PROCEEDINGS OF SPIE

[SPIDigitalLibrary.org/conference-proceedings-of-spie](https://spiedigitallibrary.org/conference-proceedings-of-spie)

Front Matter: Volume 7903

, "Front Matter: Volume 7903," Proc. SPIE 7903, Multiphoton Microscopy in the Biomedical Sciences XI, 790301 (18 April 2011); doi: 10.1117/12.890772

SPIE.

Event: SPIE BiOS, 2011, San Francisco, California, United States

Multiphoton Microscopy in the Biomedical Sciences XI

Ammasi Periasamy

Karsten König

Peter T. C. So

Editors

23–25 January 2011

San Francisco, California, United States

Sponsored and Published by

SPIE

Cosponsored by

Becker & Hickl GmbH (Germany)

Boston Electronics (United States)

Chroma Technology (United States)

Coherent, Inc. (United States)

JenLab GmbH (Germany)

Leica Microsystems (United States)

MultiPhoton Laser Technologies (United States)

Newport-Spectra Physics (United States)

Omega Optical (United States)

Semrock, Inc. (United States)

Volume 7903

Proceedings of SPIE, 1605-7422, v. 7903

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 *Multiphoton Microscopy in the Biomedical Sciences XI*, edited by Ammasi Periasamy, Karsten König, Peter T. C. So, Proceedings of SPIE Vol. 7903 (SPIE, Bellingham, WA, 2011) Article CID Number.

ISSN 1605-7422

ISBN 9780819484406

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. 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.

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 as 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

xiii	Conference Committee
xv	Introduction
xvii	Acknowledgments

KEYNOTE SESSION

7903 05	New developments in multimodal clinical multiphoton tomography (Keynote Paper) [7903-03] K. König, JenLab GmgH (Germany), Univ. of Saarland (Germany), and Beckman Laser Institute (United States)
---------	--

SESSION 1 SECOND HARMONIC GENERATION I

7903 08	High-speed, label-free second harmonic generation holographic microscopy of biological specimens [7903-06] P. Schlup, O. Masihzadeh, R. A. Bartels, Colorado State Univ. (United States)
7903 0B	Elastic fibers and collagen distribution in human aorta [7903-09] G. Vieira-Damiani, D. P. Ferro, R. L. Adam, A. A. de Thomaz, V. Pelegati, C. L. Cesar, K. Metze, Univ. Estadual de Campinas (Brazil)

SESSION 2 SECOND HARMONIC GENERATION II

7903 0E	Second harmonic generation imaging of collagen matrix remodeling in a stimulated 3D cellular environment: forward versus backward detection [7903-12] T. Abraham, A. Scott, J. Carthy, B. McManus, The Univ. of British Columbia (Canada)
7903 0F	3D myofibril imaging in live cardiomyocytes via hybrid SHG-TPEF microscopy [7903-13] Y. Shao, Shenzhen Univ. (China); H. Liu, Clemson Univ. (United States); T. Ye, Univ. of Alabama at Birmingham (United States); T. Borg, Medical Univ. of South Carolina (United States); J. Qu, X. Peng, H. Niu, Shenzhen Univ. (China); B. Gao, Clemson Univ. (United States)
7903 0G	Second harmonic phase microscopy of collagen fibers [7903-14] E. Shaffer, Ecole Polytechnique Fédérale de Lausanne (Switzerland); P. Marquet, Ecole Polytechnique Fédérale de Lausanne (Switzerland) and Ctr. Hospitalier Univ. Vaudois (Switzerland); C. Depeursinge, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
7903 0H	Three-dimensional polarization second harmonic generation (3D-PSHG) imaging: the effect of the tilted-off the plane SHG active structures [7903-15] S. Psilodimitrakopoulos, I. Amat-Roldan, ICFO - Instituto de Ciències Fotòniques (Spain); D. Artigas, ICFO - Instituto de Ciències Fotòniques (Spain) and Univ. Politècnica de Catalunya (Spain); P. Loza-Alvarez, ICFO - Instituto de Ciències Fotòniques (Spain)

- 7903 0I **Dependence of third-harmonic generation on melanin concentration in solution** [7903-16]
T.-Y. Su, C.-S. Liao, C.-Y. Yang, Z.-Y. Zhuo, S.-Y. Chen, S.-W. Chu, National Taiwan Univ. (Taiwan)
- 7903 0J **Quantitative analysis of diseased horse tendons using Fourier-transform-second-harmonic generation imaging** [7903-17]
M. Sivaguru, S. Durgam, R. Ambekar, D. Luedtke, G. Fried, A. Stewart, K. C. Toussaint, Jr., Univ. of Illinois at Urbana-Champaign (United States)

SESSION 3 TECHNOLOGY DEVELOPMENT AND APPLICATIONS I

- 7903 0P **Intensity normalization of two-photon microscopy images for liver fibrosis analysis** [7903-22]
V. R. Singh, Singapore-MIT Alliance for Research and Technology (Singapore);
J. C. Rajapakse, Singapore-MIT Alliance for Research and Technology (Singapore) and Nanyang Technological Univ. (Singapore); H. Yu, Singapore-MIT Alliance for Research and Technology (Singapore), A*STAR (Singapore), and National Univ. of Singapore (Singapore); P. T. C. So, Singapore-MIT Alliance for Research and Technology (Singapore) and Massachusetts Institute of Technology (United States);
- 7903 0Q **Combined two-photon microscopy and optical coherence tomography using individually optimized sources** [7903-116]
B. Jeong, B. Lee, M. S. Jang, H. Nam, H. K. Kim, S. J. Yoon, J. Doh, S.-J. Lee, B.-G. Yang, Pohang Univ. of Science and Technology (Korea, Republic of); M. H. Jang, Pohang Univ. of Science and Technology (Korea, Republic of) and Osaka Univ. (Japan); K. H. Kim, Pohang Univ. of Science and Technology (Korea, Republic of)

SESSION 4 RAMAN/CARS MICROSCOPY I

- 7903 0S **Chemical release from single-PMMA microparticles monitored by CARS microscopy** [7903-24]
A. Enejder, F. Svedberg, L. Nordstierna, M. Nydén, Chalmers Univ. of Technology (Sweden)

SESSION 5 RAMAN/CARS MICROSCOPY II

- 7903 0W **High power picosecond fiber lasers for Raman microscopies (Invited Paper)** [7903-28]
S. Lefrancois, L. Kong, D. Ouzounov, F. Wise, Cornell Univ. (United States); C. Yang, Tsinghua Univ. (China)
- 7903 0X **All fiber 1064-nm time-lens source for coherent anti-Stokes Raman scattering and stimulated Raman scattering microscopy (Invited Paper)** [7903-29]
K. Wang, Cornell Univ. (United States); C. W. Freudiger, Harvard Univ. (United States); J. H. Lee, Cornell Univ. (United States); B. G. Saar, X. S. Xie, Harvard Univ. (United States); C. Xu, Cornell Univ. (United States)
- 7903 0Y **Coherent anti-Stokes Raman scattering microspectroscopy based on a compact Er:fiber laser** [7903-30]
R. Selm, M. Winterhalder, A. Nagy, A. Zumbusch, G. Krauss, T. Hanke, A. Sell, A. Leitenstorfer, Univ. of Konstanz (Germany)

- 7903 0Z **CARS module for multimodal microscopy** [7903-31]
R. Zadayan, T. Baldacchini, J. Carter, C.-H. Kuo, D. Ocepek, Newport Corp. (United States)
- 7903 10 **Synchronized picosecond pulses at two different wavelengths from a compact fiber laser source for Raman microscopy (Invited Paper)** [7903-32]
K. Kieu, N. Peyghambarian, College of Optical Sciences, Univ. of Arizona (United States)

SESSION 6 RAMAN/CARS MICROSCOPY III

- 7903 15 **Integrated multiplex CARS and two-photon fluorescence microscopy for imaging biological systems** [7903-37]
D. Li, W. Zheng, J. Y. Qu, Hong Kong Univ. of Science and Technology (Hong Kong, China)
- 7903 18 **Using multimodal femtosecond CARS imaging to determine plaque burden in luminal atherosclerosis** [7903-40]
A. C.-T. Ko, L. B. Mostaço-Guidolin, A. Ridsdale, A. F. Pegoraro, M. S. D. Smith, A. Slepko, M. D. Hewko, E. K. Kohlenberg, B. Schattka, A. Stelow, M. G. Sowa, National Research Council Canada (Canada)
- 7903 19 **Nonlinear microscopy and infrared and Raman microspectroscopy for brain tumor analysis** [7903-41]
C. Krafft, Institute of Photonic Technology (Germany); B. Dietzek, Institute of Photonic Technology (Germany) and Friedrich-Schiller-Univ. Jena (Germany); T. Meyer, N. Bergner, Institute of Photonic Technology (Germany); B. F. M. Romeike, R. Reichart, R. Kalff, Univ. Medical Ctr. Jena (Germany); J. Popp, Institute of Photonic Technology (Germany) and Friedrich-Schiller-Univ. Jena (Germany)
- 7903 1A **Combining multiphoton and CARS microscopy for skin imaging** [7903-42]
H. G. Breunig, M. Weinigel, JenLab GmbH (Germany); J. Lademann, W. Sterry, Charité (Germany); I. Latka, B. Dietzek, J. Popp, IPHT, Univ. of Jena (Germany); K. König, JenLab GmbH (Germany) and Saarland Univ. (Germany)

SESSION 7 RAMAN/CARS MICROSCOPY IV

- 7903 1B **Coherent anti-Stokes Raman scattering imaging through turbid medium** [7903-43]
R. Arora, G. I. Petrov, V. V. Yakovlev, Univ. of Wisconsin-Milwaukee (United States)
- 7903 1C **A CARS solution with high temporal resolution** [7903-44]
S. Landwehr, V. Lurquin, W. C. Hay, V. Krishnamachari, U. Schwarz, Leica Microsystems CMS GmbH (Germany)
- 7903 1D **Development of a micromirror-scanned multimodal CARS miniaturized microscope for the in vivo study of spinal cord disorders** [7903-45]
S. Murugkar, B. Smith, M. Najj, Univ. of Ottawa (Canada); C. Brideau, P. Stys, Univ. of Calgary (Canada); H. Anis, Univ. of Ottawa (Canada)
- 7903 1E **Development of polarization-mode controllable CARS microscope** [7903-46]
M. Hashimoto, T. Takagi, T. Minamikawa, H. Niioka, T. Araki, Osaka Univ. (Japan)

- 7903 1F **High contrast coherent anti-Stokes Raman scattering microscopy using tightly focused cylindrical vector beams** [7903-47]
J. Lin, F. Lu, W. Zheng, Z. Huang, National Univ. of Singapore (Singapore)
- 7903 1G **Multiparameter label-free flow cytometry using multiplex coherent anti-Stokes Raman scattering (MCARS) with biological applications** [7903-48]
C. H. Camp, Jr., S. Yegnanarayanan, A. A. Eftekhari, A. Adibi, Georgia Institute of Technology (United States)
- 7903 1I **Differential CARS microscopy with linearly chirped femtosecond laser pulses** [7903-50]
W. Langbein, I. Rocha-Mendoza, F. Masia, C. Di Napoli, I. Pope, P. Watson, P. Borri, Cardiff Univ. (United Kingdom)

SESSION 8 TECHNOLOGY DEVELOPMENT AND APPLICATIONS II

- 7903 1M **Sub-100nm material processing with sub-15 femtosecond picojoule near infrared laser pulses (Invited Paper)** [7903-54]
K. König, Saarland Univ. (Germany) and Univ. of California, Irvine (United States);
A. Uchugonova, M. Straub, H. Zhang, M. Afshar, D. Feili, H. Seidel, Saarland Univ. (Germany)
- 7903 1N **Nanosurgery with near-infrared 12-femtosecond and picosecond laser pulses (Invited Paper)** [7903-55]
A. Uchugonova, Univ. des Saarlandes (Germany) and Univ. of California, San Diego (United States); H. Zhang, Univ. des Saarlandes (Germany); C. Lemke, Univ. of Jena (Germany); K. König, Univ. des Saarlandes (Germany) and Beckman Laser Institute (United States)
- 7903 1O **Wide-field two-photon microscopy with temporal focusing and HiLo background rejection** [7903-56]
E. Y. S. Yew, Singapore-MIT Alliance for Research and Technology (Singapore); H. Choi, D. Kim, Massachusetts Institute of Technology (United States); P. T. C. So, Singapore-MIT Alliance for Research and Technology (Singapore) and Massachusetts Institute of Technology (United States)
- 7903 1Q **Two-photon autofluorescence spectroscopy of oral mucosa tissue** [7903-58]
K. Edward, T. Shilagard, S. Qiu, G. Vargas, The Univ. of Texas Medical Branch (United States)
- 7903 1R **Single-wavelength STED microscope** [7903-59]
S. C. Baer, Consultant (United States)

SESSION 9 TECHNOLOGY DEVELOPMENT AND APPLICATIONS III

- 7903 1V **Multimodal nonlinear optical imaging of obesity-induced liver steatosis and fibrosis** [7903-63]
J. Lin, F. Lu, W. Zheng, National Univ. of Singapore (Singapore); D. C. S. Tai, Institute of Bioengineering and Nanotechnology (Singapore); H. Yu, Institute of Bioengineering and Nanotechnology (Singapore) and National Univ. of Singapore (Singapore); C. Sheppard, Z. Huang, National Univ. of Singapore (Singapore)

7903 1W **Time-resolved fluorescence microscopy to study biologically related applications using sol-gel derived and cellular media** [7903-64]
M. Toury, HORIBA Jobin Yvon IBH Ltd. (United Kingdom); L. Chandler, HORIBA Scientific, Inc. (United States); A. Allison, D. Campbell, D. McLoskey, HORIBA Jobin Yvon IBH Ltd. (United Kingdom); A. S. Holmes-Smith, Glasgow Caledonian Univ. (United Kingdom); G. Hungerford, HORIBA Jobin Yvon IBH Ltd. (United Kingdom)

7903 1X **Enhanced eumelanin emission by stepwise three-photon excitation** [7903-65]
J. Kerimo, Northeastern Univ. (United States); M. Rajadhyaksha, Memorial Sloan-Kettering Cancer Ctr. (United States); C. A. DiMarzio, Northeastern Univ. (United States)

SESSION 10 FLIM, FRET, FCS MICROSCOPY I

7903 20 **Simultaneous fluorescence and phosphorescence lifetime imaging (Invited Paper)** [7903-68]
W. Becker, B. Su, A. Bergmann, Becker & Hickl GmbH (Germany); K. Weisshart, O. Holub, Carl Zeiss MicroImaging GmbH (Germany)

7903 21 **Multiwavelength FLIM: new applications and algorithms (Invited Paper)** [7903-69]
A. Rück, D. Strat, F. Dolp, Institute for Laser Technologies in Medicine and Metrology (Germany); B. von Einem, C. A. F. von Arnim, Univ. Ulm (Germany)

7903 22 **Determination of calcium concentrations in cells and tissue with fluorescence lifetime imaging: (FLIM)** [7903-71]
T. Gensch, Forschungszentrum Jülich GmbH (Germany); M. Wirth, RWTH Aachen (Germany)

7903 23 **Mapping intracellular viscosity by advanced fluorescence imaging of molecular rotors in living cells** [7903-72]
P.-H. Chung, J. A. Levitt, King's College London (United Kingdom); M. K. Kuimova, Imperial College London (United Kingdom); G. Yahiglu, Imperial College London (United Kingdom) and PhotoBiotics Ltd. (United Kingdom); K. Suhling, King's College London (United Kingdom)

7903 24 **Determination of the stoichiometry, structure, and distribution in living cells of protein complexes from analysis of single-molecular-complexes FRET** [7903-73]
M. R. Stoneman, S. Patowary, M. T. Roesch, D. R. Singh, V. Strogolov, J. A. Oliver, V. Raicu, Univ. of Wisconsin-Milwaukee (United States)

7903 25 **Bayesian analysis of fluorescence lifetime imaging data** [7903-74]
M. I. Rowley, King's College London (United Kingdom); P. R. Barber, King's College London (United Kingdom) and Univ. of Oxford (United Kingdom); A. C. C. Coolen, King's College London (United Kingdom); B. Vojnovic, King's College London (United Kingdom) and Univ. of Oxford (United Kingdom)

SESSION 11 FLIM, FRET, FCS MICROSCOPY II

7903 26 **Laser-induced photobleaching of NAD(P)H fluorescence components in cardiac cells resolved by linear unmixing of TCSPC signals (Invited Paper)** [7903-75]
A. Chorvatova, A. Mateasik, D. Chorvat, Jr., International Laser Ctr. (Slovakia)

- 7903 28 **Drug transport mechanism of P-glycoprotein monitored by single molecule fluorescence resonance energy transfer** [7903-77]
S. Ernst, Univ. of Stuttgart (Germany); B. Verhalen, Upstate Medical Univ. (United States); N. Zarrabi, Univ. of Stuttgart (Germany); S. Wilkens, Upstate Medical Univ. (United States); M. Börsch, Univ. of Stuttgart (Germany)
- 7903 29 **Measuring the diffusion of fluorophores in human skin by two-photon fluorescence correlation spectroscopy combined with measurements of point spread function** [7903-78]
S. Guldbrand, C. Simonsson, M. Goksör, M. Smedh, M. B. Ericson, Univ. of Gothenburg (Sweden)
- 7903 2A **Two-photon phosphorescence lifetime microscopy (2PLM) for high resolution imaging of oxygen** [7903-79]
L. E. Sinks, E. Roussakis, Univ. of Pennsylvania (United States); S. Sakadžić, Massachusetts General Hospital (United States); G. P. Robbins, D. A. Hammer, Univ. of Pennsylvania (United States); A. Devor, Univ. of California, San Diego (United States); D. A. Boas, Massachusetts General Hospital (United States); S. A. Vinogradov, Univ. of Pennsylvania (United States)
- 7903 2B **A multispectral FLIM tomograph for in-vivo imaging of skin cancer** [7903-80]
C. B. Talbot, R. Patalay, I. Munro, Imperial College London (United Kingdom); H. G. Breunig, K. König, JenLab GmbH (Germany); Y. Alexandrov, S. Warren, Imperial College London (United Kingdom); A. Chu, Imperial College Healthcare NHS Trust (United Kingdom); G. W. Stamp, The Royal Marsden Hospital NHS Trust (United Kingdom); M. A. A. Neil, P. M. W. French, C. Dunsby, Imperial College London (United Kingdom)
- 7903 2C **Using adaptive optics for deep in-vivo multiphoton FLIM** [7903-81]
S. Poland, G. Fruhwirth, T. Ng, S. Ameer-beg, King's College London (United Kingdom)
- 7903 2D **A STED-FLIM microscope applied to imaging the natural killer cell immune synapse** [7903-82]
M. O. Lenz, A. C. N. Brown, E. Aukorius, D. M. Davis, C. Dunsby, M. A. A. Neil, P. M. W. French, Imperial College London (United Kingdom)
- 7903 2E **The HIV-1 Gag precursor induces the recruitment of Vpr oligomers to the plasma membrane as revealed by time-resolved fluorescence imaging** [7903-83]
H. de Rocquigny, D. Dujardin, T. Steffan, P. Didier, Y. Mély, Lab. de Biophotonique et Pharmacologie, CNRS, Univ. de Strasbourg (France)

POSTER SESSION

- 7903 2G **Label-free imaging of human breast tissues using coherent anti-Stokes Raman scattering microscopy** [7903-85]
Y. Yang, The Methodist Hospital Research Institute (United States); L. Gao, The Methodist Hospital Research Institute (United States) and Rice Univ. (United States); Z. Wang, The Methodist Hospital Research Institute (United States); M. J. Thrall, The Methodist Hospital (United States); P. Luo, The Methodist Hospital Research Institute (USA); K. K. Wong, The Methodist Hospital Research Institute (United States) and The Methodist Hospital (United States); S. T. C. Wong, The Methodist Hospital Research Institute (United States), The Methodist Hospital (United States), and Rice Univ. (United States)

- 7903 2H **Photo-induced cell damage analysis for multi-focus CARS microscopy** [7903-86]
T. Minamikawa, Y. Murakami, N. Matsumura, H. Niioka, S. Fukushima, T. Araki, M. Hashimoto, Osaka Univ. (Japan)
- 7903 2I **Raman spectroscopy: a powerful tool for the non-contact discrimination of bone marrow mesenchymal stem cells and fibroblasts** [7903-87]
M. Pudlas, S. Koch, Fraunhofer IGB (Germany) and Univ. of Stuttgart (Germany); C. Bolwien, Fraunhofer IPM (Germany); T. Hirth, Fraunhofer IGB (Germany) and Univ. of Stuttgart (Germany); H. Walles, Fraunhofer IGB (Germany) and Julius-Maximilians Univ. Würzburg (Germany); K. Schenke-Layland, Fraunhofer IGB (Germany)
- 7903 2J **Broadband coherent Raman imaging for multiplexed detection** [7903-88]
B. Littleton, F. Festy, S. Ameer-Beg, D. Richards, King's College London (United Kingdom)
- 7903 2L **A femtosecond stimulated Raman loss (fsRL) microscope for highly sensitive bond-selective imaging** [7903-90]
D. Zhang, M. N. Slipchenko, S. Yue, J. Li, J.-X. Cheng, Purdue Univ. (United States)
- 7903 2P **Multiphoton endoscopy based on a mode-filtered single-mode fiber** [7903-95]
S. Moon, G. Liu, Beckman Laser Institute (United States); Z. Chen, Beckman Laser Institute (United States) and Univ. of California, Irvine (United States)
- 7903 2S **Novel nanocarriers for topical drug delivery: investigating delivery efficiency and distribution in skin using two-photon microscopy** [7903-98]
V. Kirejev, S. Guldbrand, B. Bauer, M. Smedh, M. B. Ericson, Univ. of Gothenburg (Sweden)
- 7903 2T **Compact ultrafast semiconductor disk laser for nonlinear imaging in living organisms** [7903-99]
R. Aviles-Espinosa, ICFO - Instituto de Ciencias Fotónicas (Spain); G. Filippidis, Foundation for Research and Technology-Hellas (Greece); C. Hamilton, Solus Technologies Ltd. (United Kingdom) and M Squared Lasers Ltd (United Kingdom); G. Malcolm, M Squared Lasers Ltd. (United Kingdom); K. J. Weingarten, Time-Bandwidth-Products (Switzerland); T. Südmeyer, Y. Barbarin, U. Keller, ETH Zurich (Switzerland); D. Artigas, ICFO - Instituto de Ciencias Fotónicas (Spain) and Univ. Politècnica de Catalunya (Spain); P. Loza-Alvarez, ICFO - Instituto de Ciencias Fotónicas (Spain)
- 7903 2V **Two-photon excitation STED-CW microscopy** [7903-101]
P. Bianchini, Italian Institute of Technology (Italy) and Univ. of Genoa (Italy); B. Harke, Italian Institute of Technology (Italy); S. Galiani, A. Diaspro, Italian Institute of Technology (Italy) and Univ. of Genoa (Italy)
- 7903 2W **Two-photon fluorescence excitation within a light sheet based microscopy architecture (Best Poster Award)** [7903-102]
F. Cella Zanacchi, Italian Institute of Technology (Italy) and Univ. of Genoa (Italy); Z. Lavagnino, M. Pesce, F. Difato, Italian Institute of Technology (Italy); E. Ronzitti, Univ. of Genoa (Italy); A. Diaspro, Italian Institute of Technology (Italy) and Univ. of Genoa (Italy)

- 7903 2Y **Characterization of third-degree burned skin by nonlinear microscopy technique** [7903-104]
M. O. dos Santos, Instituto de Pesquisas Energéticas e Nucleares (Brazil); V. B. Pelegati, C. L. Cesar, Univ. Estadual de Campinas (Brazil); P. R. Correa, Instituto de Pesquisas Energéticas e Nucleares (Brazil); T. M. T. Zorn, Univ. de São Paulo (Brazil); D. M. Zezell, Instituto de Pesquisas Energéticas e Nucleares (Brazil)
- 7903 2Z **Diagnosing hepatocellular carcinoma with the intensity and the lifetime of two-photon red autofluorescences** [7903-105]
T.-M. Liu, C.-T. Hsieh, Y.-S. Chen, F.-L. Huang, National Taiwan Univ. (Taiwan); H.-Y. Huang, W.-J. Lee, National Taiwan Univ. Hospital (Taiwan); C.-T. Kung, C.-K. Sun, National Taiwan Univ. (Taiwan)
- 7903 30 **Fast algorithms for the analysis of spectral FLIM data** [7903-106]
I. Gregor, Georg-August-Univ. (Germany); B. Krämer, F. Koberling, R. Erdmann, PicoQuant GmbH (Germany); J. Enderlein, Georg-August-Univ. (Germany); M. Wahl, PicoQuant GmbH (Germany); S. Fore, PicoQuant Photonics North America, Inc. (United States)
- 7903 31 **Proposal of a new method to measure FRET quantitatively in living or fixed biomedical specimens on a laser microscope** [7903-107]
P. J. Helm, O. P. Ottersen, Univ. of Oslo (Norway)
- 7903 34 **The increase of NADH fluorescence lifetime is associated with the metabolic change during osteogenic differentiation of human mesenchymal stem cells (hMSCs) (Best Poster Award)** [7903-110]
H. W. Guo, J. S. Yu, S. H. Hsu, National Yang-Ming Univ. (Taiwan); Y. H. Wei, National Yang-Ming Univ. (Taiwan) and Mackay Medical College (Taiwan); O. K. Lee, H. W. Wang, National Yang-Ming Univ. (Taiwan)
- 7903 38 **Visualization of heat propagation in biological tissues with two-photon fluorescence microscopy (Best Poster Award)** [7903-115]
C.-Y. Yang, C.-S. Liao, Y.-Y. Tzeng, S.-W. Chu, National Taiwan Univ. (Taiwan)
- 7903 39 **Two-photon excitation in life sciences: neurotransmitter and fluorescence uncaging** [7903-117]
F. Bolze, J.-F. Nicoud, Lab. de Biphotonique et Pharmacologie, CNRS, Univ. de Strasbourg (France); S. Gug, S. Charon, Lab. de Biphotonique et Pharmacologie, CNRS, Univ. de Strasbourg (France) and Lab. de Conception et Application de Molécules Bioactives, CNRS, Univ. de Strasbourg (France); A. Specht, M. Goeldner, D. Warther, Lab. de Conception et Application de Molécules Bioactives, CNRS, Univ. de Strasbourg (France); X.-H. Sun, Lab. de Biphotonique et Pharmacologie, CNRS, Univ. de Strasbourg (France); P. Kessler, Y. Lutz, J.-L. Vonesch, Institut de Genetique et Biologie Moleculaire et Cellulaire (France); A. Losonczy, Columbia Univ. (United States)
- 7903 3A **Extracting quantitative biomechanical parameters for cartilage from second harmonic generation images** [7903-119]
M. B. Lilledahl, Norwegian Univ. of Science and Technology (Norway); D. M. Pierce, Graz Univ. of Technology (Austria); T. Ricken, Univ. of Duisburg-Essen (Germany); G. A. Holzapfel, Graz Univ. of Technology (Austria) and Royal Institute of Technology (Sweden); C. de Lange Davies, Univ. of Duisburg-Essen (Germany)

- 7903 3B **Delivery and characterization of sub-8fs laser pulses at the imaging plane of a two-photon microscope** [7903-120]
D. Pestov, B. Xu, H. Li, Biophotonic Solutions, Inc. (United States); M. Dantus, Biophotonic Solutions, Inc. (United States) and Michigan State Univ. (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

Ammasi Periasamy, University of Virginia (United States)

Karsten König, JenLab GmbH (Germany)

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

Program Committee

Wolfgang Becker, Becker & Hickl GmbH (Germany)

Keith M. Berland, Emory University (United States)

Guy C. Cox, The University of Sydney (Australia)

Alberto Diaspro, Università degli Studi di Genova (Italy)

Chen-Yuan Dong, National Taiwan University (Taiwan)

Dennis Donley, Olympus America, Inc. (United States)

Kevin W. Elliceiri, University of Wisconsin-Madison (United States)

Scott E. Fraser, California Institute of Technology (United States)

Paul M. W. French, Imperial College London (United Kingdom)

Hans C. Gerritsen, Utrecht Universiteit (Netherlands)

Min Gu, Swinburne University of Technology (Australia)

Stefan W. Hell, Max-Planck-Institut für biophysikalische Chemie
(Germany)

Brian A. Herman, The University of Texas Health Science Center at San
Antonio (United States)

Satoshi Kawata, Osaka University (Japan)

Arnd K. Krueger, Newport Spectra-Physics (United States)

Joseph R. Lakowicz, University of Maryland School of Medicine
(United States)

Stephen M. McDonald, Coherent, Inc. (United States)

Simon C. Watkins, University of Pittsburgh (United States)

Paul W. Wiseman, McGill University (Canada)

Sunney X. Xie, Harvard University (United States)

Bernhard Zimmermann, Carl Zeiss Jena GmbH (Germany)
Warren R. Zipfel, Cornell University (United States)

Session Chairs

Keynote Session

Ammasi Periasamy, University of Virginia (United States)

- 1 Second Harmonic Generation I
Paul J. Campagnola, University of Wisconsin-Madison (United States)
- 2 Second Harmonic Generation II
Chen-Yuan Dong, National Taiwan University (Taiwan)
- 3 Technology Development and Applications I
Francesco S. Pavone, Università degli Studi di Firenze (Italy)
- 4 Raman/CARS Microscopy I
Sunney X. Xie, Harvard University (United States)
- 5 Raman/CARS Microscopy II
Eric O. Potma, University of California, Irvine (United States)
- 6 Raman/CARS Microscopy III
Ji-Xin Cheng, Purdue University (United States)
- 7 Raman/CARS Microscopy IV
Annika M. Enejder, Chalmers University of Technology (Sweden)
- 8 Technology Development and Applications II
Peter T. C. So, Massachusetts Institute of Technology (United States)
- 9 Technology Development and Applications III
Paolo Bianchini, Istituto Italiano di Tecnologia (Italy)
- 10 FLIM, FRET, FCS Microscopy I
Alzbeta Chorvatova, International Laser Center (Slovakia)
- 11 FLIM, FRET, FCS Microscopy II
Karsten König, JenLab GmbH (Germany)

Poster Session

Holly L. Aaron, University of California, Berkeley (United States)
Aisada A. Uchugonova, Universität des Saarlandes (Germany)
Vladimir Ghukasyan, University of North Carolina Chapel Hill
(United States)
Christian W. Freudiger, Harvard University (United States)

Introduction

We started this conference in 2001 and for a few years the total number of abstracts on the average was about 45. As we enter into the 11th year of the conference, the abstract total numbers grown to 120. This is possible because of various factors including great interest in the multi-photon excitation fluorescence microscopy, technology advances in lasers, optics and support and encouragement from various sponsors (vendors) of the conference, and more importantly transformation of the multiphoton technology from bench to bed.

The multiphoton microscopy has been established as the 3-D imaging method of choice for studying biomedical specimens from single cells to whole animals with sub-micron resolution. Two decades have past since the realization of two-photon microscopy, and the ever-expanding scope of applications and the continuing instrumental innovations require a forum where new ideas can be exchanged and presented. Our conference in the SPIE BIOS2011 meeting continues to address this need. In this year, the conference enjoys the participation of four keynote presentations from leaders of our field including Professors Paras Prasad, Watt Webb, Colin Sheppard, and Karsten König. It is a particular pleasure to have Professor Webb returning to the conference who has given one of the first keynote talks of this conference.

These proceedings allows the presenters to provide a more in-depth discussion of their subject. Some of the most valuable contributions in this volume are articles written by highly experienced practitioners of multi-photon microscopy. They have enumerated the most important considerations in designing multi-photon microscopes and the imaging experiments. Further, updates on the state-of-the-art commercial multi-photon microscope systems are presented. This volume also includes articles describing some recent advances in major multi-photon microscope components such as the laser light source and the ultra-fast optics.

While the basic physical principles underlying multi-photon microscopy are well understood, the application of this method to biological systems has its unique challenges in biomedical optics and photophysics. Work in this area includes the characterization of the two-photon point spread function in turbid medium and development of new methods to quantify two-photon cross sections in chromophores. Realizing that the incorporation of spectroscopy techniques is critical for extracting quantitative information from specimens, a number of novel spectroscopy techniques based on multi-photon microscopy have been developed. New multi-photon methods have incorporated novel contrast mechanisms such as SRS and CARS, quantitative emission spectroscopy, fluorescence resonance energy transfer, fluorescence correlation spectroscopy and second and third harmonic generation microscopy for acquisition of dynamic information in biological systems.

A number of presentations in this conference have demonstrated that multi-photon imaging is a promising method for single molecular spectroscopy investigations. Single molecular studies using multi-photon fluorescence correlation spectroscopy techniques were presented. Multi-photon imaging methods based on second and third harmonic generation were described. In addition to the development in instrumentation and optics, this volume also contains a number of exciting articles on the use of two-photon microscopy in cell biological studies. Particularly important areas including FRET and FLIM imaging. Many papers were presented are on the use of multi-photon microscopy for the study of tissue physiology and pathology utilizing the long tissue penetration depth of this technique with major impact on many subfields of medicine. Finally, the impact of multiphoton imaging on biotechnology also cannot be underestimated.

A series of excellent papers in this proceeding over the past decade is a sign of the vitality in the multi-photon microscopy field. We have deliberately avoided mentioning any author by name because we believe that it would be inappropriate for us to direct the readers to any particular paper(s). As the field progress, controversies and conflicts among researchers in this field are unavoidable. We believe that this series of proceeding papers should serve as a forum where the authors can voice controversial opinions. Unlike archival journal papers, the editors of this proceeding series intentionally leave in controversial papers. It should be noted that the publication of these papers in this proceeding do not imply the scientific approval of the editors or SPIE as an organization. Further, we believe that this series should serve as a forum for civilized scientific idea of exchange in various technology development and applications. The editors reserve the right to reject any paper without a primary goal of disseminating scientific or engineering knowledge or that is deem to bleach the necessary civility.

On a personal note, the conference chairs are grateful for the participation of all authors, and acknowledge the vendors (Becker & Hickl GmbH, Boston Electronics, Chroma Technology, Coherent, Jen Lab GmbH, Leica Microsystems, MultiPhoton Laser Technologies, Newport-Spectra Physics, Omega Optical, and Semrock) for their enthusiastic support in organizing this conference successfully for the last 11 years. We look forward to other exciting conferences in the second decade and welcome your continued participation and support.

**Ammasi Periasamy
Karsten König
Peter T. C. So**

Acknowledgments

www.multiphotonlasertechnologies.com

Becker & Hickl GmbH

www.becker-hickl.com

www.omegafilters.com

www.leica-microsystems.com

www.jenlab.de

www.chroma.com

www.coherent.com

www.boselec.com

www.newport.com

www.semrock.com