

PROGRESS IN BIOMEDICAL OPTICS AND IMAGING
Vol. 10, No. 45

Diffuse Optical Imaging II

Rinaldo Cubeddu
Andreas H. Hielscher
Editors

14–17 June 2009
Munich, Germany

Sponsored and Published by
Optical Society of America (United States)
SPIE

Cooperating Organisation
German Biophotonics Research Program (Germany)

Cosponsored by
Photonics4Life—European Network of Excellence for Biophotonics
Air Force Office of Scientific Research (United States)

Volume 7369

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 *Diffuse Optical Imaging II*, edited by Rinaldo Cubeddu, Andreas H. Hielscher, Proceedings of SPIE-OSA Biomedical Optics Vol. 7369 (SPIE, Bellingham, WA, 2009) Article CID Number.

ISSN 1605-7422
ISBN 9780819476456

Copublished 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
and
Optical Society of America
2010 Massachusetts Ave., N.W., Washington, D.C., 20036 USA
Telephone 1 202/223-8130 (Eastern Time) · Fax 1 202/223-1096
<http://www.osa.org>

Copyright © 2009, Society of Photo-Optical Instrumentation Engineers and Optical Society of America.

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 the publishers 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 1605-7422/09/\$18.00.

Printed in the United States of America.

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



Paper Numbering: Proceedings of SPIE-OSA Biomedical Optics 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. In this six-digit CID article numbering system:

- The first four digits correspond to the 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

BRAIN IMAGING AND SPECTROSCOPY

- 7369 03 **Intra- and extra-cortical activation during a working memory task assessed by time-resolved near-infrared spectroscopy (fNIRS)** [7369-04]
E. Molteni, A. M. Bianchi, G. Baselli, M. Caffini, D. Contini, Politecnico di Milano (Italy); L. Spinelli, ULTRAS-INFM-CNR, National Lab. for Ultrafast and Ultraintense Optical Science (Italy); A. Torricelli, S. Cerutti, Politecnico di Milano (Italy); R. Cubeddu, Politecnico di Milano (Italy), ULTRAS-INFM-CNR, National Lab. for Ultrafast and Ultraintense Optical Science (Italy), and IFN-CNR Institut di Fotonica e Nanotecnologie (Italy)
- 7369 05 **Combining near-infrared spectroscopy with electroencephalography and repetitive transcranial magnetic stimulation** [7369-09]
T. Näsi, K. Kotilahti, H. Mäki, Helsinki Univ. of Technology (Finland) and BioMag Lab., HUSLAB, Helsinki Univ. Central Hospital (Finland); I. Nissilä, P. Meriläinen, Helsinki Univ. of Technology (Finland)

THEORETICAL ANALYSIS AND MODELING I

- 7369 0B **Reconstruction of fluorophore distribution for fluorescence diffuse tomography based on hybrid model** [7369-38]
I. Fiks, M. Kirillin, E. Sergeeva, M. Kleshnin, I. Turchin, Institute of Applied Physics (Russian Federation)
- 7369 0C **3D modeling for solving forward model of no-contact fluorescence diffuse optical tomography method** [7369-36]
F. Nouizi, R. Chabrier, LINC, Univ. de Strasbourg, CNRS (France); M. Torregrossa, LSIIT, Univ. de Strasbourg, CNRS (France); P. Poulet, LINC, Univ. de Strasbourg, CNRS (France)

THEORETICAL ANALYSIS AND MODELING II

- 7369 0E **A multilevel and multigrid optical tomography based on radiative transfer equation** [7369-24]
H. Gao, H. Zhao, Univ. of California, Irvine (United States)
- 7369 0F **Light diffusion in N-layered turbid media** [7369-37]
A. Liemert, A. Kienle, ILM, Univ. Ulm (Germany)
- 7369 0G **Rapid convergence to the inverse solution regularized with Lorentzian distributed function for NIR DOT** [7369-45]
M.-C. Pan, Tungnan Univ. (Taiwan); M.-C. Pan, Institute of Biomedical Engineering, National Central Univ. (Taiwan)

- 7369 0H **Hybrid theoretical approach for modeling the whole-space distribution of scattered light** [7369-28]
E. A. Sergeeva, M. Yu. Kirillin, Institute of Applied Physics (Russian Federation)
- 7369 0I **Nonlinear color segmentation of optical diffusion tomograms reconstructed by the photon average trajectory method** [7369-53]
A. B. Konovalov, V. V. Vlasov, D. V. Mogilenskikh, I. V. Pavlov, Russian Federal Nuclear Ctr., Zababakhin Inst. of Applied Physics (Russian Federation)

IMAGING OF BREAST AND OTHER ORGANS

- 7369 0P **Quantitative assessment of ischemia and reactive hyperemia of the dermal layers using multi-spectral imaging on the human arm** [7369-23]
J. M. Kainerstorfer, Eunice Kennedy Shriver National Institute of Child Health and Human Development (United States) and Ctr. for Biomedical Engineering and Physics, Medical Univ. of Vienna (Austria); F. Amyot, National Institutes of Neurological Disorders and Stroke (United States); S. G. Demos, Lawrence Livermore National Lab. (United States); M. Hassan, V. Chernomordik, Eunice Kennedy Shriver National Institute of Child Health and Human Development (United States); C. K. Hitzenberger, Ctr. for Biomedical Engineering and Physics, Medical Univ. of Vienna (Austria); A. H. Gandjbakhche, J. D. Riley, Eunice Kennedy Shriver National Institute of Child Health and Human Development (United States)

EXPERIMENTAL TECHNIQUES I

- 7369 0Q **Structured illumination and time gated detection for diffuse optical imaging** [7369-60]
C. D'Andrea, A. Bassi, National Lab. for Ultrafast and Ultraintense Optical Science, CNR (Italy) and Politecnico di Milano (Italy); G. Valentini, R. Cubeddu, National Lab. for Ultrafast and Ultraintense Optical Science, CNR (Italy) and Politecnico di Milano (Italy); S. Arridge, Ctr. for Medical Image Computing, Univ. College London (United Kingdom)
- 7369 0R **Tomography of brain activation using a time-gated camera** [7369-42]
A. Pifferi, National Lab. for Ultrafast and Ultraintense Optical Science, CNR (Italy) and Politecnico di Milano (Italy); Q. Zhao, Istituto Italiano di Tecnologia (Italy); L. Spinelli, Istituto di Fotonica e Nanotecnologie, CNR (Italy); A. Bassi, National Lab. for Ultrafast and Ultraintense Optical Science, CNR (Italy) and Politecnico di Milano (Italy); G. Valentini, Politecnico di Milano (Italy); D. Contini, A. Torricelli, Istituto Italiano di Tecnologia (Italy) and Politecnico di Milano (Italy); R. Cubeddu, National Lab. for Ultrafast and Ultraintense Optical Science, CNR (Italy) and Politecnico di Milano (Italy)

EXPERIMENTAL TECHNIQUES II

- 7369 0T **Impact of the measurement model deviations on fluorescence diffuse optical tomography** [7369-20]
N. Ducros, CEA, LETI, MINATEC (France) and CREATIS-LRMN, INSERM, CNRS, Univ. de Lyon (France); A. da Silva, Institut Fresnel, Aix-Marseille Univ. CNRS (France); J.-M. Dinten, CEA, LETI, MINATEC (France); F. Peyrin, CREATIS-LRMN, INSERM, CNRS, Univ. de Lyon (France)

- 7369 0U **Mice lung disease follow-up with open-air fluorescence diffuse optical tomography**
[7369-56]
A. Koenig, G. Gonon, L. Hervé, M. Berger, J.-M. Dinten, J. Boutet, CEA, LETI, MINATEC (France); V. Josserand, J.-L. Coll, INSERM, Institut Albert Bonniot (France); P. Peltié, P. Rizo, CEA, LETI, MINATEC (France)
- 7369 0V **Effects of a finite spectral bandwidth light source in time-resolved diffuse spectroscopy**
[7369-54]
A. Farina, A. Bassi, P. Taroni, D. Comelli, L. Spinelli, R. Cubeddu, A. Pifferi, Istituto Italiano di Tecnologia , ULTRAS, INFM, CNR and IFN-CNR, Politecnico di Milano (Italy)

EXPERIMENTAL TECHNIQUES III

- 7369 0Z **Influence of SNR on statistical analysis of spatial extent of brain activation measured by multi-spectral imaging** [7369-47]
N. Sakashita, K. Sakaguchi, S. Matsuo, H. Nakayama, Keio Univ. (Japan); T. Katsura, K. Yamazaki, N. Tanaka, H. Kawaguchi, A. Maki, Hitachi, Ltd. (Japan); E. Okada, Keio Univ. (Japan)
- 7369 10 **Angle-resolved ellipsometric data for selective imaging in scattering media** [7369-51]
C. Amra, J. Sorrentini, L. Arnaud, M. Zerrad, Institut Fresnel, CNRS, Aix-Marseille Univ. (France); P. Tchamitchian, LATP, CNRS, Aix-Marseille Univ. (France); A. da Silva, G. Georges, L. Siozade, C. Deumié, Institut Fresnel, CNRS, Aix-Marseille Univ. (France); P. Léon, C. Levêque, IFREMER (France); F. Chazallet, Shakti (France)
- 7369 11 **Time-resolved optical tissue characterisation: goodness of estimation** [7369-30]
L. Guyon, A. Planat-Chrétien, J.-M. Dinten, CEA, LETI (France)
- 7369 13 **Development of a diffuse optical spectroscopic imaging system for intensive care medicine**
[7369-13]
C.-W. Sun, Biophotonics Interdisciplinary Research Ctr. (Taiwan) and Institute of Biophotonics, National Yang-Ming Univ. (Taiwan); Y.-W. Lin, National Taiwan Univ. (Taiwan); M.-L. Chuang, S.-J. Liang, University Hospital Taipei, China Medical Univ. Hospital (Taiwan); J. Tsai, National Taiwan Univ. (Taiwan); C.-W. Lu, Medical Electronics and Device Technology Ctr., Industrial Technology Research Institute (Taiwan)
- 7369 14 **A new deconvolution technique for time-domain signals in diffuse optical tomography without a priori information** [7369-46]
G. Bodin, Y. Bérubé-Lauzière, Lab. TomOptUS, Univ. de Sherbrooke (Canada)

POSTER SESSION

- 7369 16 **3D light source reconstruction with spatial filter for fluorescence/bioluminescence diffuse optical tomography** [7369-15]
S. Okawa, Y. Yamada, The Univ. of Electro-Communications (Japan)
- 7369 1A **Numerical analysis on propagation of light in turbid media using path-length assigned Monte Carlo simulation** [7369-16]
K. Ishii, The Graduate School for the Creation of New Photonics Industries (Japan); I. Nishidate, T. Iwai, Tokyo Univ. of Agriculture and Technology (Japan)

- 7369 1B **Hybrid heuristic time dependent solution of the radiative transfer equation for the slab**
[7369-48]
F. Martelli, Univ. degli Studi di Firenze (Italy); S. Del Bianco, Univ. degli Studi di Firenze (Italy) and CNR, Istituto di Fisica Applicata Nello Carrara (Italy); A. Pifferi, Politecnico di Milano (Italy), IFN-CNR, Istituto di Fotonica e Nanotecnologie (Italy), and ULTRAS, INFM, CNR, National Lab. for Ultrafast and Ultraintense Optical Science (Italy); L. Spinelli, IFN-CNR, Istituto di Fotonica e Nanotecnologie (Italy); A. Torricelli, Politecnico di Milano (Italy); G. Zaccanti, Univ. degli Studi di Firenze (Italy)
- 7369 1C **Nonlinear fitting procedure for accurate time-resolved measurements in diffusive media**
[7369-10]
L. Spinelli, IFN-CNR, Istituto di Fotonica e Nanotecnologie (Italy); F. Martelli, Univ. degli Studi di Firenze (Italy); A. Torricelli, Politecnico di Milano (Italy); A. Pifferi, IFN-CNR, Istituto di Fotonica e Nanotecnologie (Italy), Politecnico di Milano (Italy), and ULTRAS, INFM, CNR (Italy); G. Zaccanti, Univ. degli Studi di Firenze (Italy)
- 7369 1D **A multichannel time-domain brain oximeter for clinical studies** [7369-22]
D. Contini, Politecnico di Milano (Italy) and ULTRAS, INFM, CNR, National Lab. for Ultrafast and Ultraintense Optical Science (Italy); L. Spinelli, IFN-CNR, Istituto di Fotonica e Nanotecnologie (Italy); M. Caffini, Politecnico di Milano (Italy); R. Cubeddu, Politecnico di Milano (Italy), ULTRAS, INFM, CNR, National Lab. for Ultrafast and Ultraintense Optical Science (Italy), and IFN-CNR, Istituto di Fotonica e Nanotecnologie (Italy); A. Torricelli, Politecnico di Milano (Italy)
- 7369 1G **Measurements of temporal-spatial change in blood flow and volume in exposed cortex of guinea pig evoked by auditory stimulation** [7369-14]
H. Nakayama, K. Sakaguchi, S. Matsuo, N. Sakashita, Keio Univ. (Japan); T. Katsura, K. Yamazaki, N. Tanaka, H. Kawaguchi, A. Maki, Hitachi, Ltd. (Japan); E. Okada, Keio Univ. (Japan)
- 7369 1H **Simultaneously reconstructing fluorescent yield and lifetime from time-resolved transmittances of a small-animal-sized phantom** [7369-29]
F. Gao, Tianjin Univ. (China) and Lab. d'Imagerie et de Neurosciences Cognitives, Univ. de Strasbourg, CNRS (France); L. Zhang, Tianjin Univ. (China); P. Poulet, Lab. d'Imagerie et de Neurosciences Cognitives, Univ. de Strasbourg, CNRS (France); J. Li, H. Zhao, Tianjin Univ. (China); Y. Yamada, Univ. of Electro-Communications (Japan)
- 7369 1I **Effect of size, location, and contrast of tumors to diagnosis limitation of NIR DOI system**
[7369-08]
M.-C. Pan, Tunghnun Univ. (Taiwan); L.-Y. Chen, C.-H. Chen, M.-C. Pan, Institute of Biomedical Engineering, National Central Univ. (Taiwan)
- 7369 1J **Noninvasive optical sensor for tissue spectroscopic** [7369-06]
O. I. Bilyy, R. Ya. Yaremyk, O. Z. Drobchak, National Univ. of L'viv (Ukraine)
- 7369 1K **Non-invasive determination of the optical properties of brain using a neural network**
[7369-32]
M. Jäger, A. Liemert, F. Foschum, A. Kienle, ILM, Univ. Ulm (Germany)

- 7369 1M **Accurate anatomical background model improves reconstruction of absorptive perturbations in optical tomography** [7369-50]
J. Heiskala, Univ. College London (United Kingdom) and BioMag Lab., Helsinki Univ. Central Hospital (Finland); I. Nissilä, Helsinki Univ. of Technology (Finland)
- 7369 1N **Angular domain optical imaging of turbid media using enhanced micro-tunnel filter arrays** [7369-03]
F. Vasefi, Simon Fraser Univ. (Canada) and Lawson Health Research Institute (Canada); B. S. L. Hung, B. Kaminska, G. H. Chapman, Simon Fraser Univ. (Canada); J. J. L. Carson, Lawson Health Research Institute (Canada) and Medical Biophysics, Univ. of Western Ontario (Canada)
- 7369 1O **Effect of source decay in bioluminescence tomography: a phantom study** [7369-05]
H. Yan, M. B. Unlu, O. Nalcioglu, G. Gulsen, Ctr. for Functional Onco-Imaging, Univ. of California, Irvine (United States)
- 7369 1Q **Video-rate near-infrared tomography using spectral analysis for hemodynamic imaging** [7369-35]
M.-C. Pan, National Central Univ. (Taiwan); V. Krishnaswamy, S. Srinivasan, B. W. Pogue, Dartmouth College (United States)

Author Index

Conference Committee

General Chairs

Mary-Ann Mycek, University of Michigan (United States)
Wolfgang Drexler, Cardiff University (United Kingdom)

Program Chairs

Christoph K. Hitzenberger, Medizinische Universität Wien (Austria)
Brian W. Pogue, Dartmouth College (United States)

Conference Chairs

Rinaldo Cubeddu, Politecnico di Milano (Italy)
Andreas H. Hielscher, Columbia University (United States)

Conference Committee

Joseph P. Culver, Washington University (United States)
Anabela da Silva, Institut Fresnel, Aix Marseille Université, CNRS
(France)
Jeremy Hebden, University College London (United Kingdom)

Alwin Kienle, Institut für Lasertechnologien in der Medizin und
Meßtechnik an der Universität Ulm (Germany)

Alexander Klose, Columbia University (United States)
Jens Steinbrink, Charité-Universitätsmedizin (Germany)

Session Chairs

Brain Imaging and Spectroscopy I
Rinaldo Cubeddu, Politecnico di Milano (Italy)

Brain Imaging and Spectroscopy II
Rinaldo Cubeddu, Politecnico di Milano (Italy)

Theoretical Analysis and Modeling I
Alwin Kienle, Institut für Lasertechnologien in der Medizin und
Meßtechnik an der Universität Ulm (Germany)

Theoretical Analysis and Modeling II

Alwin Kienle, Institut für Lasertechnologien in der Medizin und
Meßtechnik an der Universität Ulm (Germany)

Imaging of Breast and Other Organs

Andreas H Hielscher, Columbia University (United States)

Experimental Techniques I

Anabela da Silva, Institut Fresnel, Aix Marseille Université, CNRS
(France)

Jens Steinbrink, Charité-Universitätsmedizin Berlin (Germany)

Experimental Techniques II

Anabela da Silva, Institut Fresnel, Aix Marseille Université, CNRS
(France)

Jens Steinbrink, Charité-Universitätsmedizin Berlin (Germany)

Experimental Techniques III

Anabela da Silva, Institut Fresnel, Aix Marseille Université, CNRS
(France)

Jens Steinbrink, Charité-Universitätsmedizin Berlin (Germany)