-40]

Multiphoton imaging with a nanosecond supercontinuum source [9712-45]

Large field of view multiphoton microscopy of human skin (Invited Paper) [9712-47]
Design of a portable wide field of view GPU-accelerated multiphoton imaging system for real-time imaging of breast surgical specimens (Invited Paper) [9712-48]

Compact fixed wavelength femtosecond oscillators as an add-on for tunable Ti:sapphire lasers extend the range of applications towards multimodal imaging and optogenetics [9712-49]

TECHNOLOGY DEVELOPMENT IV

Multi-photon microscope driven by novel green laser pump [9712-54]

Quantitative structural markers of colorectal dysplasia in a cross sectional study of ex vivo murine tissue using label-free multiphoton microscopy [9712-57]

POSTER SESSION

Observation of tendon repair in animal model using second-harmonic-generation microscopy (Student Poster Session Competition Award) [9712-70]

Nonlinear optical Stokes ellipsometric (NOSE) microscopy for imaging the nonlinear susceptibility tensors of collagen (Student Poster Session Competition Award) [9712-77]

Multiphoton fluorescence lifetime imaging of metabolic status in mesenchymal stem cell during adipogenic differentiation [9712-28]

Comparison of in vivo and ex vivo imaging of the microvasculature with 2-photon fluorescence microscopy [9712-60]

The nature of multiphoton fluorescence from red blood cells [9712-63]

In vivo two-photon imaging measuring the blood-brain barrier permeability during early postnatal brain development in rodent [9712-66]

High-resolution stimulated Raman scattering microscopy by focal-field modulation [9712-67]

Mapping of intracellular concentrations of macromolecules by two-photon excited fluorescence lifetime imaging [9712-69]

In situ quantitative evaluation of osteoblastic collagen synthesis under cyclic strain by using second-harmonic-generation microscope [9712-71]

Time-gated FLIM microscope for corneal metabolic imaging [9712-82]

FLIM data analysis of NADH and Tryptophan autofluorescence in prostate cancer cells [9712-84]
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.

Ahsen, Osman, 1G
Andersen, Peter E., 1M
Balu, Mihaela, 1F
Baraige, Fabienne, 1D
Barbieri, Beniamino, 0S
Baria, Enrico, 17
Batista, Ana, 2C
Beier, Hope T., 0R
Blanquet, Véronique, 1D
Börsch, Michael, 0P
Breymayer, J., 04
Brooker, Jeff, 1G
Brucker, S. Y., 0X
Bystrova, A. S., 1T
Cable, Alex, 1G
Cahill, Lucas, 1G
Capitaine, E., 0M
Chandra, Dhyan, 0Q
Cicchi, Riccardo, 17
Clausen, Matthais P., 0T
Connolly, James L., 1G
Coskun, Ulas, 0S
Couderc, Vincent, 0M, 1D
Crawford, Darrell, 0Y
Cui, Meng, 03
Dantus, Marcos, 1W
DeWalt, Emma L., 1S
Djurhuus, Martin, 1M
Domingues, José Paulo, 2C
Dow, Ximeng Y., 1S
Dowler, Rhys, 0T
Eggeling, Christian, 0T
Erdmann, Rainer, 0T
Evans, Conor L., 1W
Fang, Yi-Cheng, 0N
Faulkner-Jones, Beverly E., 1G
Ferreon, Allan Chris, 0S
Fujimoto, James G., 1G
Galiani, Silvia, 0T
Giacomelli, Michael G., 1G
Glick, Gary D., 0P
Gottschall, Thomas, 02
Gräber, Peter, 0P
Greening, Gage J., 1P
Gusachenko, Ivan, 18
Hakulininen, T., 1H
Hase, Eiji, 1R, 22
Honegger, Joachim, 1G
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

Ammasi Periasamy, University of Virginia (United States)
Peter T. C. So, Massachusetts Institute of Technology (United States)
Karsten König, Universität des Saarlandes (Germany)

Conference Program Committee

Wolfgang Becker, Becker & Hickl GmbH (Germany)
Alberto Diaspro, Istituto Italiano di Tecnologia (Italy)
Chen-Yuan Dong, National Taiwan University (Taiwan)
Kevin W. Eliceiri, University of Wisconsin-Madison (United States)
Scott Fraser, The University of Southern California (United States)
Paul M. W. French, Imperial College London (United Kingdom)
Hans C. Gerritsen, Universiteit Utrecht (Netherlands)
Enrico Gratton, University of California, Irvine (United States)
Min Gu, Swinburne University of Technology (Australia)
Stefan W. Hell, Max-Planck-Institut für Biophysikalische Chemie (Germany)
Paul J. Campagnola, University of Wisconsin-Madison (United States)
Satoshi Kawata, Osaka University (Japan)
Fu-Jen Kao, National Yang-Ming University (Taiwan)
Amd K. Krueger, Spectra-Physics®, a Newport Company (United States)
Joseph R. Lakowicz, University of Maryland School of Medicine (United States)
Steve M. McDonald, Coherent, Inc. (United States)
Angelika C. Rueck, Universität Ulm (Germany)
Junle Qu, Shenzhen University (China)
Steven S. Vogel, National Institutes of Health (United States)
Paul W. Wiseman, McGill University (Canada)
X. Sunney Xie, Harvard University (United States)
Chris Xu, Cornell University (United States)
Bernhard Zimmermann, Carl Zeiss Jena GmbH (Germany)
Warren R. Zipfel, Cornell University (United States)

Session Chairs

1  Keynote Session
   Karsten König, Universität des Saarlandes (Germany)

2  Biomedical Applications of Coherent Raman I
   Eric Potma, University of California, Irvine (United States)

3  Biomedical Applications of Coherent Raman II
   Ji-Xin Cheng, Purdue University (United States)

4  Coherent Raman Technical Development
   Marcus T. Cicerone, National Institute of Standards and Technology
   (United States)

5  FLIM/FRET/FCS I
   Yuansheng Sun, ISS, Inc. (United States)

6  JenLab Young Investigator Award Papers Presentation
   Karsten König, Universität des Saarlandes (Germany)

7  FLIM/FRET/FCS II
   Michael Börsch, Friedrich-Schiller-Universität Jena (Germany)

8  Technology Development I
   Peter T. C. So, Massachusetts Institute of Technology (United States)

9  Technology Development II
   Peter T. C. So, Massachusetts Institute of Technology (United States)

10 Second/Third Harmonic Generation I
    Conor Evans, Harvard School of Medicine (United States)

11 Second/Third Harmonic Generation II
    Paul J. Campagnola, University of Wisconsin-Madison (United States)

12 Technology Development III
    Francesco S. Pavone, European Laboratory for Non-linear Spectroscopy (Italy)
Technology Development IV
Karsten König, Universität des Saarlandes (Germany)

Poster Session
Holly Aaron, University of California, Berkeley (United States)
Kevin W. Eliceiri, University of Wisconsin-Madison (United States)
Alex J. Walsh, Air Force Research Laboratory (United States)
Introduction

Multiphoton microscopy has been established as the 3D imaging method of choice for studying biomedical specimens from single cells and whole animals to patients with sub-micron resolution. 25 years have passed since the realization of two-photon laser scanning microscopy. The ever-expanding scope of applications and the continuing instrumental innovations require a forum where new ideas can be exchanged and presented. Our conference at the SPIE BIOS 2016 meeting continues to address this need.

The 16th year of this conference began with three keynote lectures from leaders in the field: Angelika C. Rueck, Universität Ulm (Germany), "Correlated phosphorescence and fluorescence lifetime imaging for cell metabolism" [9712-1]; Peter T. C. So, Massachusetts Institute of Technology (United States), "Depth-resolved incoherent and coherent wide-field high-content imaging" [9712-2]; and Xiaoliang S. Xie, Harvard University (United States), "Biomedical applications of SRS microscopy" [9712-3].

For the 5th year in a row, the conference was extremely pleased to have the JenLab Young Investigator Award in addition to our regular poster awards. This award was donated by Karsten König, President and Founder of JenLab GmbH (Germany). The award selection committee included Arnd Krueger, Spectra Physics®, a Newport Company (United States), Francesco S. Pavone, Università degli Studi di Firenze (Italy), Paul J. Campagnola, University of Wisconsin-Madison (United States), and the two conference chairs, Karsten König and Peter T. C. So. The selection process included the abstract, manuscript, and poster presentation. Two finalists were selected for oral presentation after their poster presentations.

The two finalists were
1. Lingjie Kong, Purdue University (United States), for "In vivo imaging flow cytometry based on laser scanning two-photon microscopy at kHz cross-sectional frame rate" [9712-59], and
2. Thomas Gottschall, Friedrich-Schiller-Universität Jena (Germany), for "Four-wave mixing based light sources for real-world biomedical applications of coherent Raman microscopy" [9712-61].

**Thomas Gottschall**, Friedrich-Schiller-Universität Jena (Germany) was selected as the **winner of the JenLab Young Investigator Award 2016**.

For the 16th year in a row, the conference organized poster awards for students and postdoctoral fellows. The poster awards were donated by our conference sponsors, including: Becker & Hickl GmbH, Chroma Technology Corp., Coherent Inc., ISS, Inc., Spectra Physics®, a Newport Company, Leica Microsystems, Semrock Inc., and Carl Zeiss.
The 3 poster award winners were:
1. Hequn Wang, Massachusetts General Hospital (United States), for “Noninvasive visualization of pheomelanin using coherent Raman scattering microscopy” [9712-62],
2. Eiji Hase, The University of Tokushima (Japan), for “Observation of tendon repair in animal model using second-harmonic-generation microscopy” [9712-70], and
3. Ximeng You, Purdue University (United States), for “Nonlinear optical Stokes ellipsometric (NOSE) microscopy for imaging the nonlinear susceptibility tensors of collagen” [9712-77].

Some of the most valuable contributions in this volume are articles written by highly experienced practitioners of multiphoton microscopy. They have enumerated the most important considerations in designing multiphoton microscopes and imaging experiments. Further, updates on the state-of-the-art commercial multiphoton microscope systems were presented. This volume also includes proceedings describing some recent advances in major multi-photon microscope components and applications, including laser light sources, ultra-fast optics, filters, FRET, FLIM, FCS, Raman, CARS, SRS and CRS microscopy and spectroscopy, single molecule, endoscopy, energy metabolism measurements including NADH, FAD, tryptophan in cells and tissues, and various scientific and clinical applications.

On a personal note, the conference chairs are grateful for the participation of all authors and session chairs, and acknowledge the innovation-driven manufacturers and sponsors of this conference (Becker & Hickl GmbH, Chroma Technology Corp., Coherent Inc., ISS, Inc., JenLab GmbH, Spectra-Physics®, a Newport Company, Leica Microsystems, Semrock Inc., and Carl Zeiss) for their enthusiastic support in organizing this conference successfully for the last 16 years. We look forward to other exciting conferences in the future and welcome your continued participation and support.

Ammasi Periasamy
Peter T. C. So
Karsten König
JenLab Young Investigator Award

presented to

Thomas Gottschall
Friedrich-Schiller-Universität Jena (Germany)

for

Four-wave mixing based light sources for real-world biomedical applications of coherent Raman microscopy [9712-61]

Session Chair
Peter T. C. So, Massachusetts Institute of Technology (United States)

Award Presenter
Karsten König, President of JenLab GmbH (Germany)